CHAPTER 3

Constraints to Oil Shale Commercialization: Policy Options to Address These Constraints

Contents

List of Tables

List of Figures

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Introduction

This chapter describes the requirements for establishing an oil shale industry by 1990, discusses potential constraints to its establishment, and presents policy options to address them, The effects of oil shale development on the physical, social, and economic environments are discussed in this chapter only to the extent that they are obstructions to development, Not all of these effects hinder development, and those not judged to be barriers are not included here, For instance, filling a canyon with spent shale constitutes an irrevocable alteration to the locale's appearance; but does not, by itself, bar development.

The many important issues not identified as constraints are summarized in chapter 1 and dealt with at length in the subsequent chapters. Comprehensive analyses are presented of the economics of oil shale development (ch. 6), and of the effects production could have on the air, land, water, worker health and safety (ch. 8), on regional water availability (ch. 9), and on the social and economic structure of the region's communities (ch. 10). As the next section explains, these considerations all bear on decisions about the future of oil shale, even though they may not be discussed here as barriers to its development.

This chapter is organized as follows:

- Alternative objectives for development are identified. To provide a framework for analysis, production scenarios are presented that might result from pursuing different combinations of these objectives.
- The requirements for investment capital, water, labor, and a favorable combination of marketability and land availability are summarized for the production targets of the scenarios.
- The constraints to achieving the targets are identified.
- Some policies for dealing with the constraints are discussed.
- Given the requirements, constraints, and policies, the scenarios are evaluated with respect to the relative degree they could attain each of the objectives for development.

Approaches to Development

Possible Objectives

Whether, how, and to what extent an oil shale industry should be developed will ultimately be a political decision. The past efforts of diverse groups—Government agencies, private firms, public-interest advocates, and environmental conservationists—to influence public policy on behalf of their goals will undoubtedly continue, These interests have different perceptions about the relative importance of certain basic values. The preferences they show for particular types and rates of development reflect these differences. Some of the varied, and often competing, objectives for development are discussed below.

To position the industry for rapid deployment.—The supporters of this objective acknowledge that more information is needed about oiI shale technologies if production is to be expanded rapidly in times of national need. Many techniques and sites would be required to answer most of the remaining questions about the technical, economic, and environmental implications of full-scale development. Demonstration plants to allow the evaluation of a full spectrum of technologies would be needed. Incentives and additional Federal land might be made available to encourage private sector experiments. All programs would be designed to maximize information generation. Growing international tensions, with the consequent potential for severe disruptions in oil supplies, provide a rationale for this objective.

To maximize domestic energy supplies.—This objective emphasizes the rapid development of a large industry, and has both economic and national security implications. The benefits include reduced reliance on oil imports, improved balance of payments, stimulation of private capital investment, increased employment, and lower energy costs over the long term. Policies supporting this objective emphasize the encouragement of the oil shale industry and the removal of restraints on its establishment. Among these policies might be additional Federal leasing, substantial economic incentives, waiving of environmental laws, and direct Government involvement in the production of shale oil.

To minimize Federal promotion.—This objective is supported by those who oppose Government involvement in the free market and with private enterprise. Other supporters stress that oil shale should not be promoted at the expense of other energy sources. In both cases, the advocates believe the industry should develop in response to traditional market pressures and opportunities and without the active financial participation or support of the Government. Policies that relate to this objective emphasize R&D, with particular attention to technological and environmental uncertainties; this would provide a basis for comparing oil shale with other energy alternatives and for developing regulations. Planning for future programs to mobilize the industry would be carried out; programs such as leasing, land exchanges, and financial incentives would not.

To maximize ultimate environmental information and protection.—The desirability of maintaining the existing environmental quality of the oil shale region and its environs is emphasized by the supporters of this objective. They also believe that oil shale should not be promoted more than other potential energy sources that could be less harmful to the environment. They would prefer that development proceed slowly, if at all, until its potential impacts have been determined and control strategies designed and thoroughly tested. The policies in this case would emphasize the enforcement of existing environmental regulations, the siting of any new plants to minimize their impacts, continued monitoring and R&D to provide information for the promulgation of new regulations, and public education and participation in decisions.

To maximize the integrity of the social environment.-This objective emphasizes personal and community needs. Its supporters would prefer to see a slow but steady developmental pace in order to avoid the potentially disruptive effects of too-rapid growth. Well-planned and coordinated growth management is essential to meet this objective. Policies would stress the involvement of local residents in the growth management process, efforts to avoid exceeding the growth capacities of the communities, the funding of needed community improvements, and the allocation of responsibilities for both growth management and impact mitigation among the oil shale developers, and the local, State, and Federal governments.

To achieve an efficient and cost-effective energy supply system.—Supporters of this objective emphasize the importance of providing a mix of energy alternatives with the best overall ratio of costs to benefits. They stress the need to position the industry and its technologies for long-term profitable operations. Future expansions could then be supported with internally generated financing. The related objectives of efficient development of the resource and balanced environmental and social protection are also emphasized. The proposed pace of development would allow thorough evaluation of the technologies so that the elements of production (land, labor, capital, water, energy, and incremental environmental changes) could be used most efficiently if a large-scale industry were created. Policies would give attention to incentives that left intact a degree of managerial risk, to thorough testing of diverse technologies and sites, and to advanced R&D that would provide a basis for comparing oil shale with its alternatives. These policies would not require a commitment of funds and resources to the exclusion of other potential energy sources.

Possible Futures

The Government, in preparing its policies for oil shale development, is bound to consider and weigh along with others, all of the objectives discussed above. For example, the Government is responsible for protecting the Nation from external threats of interruptions in the supply of essential raw materials like petroleum. This responsibility, when coupled with the Government's ownership of the richest oil shale deposits, would tend to encourage the rapid development of public lands. On the other hand, the public trust requires that these resources be developed with good management practices, with minimum waste and inefficiency, and with equitable treatment of the affected groups and regions. This mandate would lead to a moderate pace of development. Furthermore, the Government is required by its own laws to protect the environment of the oil shale region and to consider the socioeconomic consequences of each of its major actions. These mandates would lead to slow, carefully managed development.

Depending. on the emphasis given to the various development objectives, a number of future industries could be postulated, from none at all, to the production of several million barrels of shale oil per day. Four scenarios, based largely on shale oil production targets for 1990, will be considered as a framework for evaluating the requirements, the effects, and the policy implications of development. These are:

Scenario	Production target of shale oil (bbl/d)
1	100,000
2	200,000
3	400,000
4	1,000,000

Requirements for Development

In order to proceed, each project will need:

- land,
- water,
- adequate mining and processing technologies,
- access to markets,
- a favorable economic outlook,
- investment capital,
- compliance with environmental regulations,
- design and construction services,
- equipment and construction materials,
- construction and operating labor, and
- housing and community services.

The requirements of the scenarios for design and construction services, equipment, capital, water, and labor are shown in table 7. Also shown are the numbers of new residents who will have to be accommodated by the region's communities. Water requirements increase directly with the level of production because the amount each plant will need is independent of the others. Ranges are given because different technologies having different water requirements could be used. Because of the assumptions made about the phasing of construction, the labor requirements do not always increase directly with the level of production. In addition, whereas scenario 4 produces 2.5 times more oil than scenario 3, it requires from 2.5 to 4 times more capital. This cost escalation is attributable to the large demands for labor, materials, and equipment for 1 million bbl/d.

Table 7.–Requirements for the Production Scenarios

Resource	Requirements			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Institutional				
Design and construction services, % of 1978 U.S. capacity needed each year	Minimal	Minimal	12	35
Plant equipment, % of 1978 U S. capacity needed each year	Minimal	Minimal	6-12	15-30
Economic and financial[a]				
Loans, $ billion	$09-1.35	$1,8-2,6	$36-4.2	$90-135
Equity, $ billion	2.1-315	4.2-5.9	84-9,8	21.0-31 5
Total, $ billion	30-4,5	6.0-8,5	12,0 -14,0	30,0 -45.0
Annual, $ billion[b]	06-0,9	1.2-1 7	24-2.8	6.0-9,0
Water availability				
Water, acre-ft/yr[c]	9,800-24,600	19,600-49,200	39,200-98,400	100,000-250,000
Socioeconomic				
Workers	5,600	8,800-11,200	17,600-22,400	44,000-56,000
New residents requiring housing and community services	23,000	41,200-47,200	82,000-95,000	118,000-236,000

[a]Third-quarter 1979 dollars
[b]Maximum annual requirements for a 5-year construction period
[c]Assumes 4900.12300 acre-ft/ yr for production of 50000 bbl/d Of shale oil syncrude
[d]Assumes 1200 construction workers and 1600 operators per 50000-bbl/d plant Multipliers used for total Increase = 2 5 x (construction workers) + 5.5 x (operators) Ranges reflect adjustments In construction work forces assuming phasing of plant construction

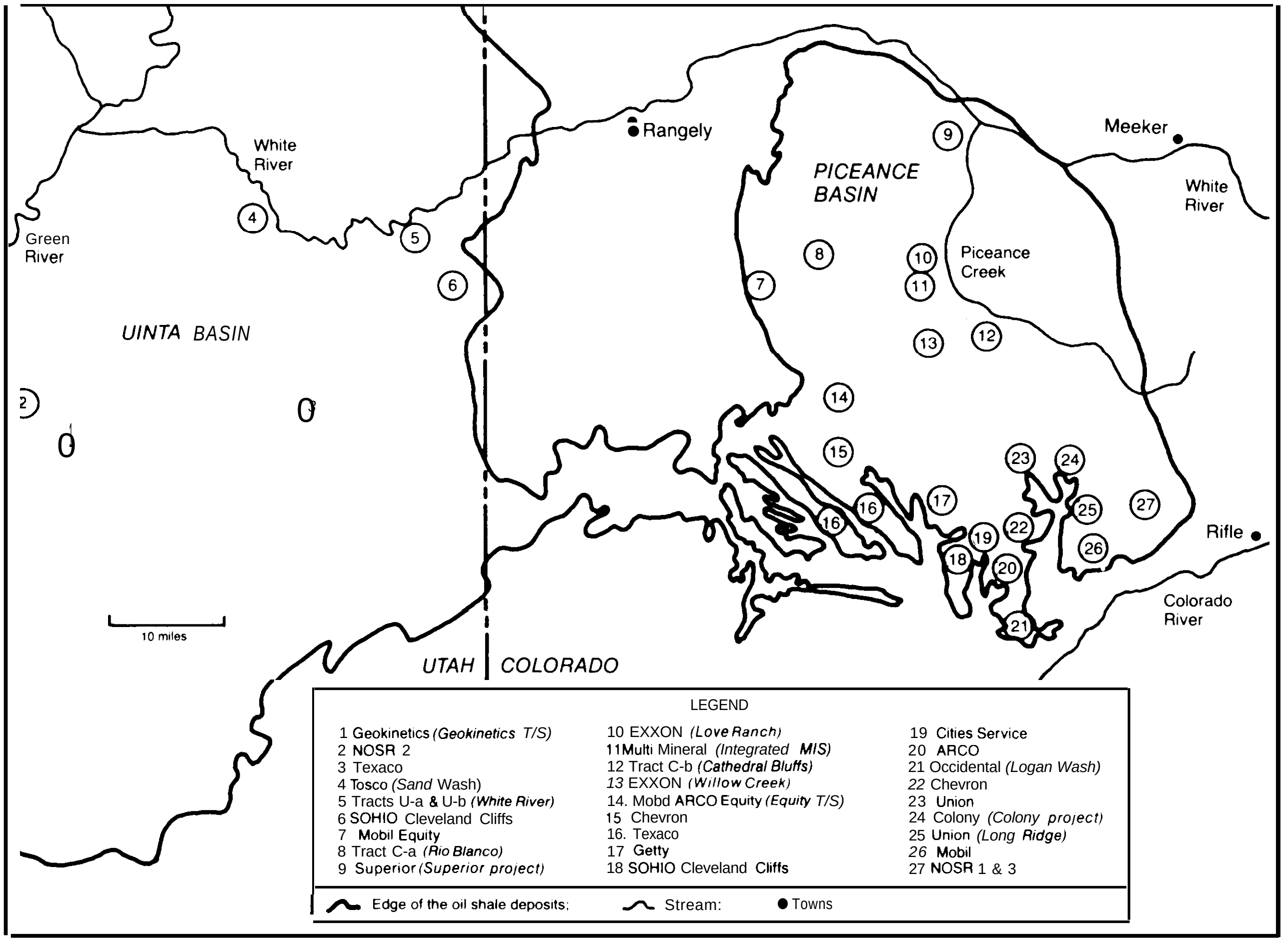
SOURCE Office of Technology Assessment

All projects share certain critical requirements that do not appear in the table. First, permits will have to be obtained. Their number and nature will depend on the project's location, on the technologies used, and on whether the site is privately owned or is controlled by either the Federal Government or a State. In order to obtain the necessary permits, the firm will have to demonstrate its ability to comply with the regulations promulgated under the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, and other laws. Second, each developer must have a transportation system to move the products and byproducts to markets. Third, a project must be economically feasible. That is, market conditions must appear favorable based on reliable cost estimates, contractor services and equipment must be available at reasonable costs, compliance with existing and future regulations must be possible, and the permitting process must not unduly delay a facility's construction and operation. Finally, the developer must have land—either public, private, or a combination of both.

The interrelationship between the requirements for land, marketability, and a conducive regulatory environment can be illustrated by considering how some projects might be combined to achieve the production goals of the scenarios. The locations of tracts on which projects could be sited are shown in figure 10. The ownership of the tracts and the status of their development are shown in table 8. Many other tracts exist that could be developed, thus the list of possible sites in table 8 is far from complete. It does not include any tracts in Wyoming, for example, because no large-scale projects have been proposed for that State. The only State-owned land shown is the tract leased for the Sand Wash project. Utah has additional land that could be leased. Also, the federally owned tracts shown total only about 160,000 acres—roughly 3 percent of the public's oil shale land in Colorado and Utah.

In table 9, potential projects on these tracts are combined in alternative ways to reach the production targets of the scenarios. The projects are assigned to four categories: active projects, suspended projects, projects needing additional Federal land, and projects on other private tracts. Three alternatives are shown for scenarios 1 and 2. The first alternative represents the completion and possible extension of presently active projects. In the second, it is assumed that two presently active projects are canceled, leaving a production shortfall. This is eliminated

Figure 10.—Some Present and Potential Oil Shale Development Sites in Colorado and Utah



SOURCE Office of Technology Assessment

by the reactivation of presently suspended projects in response to substantial improvements in the economic and regulatory climate. In the third alternative, the shortfall is eliminated by the commitment of additional Federal land. Only two alternatives are shown for scenarios 3 and **4.** The first incorporates the completion and extension of present projects and the development of new projects on private land, in response to favorable economic and regulatory conditions. The second alternative assumes that less favorable conditions exist, but that Federal land is made available.

In structuring the alternatives it has been postulated that the more advanced projects will respond to improved conditions before the less advanced. However, it should be understood that the industry patterns shown are in part arbitrary, and probably extreme in some cases. For example, the scenario 4 alternatives require either new projects on private land or new Federal tracts. In reality, an industry created under this scenario would more likely involve both types of land. Also, the combinations of projects shown are only illustrative; they do-not represent the recommendations of specific developers, technologies, projects, sites, or policies.

Table 8.–Some Potential Oil Shale Development Sites in Colorado and Utah

Site	Location	Ownership	Developer	Project title	Status	Announced production target[b]
1	Utah	State	Geokinetics	Geokinetics TIS	Small-scale field tests underway of TIS method	At least 2,000 bbl/d
2	Utah	Federal[a]	Navy/DOE	NOSR 2	No development,	None
3	Utah	Private	Texaco	None	No development,	None
4	Utah	State	Tosco	Sand Wash	Baseline monitoring and mine planning underway,	50,000 bbl/d
5	Utah	Federal[c]	Phillips/Sundeco/ SOHIO (tracts U-a & U-b)	White River	Suspended pending resolution of land-ownership issue.	100,000 bbl/d
6	Utah	Private	SOHIO/Cleveland Cliffs	None	No development,	None
7	Colorado	Private	Mobil/Equity	None	No development,	None
8	Colorado	Federal[c]	Standard of Indiana/Gulf (tract C-a)	Rio Blanco	Preparing for MIS retort demonstration,	76,000 bbl/d
9	Colorado	Private	Superior Oil	Superior	Suspended pending approval of land exchange proposal.	11,500 bbl/d
10	Colorado	Federal	EXXON	Love Ranch	Proposal submitted for land exchange,	60,000 bbl/d
11	Colorado	Federal	Multi Mineral	Integrated MIS	Negotiations begun for use of USBM mine shaft	,50,000 bbl/d
12	Colorado	Federal[c]	Occidental/Tenneco (tract C-b)	Cathedral Bluffs	Preparing for MIS retort demonstration.	57,000 bbl/d
13	Colorado	Federal	EXXON	Willow Creek	Proposal submitted for land exchange,	None
14	Colorado	Private	Mobil/ARCO/Equity	BX	Small-scale field tests underway of Equity's TIS method,	None
15	Colorado	Private	Chevron	None	No development.	None
16	Colorado	Private	Texaco	None	No development.	None
17	Colorado	Private	Getty	None	No development.	None
18	Colorado	Private	SOHIO/Cleveland Cliffs	None	No development,	None
19	Colorado	Private	Cities Service	None	No development,	None
20	Colorado	Private	ARCO	None	No development,	None
21	Colorado	Private	Occidental	Logan Wash	Small-scale field tests of Oxy's MIS technique. Results will support Cathedral Bluffs project.	Few hundred bbl/d
22	Colorado	Private	Chevron	None	No development.	None
23	Colorado	Private	Union	None	No development,	None
24	Colorado	Private	Colony Development	Colony	Suspended because of economic and regulatory uncertainty,	46,000 bbl/d
25	Colorado	Private	Union	Long Ridge	Suspended because of economic and regulatory uncertainty,	75,000-150,000 bbl/d
26	Colorado	Private	Mobil	None	No development,	None
27	Colorado	Federal[a]	Navy/DOE	NOSR 1 & 3	Development management plan being prepared,	None

[a]Naval Oil Shale Reserve
[b]Based on developers preliminary plans
[c]Leased under the Federal Prototype 011 Shale Leasing Program

SOURCE Office of Technology Assessment

Constraints to Development

The factors that will hinder or even prevent reaching the production goals of the OTA scenarios are shown in table 10. They were identified by analyzing the scenario requirements, given the present state of knowledge and the current regulatory structure. Constraints judged to be "moderate" will hamper, but not necessarily preclude, development; those judged to be "critical" could become major barriers. When it was inconclusive whether or to what extent certain factors would impede development, they were called "possible" constraints. Only those that could be addressed by Federal action are shown.

Each potential constraint is important by itself, but the combined effect that more than one might have on a scenario's realization should also be considered. Thus, a moderate restriction on the availability of land together with one on permitting could preclude investor participation. Similarly, an inadequate community water supply for the workers and their families coupled with a moderate restriction on the availability of water for a project could become a critical constraint.

Table 9. –Some Production Alternatives for the Scenarios (barrels of shale oil per day)

	Scenario 1 alternatives			Scenario 2 alternates			Scenario 3 alternatives		Scenario 4 alternates	
Possible projects	1-A	1-B	1-C	2-A	2-B	2-C	3-A	3-B	4-A	4-B
Active projects										
Rio Blanco	76,000	—	—	76,000	—	—	76,000	I 50,000"	76,000	150,000'
Cathedral Bluffs	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	57,000	100,000
Sand Wash	50,000	—	—	50,000	—	—	50,000		50,000	50,000
Geokinetics	2,000	2,000	2,000		2,000	2,000		2,000		
Equity BX	—	—	— }	17000	—	. }	21,000	- }	20,000	40,000
Suspended projects										
Union Long Ridge						—	150,000	—	150,000	150,000
Colony	+ }	41,000	:	}	141,000	—	46,000		46,000	46,000
White River	—	—		—	—	—	—		100,000	100,000
Projects needing more Federal land										
Superior		—	11,500		—	11,500	—	11,500	—	11,500
Multi Mineral	—	—		—	—	50,000		50,000	—	50,000
EXXON Love Ranch		—			—	60,000		60,000		60,000
EXXON Willow Creek					—					
NOSR 1	—	—	29,500	—	—		—		}	
NOSR 2					—	19,500	—	69,500		242,000
New lease tracts	—	—			—		—		—	
Other private tracts	—	—		—	—		—	—	501,000	–
Total	185,000	100,000	100,000	200,000	200.000	200,000	400,000	400,000	1,000,000	1,000,000

'Possibly involving open pit mining and of ftract waste disposal

SOURCE Office of Technology Assessment

Table 10.–Constraints to Implementing Four Production Targets

	1990 production target, bbl/d			
	100,000	200,000	400,000	1 million
Possible deterring factors	Severity of Impediment			
Technological				
Technological readiness	None	None	None	Critical
Economic and financial				
Availability of private capital	None	None	None	Moderate
Marketability of the shale 011	Possible	Possible	Possible	Possible
Investor particlpation	None	Possible	Possible	Possible
Institutional				
Availability of land	None	None	Possible	Critical
Permitting procedures	None	None	Possible	Critical
Major- pipeline capacity	None	None	None	Critical
Design and construction services	None	None	Moderate	Critical
Equipment availability	None	None	Moderate	Critical
Environmental				
Compliance with environmental regulations.	None	None	Possible	Critical
Water availability				
Availability of surplus surface water	None	None	None	Possible
Adequacy of existing supply systems	None	None	Critical	Critical
Socioeconomic				
Adequacy of community facilities and services	None	Moderate	Moderate	Critical

SOURCE Office of Technology Assessment

Technological

Technological readiness will not hinder the first three scenarios because the relatively slow pace of their development will allow normal scaleup practices to be followed. Scenario 4 presents a different case. To achieve its goals, the construction of almost all plants will have to be started before 1984, which does not allow sufficient time either to undertake much preliminary experimentation, or to gain experience by modular demonstration or by the operation of pioneer facilities. In addition, the necessity to standardize the plant designs could have a number of unfortunate consequences. Among these could be that erroneous equipment specifications and other design flaws would be duplicated, and plant components would be unreliable and short-lived. Unanticipated environmental problems caused by the failure of pollution control systems could delay the projects, increase their costs, and have severe ecological consequences. Unreliability and less than optimum performance could prevent some plants from ever operating at their design capacity.

Economic and Financial

For a project to be economically viable and attract investors, it needs to have a favorable combination of market conditions, of construction and operating costs, and of resources such as land, water, and workers. The necessary permits must also be readily obtainable. Tradeoffs are possible. Thus, if adequate resources are available, and permits obtainable without undue expenditure of time and money, then somewhat less favorable market conditions might be acceptable.

Until late in 1979, it was assumed that sizable subsidies would be needed to offset unfavorable market conditions. However, in January 1980, developers estimated that they could profitably market shale oil syncrude at $35 to $40/bbl. * The present selling price for similar high-quality crudes is within this range (e.g., Wyoming Sweet sold in January of 1980 for a posted price of around $35/bbl). The "spot" or noncontract prices for these crudes are considerably higher ($40 to $52/bbl). Industry sources and petroleum economists expect the world price of crude to continue advancing in the future. Consequently, in a narrow economic sense shale oil appears to have reached parity with conventional crude.

The situation calls into question the need for financial incentives for the oil shale industry. This assumes, however, that market conditions continue to improve, and that institutional barriers (e.g., regulations, permitting requirements, and land availability) do not preclude development. Such could be the case if the developers responded to normal market pressures and opportunities. If, however, high levels of production must be achieved within a relatively short time, then Government support will probably be required to reduce the remaining risks associated with oil shale development. The most important of these risks are:

- Present capital and operating cost estimates for oil shale plants could substantially underestimate actual costs. No commercial facility has ever been built, and most of the existing engineering design estimates are preliminary. Estimates for the costs of building plants have consistently increased much faster than the rate of general inflation.
- Uncertainties in the regulatory or permitting process, or changes in the regulations after a plant was built, could jeopardize a project's economics or even preclude its development.
- Future petroleum prices might not allow shale oil to be profitably marketed once the plants were built. Since developers do not know precisely what their production or construction costs will be, the uncertainty of future prices for shale oil's primary competitor is a crucial risk.

Investor participation is not considered to be a problem for scenario 1, and the financial community will be able to supply the neces-

*Whether shale oil requires subsidy for profitable marketing depends in part on the discount rate developers are assumed to require in order to proceed. See table 12.

sary capital for scenarios 1, 2, and 3. The financial requirements of scenario 4 will strain the Nation's resources of investment capital only slightly or moderately. However, it is questionable whether investors would be willing to risk participating in scenarios 2, 3, and 4 because of such factors as the uncertainties in world oil prices, the existence of institutional barriers, and the doubtful future of Government policies. "Possible" obstacles are shown for these scenarios.

Institutional

Land

The availability of land is not expected to be a problem with scenarios 1 and 2 because potential developers already have access to sufficient private and public lands to achieve the relatively modest production goals. It could, however, cause some problems for scenario 3, particularly if multimineral recovery or open pit mining were to be tested, It will be a critical obstacle for scenario 4. The production target (1 million bbl/d) will require about 15 to 20 plants each on a tract of approximately 5,000 acres, or a smaller number of larger operations, probably including some open pit mines. It is doubtful that private holdings are either large enough or contain enough rich oil shale to support this many projects by 1990.

Permitting Procedures

As a production target increases in size, so will the number of permits that must be obtained from the many different Government agencies. If many projects are involved, these agencies are likely to be overwhelmed by the sheer number of applications that must be reviewed, revised, and approved, The evaluation process could become more lengthy and complicated, which would increase the risk of delays in project schedules. Financial losses to the developers would be the outcome. Alternatively, if the agencies bypassed certain review steps in order to expedite the permitting process, design problems could slip by that would subsequently need to be corrected, introducing additional delays; or, if not caught, would result in environmental damage. Regulatory changes during the development of the projects could mandate unanticipated, and possibly uneconomical, process modifications that could have more easily been made during the design phase. These factors are likely to discourage some developers in scenario 3; they would severely impede reaching the targets of scenario 4.

Pipelines

Under the first three scenarios, the existing system of major pipelines should be adequate to convey the shale oil to nearby markets as well as to more distant ones in the Rocky Mountain region. Only relatively small pipeline spurs, plus some truck and rail transport, will be needed to supplement the system. The system will not be adequate for scenario 4, and new pipelines will be needed to provide access to markets in the Midwest,

Design and Construction Services

Only about 20 architectural, engineering, and design firms in the United States have the capacity to design and build an oil shale facility. The projects that would be needed for scenario 3 would require about 12 percent of their capacity; those in scenario 4 about 35 percent. If other industrial expansion competes for their services, the availability of these firms could delay the attainment of both scenarios. Contracting with foreign firms could be a short-term solution. In the longer term, as domestic firms expanded and smaller companies merged, the necessary array of technical expertise would become available. If the projects were to be completed before the 1990 deadline, however, these adjustments would have to take place in the early 1980's, which may not be possible. In any case, the demand for design and construction services would escalate project costs, especially in scenario 4.

Equipment

Scenario 3 will require between 6 and 12 percent of the U.S. production of valves, compressors, heat exchangers, pressure vessels, and other industrial equipment. If there were shortages, scenario 4, which will need 15 to 30 percent, could be severely hampered by project delays and cost escalations. Deficiencies in equipment supplies and design and construction services could escalate project costs by as much as 50 percent. *

Environmental

Although harm to the air, water, and land would certainly increase as the industry expanded, existing regulations for water quality, land use, and worker health and safety do not appear, at present, to be obstacles under any of the scenarios. This observation is based only on the results of laboratory tests, engineering design studies, and experience with small-scale plants. Therefore, it is not possible to accurately evaluate large-scale operations with respect to the efficacies of their control systems, the characteristics of their ultimate emissions streams, the consequences of the scaleup necessary to build them, and thus their effects on the environment. It is not known whether the industry will be able to meet, in the future, permitting standards and regulations for environmental protection.

The same types of uncertainties also apply to air quality. Recent studies, however, indicate that even when the best available control technologies are used, production capacity will be limited by the standards for prevention of significant deterioration (PSD). These were promulgated under the Clean Air Act, and specify the maximum allowable increases in the ambient concentrations of sulfur dioxide and particulate for any area.

The oil shale region has been designated as a Class II area, i.e., some additional air pollution and moderate industrial growth are allowed. There are also Class I areas nearby, where the air quality must be kept virtually unchanged. These could be affected by oil shale operations. One of these, the Flat Tops Wilderness, is less than 40 miles from the edge of the Piceance basin, and about 95 miles from the eastern edge of the Uinta basin. A preliminary regional modeling study undertaken by the Environmental Protection Agency (EPA) has indicated that by carefully siting the plants in the Piceance basin, an industry of up to 400,000 bbl/d could probably be controlled to satisfy the PSD standards for Flat Tops. The standards might hinder scenario 3 if all the capacity were concentrated in the eastern Piceance basin, but this is unlikely. It is more probable that some projects will be sited in the Uinta basin. Thus the scenario's goal could probably be achieved. Under scenario 4, air quality deterioration would be sufficiently large that compliance would not be possible because at least half of the capacity (500,000 bbl/d) would be located in the Piceance basin.

*Such increases occurred in process plant construction during the period from 1973 to 1975. See ch. 6.

Water Resources

The availability of surplus surface water for large-scale oil shale development depends on the rate of regional growth holding to the medium levels anticipated by the States, and the long-term average flow of the Colorado River remaining at or very near the levels that have obtained since 1930. If there are higher rates of regional growth, or if the river's flows decrease by a few percent, production could be limited to about 500,000 bbl/d unless water were diverted from other users. Shortages of surface water, which could hinder scenario 4, could be offset by developing ground water, by purchasing surface water from other users, or by importing water from other areas. However, these strategies could encounter institutional obstacles. For example, importation of water is presently banned by Federal statutes, and ground water could be developed only if the rights of surface water users were protected.

All of the scenarios will require additional reservoirs to assure year-round water supplies. In many cases, these will be small and located at the plantsites. However, a large industry will need new reservoirs if the projects, and all other users, are to have adequate water supplies, The existing reservoirs will not be adequate for scenarios 3 and 4, and new storage will have to be built in the basins of the White River and the Colorado River mainstem. Reservoir siting could be restricted on some streams by their designation as wild and scenic rivers, or by the presence of rare and endangered species.

All of the scenarios will require diversion projects to carry water from the streams and reservoirs to the oil shale plants. Their construction would also come under environmental laws.

Socioeconomic

Social and economic obstacles will arise if the communities are unable to adapt to the growth caused by shale development, These obstacles have two aspects, The first relates to the physical ability of the towns to provide adequate housing, facilities, and services. The second involves the effects of local living conditions on workers and other residents. Even when physical facilities are adequate, the way of life can be unpleasant. In some Western and Great Plains communities where large and rapid growth has accompanied energy industry construction, living conditions have become so intolerable that workers and their families have simply left. The consequences for the projects of this labor turnover were construction delays, cost overruns, and poor workmanship.

Communities in the oil shale region are preparing for additional growth. In Colorado, for example, the State government, and the oil shale counties and municipalities—with the support and cooperation of industry—have been preparing for increased development for nearly 10 years. Consequently, the region is awaiting expanded oil shale development, and is prepared to absorb a moderate number of new residents. Assuming there are no breakdowns from boomtown stresses, and that presently planned facilities (such as the new town of Battlement Mesa) can be built, the region could accommodate up to 35,000 people between 1985 and 1990. (See table 11.) More could be incorporated if preparations were begun at once. The established communities could expand and new towns could be constructed, provided that financing were available, regulatory actions could be taken in a timely fashion, and the political and administrative atmosphere were favorable. However, if community and individual stress became too great and social institutions faltered, not even the total of 35,000 residents could be absorbed without disruption.

Although some social stress can be anticipated, the area should be able to deal with the growth associated with scenario 1. Scenario 2 could probably be accommodated if project construction were phased, and if some projects were developed in Utah. Severe problems would accompany the growth expected for scenario 3, and the growth for scenario 4 would greatly exceed the capaci-

Table 11 .–Actual and Projected Population and Estimated Capacity of Oil Shale Communities in Colorado

	Population		
Location[a]	1977 census[b]	1980 projected	1985-90 capacity[d]
Garfield County			
Rifle .	2,244	4,362	10,000
Silt :	859	1,211	2,800
New Castle	543	831	1,000
Grand Valley. ~ ~	377	589	3,000
Battlement Mesa[e] ~	—	198	2,500
Other ~ ~	–	–	1,700
Subtotal [f]. .,	4,023	7,191	21,000
Rio Blanco County			
Meeker	1,848	2,779	6,000
Rangely ...	1,871	2,223	6,000
Other. .	1,381	1,542	2,000
Subtotal	5,100	6,544	14,000
Total ., ,..	9,123	13,735	35,000

[a]Does not include Mesa or Moffat Counties both of which are more distant from the area of development

[b]Actuals from a special U S census

[c]End-of-the year projections by the Colorado West Area Council of Governments

[d]Estimated by OTA from various planning and needs assessment documents assumes completion of currently planned *projects (e g housing* waler and sewer system *expansions street* and road Improvements etc)

[e]A new town Construction anticipated to begin in the early 1980 s

[f]Includes only the immediate oil shale vicinity

SOURCE Off Ice of Technology Assessment

ties of the communities. Not only would the existing towns have to double or triple in size, but several new ones would have to be established. Disruption from social and psychological stress would be inevitable for scenario 4, and there is little doubt that adverse living conditions would prevent the realization of its production goal.

Policy Considerations

Some possible Federal policy responses to the constraints that would inhibit or preclude the expansion of the oil shale industry are discussed in this section. Other issues and impacts that have not been identified as constraints are dealt with in the subsequent chapters and summarized in chapter 1. Some examples are the efficacies, over the long term, of the proposed solid waste disposal practices, and the consequences of decreases in the flows of the Colorado River system.

Technology

Accelerated research, development, and demonstration would be needed to remove the technological barriers to scenario 4. The following programs might be considered.

R&D Policy Options

Some of the remaining technical questions could be answered in small-scale R&D programs. These could be conducted by Government agencies or by the private sector, with or without Federal participation. If Federal involvement is desired, the R&D programs could be implemented through the congressional budgetary process by adjusting the appropriations for the Department of Energy and other executive branch agencies, by providing additional appropriations earmarked for oil shale R&D, or by passing new legislation specifically for R&D on oil shale technologies.

Demonstration Options

In general, potential developers would prefer to follow conventional engineering practice, and to approach commercialization through a sequence of increasingly larger production units. Union, Colony, and Paraho have progressed through this sequence to the semiworks scale of operation—about one-tenth of commercial module scale. Larger demonstration projects will be needed to accurately determine the performance, reliability, and costs of processing technologies under commercial operating conditions. For Union and Paraho, the next step is a modular demonstration facility that would incorporate only one retort. Although costing several hundred million dollars, this facility would provide the necessary experience and the technical and economic data to decide whether to commit much larger sums to commercial plants. Rio Blanco and Cathedral Bluffs are also following the modular demonstration path. Colony regards the pioneer commercial plant as more suitable for demonstrating the TOSCO II technology.

As discussed in the section on economic and financial policies, whether the Federal Government plays an active role in funding and operating the demonstration projects will strongly influence the balance that is achieved between information generation and dissemination, timing of development, and cost to the Treasury. There are four possible structures for demonstration programs. In all cases, the net cost of the program will depend on where the facilities are sited. If the site could be subsequently developed for commercial production (e.g., a private tract, a potential lease tract, or a candidate for land exchange), the facility would have substantial resale value. Otherwise, it would have only scrap value.

A single module on a single site.—This option would provide comprehensive information about one process on one site. Either underground or surface mining experiments could be performed, but probably not both. The costs would be small overall but large on a per-barrel basis, because there would be no economies of scale. Some of the mined shale could be wasted because the single retort might not be able to process all of it economically.

Several modules on a single site.—This program might consist of an MIS operation coupled with a Union retort for the coarse portion of the mined oil shale and a TOSCO II for the fine portion. As with the single-module option, either surface or underground mining could be tested, or possibly both if the plant had sufficient production capacity. The total costs would be larger than for the single-module program, but unit costs would be much lower. For example, a three-module demonstration plant would cost about twice as much as a single-module facility; a six-module plant about four times as much. Different technologies could be combined to maximize resource utilization, and detailed information could be obtained for each. However, all of the information would be applicable to only one site. If many modules were tested, the demonstration project would be equivalent to a pioneer commercial plant, except that a true pioneer operation would probably not use such a wide variety of technologies.

Single modules on several sites.—Several technologies might be demonstrated, each at a separate location. For example, an underground mine could be combined with a TOSCO II retort on one site; a surface mine with a Paraho retort at another. Total costs would be large, as would unit costs, which would be comparable with those of the single-module/single-site option. The principal advantage would be that different site characteristics, mining methods, and processing technologies could be studied in one program.

Several modules on several sites.—For each site, a combination of mining and processing methods could be selected that would be appropriate for the site's characteristics and the nature of its oil shale deposits. The maximum amount of information would thus be acquired in exchange for the maximum amount of investment. Each project would resemble the several-module/single-site option; the collection would constitute a pioneer commercial-scale industry.

Economic and Financial

Continuing uncertainties over eventual plant costs, along with present regulatory deterrents, may mean that financial incentives will be needed. Government action to allow easier access to public oil shale land, or to remove regulatory impediments, could reduce this need. If, however, assuring the production for scenarios 3 or 4 by 1990 is a major objective, then financial incentives should be seriously considered. They would be particularly important in meeting the goals of scenario 4, because the rapid deployment of a large number of projects within 10 years is likely to create cost overruns and jeopardize project economics.

Government Financial Support

Several types of Government financial supports are discussed below. These are basically of two kinds: incentives to private industry, and direct Government ownership or participation.

Incentives to industry.—An effective incentive must avert one or more economic risks. It should also be cost-effective: its cost to the Government should be low and its subsidy effect high. It should promote, or at least not impede, efficient investment and production decisions, and should encourage competition. It should facilitate access to capital. It should entail small administrative and bureaucratic costs. Finally, it should be phased out as market conditions improve and risks are reduced. The following analysis assumes that only temporary incentives will be required for the first generation of oil shale facilities. If this assumption proves incorrect, the implications of subsidizing the industry should be reevaluated; permanent subsidies are a very different economic proposition from temporary ones.

OTA analyzed 10 possible economic incentives. These differ with respect to the criteria described above and also with respect to whether the Government provides the incentive before or after production begins. The latter option is desirable because the Government could phase in the subsidy disbursement. Production incentives (those applied after production begins) limit the Government's financial exposure and risk. The use of production subsidies alone, however, may encourage only large corporations with exceptional debt capacity.

The net cost to the Government of a particular incentive can directly reflect the extent of its subsidy effect, but the relationship is not necessarily linear: some incentives definitely provide more subsidy at a lower cost to the Treasury than others. (See table 12.) It is also important to note that the corporate, financial, technical, and fiscal circumstances of the potential developers will show considerable differences. Consequently, it is unlikely that any single "best" incentive will be revealed. However, some are clearly superior to others from the viewpoints of both the Government and developers. An optimal policy might be to provide a variety of incentives of approximately equal dollar value, and to allow each company to choose the one that is most appropriate to its particular circumstances. The implications of each of the incentives follow. *

- Construction grant. —The Government provides a direct grant to cover a prespecified percentage of total construction costs.

*Full discussion is found inch. 6.

Table 12.–Subsidy Effect and Net Cost to the Government of Possible Oil Shale Incentives'

(12-percent rate of return on invested capital)

Incentive	Total expected profit ($ million)	Change in expected profit ($ million)	Probability of loss	Total expected cost to Government ($ million)	Breakeven price ($/bbl)
Construction grant (50%)	$707	$487	000	$494	$34.00
Construction grant (33%)	542	321	0.00	327	38.70
Low-interest loan (70%)	497	277	0,00	453	43,40
Production tax credit ($3)	414	194	0,01	252	42,60
Price support ($55)	363	142	0.01	172	NA
Increased depletion allowance (27%)	360	140	0.05	197	4570
Increased Investment tax credit (20%)	299	79	0.05	87	4580
Accelerated depreciation (5 years)	296	76	0.05	79	46,00
Purchase agreement ($55)	231	11	0.03	0	NA
None	220	0	009	0	4820

(15-percent rate of return on invested capital)

Incentive	Total expected profit ($ million)	Change in expected profit ($ million)	Probability of loss	Total expected cost to Government ($ million)	Breakeven price ($/bbl)
Construction grant (50%)	$281	$477	0.00	$494	$4060
Construction grant (33%)	119	315	0.19	327	47,70
Low-Interest loan	81	277	0.23	453	5470
Production tax credit ($3)	-61	135	063	252	56.10
Price support ($55)	-88	108	077	172	NA
Increased depletion allowance (27%)	-110	86	0.75	197	57.20
Increased Investment tax credit (20%)	-131	65	0.77	87	58,80
Accelerated depreciation (5 years)	– 127	69	0.76	79	5890
Purchase agreement ($55)	-150	46	092	0	NA
None	-196	0	093	0	61.70

[a]The calculations assume a $35/bbl price for conventional premium crude that escalates at a real rate of 3 percent per year Thus the predicted $48/bbl breakeven price for the 12-percent discount rate 'Will be reached in 11 years or in the fifth year of production Therefore in narrow economic terms 011 shale plants starting construction now which assume a 12-percent discount rate will be profitable over the life of the project without subsidy (See discussion for caveats concerning this conclusion) The calculations are for a 50,000 -bbl/d plant costing $1 7 billion All monetary values are in 1979 dollars

SOURCE Resource Planning Associates Inc Washington O C

(OTA analyzed both 50- and 33-percent grants.) This incentive has a strong effect on project financing. It benefits all developers, and does not distort investment or production decisions. However, it would impose large administrative burdens on both the Government and industry. There would be no assurance that production would occur even with the grants. Large initial lump-sum payments would be required rather than phased-in treasury disbursements. The subsidy would probably be politically unpopular.

- Production tax credit.—The developer is allowed a credit against corporate income taxes for each barrel of shale oil produced. (A $3 credit per bbl of crude shale oil was analyzed.) This incentive provides a strong subsidy effect, and moderately shares investment cost uncertainty. It imposes minimal administrative burdens. It only slightly improves project financing, however, and entails some distortion of product price, It most strongly affects firms that have large tax liabilities, and its net cost to the Government is high compared with other possible incentives. It is widely supported by potential developers.
- Price support.—A minimum price for shale oil is guaranteed for a long enough period to allow developers to recover their capital. (OTA analyzed a minimum price of $55/bbl of shale oil syncrude-the Government would pay the difference if the market price were lower.) This incentive has a very strong effect on project economics. It removes most of the risk of price fluctuations in foreign oil. On the other hand, it does not prevent shale oil from being sold in the private market if prices there are higher than the supported price. With present and projected world oil prices, it is very possible that no Government purchases would be necessary. In this case, the Government would gain income since the developers would pay taxes on their production. This incentive limits the Government's financial exposure—a highly desirable feature. * Its availability would also help developers obtain project financing.

  Price supports would benefit all firms. However, they might not be sufficient for firms with limited debt capacity (i.e., firms that could not borrow the required capital), especially if they were considering costly commercial-size plants. The administrative burden would range from slight to moderate. This subsidy is supported by a variety of potential developers. Its characteristics make it attractive to both developers and the Government.
- Purchase agreement.—A developer contracts with the Government to sell shale oil at a specified price that is usually somewhat above the expected market price. (OTA's analysis assumed a price of $55/bbl in constant 1979 dollars.) This incentive is similar to a price support except that the developer must sell the oil to the Government; he does not have the option of selling it in the open market. Purchase agreements increase profitability to a lesser extent because the firm does not benefit if the market price is above the contract price. On the other hand, the Government shares in both the risks and the potential benefits of shale oil production. Consequently, the average cost to the Government is somewhat lower than with a price support. Purchase agreements limit the possibility of loss, but also reduce the likelihood of large profits. They are less popular with industry than are price supports. The administrative costs are also higher than those of price supports, but their severity can be controlled, to some extent, by the manner in which the subsidy is constructed.
- Low-interest loan.—The developer borrows a specified percentage of capital costs from the Government at an interest rate below the prevailing market rate. (OTA's analysis assumed 70-percent fi-

*As indicated in table 12, the net cost to the Government of providing such an incentive—even if developers chose to sell to the Government-would be low relative to most other incentives, nancing at 3 percentage points below the market rate.) This incentive requires the Government to share significantly in the risk of project failure, and it has a marked effect on a developer's ability to obtain financing, but it tends to distort input costs, and to bias investment decisions in favor of capital-intensive technologies. It also imposes large administrative burdens. This type of subsidy is usually designed to provide the greatest benefits to firms with weak financial capability. In practice, however, it is difficult to deny loans to strong firms.

- Debt guarantees.—The Government agrees to pay back a loan if the developer defaults. With this insurance, a firm can usually obtain lower interest rates. Usually, only a fraction of the total loan is insured, and the borrower is required to pay a premium for the insurance. This incentive only slightly subsidizes the investment, but it provides maximum sharing of the risk of project failure. It considerably eases borrowing problems. Loan guarantees primarily benefit financially weak firms. They distort input cost, and they bias investment decisions toward capital-intensive technologies. They also impose a significant administrative burden. Perhaps the most obvious drawback is the uncertain financial exposure of the Government. The Government's costs would be zero if no plants failed, but huge if even a few failures occurred. The Government has had considerable experience with debt insurance programs during the last 15 years, and the fees paid by firms for the protection have, in sum, yielded it net income. If the participation of small- and medium-sized firms is desired, then either debt guarantees or low-interest loans will probably be necessary.
- Investment tax credit (10 percent), accelerated depreciation (5 years), and increased depletion allowance.—None of these would be likely to have a major impact on oil shale development. Their incentive characteristics are discussed in chapter 6.

Direct Government Participation or Ownership

The Government could share the capital and operating costs with industry, and thereby become a part owner of the project. The consequences would be similar to the construction grant option, except that the Government would share all of the risks and benefits. Almost without exception, potential developers believe that active Government participation would increase managerial complexity and inefficiency. Administrative burdens would be very high.

The Government could also contract for the construction of several modular plants it would then operate, either alone or through contracts. It could thus conduct operations to obtain accurate information on technical feasibility, project economics, and the relative merits of different processes. This would be of assistance in evaluating its future policies towards oil shale, in disseminating technical information, and in improving its understanding of the value of its oil shale resources. After enough information had been obtained, the facility could be scrapped or sold to a private operator. This policy would provide the Government with information and experience, but the cost would be much higher than that of incentives to private developers.

Because industrial partners would insist on some protection of proprietary information, the Government would probably not be able to disseminate all project data as it chose. In addition, its experience in designing, financing, managing, and obtaining permits for an oil shale plant may not resemble that of private industry. Thus, the information acquired may be of only limited use to subsequent private developers.

Most of the information secured through Government ownership could be made available as a condition of granting private financial incentives. Furthermore, this kind of Government intervention is likely to discourage private developers from undertaking their own modular development and R&D programs. Government programs of this kind tend to reduce the benefits that a particular firm could obtain from R&D or modular testing. Finally, when patenting and licensing technologies, definite provision is made for the dissemination of technical information on both gratis and fee terms to possible users of the processes,

Institutional

Use of Federal Land*

The Federal Government owns over 70 percent of the oil shale lands and nearly 80 percent of the best shale resources. Essentially all of the large deposits of nahcolite and dawsonite** in the Piceance basin are federally owned. No permanent leasing program exists for these lands, and the current Prototype Oil Shale Leasing Program is limited to no more than six tracts of 5,120 acres each. To date, four tracts have been leased: Utah tracts U-a and U-b (the White River project) and Colorado tracts C-a (Rio Blanco) and C-b (Cathedral Bluffs). The other two tracts were proposed for Wyoming, but no bids were received when their leases were offered in 1974. Development is proceeding on the Colorado tracts, but the ones in Utah have been stalled by litigation between the State and the Federal Government. ***

*On May *27, 1980* the Department of the Interior (DOI) announced several oil shale decisions. Up to four new tracts will be leased under the Prototype Program and preparations started for a permanent leasing program. At least one multimineral tract will be included in the renewed Prototype Program. Land exchanges will not be given special emphasis, and no decision will be made to settle mining claims until the Supreme Court rules on *Andrus* v. *Shell Oil* (the oil shale mining discovery standard case). [NOTE: This case was decided on June 2, 1980. No. 78-1815.] The administration will propose to Congress legislation to give DOI the authority to grant leases bigger than the present statutory limitation of 5,120 acres, to provide for off-lease disposal of shale and siting of facilities, and to allow the holding of a maximum of 4 leases nationwide and 2 per State.

**Nahcolite is a mineral containing sodium; dawsonite contains aluminum.

***On May 19, 1980, the U.S. Supreme Court reversed the lower court decisions and held that the Secretary of the Interior could reject Utah's applications for oil shale lands as school land indemnity selections (*Andrus* v. Utah, No. 78-1522).

Additional Federal land would not be needed to achieve the goal of scenario 1, nor to reach that of scenario 2 if economic conditions favored oil shale development. The goal of scenario 3 could also be met without more Federal land if regulatory and economic uncertainties were sufficiently reduced to encourage Tosco, Colony, Union, and Rio Blanco to continue their commercialization programs. On the other hand, implementation of scenario 4 would require a highly favorable economic and regulatory climate (probably including Federal subsidies), or the use of additional Federal land, or both. In any of the scenarios, more public land may be required if large-scale multimineral recovery processes or open pit mining are to be tested in the near future.

The land could be leased, exchanged for private land, or developed by the Government. All three options may be affected by the fact that much of the best Federal oil shale land is subject to unpatented mining claims by private parties. The validity of some of these claims will be determined by the Supreme Court in 1980. If the Court's ruling favors the claimants, much less Federal land may be available for disposition.

Leasing.—Under the Mineral Leasing Act of 1920, the Department of the Interior (DOI) has the authority to lease public oil shale lands to private developers. The Act limits the number of leases to one per person or firm, and restricts the maximum size of a single tract to 5,120 acres (8 mi^2). Individuals and firms are allowed to hold shares in several leases, but the total area covered by these shares cannot exceed 5,120 acres.

Whether the acreage limitation will impede development will depend on the location of the tract and on the types of development technologies to be employed. It might preclude large-scale operations in the thinner, leaner deposits in Wyoming. However, a 5,120-acre tract in the relatively rich areas of the Piceance and Uinta basins could easily support a commercial-scale operation over its economic lifetime. On the other hand, if a very large facility were desired, the acreage limitation could impede efficient resource development, especially if surface mining were to be used. If the entire tract were suitable for surface mining, the need to dispose of mining and processing wastes within the tract boundaries would reduce overall resource recovery, and might allow only relatively inefficient development. One solution would be to include in the tract an area (such as a dry canyon) that contains no oil shale resources but that could be used for waste disposal. This option would not require amending the Leasing Act, but it could complicate mining operations and would reduce the value of the tract to the private sector. Another option would be to allow disposal in similar areas outside the tract boundaries, as was originally proposed for tract C-a, but this would require amending the Federal Land Policy and Management Act of 1976 (FLPMA).

The argument in favor of limiting the number of leases per individual or firm is that it prevents a small number of entrepreneurs from cornering the lease market. The argument against the restriction is that it prevents a developer from acquiring experience and technical information on one tract and then applying it to another while the first is still operating. The latter position is valid for potential developers who do not have their own oil shale land, but not for those whose privately owned tracts could be developed commercially if the company could acquire the necessary expertise in the richer deposits on public land. The options are to increase the number of leases allowed to two or three per company or individual, regardless of the locations of the tracts; or to allow one lease per developer per State. The latter would allow a developer to obtain experience with the richer oil shales in Colorado, for example, which could then be applied in Utah or Wyoming. Potential developers prefer the first option because the shales in Utah and Wyoming are much poorer than those in Colorado. Both options would require amending the Mineral Leasing Act.

If additional leasing is desired, it could be carried out either in a new, permanent leasing program, or as part of the Prototype Program. Opportunities exist for leasing at least two additional tracts within the Prototype Program because of the two Wyoming leases that were not purchased during the 1974 offering. No congressional action would be required to extend the Prototype Program, but its extension would constitute a major Federal action. Therefore, a supplementary environmental impact statement (EIS) would be required. Its preparation could take from 1 to 2 years.

Nomination of the tracts and preparation of leasing regulations could add several months to a year to the front end of the schedule. Unless the preliminary steps were expedited, the leases could probably not be sold until about 1983. If the leases were similar to those for the existing Prototype tracts, a 2-year environmental monitoring program would be mandated before site development could proceed. Thus, the first construction work could not begin until about 1985. If a commercial plant were built without a preliminary demonstration phase, commercial production could start in about 1990. With a demonstration phase, commercial production could not begin before 1992 or 1993.

The timespan could be reduced somewhat by offering the tracts that were considered in the mid-1970's as replacements for the Wyoming tracts. The nomination process was completed for these tracts, and work was begun on a supplemental EIS. They were originally selected as sites for in situ operations, and to offer them now for this type of development would be inconsistent with one of the Program's major goals, which was to test a variety of processing technologies. (Both of the active Prototype tracts are being developed by in situ techniques.) If they were also suitable for aboveground processing, their use in the program extension would shorten the commercialization schedule by about a year.

The other leasing option would be a new, permanent leasing program that would be independent of the Prototype Program and therefore not restricted by its six-tract limit. Implementing this option would take longer than extending the Prototype Program, because of the need to prepare new leasing regulations and an entirely new EIS. No congressional action would be required, unless the program were to be coupled with an incentives package or with amendments to the Mineral Leasing Act.

The adoption of a new leasing program would imply the abandonment of another objective of the Prototype Program, namely to obtain the technical, economic, and environmental information needed to design a permanent leasing program. For a variety of reasons, the Prototype Program has not yet provided this information. (See vol. II.) Its abandonment would engender political opposition from the individuals and groups that criticize oil shale development, especially where public land is involved.

Land exchange.—Private interests own several million acres of oil shale land. Of the approximately 400,000 acres of privately owned land in Colorado, at least 170,000 acres contain beds that are at least 10 ft deep with a potential yield of 25 gal/ton, It has been estimated that the total potential oil yield from these richer tracts is at least 80 billion bbl. However, much of the privately held land is located on the fringes of the oil shale basins, and contains thinner, leaner deposits than does the adjacent Federal land, Furthermore, many of the private tracts are in small, noncontiguous parcels (mainly former homesteads and small mining claims) that cannot be economically developed. Private oil shale development would be encouraged if these lands were exchanged for more economically attractive Federal tracts.

There are essentially two land exchange options. The first involves “blocking up’ scattered or oddly shaped private tracts by exchanging some of them for adjacent Federal lands. (Superior Oil Co. proposed such an exchange for its tract near the northern edge of the Piceance basin.) The second option involves the exchange of large privately owned parcels for equivalent Federal tracts, perhaps in an area that is more suitable for a specific development method.

Both options are allowed by FLPMA. Under FLPMA, the Government may exchange public land for private land, provided that the exchange is in the public interest and that the properties involved are within 25 percent of equal value. The difference can be made up with cash. The major problem with exchanges under FLPMA is that the procedures are time-consuming, complex, and costly. Several Federal agencies must be involved in estimating the relative values of the tracts in question and in determining whether the exchange is in the public interest. An EIS may be needed; its preparation could take as long as 2 years. The overall process, including review, evaluation, and approval by the agencies plus a period for public comment, can take even more time.

There are several ways to improve the exchange process. One would be to streamline the review procedures, perhaps by setting up a task force within DOI to deal with exchange proposals involving oil shale lands. Another option would be for DOI to nominate Federal tracts, to characterize their environments, and to evaluate their resources, even if no exchange proposals had been received from private parties. With this advance preparation, the exchange process would be shortened, and the Government would be able to control the location of the future oil shale plants. Both options would be costly and would enlarge the bureaucracy. Additional appropriations, and possibly authorizing legislation, would have to be provided by Congress.

A third option would be to exchange private land for Federal land that is adjacent to State-owned tracts. The mix of private and State land could then be developed under a State-controlled leasing program. This option would be most applicable to the Uinta basin, where the State’s extensive holdings are intermingled with Federal and private tracts.

Government development.—The Government could also develop its own oil shale lands. Two likely tracts are the 40,000-acre Naval Oil Shale Reserve I (NOSR 1) in Colorado and the 90,000-acre NOSR 2 in Utah. (The resources on NOSR 2 are of much poorer

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quality.) These sites could be developed either with a Government-owned corporation, or through a cost-sharing arrangement with industry. The advantages and disadvantages of different types of Government participation are discussed in the section on economic and financial policies.

Permitting Procedures

Developers view the costs and potential risks of the present regulatory process as one of two primary impediments to development. Reaching the production goals of scenarios 1 and 2 will probably not require expediting the permitting process, but it will be needed to meet the goals of scenario 3, and is even more important for scenario 4. One or more of the following actions could speed up the process: require regulatory agencies to make decisions in a specified period of time; "grandfather" projects under development to make new laws and regulations inapplicable to them; create an energy board or authority with the power to overrule Federal regulatory decisions; or limit litigation as was done with the Alaskan oil pipeline. The first two options are likely to be a part of the powers of the Energy Mobilization Board.

Another possibility would be for regulatory agencies themselves to take the lead in simplifying their own permitting procedures. This could be done by the imposition of internal time limits on the period of review, and could be combined with an arrangement whereby developers applied for a package of related permits. This would consolidate the number of permits required, and eliminate some of the existing permit duplication. EPA Region VIII appears to be adopting these procedures, although it is not clear whether and to what extent they will actually expedite the permitting process.

Pipelines

A major pipeline would have to be built to ship most of the l-million-bbl/d target of scenario 4 because existing pipelines to Wyoming and Midwestern refineries are inadequate. Its construction could require access across Federal land and eminent domain rights to private land, as well as extensive regulatory actions and EISs. Congressional action might be needed to facilitate such a project.

Design and Construction Services and Equipment

To achieve the goals of scenario 4, Federal assistance might be needed to deal with scarcities of heavy equipment and limited design and construction services. The following policies might be developed:

- Training programs could be set up for construction workers to provide a skilled work force when construction begins.
- Equipment with long delivery times could be identified and supplies increased by either expanding existing capacity, stimulating additional capacity, or encouraging early orders.
- Tariffs and quotas on imported equipment could be reduced or eliminated.
- Federally sponsored R&D programs could address the technical questions of scaling up to commercial-sized facilities.
- Developers, local governmental units, related industries, concerned interest groups, and appropriate Federal agencies could be encouraged to coordinate their efforts. This would help avoid construction delays,
- Standardization of plant designs could be used to reduce complexity and simplify construction.

Environmental

Air Quality

The PSD standards promulgated under the Clean Air Act could hinder scenario 3 and will, with current "best available control technologies, " prevent achieving scenario 4. Policy options for addressing these obstacles include:

- Coordinate the issuance of PSD permits.—This option would not alter the PSD regulations nor relax air quality standards, but would change the methods for issuing the PSD permits that are needed before construction of the plants can begin. Rather than issuing the permits on a first-come first-served basis, EPA would encourage all prospective developers to coordinate their development plans before applying for their permits. The goal would be a siting pattern that maximized production while complying with air quality standards. This might relieve some of the siting difficulties envisioned for the Piceance basin as a result of its proximity to the Flat Tops Wilderness area. The implementation of this type of option, however, could be complicated by factors such as antitrust laws.

- Redesignate the oil shale region from Class 11 to Class III.—This option would be initiated at the State level, with a requirement for final approval from EPA. The criteria that would have to be satisfied include:
  —the Governors of Colorado, Utah, or Wyoming must specifically approve the redesignation after consultation with legislators, and with final approval of local government units representing a majority of the residents of the area to be redesignated, and
  —the redesignation must not lead to pollution in excess of allowable increments in any other areas.

  This option would allow greater degradation of air quality, but would permit more industrial development. While it would appear that with such an option there could be about twice as much oil shale development as presently possible, there would still be limitations owing to nearby Class I areas. With this option it is expected that the production target of scenario 3 could be achieved, but not that of scenario 4.
- Amend the Clean Air Act.—This congressional option would exempt the oil shale region from compliance with certain provisions of the Act. Under this option Congress might direct EPA and the States to redesignate the oil shale region from a Class 11 to a Class III area, and to exempt the developers from maintaining the visibility and air quality of nearby Class I areas. This would remove both the major uncertainties surrounding the siting of facilities within the resource region itself and any siting barriers connected with the degradation of the Class I areas. Such an option should allow achievement of the scenario 4 production goal at the cost of increased air pollution in the oil shale and nearby regions.

Environmental R&D

The public and private sectors have carried out extensive work on the environmental impacts of oil shale development and on pollution control technologies to reduce these impacts. Yet many questions remain about the effects that a commercial-size industry would have both on the physical environment and on worker health and safety. It is essential, therefore, that R&D keep pace with the industry's development. The information generated would also assist regulatory agencies to develop emission and effluent standards for the industry.

Options at the Federal level for improving technical information include improved coordination of R&D among executive branch agencies, increased appropriations for oil shale R&D, the use of existing national commissions (e.g., the National Commission on Air Quality) and the passage of legislation specifically directed to R&D on the environmental impacts of oil shale technologies. (Environmental R&D needs are discussed in ch. 8 and summarized in ch. I.)

Water Resources

Policy options for removing obstacles associated with water resources are discussed below.

Financing and Building New Reservoirs

Major new reservoirs will be needed for scenarios 3 and 4 to ensure that the water needs of oil shale developers as well as all other users can be satisfied. They could be financed and built by the Federal Government, by State organizations, or by the developers. The options for Federal involvement are discussed below. (Those for the States and the developers are discussed inch. 9.)

Congress could provide for the construction and financing of new water projects through two mechanisms. First, funds could be appropriated for a projector projects that have already been authorized. Several have already been evaluated by the Water and Power Resources Service (WPRS), * and their construction approved. Actual construction cannot not be started until they are funded. However, not all of these projects have been evaluated for their suitability to supply water for oil shale development, and some projects may not be optimally located to serve oil shale plants. A second option would be to pass legislation that would specify both the construction and funding of new, but not previously authorized, Federal water projects. Unless language were included to expedite construction, these projects would require a long review process. They could, however, be designed and sited as water sources for oil shale (as well as other possible uses). An example would be constructing irrigation reservoirs with additional capacity for oil shale requirements.

Under either option, DOI, through WPRS, could operate these reservoirs in accordance with State water law. Their costs could be recovered over the operating life of the facilities from revenues generated by selling water to oil shale developers and other users, in accordance with authorizing legislation.

The Siting of Reservoirs and Direct Flow Diversions

The construction of new reservoirs and direct flow diversions (e.g., pipelines) might be hampered, delayed, or even disallowed under provisions of the Endangered Species Act, the National Wild and Scenic Rivers Act, and the Wilderness Act. Potential problems could be reduced by the following mechanisms.

- Identifying endangered or threatened species.—Two federally designated rare and endangered fish species, the humpback chub and the Colorado River squawfish, have already been found in the waters of the oil shale region, and additional species requiring protection may be found during future studies. The Endangered Species Act may be interpreted as restricting activities that might affect the critical habitats of such species, although no critical habitat has been declared for the squawfish or humpback chub. Knowing the approximate location of the critical habitats of endangered species would be helpful if it were decided to establish an oil shale industry because the timely siting of reservoirs and direct flow diversions could be affected by agency interpretations involving instream flows. Should construction of these facilities begin before the critical areas were identified, there could be opposition to their completion, and water supplies from a particular reach of a river could be delayed or interrupted. If the locations of all designated critical habitats were identified by DOI and the required biological opinions obtained, the facilities could be sited to minimize interference and delay.

  Alternatively, Congress could designate such reservoirs to be in the national interest, and could allow their construction in spite of the effect this might have on endangered species.

- Designating wild and scenic rivers and wilderness areas.—To date, no rivers in the oil shale region have been designated for inclusion in the Wild and Scenic Rivers System; however, several within the basins of the Colorado River mainstem are being considered, Diversions of water from specific stream reaches could be affected if they are set aside. An early designation of the eligible rivers would assist in the planning for future shale oil production. Given this information, direct flow diversions could be sited downstream from the por-

*Formerly the U.S. Bureau of Reclamation (USBR).

tions designated as wild or scenic. This would avoid a direct conflict within a given river stretch but could add to the water supply costs. (Supply costs are discussed in detail inch. 9.)

To date, four areas in the basins of the White River and the Colorado River mainstem have been designated under the Wilderness Act. Other areas are being considered pursuant to the Roadless Area Review and Evaluation II (RARE II) program. * New reservoirs would not be permitted in the designated areas. A complete listing of wilderness areas that might be considered in the near future would allow potential developers to locate their water storage facilities elsewhere. Alternatively, Congress could specifically exclude rivers and/or new areas in the oil shale region from designation as wild and scenic rivers or wilderness areas.

Federal Sources of Water for Oil Shale Development

Congress, under its constitutional powers, could make water available from Federal water projects, or potentially from the reserved rights doctrine. (See ch, 9.) If Congress decides that water from congressionally funded projects should be made available for oil shale development, then any legislation enacted should provide that the term "industrial use or purpose" includes the use of water for oil shale development,** Congress could also amend the authorizing legislation for those projects from which water for oil shale development might be sought, to permit the use of their water for this purpose. The objective of this action would be to overcome any administrative reluctance to permit the use of water for oil shale development under an authorization that did not specifically mention oil shale,

The power of Congress over reserved waters is more limited than its power over waters in congressionally funded projects. Water rights covered by the reserved right doctrine must be used "in furtherance of the purpose of the reservation. " For this reason, Federal water rights do not seem to be likely sources for oil shale development, except perhaps in the case of lands set aside for the Naval Oil Shale Reserves. This question, however, is in the early stages of litigation.

Interbasin Diversion

Interbasin diversion is a technically feasible although costly option for bringing additional water to the oil shale region, There are also serious political obstacles to this alternative. The Reclamation Safety of Dams Act of 1978, amending the Colorado River Basin Project Act, prohibits the Secretary of the Interior from studying the importation of water into the Colorado River Basin until 1988. If it were decided to pursue this option as a means of supplying water to an oil shale industry coming online in 1990, this prohibition would have to be lifted.

Interbasin transfers could be used to relieve the water problems of the oil shale region in several ways, Water could be transferred directly to the oil shale region, either exclusively for oil shale development or for all users. Alternatively, the water needs of Colorado's eastern slope cities, presently being supplied in part from the Upper Colorado River Basin, could be met from other hydrologic basins. The water presently being exported from the Upper Basin then could be used for oil shale development. In a third application of interbasin transfers, all or a portion of the 750,000 acre-ft/yr presently being supplied to Mexico by the Upper Basin States under the Mexican Water Treaty of 1944-45, could be taken from another hydrological

*The Forest Service, in its RARE 11 program, is evaluating over 66 million acres of land to determine their suitability for designation as wilderness, During the period of initial evaluation, and up to final recommendation by Congress, these lands will be in some form of restrictive management.

**A Memorandum of Understanding ex ists between DOI and the State of Colorado with respect to the use of water from existing or authorized U.S. Bureau of Reclamation (now WPRS) projects, The State desires that the water not be changed from agricultural, municipal, or light industrial uses to energy product ion (including oil shale] that are inconsistent with State policies. Under this memorandum, the State will review any applications to redistribute water from conventional uses to energy production. The memorandum could be superseded bv direct congressional directives of overriding national importance.

basin (perhaps the Mississippi basin). The water thus freed in the Upper Basin could be assigned in part to oil shale development (750,000 acre-ft/yr would be sufficient for a 3-million- to 7.5-million-bbl/d shale oil industry).

The Allocation of Water Resources

If Congress were to pass legislation encouraging the development of an oil shale industry, it might wish to address the issue of how the necessary water would be supplied and how oil shale legislation might affect water allocation.

Water in the oil shale region is presently distributed by a complex framework of interstate and interregional compacts, State and Federal laws, Supreme Court decisions, an international treaty, and administrative decisions. Within the Western States, water rights are apportioned by the States to competing users according to a doctrine of prior appropriation under which water rights are a form of property separate from the land.

Oil shale developers presently hold extensive, but largely junior (i.e., low priority) surface water rights. Therefore, if water shortages were to occur, existing developer supplies could be interrupted. More reliable supplies may be provided through development of ground water not tributary to the surface, purchase of the consumptive portion of irrigation rights during the irrigation season, purchase of surplus water from Federal reservoirs, or importation of water from more distant hydrological basins. (The last two options have been discussed above). A discussion of the amount of water needed for oil shale development is presented in detail in chapter 9.

If control over the water supply for oil shale is to be left to the States, then Congress should probably so specify that decision in oil shale legislation to avoid any question of the preemption of State water laws. Legislation that would confirm preservation to the States of the same power over water for oil shale as they have over other water supplies should require the developer to comply with State procedures in securing a water supply, and provide that the established State appropriation system has the same authority to grant, deny, or place conditions on a water right and permit as would prevail in the absence of the legislation.

If Congress were to attempt to remove the water supply for oil shale production from the control of the State, strong legal and political resistance would ensue. Such resistance could delay oil shale development.

Socioeconomic

The social and economic effects of oil shale development are not unique to the resource being produced or to the technologies involved. Rather, they derive from an influx of people, regardless of the cause. In this respect, they are similar to the effects of growth in other energy industries, such as coal or oil and gas. Before looking at specific policy options for the effects of oil shale development, the perspective from which they are viewed and the role of the Federal Government in impact mitigation must be considered.

Congress can view socioeconomic impacts from one of three policy perspectives:

- As part of the consequences of all kinds of energy development.—In recent sessions, Congress has considered bills that would provide assistance to communities faced with problems from the growth of many different energy industries, and programs for oil shale could be included in such legislation.
- As an aspect of specific energy initiatives.—Proposed amendments to the Powerplant and Industrial Fuel Use Act of 1978 are illustrative of this more limited approach. These amendments are directed to the adverse effects of major energy developments, which could include oil shale. They authorize grants, loans, loan guarantees, and payments of interest on loans; and propose an expediting process for present Federal pro-

grams as well as an interagency council to coordinate Federal impact assistance.

- As the result of oil shale development alone.—In this case, specific language dealing with socioeconomic effects could be included in bills providing for the development of oil shale resources.

The ways in which Congress deals with the impacts will depend on which perspective is adopted.

Policy decisions must also consider the role of the Federal Government in impact mitigation. Assistance in coping with the consequences of growth is not expected in the usual course of economic development. Recently, domestic energy development has become an exception when the distinction has been drawn between effects that can be handled by local communities—i.e., those that can be considered a normal adjunct of development, and those that cannot be readily solved with local resources—boomtown problems. The extent and nature of Federal involvement in impact mitigation is highly controversial. On the one side, it is argued that social and economic difficulties are State and local problems that should be viewed as the inevitable consequences of industrial growth, and thus the Federal Government need not be involved with their amelioration. On the other side, the position is taken that national energy requirements are the root causes of impacts, therefore a Federal role is appropriate. Several Western States propose that for reasons of equity, the national goal of accelerated domestic energy production requires direct Federal participation in alleviating negative impacts. This question about the Federal role must be faced before decisions can be made about appropriate Federal actions for dealing with the impacts of oil shale development.

No new Federal initiatives appear to be needed for scenarios 1 and 2, as long as the existing mechanisms are effective. Several requirements must be met, however:

- both Federal and State actions must support already established growth management processes;
- efforts to improve the delivery of Federal programs should continue;
- State appropriations from funds designated to assist the oil shale communities will be necessary; and
- support services, such as technical assistance to the local governments, should not be reduced.

Increased Federal participation will be needed if the region is to accommodate the growth anticipated under scenarios 3 and 4. Several kinds of support could be given. One option would be to provide additional financing for expanding the communities and for planning and establishing new ones. Another would be to create Federal programs to solve problems for which local groups have neither the time nor the resources. For instance, difficulties may arise from inequities in the distribution of revenues among States. These could be evaluated, and Federal actions taken for their correction. Such problems will occur if the workers for Utah developments choose to live in Colorado; Utah will gain tax revenues from the plants but Colorado will have to pay for the consequences of increased growth in its rural areas. Yet another option would be to expand Federal R&D efforts. As an example, it would be valuable to have estimates of the maximum rate at which the communities could grow without experiencing severe disruption. These estimates could be used by policymakers to adjust the timing and location of additional Federal oil shale leases to take into account socioeconomic impacts.

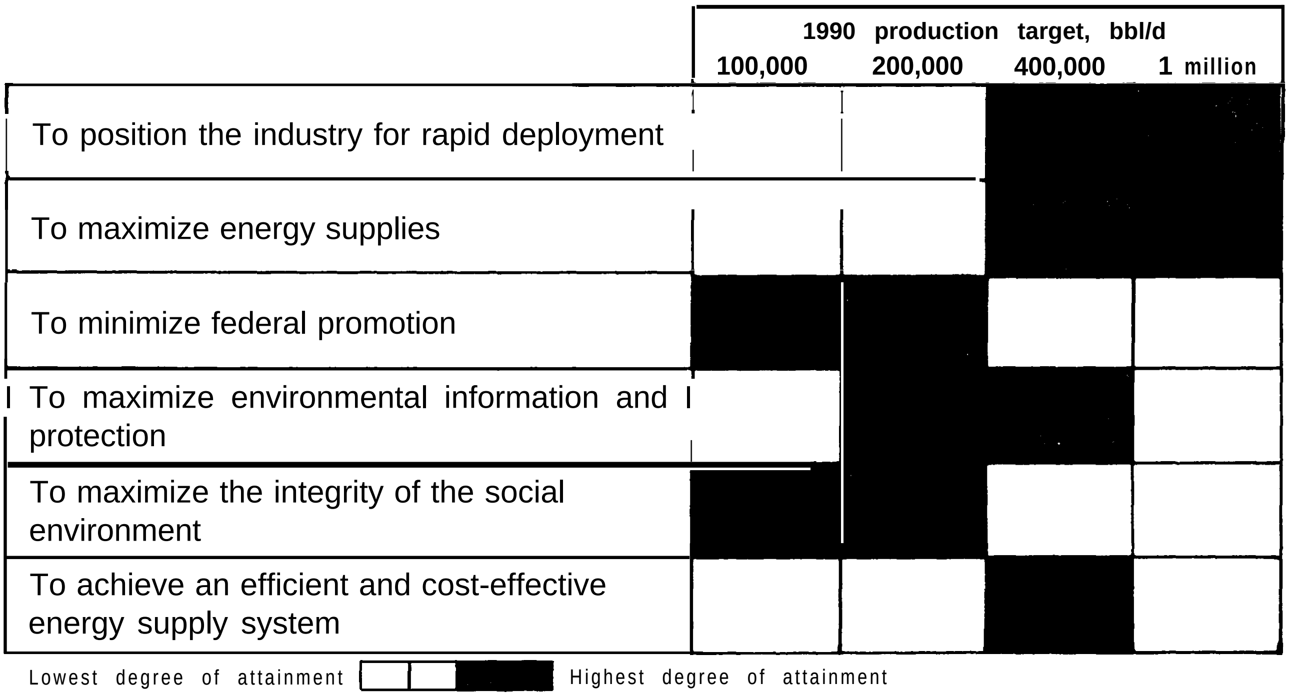
Which of the options would be best will depend on the success of local preparations and on the nature and timing of new development. If the industry grows slowly, Federal participation might be limited to R&D and other supporting activities. If it expands rapidly, substantial direct financial support and active growth management efforts will be needed. For example, a coordinated strategy will be required to cope with the growth that would accompany the production of 1 million bbl/d, as envisioned by scenario 4; and the responsibilities would have to be shared by Federal, State, regional, and local governmental units as well as by all private sectors. Extensive Federal participation would be unavoidable. One option would be to create a new Federal regional authority, for the impacts will extend into Utah and Wyoming. The powers granted to such an authority would depend on the degree of coordination and cooperation between the public and private sectors, and on the severity of the negative impacts. For instance, construction of new homes, apartments, and other living facilities will have to be financed. This will involve private parties like lending institutions, and possibly the oil shale developers. But where private capital is insufficient, the Federal or State governments will have to step in. Housing is only one sector where the needs can be expected to outstrip the resources, and where combined efforts to meet them will be essential. Many agencies, operating in many areas and at all levels, would have to be involved to cope with the growth that would accompany the establishment of a l-million-bbl/d industry by 1990.

Scenario Evaluation

As has been shown for the four scenarios, different development strategies entail substantially different requirements, consequences, and Federal actions. Regardless of the strategy selected, tradeoffs among objectives and requirements are inevitable. This is indicated in figure 11, where the scenarios are rated according to the relative degrees to which they are expected to attain the objectives for development. The following summarizes how the attainment of each objective varies with the production goals.

- To position the industry for rapid deployment.—The 400,000-bbl/d industry is given the highest rating because a wide variety of technologies and sites would be evaluated and substantial technical, environmental, and economic information would be obtained; all of which would place the industry in a good position for rapid scale-up. The l-million-bbl/d goal is rated next since production at this level would constitute a major industry; further rapid deployment could then follow. It is rated lower than the 400,000-bbl/d" scenario because its accelerated construction schedule would preclude valuable precommercial experiments and would probably not result in the most technically efficient plants. The other goals are rated lower because fewer processes could be evaluated.
- To maximize energy supplies.—The benefits, and thus the ratings, are proportional to the production rate.
- To minimize Federal promotion.—The 100,000-bbl/d target is rated highest because it could be achieved by completing the presently active projects. The 200,000-bbl/d goal probably would require some incentives, and the 400,000-bbl/d" one would require incentives, a small land exchange, and the short-term leasing of a Federal R&D facility in Colorado for a demonstration project. The l-million-bbl/d target would require much stronger subsidies, additional leasing of public land for a longer period, permitting modifications, variances, and extensive Federal involvement in growth management.
- To maximize ultimate environmental information and protection.—The quantity of pollutants and wastes generated will increase in proportion to the rate of production. Establishing a l-million-bbl/d industry in 10 years would cause the most disturbance per unit of production because there would not be enough time to improve the control technologies. The 100,000-bbl/d industry is also given a low rating because the limited number of technologies tested would provide neither extensive information on impacts nor guidance for the improvement of controls and regulations. The 400,000-bbl/d target would meet the needs for information and testing of control technologies but would incur a greater environmental risk per unit of production than

Figure 11 .—The Relative Degree to Which the Production Targets Would Attain the Objectives for Development



SOURCE Off Ice of Technology Assessment

200,000 bbl/d. The latter would maximize the attainment of this objective.

- To maximize the integrity of the social environment. —The 100,000-bbl/d target is rated high because this level of growth should be within the physical capacities of the communities. The 200,000-bbl/d" goal would create some strain in the ability of the towns to absorb the number of expected new residents; the degree of stress would depend on the location of the development. Adjusting to the growth associated with a 400,000 -bbl/d industry would be possible if the plantsites were dispersed in Utah and Colorado, if plant construction were phased, and if preparations for the construction of new towns were started at once; but there would be a high probability that boomtown effects would accompany this level of growth. A l-million-bbl/d industry would require coordinated growth management strategies and extensive financial outlays. Severe social disruption could be anticipated.
- To achieve an efficient and cost-effective energy supply system.—The 400,000-bbl/d target has the highest rating because, among other factors, it would provide a balance of information generation and process development and demonstration. The 100,000- and 200,000-bbl/d targets are rated lower because only a few technologies and sites would be tested. The l-million-bbl/d industry is also rated low because its deployment strategy would poorly utilize many of the elements of production. Furthermore, the plants might not generate sufficient profit capital for subsequent expansion.

An illustration of the need for tradeoffs between objectives can be seen at the l-million-bbl/d level. This choice has high attainment of the positioning and energy production objectives (e.g., it would displace about 16 percent of the imported oil and reduce the balance of payments significantly). However, reaching the target requires tradeoffs in all the other areas. (For example, it would violate the Clean Air Act.)