CHAPTER 6

Development Potential and Production Prospects of Federal Coal Leases

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CHAPTER 6

Development Potential and Production Prospects of Federal Coal Leases

This chapter presents the results of OTA's assessment of the development potential and production prospects of Federal coal leases. These results constitute OTA's response to the first and second of its four charges in the Federal Coal Leasing Amendments Act of l976 (FCLAA): an analysis of all mining activities on Federal leases and of the present and potential value of existing Federal coal leases.

Introduction and Summary of Findings

This chapter presents OTA's estimate of the amount of coal that could be produced from mines with Federal leases in the next 10 years. The estimates of the potential production from Federal leases made in this report are not forecasts of the coal that would be produced at a given price or a given demand. They are estimates of the total amount of coal that could be produced from currently operating and proposed Federal mines and from those undeveloped Federal leases that have characteristics comparable to operating mines in the same region. Coal from these leases would thus be likely to be produced at a price that is competitive with other mines in the same area, (Most analyses of coal market trends in the 1980's, including those used in OTA's State task forces, have projected that demand for Western coal will expand significantly while the price of coal will remain stable during the next decade with primary increases because of inflation.) If the projected increases in demand fail to materialize or if holders of existing leases do not capture a proportionate share of any expanded market, then not all the leases that could technically and economically be developed will be brought into production, Under those circumstances, OTA's production estimates will be higher than actual production from existing leases.

The years 1986 and 1991 are key years in Federal coal development. All Federal coal leases issued before the passage of FCLAA must meet the diligent production requirement of 2½ percent of recoverable reserves by June 1, 1986, under Department of interior (DOI) regulations. Failure to meet this requirement could result in cancellation of the lease. However, the diligence period may be extended for up to 5 years to June 1, 1991, if certain conditions are met (see ch. 9).

The production estimates for these two key years are based on resource potential and other factors that will affect output, e.g., 1) the lessees' plans, financial capability, and mining experience; 2) geological conditions on the lease: 3) mining and reclamation conditions on the lease; 4) possible environmental permit restrictions; 5) availability of transportation; 6) socioeconomic impacts and limitations; and 7) potential markets and demand for Western coal.

Mining plans are an excellent source of detailed information for analyzing potential production and assessing specific problems concerning the development of Federal coal leases, The submission of a mining and reclamation plan to the U.S. Office of Surface Mining (OSM) and the U.S. Geological Survey (USGS)* is a necessary step in the process of mine development and coal production, As the first step in its analysis, OTA has grouped leases in three categories: 1) those with approved mine plans; 2) those with mine plans submitted and pending approval; and

*Both surface and underground mines must submit mine plans to thc Office of Surface Mining,

3) those with no submitted mine plan, which are referred to as "undeveloped leases" in this report.

OTA examined each mine plan to determine: 1) major geological, mining, and reclamation conditions associated with the operation; 2) the lessee's mine design capacity and projected annual production over the next 10 years; and 3) likelihood of the mine's production meeting diligence requirements, Mine design capacity is the maximum annual production of coal that all facilities located at a mine can support.

OTA analyzed undeveloped leases, (those without mine plans) differently. These leases were grouped in blocks of adjoining leases held by the same lessee, Based on geological and technical characteristics of the blocks, each lease block was assigned favorable, uncertain, or unfavorable development potential. These assignments were made in part by comparing the reserves, coal quality, and the mining and reclamation conditions of undeveloped leases with similar mines in the area, Leases that had questionable development potential based on the criteria were further evaluated for their potential to be integrated into an adjoining mine or to be combined with other undeveloped reserves.

Those leases with favorable or uncertain development potential were analyzed block by block to assess the factors that could affect their rate and level of development. Factors examined included coal markets and demand. Production estimates were then developed for each lease block.

A more detailed description of the methodology for evaluating development potential and estimating production is given in chapter 2.

Summary of Findings

As of late 1980, there were 502 Federal coal leases in the six Western States of Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming. * These 502 leases, 89 percent of the 565 existing Federal coal leases, contain 16.3 billion tons of recoverable reserves, over 98 percent of the total of 16.5 billion tons of Federal coal currently under lease; they account for over 99) percent of Federal coal production.**

The 502 Federal coal leases in these six States are grouped as follows:***

1. 182 leases with 7.3 billion tons of recoverable reserves (# percent of the total leased reserves) are in approved mine plans.
2. 117 leases with 2.5 billion tons of recoverable reserves (15 percent) are in pending mine plans. ****
3. 203 leases with 6.4 billion tons of recoverable reserves (39 percent) are not in mine plans. (These leases, plus five leases in pending mine plans in Wyoming are called undeveloped leases.)

Of these 208 undeveloped leases (203 leases with no mine plans and the five Wyoming leases in pending mine plans), 80 leases containing 4.1 billion tons of recoverable reserves have favorable prospects for develop-

*The leases issued in early 1981 under the new Federal coal management program are not included in I h is tot a I and were not considered in this study. See also p. 164 of this chapter, for a discussion of the 46 Federal leases i n Oklahoma.

* *Coal from Federal coal leases is referred to as Federal coal. A mine that includes a Federa 1 lease is called a Federal mine. Sometimes, for the sake of efficiency of recovery or economy of opera t ions, in terveningState or private coal is mined with Federal lease(s) in the same m inc. This practice is the rule in southern Wyoming and North Dakota, for example. Thus, many Federal mines produce both Federa I and non-Federal coal. A mine which conta ins no Federal coal is called a non-Federal mine, Total coal production in a State or region is thus the sum of: 1) Federal coal production from Federal mines plus 2) non-Federal coal production from Federal mines, plus 3) non-Federal coal production from non-Federal mines.

** *Five small leases, isolated from principal coal-producing regions, t h ree in Montana and two in Wyom i ng, were not a na-lyzed in this chapter, hut are included in these totals. Four are undeveloped leases with lit tle likelihood of being developed. One is a producing lease. These leases do not appear in the tables in this chapter,

****Five leases in pending mine plans in Wyoming are included in this total. Because of the preliminary nature of the mine plans a t the time the a nalvs is was done, these leases are. however, analyzed as undeveloped leases later in this chapter.

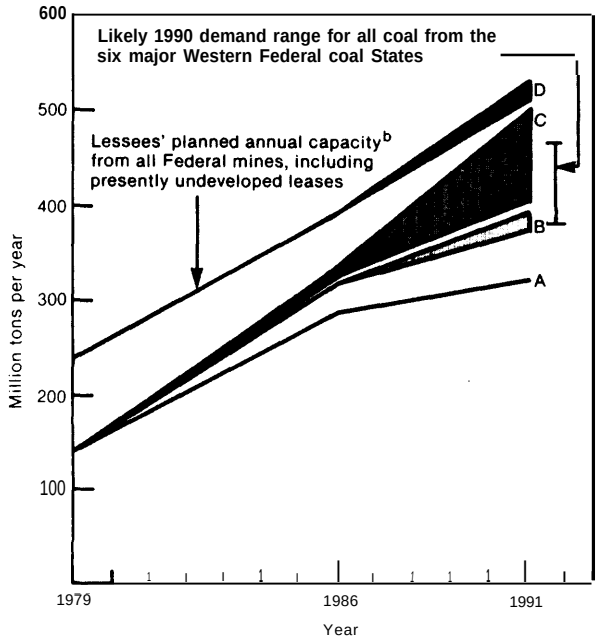
ment by 1991. The majority of these reserves are concentrated in the Wyoming portion of the Powder River basin (3.2 billion tons of surface-minable reserves) and in the Uinta region of Utah (0.4 billion tons of underground reserves). In almost all cases, the lessees are actively developing these leases.

Another 65 leases containing 2.3 billion tons of recoverable reserves have uncertain prospects for development by 1991. The large majority of these reserves (about 90 percent] are about evenly divided among the Kaiparowits Plateau coalfield of southwestern Utah, the Green River region of Colorado and the Wyoming portion of the Powder River basin. Development depends on factors such as pace and scale of construction of associated powerplants or synfuel projects, development of in situ gasification, availability of additional Federal reserves from pending preference right leasing applications (PRLAs] or from new lease sales, construction of transportation systems and lessee development priorities.

Finally, 63 leases with approximately 0.5 billion tons of recoverable reserves are unlikely to be developed. Most of these leases lack sufficient minable reserves of marketable quality to be developed as new mines. Many also have difficult mining conditions that would make them expensive to develop, and some are located outside active mining areas and lack adequate transportation. Because they are unlikely to be developed, any production is unlikely from these leases.

Production from existing Federal coal leases is likely to increase substantially over the next 10 years, Planned production capacity for 1986 for Federal mines is 400 million tons per year; for 1991, over 535 million tons per year (see fig, 24). OTA estimates that production from Federal mines could range between 410 million and 500 million tons per year in 1991 depending on markets, synfuels development, and rail construction. According to the plans of lessees, about 65 percent of 1991 upper limit projected production (325 million tons) is expected to be mined from Federal mines with currently approved mine plans. About 14 percent would come from Federal mines with currently pending mine plans (69 million tons). The remaining 22 percent (109 million tons) is projected to come from presently undeveloped leases. Actual

Figure 24.— Potential Production From and Planned Capacity of Federal Mines Summed Over the Six Major Federal Coal States[a]



Potential annual production.[b]

A Lessees' planned annual production from Federal mines in currently approved mine plans only

B Lessees' planned annual production from Federal mines in currently approved and pending mine plans

C The **sum of E?, above, plus estimates of potential production from presently undeveloped Federal leases**

[a]**Wyoming, Montana, Colorado, Utah, New Mexico, and North Dakota**

[b]**Planned capacity for a given year** IS **the upper limit to potential production in that year (although an even higher total capacity might be attainable in a very strong market for coal) In many cases (e g currently approved mines In the Powder River basin in 1991), the lessees' production plans call** for them to **produce** at or near **capacity In other cases, even optimistic production plans fall short of using planned capacity to the full Some mines, particularly newer mines in the Southern Rockies will not attain thelr** planned maximum capacity until the 1990's. In all cases, however the capacities planned for 1986 or 1991 were used in deriving fig. 24, above, not the higher numbers for planned maximum capacities in the post 1991 period For most **Federal** mines in the Southern Rockies the planned productions for 1986 and 1991 are close to the planned **capacities for those years**

Explanation of ranges

C. 92 million **ton per year range in 1991**

65 mty = Dominant uncertainty is the development of markets for the coal

22 mty Dominant uncertainty IS the construction of two railroads one to the Kaiparowits Plateau in Utah (14 mty) and one to the Star Lake Bisti area of New Mexico (8 mty)

5 mty Dominant uncertainty IS the schedule of synfuels development

D: 22 million ton per year range in 1991

Dominant uncertainty **IS** the construction of the two railroads mentioned above under C

SOURCE Off Ice of Technology Assessment

production in 1991 could fall below this range, however, because of competition with non-Federal mines and new Federal leases in the West and from other coal-producing regions of the country and because overall demand for coal may not grow sufficiently during the next decade to support this level of production from Federal mines.

During the 1990's, demand for coal in general and Western and Federal coal in particular might grow rapidly, particularly if coal-based synfuels and exports to foreign countries become important.

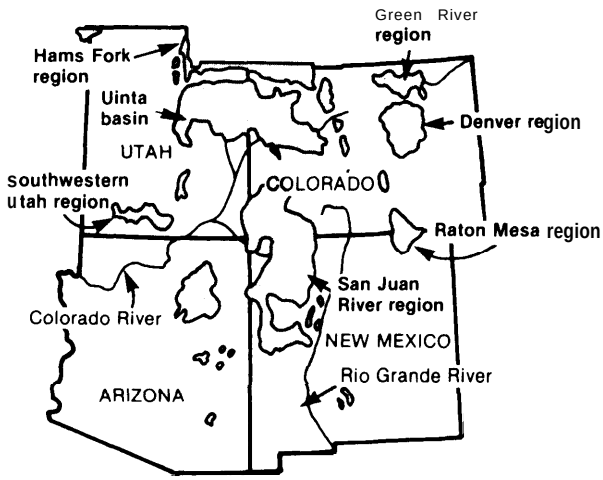
Development Potential and Production Prospects of Federal Coal Leases in Colorado, New Mexico, and Utah

Overview

Colorado, New Mexico, and Utah comprise what is referred to in this report as the Southern Rocky Mountain region. * This three-State area embraces five major Western coal-producing regions—the Uinta region, the San Juan River region, the Denver-Raton Mesa region, Southwestern Utah, and the Colorado portion of the Green River-Hams Fork region (see fig, 25). The 360 Federal coal leases in these States cover over 451,000 acres and contain over 5.9 billion tons of recoverable coal reserves (see table 34), These States have 64 percent of the total Federal leases, over 55 percent of the acreage under lease, and over 35 percent of the reserves under lease. Roughly one-third of the leases in the Southern Rockies are in approved mine plans, another third are in proposed mine plans, and the remaining third are undeveloped. Total production from Federal coal reserves in Colorado, New Mexico, and Utah was 20 million tons in 1979 or about 45 percent of the total production of 45 million tons in the three States. In 1980, production from Federal reserves was 24.4 million tons out of total production in the Southern Rocky Mountain area of over 49 million tons. These three States contributed about 33 percent of the total production from all Federal leases in 1979 and 35 percent of the 1980 production.

*The Southern Rocky Mountain and the Northern Great Plains regions-as used in this report-should not be confused with the Northern Great Plains and Rocky Mountain coal provinces. The Rocky Mountain coal province is a geologic and physiographic designation that includes coalfields west of the continental divide and the Denver basin and Raton Mesa coal regions of Colorado and New Mexico. The Rocky Mountain coal province runs from the Big Horn basin of northwestern Wyoming to coalfields in southern New Mexico. The Great Plains coal province includes the Powder River basin and Fort Union region of Wyoming, Montana, and North Dakota. Geologic province designations are made on the basis of the geologic characteristics and age of the real deposits. (Arizona, which is also part of the Rocky Mountain coal province, has little Federal coalland and no Federal coal leases.)

Figure 25.–Coal Regions in the Southern Rocky Mountain States



SOURCE Office of Technology Assessment

Summary of Production Potential and Planned Capacity

Production from mines with existing Federal leases in the Southern Rocky Moun-

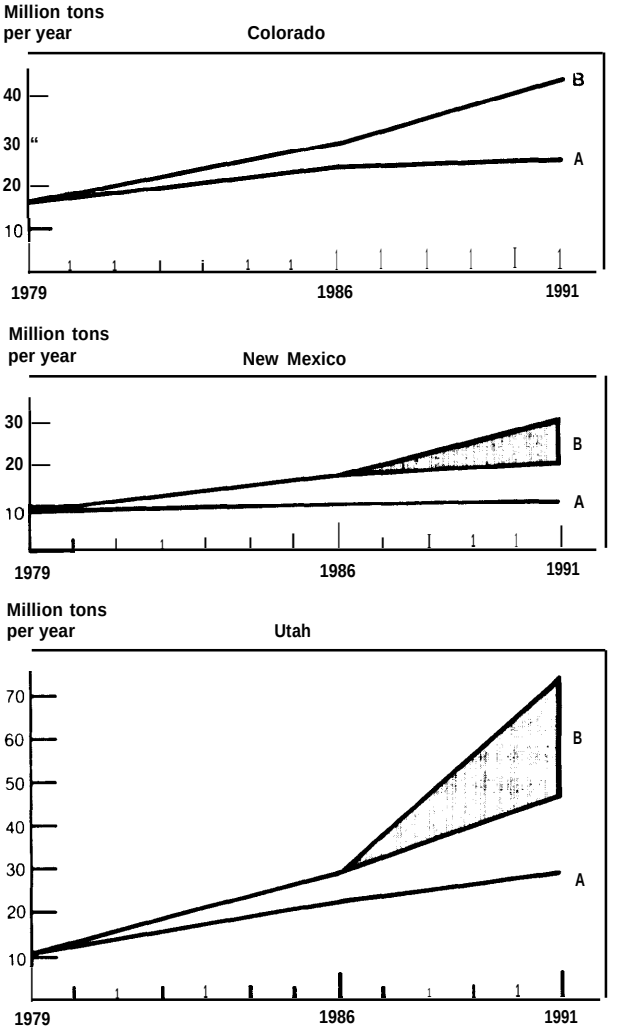
Table 34.— Federal Coal Leases in Colorado, New Mexico, and Utah

State/region	Total number of leases	Total number of plans or lease blocks	Total Federal acres	Total recoverable reserves (millions of tons)
Colorado				
Green River	57	34	53,254	1,363
Uinta	63	27	69,793	803
San Juan .,	1	1	160	1,6
Denver-Raton Mesa	6	4	3,686	66
Total	127	66 -	126,893	2,234
New Mexico				
San Juan . .	26	12	44,560	447
Denver-Raton Mesa	3	3	200	0.5
Total	29	15	44,760	447
Utah				
Uinta, ...	108	42	128,930	1,503
Southwestern Utah	96	14	150,566	1,750
Total . .	204	56	279,496	3,253
Regional total .,	360	137	451,149	5,934

NOTE Sums of acreage and reserves may not add to totals because of Independent rounding

SOURCE Off Ice of Technology Assessment

Figure 26.— Potential Production Capacity of All Mines With Federal Leases in Colorado, New Mexico, and Utah



A. **Lessees' planned annual production capacity for Federal mines in currently approved mine plans only**
B. The sum of A, above, plus estimates of production capacity for Federal mines in pending mine plans and for presently undeveloped Federal leases

SOURCE Office of Technology Assessment

tain area is expected to rise substantially in the next decade as existing and planned mines reach full operation and new mines are opened on undeveloped leases. By 1986, according to current mine plan schedules, production from Federal mines could reach over 76 million tons- more than double 1979 production. By 1991, depending on the rate at which Federal leases are developed, production from Federal mines could total between 110 million and **146** million tons— potentially doubling the **1986** output and at least tripling the 1979 level. Figure 26 shows projected increases in production from Federal leases in Colorado, New Mexico, and Utah. The percentage of total regional production coming from Federal leases will also increase significantly from about 44 percent in 1980 to over 60 percent by 1991.

Most of the projected increases in production will come from new mines that will not achieve their full design capacity until the mid-l990's. The estimated 1991 production range of 110 million to 146 million tons is less than the total maximum annual capacity of over **200** million tons per year that could be supported by mines on existing Federal leases in the mid-l990"s, In the late **1990's** however, as many of the mines that are now operating exhaust their reserves, the total capacity supported by existing leases will begin to decline slowly.

The maximum annual capacity of the 35 mines with 113 Federal leases that currently have approved mine plans is about 74 million tons per year at full operation, Proposed mine

plans have been submitted for 25 new mines with 108 Federal leases that would add over 71 million tons of annual capacity. (When the capacity of existing mines is referred to, it means capacity at full-scale operation, not current installed capacity.) Nearly half of the existing and planned capacity (about 64 million tons per year) is in underground mines in the Uinta region of Utah and Colorado. About 40 percent of the capacity (nearly 30 million tons) in pending mine plans is from proposed mines in Southwestern Utah.

Production in the Southern Rockies will generally be less than capacity until the mid-1990's, however, overcapacity is not expected to be as significant in this region as in the Northern Great Plains. Many of the larger mines in the Southern Rockies have opened in the past 4 years and are still under construction. These new mines will not reach full commercial operation for several more years. Other existing and proposed mines have scheduled production to fuel new electric powerplants when they begin operations. Several of the mines with pending mine plans will not begin producing until after 1986 and will reach full-scale production by the early 1990's.

Many of the 139 currently undeveloped leases could, according to OTA's analysis, support new mines and at least 13 undeveloped lease blocks with 27 leases are already in mine plan preparation stages. By **1986,** few undeveloped leases will be producing. By 1991, they could contribute between 17 million and 32 million tons of production. If all of the undeveloped leases with favorable or uncertain development potential go into production, they could add 34 million to 57 million tons of new annual capacity. Most of this new capacity (between **23** million and 45 million tons per year) would come from mines in Utah and in the Green River region of Colorado. Besides market uncertainties, the major difficulty affecting production from undeveloped leases is construction of coal transportation systems in Utah and New Mexico.

Quality of Coal Under Lease

The Southern Rocky Mountain States have a wide variety of coal resources and mining conditions. The coal quality ranges from lignite deposits in the Denver basin to high-grade metallurgical bituminous coals in the Uinta region of Colorado and Utah and in the Raton Mesa fields of New Mexico and Colorado. The three-State region has supported an active coal mining industry for over a century. Mines currently in operation in the region range from small underground mines producing several thousand tons per year to large surface mines producing over 5 million tons per year. Several of the underground mining operations will reach production levels of 4 million to 6 million tons per year by the early **1990's,** and several new surface and underground mines are planned that will achieve annual production levels in excess of 10 million tons per year.

Generally the active mining areas have good quality minable coal reserves, however, they do not have the extensive shallow, very thick seams that give a cost advantage to surface mines in areas of the Powder River basin. The higher heat content of Southern Rocky Mountain coals, however, partially offsets the lower mining costs in the Northern Great Plains, especially, when coals are shipped great distances. In some fields in the Southern Rockies, the location and quality of the coals make them strong competitors for coal from other areas. In northwest Colorado, for example, minable surface reserves can reach an aggregate seam thickness of 60 ft with overburden depths between zero and 400 ft.

Underground mining conditions in the coalfields vary, but generally, these regions are characterized by thick minable seams of 5 to **12** ft. Some underground seams are **25** ft thick or more, however, current mining methods have limited recovery to only 12 to 14 ft of coal. Newer techniques, such as multiple-lift longwall, promise improvements in recovery rates; but even with recovery rates of only **40**

percent in some underground mines, the mining conditions and seam thicknesses are often more favorable than those encountered in some Eastern and Midwestern coalfields.

Most of the reserves under lease in the Southern Rocky Mountain region are subbituminous to bituminous in rank. They include high-quality coal reserves with heat contents ranging from 9,000 to over 14,000 Btu/lb. Most have relatively low sulfur contents of 1.5 percent or less, making them suitable for compliance quality coal. * The ash content also averages less than 15 percent. Some coals in the San Juan basin of New Mexico and the Denver basin of Colorado are an exception with relatively lower Btu values, (as low as 7,800 Btu/lb in the San Juan basin) and relatively higher average ash contents of up to 29 percent at the mine. These coals are nevertheless considered marketable for their area because the coal can be washed to reduce ash contents to between 16 to 17 percent.

Table 35 shows the rank of coal under lease in each of the major coal production regions in the three States and the amount of recoverable reserves of each type by mine plan status. Federal lease reserves in approved mine plans contain about 1.2 billion tons of bituminous coal and 0.3 billion tons of subbituminous coal. There are about 1.4 billion tons of bituminous reserves and about 0.5 billion tons of subbituminous reserves on leases in pending mine plans. Undeveloped Federal lease reserves include over 2 billion tons of bituminous coal and nearly 0.3 billion tons of subbituminous coal. Only about 49 million tons of leased reserves in the three States are classified as lignite.

*As discussed in chs. **4** and **5, one strategy** of complying with Clean Air Act requirements before the 1977 amendments and implementing regulations was to blend low-sulfur "compliance" coals with higher sulfur local coals so that average sulfur content would be low enough so that pollution control equipment costs were minimized while meeting Clean Air Act requirements. The 1977 changes requiring sulfur reduction for all coals removed what had been an advantage for Western coals.

Table 35.—Rank of Coal Under Lease in the Southern Rocky Mountain Region
Reserves and Mine Plan Status (all reserves in millions of tons)

	Approved mine plans					Pending mine plans					Leases without mine plans						
	Bituminous			Sub-bituminous		Bituminous			Sub. bituminous		Bituminous			Sub-bituminous			Lignite
State/region	HvAb	HvBb	HvCb	SbA	Sbc	HvAb	HvBb	HvCb	SbA	SbC	HvAb	HvBb	HvCb	SbA	SbB	SbC	Lignite A
Colorado																	
Green River			146	160				29				185	487	43	88	18	
Uinta	63	164	8			92	165	110			1	31	7		130		
San **Juan**		2															
Denver-Raton Mesa											17	01					49
Total	63	166	154	160		92	165	139			18	217	494	43	218	18	49
New *Mexico*																	
San Juan			34		135			38	56	89		94		1			
Denver-Raton Mesa											0.1		04				
Total			34		135			38	56	89	01	94	04	1			
Utah																	
Uinta	2	676	114			16	141	108			83	359	0.3				
Southwestern Utah								671	335		43	02	698	3	0 3		
Total	2	676	114			16	141	778	335		125	359	698	3	0 3		

Total reserves by rank may vary slightly from total lease reserves in other tables because of differences in the sources of coal quality data Column totals may not add due to Independent rounding

NOTE Calorific values by rank in Btu per pound based on a moist, mineral matter. free basis, are as follows
(HvAb) high volatile A bituminous > 14,000 Btu/lb (SbA) sub.bituminous A 10,500-11,500 Btu/lb Lignite A 6,300.8,300 Btu/lb
(HvBb) high volatile B bituminous 13,000-14,000 Btu/lb (SbB) sub-bituminous B 9,500-10,500 Btu/lb
(HvCb) high volatile C bituminous 11,500-13,000 Btu/lb (Sbc) sub.bituminous C 8,300-9,500 Btu/lb

See ch. 4 for di!scussion of coal rank.

SOURCE Off Ice of Technology Assessment, Mine Plan Data and Department of Interior Automated Coal Lease Data System

Production and Consumption of Coal From Colorado, New Mexico, and Utah

The Rocky Mountain region coals serve many markets. Most of the coal produced in the three States is consumed in the region or in the west coast markets (see fig. 20, ch. 5.) Under existing long-term contracts, however, a significant amount is shipped to the South and Midwest. Coal from Utah is shipped to Mississippi utilities, and coal from Colorado is burned by Indiana utilities. Coals from Colorado and Utah have been sold under contract for export to consumers in Korea and Japan.

Colorado, New Mexico, and Utah also have deposits of metallurgical coal. Although some of this coal is not of as premium a quality as some metallurgical coals in the East, these Western reserves have supplied the Western steel industry for decades and also show some promise for expanding export markets. Over the next decade, production of metallurgical coal in the Rocky Mountain States is expected to continue at current annual levels of about 3 million tons a year because of conditions in the domestic steel industry.

In the past decade, Colorado, Utah, and New Mexico have seen an increase in coal production and planned mining activities, Many Federal leases have recently gone into production and new mine plans have been proposed for others. Table 36 shows the increases in total and Federal production in these States for selected years since 1972, Federal coal production in these States has risen from 4.6 million tons in 1972 to over 24 million tons in 1980, while total annual production for the region has risen from 19.4 million tons in 1972 to approximately 49 million tons in 1980. Federal leases thus have contributed an even larger share of total production, growing from about 25 percent in 1972 to approximately 50 percent in 1980. The Federal share of total regional production is expected to increase substantially over the next decade. Coal producers in these three States have shared in the generally increased level of coal development activities in the West and hold the optimistic expectation that the coal production from these States will be competitive and capture its share of the expanding market.

In 1979, Federal mines in the Southern Rockies produced 34.7 million tons of coal, with about 20 million tons mined from Federal reserves. If all existing and proposed mines on Federal leases are developed and produce at their expected rates, the 1986 production from mines with Federal leases could more than double the 1979 levels (see table 37). By 1991, production from Federal mines could be more than three times the 1979 level. The increases in production would be most dramatic in Utah, rising from 10 million tons in 1979 to as much as 74 million tons in 1991. In general, the OTA potential production from Federal mines compares favorably with the State task force production estimates and with the Department of Energy's (DOE) final 1985 and 1990 production goals, previously

Table 36.—Total and Federal Production in Colorado, New Mexico, and Utah: Selected Years, 1972-80
(millions of tons)

	1972		1976		1977		1978		1979		1980	
	Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal	Total	Federal
Colorado	5.5	2.4	9.4	1.6	12.0	4.0	13.8	5.7	18,1	7.7	19,5	9.4
New Mexico	8.2	0.2	10.0	1.2	11.1	2.3	12,6	4,3	15.1	5.4	16,5	6.3
Utah	5.7	2.0	799	4.4	8.6	5.8	9.1	5.3	11.8	6.9	13,1	8.7

SOURCES U.S Department of the Interior, *Annual Federal* Coal Management *Reports, Fiscal Years 1979 and 1980*
U S **Geological Survey,** *Federal* **and** *Indian Lands Coal, Phosphate,* Potash, *Sodiurn, and Other Minerals Production,* Royalty Income *and* Related *Statistics* Calendar year 1960, June 1981
Bureau of Land Management, *Public Land Statistics 1976.*
U.S. Department of the Interior, Final *Environmenal Statement Proposed Federal Coal Leasing Program (1975)*
McGraw Hill, *Keystone* Coal *Indusfry Manual 1977.*
U.S. Department of Energy, Energy Information Administration, Coal *Production 1980* **(preliminary), June 1981**

Table 37.—Potential Production From Federal Coal Leases
(all production in million tons per year)

State/reglon	Production in 1979	Potential production from mines with Federal leases: 1986 From leases in approved mine plans[a]	1986 From leases in pending mine plans[a]	1986 From leases without mine plans[b]	1986 Total	1991 From leases in approved mine plans[a]	1991 From leases in pending mine plans[a]	1991 From leases without mine plans[b]	1991 Total
Colorado									
Green River ...	11.2	19.0	1.3	0.6	20.9	20.0	1.8	6.4	28.1
Uinta	4.7	5.6	2.8	0	8.4	5.8	7.4	1.3	14.5
San Juan	0.08	0.07	0	0	0.07	0	0	0	0
Denver-Raton Mesa	0	0	0	0		0	0	0.5	0.5
Total ., ., ...	16,0	24.7	4.1	0.6	29.4	25.8	9.3	8.2	43.1
New Mexico									
San Juan	8.4	10.0	6.6	0.2	16.8	10,5	7.5-10.5	1.7-8.0	19.7 -29.0
Denver-Raton Mesa ., . .	0	0	0	0	0	0	0	0	0
Total . . . . . .,	8.4	10.0	6.6	0.2	16.8	10.5	7.5-10.5	1.7-8.0	19.7 -29.0
Utah									
Uinta	10.4	24	5.6	0	29.6	29.0	11.3	7.0-8.6	47.3-48.9
Southwestern Utah	0	0	0.6	0	0.6	0	0-18.0	0-7.4	0-25.4
Total ., ...	10.4	24	6.2	0	30.2	29.0	11.3-29.3	7.0-? 6.0	47.3-74.3
Grand total	34.7	58.7	16,9	0.8	76.4	65.3	28.1 -49.1	16.8 -32.1	110.1 -146.4

[a] For leases in mine plans, with few exceptions, the lessees' planned production is used.
[b] For leases with no mine plans and favorable or uncertain development potential, OTA estimates are used, Ranges in production reflect uncertainties In construction schedules and final mine capacity

Columns may not add to totals due to independent rounding

SOURCE Office of Technology Assessment

described in chapter 5 of this report (see table 31).

In 1986, production from all mines on Federal leases, including currently undeveloped leases, could reach 76.4 million tons with about 29 million tons coming from Colorado mines, 17 million tons from New Mexico, and over 29 million tons from Utah. Estimated production from mines on Federal leases in the Colorado portion of the Green River-Hams Fork region is 20.9 million tons in 1986 with about 15.7 million tons from surface mines. Total production from Federal mines in the Uinta region in 1986 is expected to be about 36 million tons (8.4 million tons in Colorado and 29.6 million tons in Utah). Almost all of this production will come from underground mines. Production from mines with Federal leases in the San Juan region is estimated to reach 16.8 million tons in 1986 with most of it coming from large surface mines in New Mexico,

For both Colorado and New Mexico, the DOE 1985 production goals are higher than the potential production from Federal leases, however, the difference is in large part offset by production from existing and planned non-Federal mines and from new mines on Federal PRLAs. In Utah, OTA's potential production from Federal mines of 30 million tons matches the DOE medium production goal, but both estimates are higher than the estimate of 15 million to 18 million tons used by the OTA Utah task force.

For 1991, production from mines with Federal leases is projected to increase to between 110 million and 146 million tons depending on the rate of mine construction. Federal mines in Colorado would account for 43 million tons, New Mexico mines for up to 30 million tons and production from Utah mines would add between 47 million to 74 million tons. About 28 million tons could come from Federal mines in the Green River region. Between 59 million and 61 million tons could be produced from Federal mines in the Uinta region (14.5 million tons in Colorado and 44.8 million to 46.4 million tons in Utah). Between 19.7 million and 29 million tons is expected to be produced from Federal mines in the San

Juan region in New Mexico. Production from Federal leases in Southwestern Utah is uncertain and ranges from no production at all to as high as 25 million tons by 1991.

The 1990 DOE production goals for Colorado range from a low of 28 million tons to a high of 43 million tons; 35 million tons is the midlevel goal. (These goals were reduced slightly from the preliminary DOE goals published in August 1980.) Potential production of 37 million to 43 million tons from Federal mines and undeveloped leases could meet or exceed the DOE goals and the State task force 1991 minimum production estimate of 32 million to 38 million tons. Even though non-Federal mines are expected to contribute a smaller relative share of State production by the late 1980's, the large production capacity of existing Federal leases is apparent. However, at least a portion of this capacity could be used to replace existing mines that will shut down in the mid-1990's. Potential Federal mine production of 47 million to 74 million tons in Utah in 1991 could also exceed the DOE high production goal of 63 million tons and the State task force estimate of 30 million tons. However, when the likelihood of little, if any, production from Southwestern Utah is considered, the lower estimate of 47 million tons in 1991 is comparable to the DOE medium goal of 49 million tons. Both the DOE 1990 New Mexico production goals (56 million to 67 million tons) and the OTA task force 1991 maximum production estimate of 72 million tons are substantially higher than Federal mine production of 20 million to 29 million tons. When planned production from Indian and non-Federal mines is added to Federal mine production, the total is around 67 million tons, the DOE goal, but still less than the OTA task force estimate. Thus, while there is a substantial variety in estimates of coal demand and production for the Southern Rocky Mountain States, in most cases, OTA's estimated potential production from Federal mines falls within the ranges of production that would be absorbed under the various forecasts.

By the early 1990's, several currently operating mines on Federal leases will deplete their existing lease reserves. Replacement capacity for at least three of these mines will come from new mines on other existing Federal leases. Replacement capacity amounts to between 5 million and 10 million tons of total new annual production capacity.

OTA's production estimates include some uncertainties that are reflected as ranges of potential production and capacity. If all leases meet current mine plan schedules and demand for coal from these States increases as expected, production from Federal mines could reach 110 million tons in 1991. Production of an additional 36 million tons of coal in 1991 is possible, but subject to large uncertainties as a result of factors that could delay or prevent development. About 10 million tons of estimated 1991 output comes from existing or proposed captive mines that may not reach planned full production levels because of changes in internal coal requirements or production schedules. Between 4 million and 8 million tons of 1991 production could be used in proposed synthetic fuel projects. However, according to the lessees, delays in these projects are not expected to affect planned production in 1991 since the coal produced could be used to meet existing contracts.

The greatest uncertainty involves the estimated 25 million tons of production, and 36 million to 45 million tons of annual capacity from mines in Southwestern Utah. Except for the Alton Mine, none of the existing leases there have even tentative commitments for potential production. Furthermore, the Alton and Kaiparowits Plateau fields are not connected to existing transportation networks. A slurry system and rail line have been proposed to link these fields to potential markets, primarily in Nevada and California. However, according to most estimates, at least 30 million tons of annual coal production would be needed to support construction of the needed transportation system. OTA's anal-

ysis indicates that Federal leases on the Kaiparowits Plateau could support that level of production, however, it is unlikely that the lessees would begin producing without assurances that the transportation system would be built. Mine-mouth powerplants that were once proposed for Southern Utah, have been abandoned because of high capital costs and water availability and air pollution problems. The Alton Mine and slurry project is opposed by environmental groups because of potential impacts on Bryce Canyon and Zion National Parks and on regional water supplies and air quality.

The rate of development for about 10 million tons of capacity in the central San Juan basin of New Mexico is also in question because of delays in the original construction schedule and final right-of-way approvals for the proposed Star Lake Railroad. In addition, two proposed mines there are linked to pending PRLAs and sustaining full production capacity depends on the availability of PRLA reserves. Several of the lessees could, however, begin small-scale production on existing leases before 1986 in order to meet diligence requirements and could delay expansion until the rail line is completed. Thus, delays are not expected to affect lease development except in the rate of construction and production.

The factors affecting development and production from Federal leases in Colorado, New Mexico, and Utah are discussed in more detail in the State appendixes to this report and in the OTA task force reports.

Development Status of Federal Coal Leases in the Southern Rocky Mountain Region

Over **60** percent of the 360 coal leases in the Southern Rocky Mountain region were covered by approved or pending mine plans as of September 30, 1980. About 30 percent, 113 leases, are part of 35 operating mines with approved mining plans. During fiscal year 1980, coal was actually produced from 57 of these leases in approved mine plans. (The number of leases in approved mine plans that are actively being mined varies according to the lessees' production schedules and mine configurations.) Another 108 leases are included in 25 proposed new mines for which mine plans have been submitted to DOI. The remaining 139 leases, 38 percent of the leases in the region, have not yet reached the mine plan stage of development. The 139 undeveloped leases are divided into 77 different blocks of contiguous leases in common ownership. (Table 38 summarizes the acreage and reserves under lease by mine plan status.)

While many existing leases are in historically active mining areas, some are located in areas that have not been mined extensively. Two such areas—the southern San Juan basin and Southwestern Utah—are largely rural and have supported little past coal mining activity. Proposed large-scale coal development in these two fields with substantially untapped coal resources raises potentially difficult conflicts with other resource values and land uses. Several of the active mining areas face major expansions of coal mining at the same time that they are already being affected by development of other energy sources—oil shale, oil and gas, uranium, and tar sands. If all these development activities proceed, they could change the predominantly rural character and economic base of these regions which primarily have depended on mining, agricultural, recreational, and nonindustrial activities.

Federal coal production in the Southern Rocky Mountain region has more than quadrupled in the past decade and it will continue to grow during the 1980's as new mines open and existing mines expand capacity. By 1991 according to OTA's analysis, total production from mines operating on existing Federal leases in the region could reach as much as 146 million tons. Total mine capacity could eventually reach more than 216 million tons per year in the mid-1990's if all planned mines and leases with favorable and uncertain development prospects go into production.

Table 38.—Acreage and Reserves Under Lease by Development Status

	Approved mine plans				Pending mine plans				No mine plans		
	Number of leases	Number of plans	Acres	Recoverable reserves (millions of tons)	Number of leases	Number of plans	Acres	Recoverable reserves (millions of tons)	Number of leases	Number of blocks	Acres	Recoverable reserves (millions of tons)
State/BLM *coal region*												
Colorado												
Green River	31	10	25,687	519	3a	3	3,150[a]	28	[a] 23	21	24,417	816
Uinta	22[b]	8	16,239[b]	203[b]	18[c]	8	34,704[c]	427	[c] 23	11	18,850	173
San Juan	1	1	160	1.6	—	—	—	—	—	—	—	—
Denver-Raton Mesa	—	—	—	—	—	—	—	—	6	4	3,686	66
Total	54	19	42,086	724	21	11	37,855	455	52	36	46,953-	1,055
New Mexico												
San Juan	9[d]	2	18,828	169[d]	9	3	21,098	183	8	7	4,634	95
Denver-Raton Mesa	0	0	0	0	0	0	0	0	3	3	200	0.5
Total	9	2	18,828	169	9	3	21,098	183	11	10-	4,834	95
Utah												
Uinta	50	14	55,540	792	14[e]	8	25,711[e]	264	[e] 44	20	47,679	447
Southwestern Utah.	0	—	—	—	64	3	93,029	1,006	32	11	57,537	744
Total	50	14	55,540	792	78	11	118,740	1,270	76	31	105,215	1,191

NOTE: Sums of acreage and reserves columns may not add to totals because of Independent rounding

[a]Lease total does not include one lease in pending Trout Creek underground mine **plan,** which is also part of approved Edna surface mine, acreage and **reserves totals** have been adjusted 10 avoid double counting

[b]**Approved mine plan lease and acreage totals exclude one** lease in the approved Bear Mine, which is included in the larger, proposed Mt. Gunnison Mine to avoid double counting.

[c]Pending mine plan lease, acreage and reserve totals exclude one lease in **proposed Blue Ribbon Mine located on a portion of U.S. Steel's Somerset Mine leases** that have an approved plan, totals have been adjusted to avoid double counting.

[d]Approved mine plan lease, acreage and reserve totals also include one lease issued in 1980 for the San **Juan Underground Mine Extension and one small lease Included in a minor modification to the San Juan surface mine.**

[e]**Total does not include three leases that are part of the pending O'Connor mine plan and which are also covered in part by the approved Belina and skyline mine plans, totals** have been adjusted to avoid double counting

SOURCE: Off Ice of Technology Assessment

Leases With Approved Mine Plans

There are 113 leases in 35 active mines with approved mine plans in the Southern Rocky Mountain region. They cover a total of over 116,000 acres of Federal land and contain more than 1.6 billion tons of recoverable Federal coal reserves. Nine mines are surface operations (seven in Colorado, two in New Mexico) and 26 are underground mines (12 in Colorado, 14 in Utah). Over the next decade, two of the active surface mine operations are planning to shift to underground operations to recover deeper reserves (one in Colorado, one in New Mexico). Table 39 summarizes the acreage and reserves for mines with Federal leases in Colorado, New Mexico, and Utah. Table 40 shows the total capacity and estimated 1979, 1986 and 1991 production for mines with approved mine plans on Federal leases.

The 26 underground mines range in size from two small mines producing less than 100,000 tons per year (one in Colorado, one in Utah) to large mine complexes producing over 1 million tons annually. Three of the existing underground mines propose to expand annual production capacity to 5 million tons per year or more by 1986. The nine active surface mines on Federal leases range in size from one small operation producing just over 100,000 tons annually to several large surface mines producing over 5 million tons per year. Most of the surface mines produce between 1 million and 3 million tons annually. Surface mining activity on existing leases is currently limited to the Green River region of

Table 39.—Summary of Mine Plan and Federal Lease Acreage and Recoverable Reserves: Approved Mine Plans, Sept. 30, 1980 (all reserves shown in millions of tons)

State/region	Number of leases	Number of mine plans	Total mine plan acres	Total Federal mine plan acres	Total Federal lease acres	Total mine plan reserves			Total Federal lease reserves		
						Under-ground	Sur-face	Total	Under-ground	Sur-face	Total
Colorado											
Green River	31	10	40,300	25,687	25,687	113	303	416	199	320	519
Uinta	22	8	24,104[a]	16,239[a]	16,239[a]	208	0	208	203	0	203
San Juan	1	1	160	160	160	0.7	0	0.7	1.6	0	1.6
Denver-Raton Mesa	—	—	—	—	—	—	—	—	—	—	—
Total	54	19	64,564	42,086	42,086	322	303	625	404	320	724
New Mexico											
San Juan	9	2	13,622[b]	14,972[b]	18,828	0	194	194	0	169	169
Denver-Raton Mesa	—	—	—	—	—	—	—	—	—	—	—
Total	9	2	13,622	14,972	18,828	0	194	194	0	169	169
Utah											
Uinta	50	14	85,260[c]	54,523[c]	55,540[c]	630	0	630	792[c]	O	792[c]
Southwestern Utah	—	—	—	—	—	—	—	—	—	—	—
Total	50	14	85,260	54,523	55,540	630	0	630	792	0	792

[a]Total excludes acreage in approved Bear Mine that is also included in pending Mt. Gunnison mine Plan.
[b]Total mine plan acreage and Federal mine plan acreage exclude 3,856 acres in San Juan Underground Mine expansion not approved as of Sept. 30, 1960
[c]All totals have been adjusted to avoid double Counting of lease acres and reserves Included in the Belina and Skyline approved mine plans and the pending O'Connor mine plan

SOURCE Off Ice of Technology Assessment, mine plan review

northwest Colorado and to the San Juan basin of New Mexico, although two surface mine operations are proposed for Federal leases in Utah.

Total capacity of the active mines with Federal leases is 74.3 million tons per year at full production. The surface mines in Colorado and New Mexico account for about 26 million tons of annual capacity. The remaining 48 million tons of capacity is in underground mines. Many of the active mines have been opened within the last 5 years and will not produce at full capacity until about 1986.

Most of the approved mining operations include both Federal and non-Federal coal reserves. Total estimated production from these mines in 1979 was 34.7 million tons. About 20 million tons of this production came from the more than 55 Federal leases in approved mine plans that were actually mined. About 20 million tons of the total 1979 Federal mine production came from surface mines and 14 million tons was from underground mines.

By 1986, production from mines with approved mine plans could total 58.7 million tons. About 26 million tons of this will come from surface mines. By 1991 production from currently active mines is projected to be 65.3 million tons. Over the next decade at least two of the mines with approved plans are expected to exhaust their reserves and the operators will shift to proposed new mines on other Federal leases.

Colorado.—There are 19 mines with approved mine plans operating on Federal leases in Colorado. The 54 leases in these mines cover over 42,000 acres and contain an estimated 724 million tons of recoverable reserves. Seven of the approved operations are surface mines located in the Green River region of northwest Colorado. The remaining 12 mines are underground mines. Three of the underground mines are in the Green River region, eight are found in the Uinta region and one in the San Juan River region. There are no active mines on Federal leases in the Denver-Raton Mesa region of Colorado.

Table 40.—Mine Capacity and Projected Production: Leases in Approved Mine Plans: Colorado, New Mexico, and Utah, Sept. 30, 1980 (capacity and production in millions of tons)

State/basin	Number of mine plans with Federal leases	Number of Federal leases in these plans	Maximum annual capacity of all proposed mines	1979 Actual production from mines with Federal leases	1986 Maximum mine capacity of producing mines	1986 Projected production from mines with Federal leases	1991 Maximum mine capacity of producing mines	1991 Projected production from mines with Federal leases
Colorado								
Green River	10	31	23.6	11.2	20.6[a]	19.0	20.5[b]	19.9
Uinta	8	22	8.0	4.7	7.7[c]	5.6	6.5[d]	5.8
San Juan	1	1	0.07	0.08	0.07	0.07	0[e]	0
Denver-Raton Mesa	0	0	0	0	0	0	0	0
Total	19	54	31.6	16.0	28.4	24.7	27.0	25.8
New Mexico								
San Juan	2	9	10.5[f]	8.4	10.5	10.0	10.5	10.5
Denver-Raton Mesa	0	0	—	—	—	—	—	—
Total	2	9	10.5	8.4	10.5	10.0	10.5	10.5
Utah								
Uinta	14	50	32.2	10.4	32.2	24.0	32.1[g]	29.0
Southwestern Utah	0	0	0	0	0	0	0	0
Total	14	50	32.2	10.4	32.2	24.0	32.1	29.0
Regional total	35	113	74.3	35.4	71.1	58.7	69.6	65.3

[a]**Empire Energy Eagle #5 and #9 Mines** exhaust existing lease reserves; possibility Of extending mine life with new lease reserves not known.
[b]canadian Strip mine exhausts existing lease reserves; additional new lease reserves have been requested.
[c]Bear Mine shuts down in early 1980's, production from lease continues as part of proposed Mt Gunnison Mine.
[d]Roadside Mine exhausts existing lease reserves according to mine plan.
[e]Kng Coal Mine shuts down because existing lease reserves exhausted.
[f]Capacity excludes 2 million tons of replacement capacity from the San Juan underground mine, which will open in early 1980's, to maintain production at San Juan Mine complex at 5.5 million tons annually.
[g]Trail Mountain Mine exhausts existing lease reserves according to mine plan; additional new lease reserves have been requested.

Maximum capacity means the highest annual production from a mine operating at its full designed capacity level and not the installed capacity in place in 1988 to 1991. Actual installed capacity for most mines in the Southern Rocky Mountains will be at or near the projected production levels,
Production estimates based on lessees' mine plan schedules,

SOURCE: Office of Technology Assessment.

At full operation, the total production capacity of the active mines on Federal leases is 31.6 million tons per year. These mines include large surface mines producing over 3.4 million tons annually, medium to large underground mines yielding from 200,000 to over 1 million tons annually, and several small operations serving local or spot markets. Several of the underground mines are expanding their capacity by constructing new portals that will allow mining of several overlying seams at the same time. These enlarged underground mines will be capable of producing over 4 million tons annually—thus matching the capacity of large surface mines in the same area. By the early 1990's, several large surface mines in the Green River area are expected to exhaust their current mine plan reserves and will have to either shut down or shift to underground recovery if additional strip reserves are not available. At least one underground mine will require additional unleased Federal reserves to maintain the planned level of production.

Total 1979 production from the 19 mines with Federal leases in Colorado was more than 16 million tons; 7.7 million tons was mined from 39 of the Federal leases. According to current mine plan projections, production from currently active mines on Federal leases is expected to reach 24.7 million tons by 1986 and by 1991 their total output will rise slightly to about 25.8 million tons. The

Federal leases in approved mine plans are discussed more fully in the Colorado appendix.

New **Mexico.** —The two currently operating mines on Federal lands in New Mexico include nine Federal leases with over 18,000 acres and 169 million tons of Federal reserves. Both mines are located in the San Juan basin in northwestern New Mexico. The McKinley Mine, near Gallup operates on Federal, Navajo and private lands; the San Juan Mine near Farmington operates mostly on Federal land. The total annual production capacity of these two surface mines is currently 10.5 million tons. The San Juan Mine will replace about 2 million tons of surface capacity with underground capacity as it moves to deeper seams.

In 1979, the two mines produced a total of 8.4 million tons with 5.4 million tons coming from Federal reserves. According to current mine plans and information from lessees, total production will increase to 10 million tons by 1986. Capacity and production from the two mines are projected to remain at around 10 million tons per year through 1991. Production from both mines is used primarily at powerplants in the Southwest. See the New Mexico appendix for additional information on these mines.

Utah.—There are currently 14 active underground mines with Federal coal leases in the Uinta coal region in central Utah. These 14 approved mine plans include 50 leases covering a total of more than 55,000 leased acres and containing about 792 million tons of recoverable coal reserves. At full operation, the total capacity for these mines will be 32.2 million tons per year, or roughly three times greater than the 1979 production levels.

Total coal production in Utah in 1979 was 11.8 million tons. About 10.4 million tons of this was produced by the mines with Federal leases, with 6.9 million tons mined from Federal reserves. The Utah State Geological Survey estimates that up to 2 million tons of coal were stockpiled by several Utah mines in 1979 because of low demand. This overcapacity is expected to be short-lived. With the opening of the new Emery and Intermountain Power Project electric generating stations, in-State use will expand significantly. Spot market sales and long-term contracts for exports to Japan and Korea are being negotiated. According to several coal operators in the region, all current excess capacity in Utah was under contract by early 1981.

By **1986,** production from mines with approved plans on Federal leases in Utah is expected to rise to about 24 million tons. Two of the currently producing mines are scheduled to be depleted in the early 1990's. However, this loss in capacity will be offset as newer operations reach full production levels in the late 1980's. By 1991, total production from the currently approved mining operations is projected to increase to about 29 million tons. A significant portion of this total is captive production for steel and utility companies. See the Utah appendix for additional information on active mines on Federal leases in Utah.

Leases in Pending Mine Plans

As of September 30, 1980, 25 mine plans with 108 Federal leases were under review by DOI. These new mines include a total of 108 Federal leases with over 177,000 acres and 1.9 billion tons of recoverable reserves. Most of the proposed mines include both Federal and non-Federal coal reserves. The mine plans cover more than 221,000 acres with Federal leased acreage making up about 75 percent of the total. The 25 pending mine plans vary widely in completeness and sophistication, ranging from multivolume, technically complete proposals in the final stages of permit review, to more general "conceptual" descriptions of the lessee's 1ong-range plans. Many of the conceptual mine plans were submitted in 1976-78 in response to DOI requests for information on diligent development or for inclusion in regional coal statements and have not been updated to include information for permit approval under

the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Table 41 summarizes the acreage and reserves for these proposed mines, and table 42 shows the estimated capacity and production.

The 25 pending mine plans include 4 new surface mines (2 in New Mexico, 2 in Utah) and 21 new underground mines (11 in Colorado, 9 in Utah, and 1 in New Mexico). The two Utah surface mines also include some underground operations. The total annual production capacity of these proposed mines at full operation is 71.6 million tons. About 25 million tons is surface mine capacity and 47 million tons is underground mine capacity. Most of these mines will not reach full capacity until the 1990's. The proposed underground mines range in size from some with annual capacity between 100,000 and 500,000 tons per year to several new, large mines capable of producing over 1 million tons per year. Several of the largest proposed underground mines would produce over 10 million tons annually. The proposed new surface mines range in size from 1.6 million to more than 11 million tons of annual production capacity. Two of the proposed surface mines are in areas where there is currently no large-scale surface coal mining activity—the Alton Field of Southwestern Utah and the central San Juan basin of New Mexico.

All of the proposed mines are scheduled to begin production over the next decade. The more technically complete and active mine plan proposals will probably receive the necessary permits and begin construction in the next few years. Some of these will be producing by 1986. Initiation of production from several mines with inactive mine plans is less certain. According to mine plan estimates, about 16.9 million tons will be produced from proposed mines with Federal leases in the Southern Rocky Mountain States in 1986. By 1991, production from proposed mines with Federal leases is expected to be between 28.1 million tons and 49.1 million tons. The range

Table 41.—Summary of Mine Plan, Federal Lease Acreage and Recoverable Reserves Pending Mine Plans—Colorado, New Mexico, and Utah, Sept. 30,1980 (all reserves shown in millions of tons)

State/region	Number of leases	Number of mine plans	Total mine plan acres	Total Federal mine plan acres	Total Federal lease acres	Total mine plan reserves			Total Federal lease reserves		
						Under-ground	Sur-face	Total	Under-ground	Sur-face	Total
Colorado											
Green River	3[a]	3	3,150[a]	3,150[a]	3,150[a]	31[b]	0	31[b]	28[b]	0	28[b]
Uinta	18	8	39,144	34,704	34,704	423	0	423	427	0	427
San Juan	—	—	—	—	—	—	—	—	—	—	—
Denver-Raton Mesa	—	—	—	—	—	—	—	—	—	—	—
Total	21	11	42,293	37,854	37,854	454	0	454	455	0	455
New Mexico											
San Juan	9	3	29,580	14,979	21,098	42	352	394	56	127	183
Denver-Raton Mesa	—	—	—	—	—	—	—	—	—	—	—
Total	9	3	29,580	14,979	21,098	42	352	394	56	127	183
Utah											
Uinta	14[d]	8	33,020	19,902	25,711	300	15	315	247	17	264
Southwestern Utah	64	3	116,949	93,029	93,029	100	823	923	776	230	1,006
Total	78	11	149,969	112,931	118,740	400	838	1,236	1,023	247	1,270

[a]Excludes one lease in Trout Creek underground mine that is also part of approved Edna surface mine: acreage figures have been adjusted to avoid double counting.
[b]Reserves totals Include Trout Creek Mine underground reserves
[c]Acreage totals include leased area in approved Bear Mine that is also Part Of proposed Mt Gunnison Mine
[d]Excludes three leases in the proposed O'Connor Mine that are also partly covered by the approved Skyline and Belina mines Acreage and reserves figures include actual lease portions in the O'Connor mine plan

Acreage and reserves may not add to totals because of Independent rounding

SOURCE: Office of Technology Assessment; mine plan review.

Table 42.—Mine Capacity and Projected Production: Leases in Pending Mine Plans, Colorado, New Mexico, and Utah (all capacity and production in millions of tons)

State/basin	Number of mine plans with Federal leases	Number of Federal leases in these plans	Total maximum capacity in pending mine plans	1986 Maximum* capacity of mines producing in 1986	1986 Projected production from mines with Federal leases	1991 Maximum capacity of mines producing in 1991	1991 Projected production from mines with Federal leases
Colorado							
Green River	3	4[a]	2.3	2.3	1.3	2.3	1.8
Uinta	8	18	11.1	8.7	2.8	11.1	7.4
San Juan	0	0	0	0	0	0	0
Denver-Raton Mesa	0	0	0	0	0	0	0
Total	11	22	13.4	11.0	4.1	13.4	9.3
New *Mexico*							
San Juan	3	9	15.3	15.3	6.6	15.3	7.5-10.5
Denver-Raton Mesa	0	0	0	0	0	0	0
Total	3	9	15.3	15.3	6.6	15.3	7.5-10.5
Utah							
Uinta	8	17[b]	13.1	11.9	5.6	13.1	11.3
Southwestern Utah	3	68	29.8	11	0-0.6	29.8	0-18.0
Total	11	85	42.9	22.9	5.6-6.2	42.9	11.3 -29.3
Regional total	25	116	71.6	49.2	16.3 -16.9	71.6	28.1 -49.1

[a]Includes one lease also in an approved plan
[b]Includes three leases also in approved plans.
* Maximum capacity means highest annual production from mine operating at full design capacity level and not the Installed capacity in place in 1986 or 1991 Actual Installed capacity for most mines in Southern Rocky Mountains will be at or near the projected production levels
Product Ion and capacity columns may not add to totals because of Independent rounding

SOURCE' Off Ice of Technology Assessment

in production reflects uncertainties about the pace and scale of planned mine construction.

At least seven of the new mines with pending plans will not begin production until after 1986. There are several reasons for this: 1) some new mines are replacement capacity for existing operations and will not open until the active mines shut down or reduce production; 2) other mines are being developed under difficult mining conditions, and thus require longer periods for construction, and 3) several mines are intended to supply new powerplants that have been delayed or deferred. The planned production dates show that some operators clearly intend to open mines according to their own schedules and market situations rather than to accelerate development or project early starts to meet 1986 diligence requirements. All of the operators expect to qualify for extensions or modification of the diligence requirements under current guidelines,

Despite the optimism reflected in pending mine plans, OTA's analysis indicates that production from some of these mines is uncertain. In several instances, the mine plans appear to be inactive and the lessee has not proceeded with development according to the original plan schedule. Moreover, because of the substantial difficulties facing developers in Southwestern Utah, it is likely that the proposed mines there will not open in the late 1980's as originally announced, if at all.

Colorado.—Proposed mine plans for 11 new mines on Federal leases in Colorado have been filed for review by DOI. The plans include 21 leases with a total acreage of over 37,000 acres and with estimated recoverable reserves in excess of 450 million tons. All of the proposed new mines are underground operations, All but three of the pending mine plans are in the Uinta region. The production capacity of the pending mine plans at full operation is over 13 million tons per year.

For 1986, these mines are projected to produce about 4 million tons. By 1991, production is estimated to increase to around 9.3 million tons. Several of the mines are expansions or replacements of existing capacity. Many of the pending Colorado mine plans were recently submitted or updated. Although markets for some mines are still unknown, at least two of the new mines have contracts or letters of intent to supply existing or planned powerplants. See the Colorado appendix for additional information on pending mine plans in Colorado.

New **Mexico.—** Mine plans were recently submitted for three new mines on Federal leases in the San Juan basin of New Mexico. The plans include nine Federal leases covering over 21,000 acres and 183 million tons of recoverable reserves. The proposals include two new large surface mines in the Star Lake-Bisti area and one underground mine that will produce coal for industrial use. Total production capacity for these mines is 15.3 million tons per year. By 1986, OTA estimates that production could approach 6.6 million tons, or about 43 percent of full capacity. The production estimates for 1991 are more variable, and range between 7.5 million and 10.5 million tons depending on the rate of mine construction of the proposed surface mines.

Portions of two Federal leases in the proposed Bisti Mine are under review for exchange for unleased Federal coal. The exchange is not expected to delay mine construction. Production from the Bisti Mine will supply the San Juan Power Plant and the as-yet-unsited New Mexico Generating Station. The Star Lake Mine is associated with pending PRLAs; the attainment of full commercial production at Star Lake Mine is contingent on the availability of PRLA reserves and on construction of the Star Lake Railroad for access to out-of-State markets. See the New Mexico appendix for additional information on these mines.

Utah.—Eleven new mines on Federal leases in Utah have been proposed. The mines contain 78 Federal leases and over 118,000 acres of Federal land with nearly 1.3 billion tons of recoverable coal reserves. The mine plans cover almost 150,000 acres, and the total mine plan reserves, which include both Federal and non-Federal coal, are over 1.2 billion tons. (Total mine plan reserves are less than the total lease reserves because plans currently do not cover all of the leased land.) Eight of the mines are located in central Utah and three are in Southwestern Utah. The proposed mine plans include nine new underground mines and two new surface mines—the first strip mines on Federal leases in Utah.

The total annual capacity of these proposed mines at full production is 42.9 million tons. The smallest of the mines will produce 220,000 tons per year at full capacity; the largest mine will have an annual capacity of 12 million tons. The three mines in Southwestern Utah have a total proposed capacity of 29.8 million tons per year. Several mines will not reach full production levels on current schedules until the late 1980's or early 1990's. Markets for several of the new mines in Utah are as yet unknown, although at least 4,2 million tons of capacity can be considered captive production.

According to the pending mine plans, total production could reach 6.2 million tons by 1986. As the new mines near full-scale operations in 1991, total production is expected to be between 11.3 million and 29.3 million tons, depending on whether the three mines in Southwestern Utah open as planned. The rate of production from several mines in central Utah could be less than currently projected because of changes in construction plans for associated projects. See the Utah appendix for additional information on the uncertainties in the potential production from pending mine plans.

Undeveloped Leases

In the three Southern Rocky Mountain States there are 139 Federal coal leases

classified as undeveloped (without mine plans). Table 43 shows the acreage and reserves for undeveloped leases in Colorado, New Mexico, and Utah. These 139 leases are divided into 77 lease blocks and contain over 2.3 billion tons of reserves. OTA's review of the reserves and mining conditions on the leases found that 96 leases in 37 minable blocks with 95 percent of the undeveloped lease reserves could support new mining operations. OTA's analysis further showed that most, but not all of these 96 leases, could be developed over the next decade. In addition, there are a small number of leases that could be mined as part of adjoining operations on existing or new base tracts.

OTA identified 42 leases with 599 million tons of reserves that actually have favorable prospects for development by 1991. An additional 54 leases with over 1.5 billion tons of reserves have uncertain prospects for development. Forty-three leases with 219 million tons of reserves were found to have unfavorable development potential. Over 70 percent of the lease reserves with favorable development potential are found in the Uinta region of central Utah. Almost all of the reserves with uncertain development potential are located in the Green River region of Colorado and in Southwestern Utah. The major uncertainties associated with lease development are: 1) markets; 2) construction of proposed transportation systems; and 3) availability of additional reserves. Most of the leases that were found to have unfavorable potential for development are small isolated lease tracts with limited reserves.

Table 43.—Undeveloped Leases in Colorado, New Mexico, and Utah: Acreage and Recoverable Reserves

State/region	Total number of leases	Total number of lease blocks	Total Federal acres	Total recoverable reserves (millions of tons)
Colorado				
Green River	23	21	24,417	816
Uinta	23	11	18,850	173
San Juan	0	0	0	0
Denver-Raton Mesa	6	4	3,686	66
Total	52	36	46,953	1,055
New Mexico				
San Juan	8	7	4,634	95
Denver-Raton Mesa	3	3	200	0.5
Total	11	10	4,834	95
Utah				
Uinta	44	20	47,679	447
Southwestern Utah	32	11	57,537	744
Total	76	31	105,215	1,191
Regional total	139	77	157,002	2,341

Acreage and reserves may not add 10 totals because of Independent rounding

SOURCE. Office of Technology Assessment.

Potential production from undeveloped leases that were rated as favorable or uncertain development prospects is estimated to be only about 800,000 tons by 1986, however by 1991, potential production from these leases could range between 16.8 million and 32.2 million tons depending on the rate of mine construction and resolution of various uncertainties. The undeveloped leases could contribute between 32 million and 55 million tons of new annual capacity and 2.6 million tons of replacement capacity,

Summary of Undeveloped Lease Statistics

Of the 360 Federal leases in the region, 39 percent are classified as undeveloped. They cover more than 157,000 acres, or about 35 percent of land under lease in the three States, and include over 2.3 billion tons of recoverable reserves, or over 39 percent of the leased reserves in these States. Of all leases identified as undeveloped by OTA, 56 percent are located in this region.

Utah, with 76 undeveloped leases, has more than half of the region's undeveloped leases; there are 52 undeveloped leases in Colorado and 11 in New Mexico. Utah and Colorado each have slightly over 1 billion tons of undeveloped lease reserves. Nearly all of New Mexico's undeveloped reserves are surface minable; in contrast, most of the undeveloped lease reserves in Utah must be deep mined. Slightly more than half of Colorado's undeveloped lease reserves are accessible by underground methods; the rest can be surface mined.

The undeveloped leases in the Southern Rocky Mountain region vary widely in character. At least 13 lease blocks are part of pro-

posed mining projects for which mine plans are nearly completed. Another 13 blocks with 17 leases are small tracts of less than 100 acres that formerly sustained small underground mines serving local markets. These mines closed for various reasons: 1) inability to meet increased health and safety requirements; 2) difficult mining conditions; 3) depleted reserves; or 4) a decline in local markets. Many of these smaller leases are located in the isolated mountainous areas. Several large multilease blocks in remote areas are also isolated from potential markets because of lack of rail service. Two of these lease areas—Southwestern Utah and the Star Lake-Bisti area of the San Juan basin in New Mexico—also present possible environmental conflicts for large-scale coal developers because of potential impacts on nearby national parks, monuments and other scenic and archeological resources.

OTA has grouped the 139 undeveloped leases in the Southern Rocky Mountain region into 77 blocks of contiguous leases that are owned by the same lessee(s). Each block will probably be mined as one operation if developed. The blocks range from single leases of **40** acres to multilease blocks with as many as 10 leases and a total of more than 25,000 acres.

Colorado has the largest number of lease blocks, 36, of which 31 are single lease blocks and 5 are multilease blocks. New Mexico's 11 undeveloped leases are divided into 10 blocks. Seven of these are single lease blocks of less than **160** acres, one is a two lease block of **160** acres, and two are large leases, each with enough reserves to sustain a new large mine.

Utah's 76 leases are divided into **31** lease blocks—20 blocks in central Utah and 11 blocks in Southwestern Utah. These blocks include 12 multilease blocks and 19 single lease blocks. The single lease blocks in Utah range in size from **40** acres to 1,908 acres.

The Colorado, New Mexico, and Utah sections of the appendix to this report describe the lease blocks in more detail.

Assessing the Development Potential of Undeveloped Leases (in Colorado, New Mexico, and Utah)

OTA's analysis of undeveloped leases included an assessment of each lease block to determine which blocks could potentially support a new mine. OTA compared the resource characteristics of each block with those of active or proposed mines in the same region. Both large and small mines were included in the regional mine profiles. * The following criteria were used:

1. Approximate mining unit. Is the lease block compact, contiguous, and under single ownership to allow for orderly development as a mining unit?
2. Coal *reserves.* Are the recoverable coal reserves within the lease block sufficient to support a competitively sized new mine, i.e., large mines producing **0.5** million to 1.0 million tons per year; small mines producing **50,000** tons per year?
3. Coal quality. Do the coal reserves meet minimum Btu, sulfur, and ash quality standards for the expected end use, e.g., steam coal, industrial use, synthetic fuels?
4. Geological characteristics. Do the geological conditions of the coal reserve such as depth of overburden, seam thickness and dip, and surface topography permit efficient mine design and economic coal recovery comparable to other operating mines in the area?

When the quality and quantity of the reserves and the potential mining conditions on the lease blocks are considered, 37 blocks with a total of 96 leases were found to have sufficient minable reserves to sustain a new mine without additional Federal or non-Federal reserves. Of these 37 blocks, 10 lease blocks could support new small mines. It is from these 96 Federal leases with sufficient amounts of good quality minable reserves that most, if not all, of the new production

*These profiles and the results of OTA's evaluation of property characteristics are discussed in detail in the State task force reports.

from existing Federal leases will come. See table 44 for the results of OTA's review of the resource characteristics of undeveloped leases.

In addition to the resource characteristics, OTA's analysis of the development potential of leases without mine plans also included an evaluation of other factors, such as market conditions, transportation availability, and environmental requirements, that will influence whether a lease will go into production, For the Southern Rocky Mountain region, OTA found that the undeveloped leases divide almost evenly among three categories: favorable, uncertain, and unfavorable development prospects. The leases, acreage and reserves in these categories are summarized in table 45. Forty-two leases (13 blocks) were rated as favorable prospects for development by 1991; 54 leases (28 blocks) were rated as uncertain; and 43 leases (36 blocks] were rated as unfavorable. Only 9 percent of the undeveloped lease reserves are included in blocks with unfavorable development potential. Roughly 65 percent of the undeveloped reserves, 1.5 billion tons, fell into the uncertain category and 599 million tons, or 25 percent of the undeveloped reserves in the region received a favorable rating. As a result of the analysis of the prospects for development of existing leases, several lease blocks with minable reserves that could support new mines were found to have little chance of actually going into production in the next decade. A small number of leases that could not independently support viable mining operations were found to have some potential for development in association with adjacent Federal or non-Federal reserves.

At least 17 leases (5 blocks) with favorable ratings are part of proposed mining projects with mine plans in preparation and potential customers for future production. The lease blocks with favorable prospects for development also include several large tracts of excellent reserves for which current development plans are unknown. The undeveloped leases with unfavorable development potential include many single lease tracts with small reserves as well as several larger tracts in areas that are not likely to be linked to an adequate coal transportation system within the next 10 years. Some of the leases receiving uncertain development prospect ratings face resolvable development problems such as potentially adverse environmental impacts, uncertainties about construction of proposed transportation systems,

Table 44.—Resource Characteristics of Undeveloped Leases: Colorado, New Mexico, and Utah (all reserves in millions of tons)

	Leases in blocks with sufficient good quality minable reserves to support a new mine				Leases in blocks that do not have enough good quality minable reserves to support a new mine			
State/region	Number of leases	Number of blocks	Acres	Recoverable reserves	Number of leases	Number of blocks	Acres	Recoverable reserves
Colorado	39	23	44,274	1,017	13	13	2,679	38
Green River	16	14	22,970	792	7	7	1,447	24
Uinta	18	6	17,658	159	5	5	1,192	14
Denver-Raton Mesa	5	3	3,646	66	1	1	40	0.1
New Mexico	2	2	3,954	94	9	8	880	1.5
San Juan	2	2	3,954	94	6	5	680	1.0
Denver-Raton Mesa	0	0	0	0	3	3	200	0.5
Utah	55	12	99,274	1,119	21	19	5,942	67
Uinta	30	8	44,658	417	14	12	3,021	25
Southwestern Utah	25	4	54,616	702	7	7	2,921	42
Regional total	96	37	147,502	2,230	43	40	9,501	106

NOTE Columns may not add to totals because of independent rounding

SOURCE: Off Ice of Technology Assessment

Table 45.—Summary of Development Potential of Undeveloped Leases in Colorado, New Mexico, and Utah

State/region	Favorable development potential				Uncertain development potential				Unfavorable development potential			
	Number of leases	Number of blocks	Acres	Recoverable reserves (millions of tons)	Number of leases	Number of blocks	Acres	Recoverable reserves (millions of tons)	Number of leases	Number of blocks	Acres	Recoverable reserves (millions of tons)
Colorado												
Green River	2	2	3,600	37	14	12	17,815	739	7	7	3,002	40
Uinta	8	1	3,469	47	3	3	1,866	29	12	7	13,514	97
Denver-Raton Mesa	0	0	0	0	4	2	2,684	49	2	2	1,002	17
Total	10	3	7,069	84	21	17	22,365	817	21	16	17,518	154
New Mexico												
San Juan	2	2	3,954	93	3	2	320	0.6	3	3	360	0.5
Denver-Raton Mesa	0	0	0	0	2	2	160	0.4	1	1	40	0.1
Total	2	2	3,954	93	5	4	480	1.0	4	4	400	0.5
Utah												
Uinta	30	8	44,658	422	3	3	560	3	11	9	2,461	22
Southwestern Utah	0	0	0	0	25	4	54,616	702	7	7	2,921	42
Total	30	8	44,658	422	28	7	55,176	705	18	16	5,382	64
Regional total	42	13	55,681	599	54	28	78,021	1,523	43	36	23,300	219

Acreage and reserves may not add to totals because of independent rounding

SOURCE: Office of Technology Assessment.

or difficulties in marketing coal competitively in the current era of overcapacity.

OTA's analysis identified 96 leases in the Southern Rocky Mountain region that have favorable or uncertain prospects for development in the next decade. These leases contain over 2. I billion tons of reserves—over 90 percent of the undeveloped Federal lease reserves in the three States. While a classification of favorable or uncertain does not mean that OTA has found that the lease will definitely go into production by 1991, it is probable that many of these leases will in fact be mined because they include very good reserves and the market situations for those states show at least limited opportunities for expanded coal production.

Production Prospects for Undeveloped Leases

The potential production and mine capacity for Federal leases with favorable or uncertain development prospects are summarized in table 46. OTA's production and capacity projections represent a rough estimate of the production and capacity that could be supported by each block based on consideration of the amount and type of reserves and expected mining conditions for each block.

OTA identified only two undeveloped leases, one in the Green River region of Colorado, and one in the San Juan basin of New Mexico, which are expected to be in production by 1986. Together they could yield 0.8 million tons in 1986. One of the leases is already committed to supply an existing powerplant; the other is associated with a proposed mine on adjacent non-Federal land serving a local powerplant.

By 1991, 23 blocks including 77 leases (55 percent of the total undeveloped leases in the Southern Rockies) could be in production. If all 22 mines on these leases were developed, they could produce between 16.8 million and 32.2 million tons of coal in 1991. If a very strong coal market develops, however, production could approach the total maximum capacity of 57.7 million tons that these leases could support. Twelve of the 23 lease blocks which might be in production in 1991 have favorable development prospects. The remaining 11 blocks have uncertain prospects for a variety of reasons including lack of transportation, uncertain markets, and the need for additional reserves. Despite these current

Table 46.—Summary of Potential Production and Mine Capacity for Undeveloped Leases With Favorable or Uncertain Development Prospects in Colorado, New Mexico, and Utah (all production and capacity in million of tons)

State/region development potential	Total number of		Estimated production in 1986[a]				Estimated production in 1991a			
			Number of producing		Maximum mine capacity[b]	Estimated production	Number of producing		Maximum mine capacity[b]	Estimated production
	Leases	Blocks	Leases	Blocks			'Leases	Blocks		
Colorado ...	**31**	**20**	1	1	**0.6**	**0.6**	**22**	**10**	**12.2 -17.7**	**8.1**
Green River										
Favorable....	2	2	1	1	0.6	0.6	2	2	1.6	1.6
Uncertain....	14	12	0	0	0	0	8	5	8.6-14.1	4.8
Uinta										
Favorable....	8	1	0	0	0	0	8	1	1.0	0.8
Uncertain....	3	3	0	0	0	0	1	1	0.5	0.5
Denver-Raton-Mesa										
Favorable....	0	0	0	0	0	0	0	0	0	0
Uncertain....	4	2	0	0	0	0	3	1	0.5	0.5
New Mexico. .,	**7**	**6**	1	1	**2.0**	**0.2**	**2**	**2**	**4.0-12.0**	**1.7-8.0**
San Juan										
Favorable....	**2**	**2**	1	1	**2.0**	**0.2**	**2**	**2**	**4.0-12.0**	**1.7-8.0**
Uncertain....	**3**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Denver-Raton-Mesa										
Favorable. . .	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Uncertain....	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Utah	**58**	**15**	**0**	**0**	**0**	**0**	**53**	**11**	**18.5 -28.0**	**7.0-16.0**
Uinta										
Favorable....	**30**	**8**	**0**	**0**	**0**	**0**	**28**	**7**	**12.0**	**7.0-8,6**
Uncertain....	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Southwestern Utah										
Favorable, . .	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Uncertain....	**25**	**4**	**0**	**0**	**0**	**0**	**25**	**4**	**6.5-16.0**	**0-7.4**
Total	96	41	2	2	2.6	0.8	77	23	34.7 -57.7	16.8 -32.2

Capacity and production columns may not add to totals because of Independent rounding.
[a]Some leases have favorable or uncertain development potential because they could be mined as part of adjacent operations. In almost all of these case, the estimated Federal production would be very small and thus, neither those leases nor the possible production are shown in the production and capacity estimates above.
[b]Maximum capacity means the actual amount of **coal that** could be produced by the mine operating at full production levels and not **the actual** installed capacity in **place by 1986 or 1991 Actual Installed capacity for new mines with Federal leases in those years will be at or near the estimated production level**

SOURCE Office of Technology Assessment

problems, the lessees of 13 blocks are planning for development and the outlook for resolving their problems is good enough to support a forecast of some coal production from their leases by 1991.

According to OTA's analysis, a total of 77 of the 96 undeveloped leases with favorable or uncertain development potential are likely to be in production within the next decade. The remaining leases, 17 of which received uncertain development prospect ratings and two of which received favorable development prospect ratings, either are not as likely to overcome the probable obstacles to development by 1991 or will contribute only very small production.

Colorado.—Colorado has 52 undeveloped leases with a total of over 1 billion tons of recoverable reserves. The Green River region has 23 undeveloped leases and 77 percent of the undeveloped lease reserves in the State.

Ten Colorado leases in three lease blocks with a total of 78 million tons of recoverable reserves were classified as favorable development prospects. All of the leases are located in western Colorado and all are part of new mine projects that have not yet sub-

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mitted mine plans. One of the leases is expected to be producing at it's planned capacity of 600,000 tons per year by 1986; the other two blocks could produce 1.8 million tons in 1991 out of a total planned capacity of 2 million tons (see table 45).

Twenty-one leases were classified as uncertain prospects for development. Over 90 percent of the 817 million tons of lease reserves rated as uncertain are found in the Green River region of northwest Colorado. Several very large tracts of underground and surface recoverable reserves are included in this category. The uncertain rankings were based on a variety of considerations that were different for each lease block, including coal quality, the availability of additional reserves from PRLAs or new Federal leases, transportation problems, and uncertain coal demand due to the slow pace of construction of planned powerplants and coal-based synthetic fuel projects. Almost all of these lessees are proceeding with mine plan development. By 1991, these leases with uncertain development prospects could produce up to 5.8 million tons with an eventual capacity of between 9.6 million and 15.1 million tons per year depending on the mine design.

Colorado has more leases and reserves rated as unfavorable development prospects than New Mexico and Utah combined. Even so, only 15 percent of the undeveloped lease reserves in Colorado were found to be unlikely to be developed. Twenty-one leases in 16 blocks with 154 million tons of reserves were classified as unfavorable development prospects. Most of the unfavorable lease blocks were single lease tracts with small amounts of reserves. Two blocks in the Tongue Mesa Field with a significant amount of good quality minable reserves were rated as unfavorable because the area is not served by adequate coal transportation. These two blocks were the only large blocks in the three-State region that were found to have little potential for development in the next 10 years. See the Colorado appendix for additional information on potential production from undeveloped leases in the State.

New Mexico.—There are 11 undeveloped leases with 95 million tons of recoverable reserves in New Mexico; 8 of these leases and over 99 percent of the reserves are located in the San Juan basin of northwest New Mexico. The Raton Mesa region in the northeast has three scattered Federal leases that once supported small mines.

Two large leases in the San Juan basin were found to have favorable potential for development. These two leases cover 82 percent of the acreage of undeveloped leases and contain nearly all of the undeveloped reserves. These leases could produce 200,000 tons in 1986 and from 1.7 million to 8 million tons in 1991 depending on the rate of mine expansion.

One block is located in the northern part of the basin near Farmington and is associated with the proposed La Plata Mine on adjacent non-Federal land. Production from this lease will probably be sold to the San Juan powerplant. The other lease is located at Black Lake in the Star Lake-Bisti area of the south-central part of the basin, and is associated with several pending PRLAs At least a portion of the production will reportedly be used in the proposed Texas Eastern Synfuels coal gasification project. Coal from the mine would be shipped on the Star Lake Railroad. Both leases would be surface mined. Mine plans were submitted to the State surface mine agency after OTA's analysis was completed.

Five leases were rated as having uncertain development prospects including three leases in the San Juan basin and two leases in the Raton Mesa region. All of the leases are less than 160 acres and contain a total of about 1 million tons of reserves. These leases could be developed only in association with adjacent properties. It is unknown whether operating agreements or assignments for such development have been negotiated. The amount of production from these leases would be very small. The four remaining leases were found to have unfavorable development prospects. See the New Mexico appendix for additional information on these leases,

Utah.—There are 76 leases without mine plans in Utah. These leases are divided into 31 lease blocks containing about 1.2 billion tons of recoverable reserves, nearly all of which are accessible by underground mining. Thirty-two leases with over 63 percent of the undeveloped lease reserves are found in southwestern Utah, which currently has no active coal mining operations. Several hundred million tons of reserves are contained in large multilease blocks on the rugged and isolated Kaiparowits Plateau.

OTA identified 301 eases in 8 1ease blocks in central Utah that have favorable prospects for development in the next decade. These leases cover some of the best quality undeveloped coal reserves currently under lease. Several of the blocks contain metallurgical coal reserves. Most of the reserves would be deep mined, but portions of one block could probably be strip mined. These 30 leases include over 70 percent of the undeveloped lease reserves with favorable development potential in the entire Southern Rocky Mountain region. These leases could produce up to 8.6 million tons in 1991 with maximum mine capacity reaching 9 million to 12 million tons per year in the mid-1990's.

Twenty-eight leases in seven lease blocks were found to have uncertain prospects for development. Three small leases in central Utah have uncertain development prospects because the lessees reportedly intend to mine the leases in conjunction with adjacent or nearby operations. The amount of reserves and annual production are small. Over 702 million of the 705 million tons of reserves rated as uncertain for development are contained in 25 leases located in four blocks on the Kaiparowits Plateau in southwestern Utah. Production from these leases is highly uncertain because of their distance from rail service, lack of established communities, difficult underground mining conditions, and potential environmental conflicts resulting from development. These lease reserves could support mines with an eventual annual capacity of between 6.5 million and 16 million tons per year depending on the mine size. OTA estimates that these mines could produce between zero and 7,4 million tons in 1991.

Utah's undeveloped leases with favorable and uncertain development potential could add as many as 11 new Federal mines by 1991 with a total capacity of 18.5 million to 28 million tons. The production capability of the individual mines ranges from less than I00,000 tons to more than 6.0 million tons per year.

The remaining 18 leases in Utah were found to have unfavorable prospects for development. These 16 blocks with 64 million tons of reserves consist of small, scattered lease tracts, many of which once supported small mines. None of the lease tracts have enough good quality reserves remaining to support even a new small mine. Several undeveloped leases in central Utah are adjacent to Utah Power & Light's Deer Creek-Wilberg Mine complex and to several proposed new lease tracts. These unfavorable leases could conceivably be combined with adjacent operations. However, as of May 1980, when OTA completed its review of these leases, no such action had been taken. Only 29 percent of the undeveloped reserves in the region with unfavorable development ratings are located in Utah. The Utah appendix discusses the location, production potential, and development uncertainties of leases without mine plans in central and southwestern Utah.

Development Potential and Production Prospects of Federal Coal Leases in North Dakota, Montana, and Wyoming

The areas of the Northern Great Plains coal province and the northern portion of the Rocky Mountain coal province which contain leased Federal coal are located in Montana, North Dakota, and Wyoming (see fig. 2 in ch. I). The Fort Union lignite region of western North Dakota and east-central Montana, and the Powder River basin of southeastern Montana and northeastern Wyoming are located in the Northern Great Plains coal province. In southern Wyoming, which is located in the northern portion of the Rocky Mountain province, the Hanna Field, the Rock Springs Field, and the Kemmerer Field contain significant amounts of leased Federal coal (see fig. 3 in ch. 1). *

There are 137 existing Federal coal leases in these three regions covering nearly 273,000 acres and containing 10.3 billion tons of recoverable reserves.** These regions have 24 percent of the total Federal leases, 34 percent of the acreage under lease, and 62 percent of the reserves under lease. Sixty-eight of the leases in this three-state area are in approved mine plans; only nine are in pending mine plans; the remaining 60 leases are not in mine plans, and are referred to as undeveloped leases in this report. Coal production from mines with Federal leases in North Dakota, Montana, and Wyoming was 109 million tons in 1979 or over 90 percent of the total production of 119 million tons in these three States and over 75 percent of the total production of all mines with Federal leases in the West. *

Summary of Production Potential and Planned Capacity

Table 47 summarizes the production potential of all mines with Federal coal leases in North Dakota, Montana, and Wyoming. Operating mines with Federal leases in these three States produced 109 million tons of coal in 1979. According to the lessees' plans, Federal mines in currently approved mine plans are scheduled to produce 232 million tons in 1986 and 260 million tons in 1991. OTA estimates that under favorable market conditions mines with Federal leases in pending mine plans and undeveloped Federal leases located in this three-State area will contribute an additional 32 million tons of coal production in 1986 and 97 million tons in 1991, If these OTA estimates and the lessees' plans are realized, total production from mines with Federal coal leases in North Dakota, Montana, and Wyoming will be 264 million tons in 1986 and 357 million tons in 1991.

In the Powder River basin of Wyoming and Montana, Federal mines accounted for 88 percent of total coal mine capacity in 1980. This percentage is projected to remain relatively constant throughout the decade. However, production from Federal leases them-

*PPL's Cherokee lease block is technically part of the Little Snake River Field in southern Wyoming, but is included in the Rock Springs Field in the numerical analysis in this chapter.

**By confining the discussion in this section to the Fort Union region, the Powder River basin and the Hanna, Rock Springs, and Kemmerer fields of southern Wyoming, three small leases in Montana in the Yellowstone and Bull Mountain region, and two small leases in Wyoming in the Big Horn basin are omitted. Four of these leases have unfavorable development potential. The fifth, in Montana, is currently producing.

*Coal from Federal coal leases is referred to as **Federal coal.** A mine that includes a Federal lease is called a **Federal mine.** Sometimes, for the sake of efficiency of recovery or economy of operations, intervening state or private coal is mined with Federal lease(s) in the same mine. This practice is the rule in Southern Wyoming and North Dakota. for example. Thus, many Federal mines produce both Federal and non-Federal coal. A mine that contains no Federal coal is called a **non-Federal** mine. Total coal production in a State or region is thus the sum of: 1) Federal coal product from from Federal mines **plus 2)** non-Federal coal production from Federal mines **plus 3)** non-Federal coal production from non-Federal mines.

Table 47.—Potential Production From Mines Containing Federal Coal Leases: North Dakota, Montana, and Wyoming (all production in million tons per year)

State/region	Production in 1979	Potential production in 1986			Potential production in 1991		
		Federal mines in approved mine plans[a]	Federal mines in pending mine plans and leases not in mine plans[b]	Total	Federal mines in approved mine plans[a]	Federal mines in pending mine plans and leases not in mine plans[b]	Total
North Dakota							
Fort Union	14.1[c]	12	15	27	12	20	32
Subtotals	**14.1**	**12**	**15**	**27**	**12**	**20**	**32**
Montana							
Fort Union	0.3	0.3	0.0	0.3	0.3	0.0	0.3
Powder River basin	27.1	46	0 to 1.6	46 to 48	49	0 to 8.8	49 to 58
Subtotals	**27.4**	**47**	**0 to 1.6**	**47 to 48**	**49**	**0 to 8.8**	**49 to 58**
Wyoming							
Powder River basin	44.5	144	5.6 to 9.5	150 to 154	170	17 to 56	186 to 225
Hanna Field	10.7	10	0.4 to 0.6	10 to 11	8	0.3 to 0.6	8 to 9
Rock Springs Field	7.2	13	1.3 to 2.0	14 to 15	15	1.1 to 7.0	16 to 22
Kemmerer Field	5.1	6	2.2 to 3.5	9 to 10	6	2.6 to 4.5	9 to 11
Subtotals	67.5	173	10 to 16	183 to 189	199	21 to 68	219 to 266
Totals	109	232	25 to 32	257 to 264	260	41 to 97	301 to 357

[a]With few exceptions, the lessee's planned production is used for approved mine plans (and for pending mine plans in North Dakota)
[b]Office of Technology Assessment estimates are used for pending mine plans (Wyoming) and for leases with no mine plans
[c]Includes 56 million tons of production from mines with Federal leases in currently pending mine plans.

SOURCE Office of Technology Assessment

selves is projected to increase from less than 40 percent of total coal production in the basin in 1979 to approximately 80 percent in 1991. In southern Wyoming, essentially all coal production is from Federal mines with about one-third of the production from the Federal leases, This pattern is expected to continue with the contribution from Federal reserves rising to perhaps 40 percent by 1991. In 1979, Federal mines in the North Dakota portion of the Fort Union region accounted for over 90 percent of the State's coal production; the amount produced from Federal reserves was less than 7 percent. This situation is expected to continue, with however, production from Federal reserves rising to perhaps 20 percent by 1991.

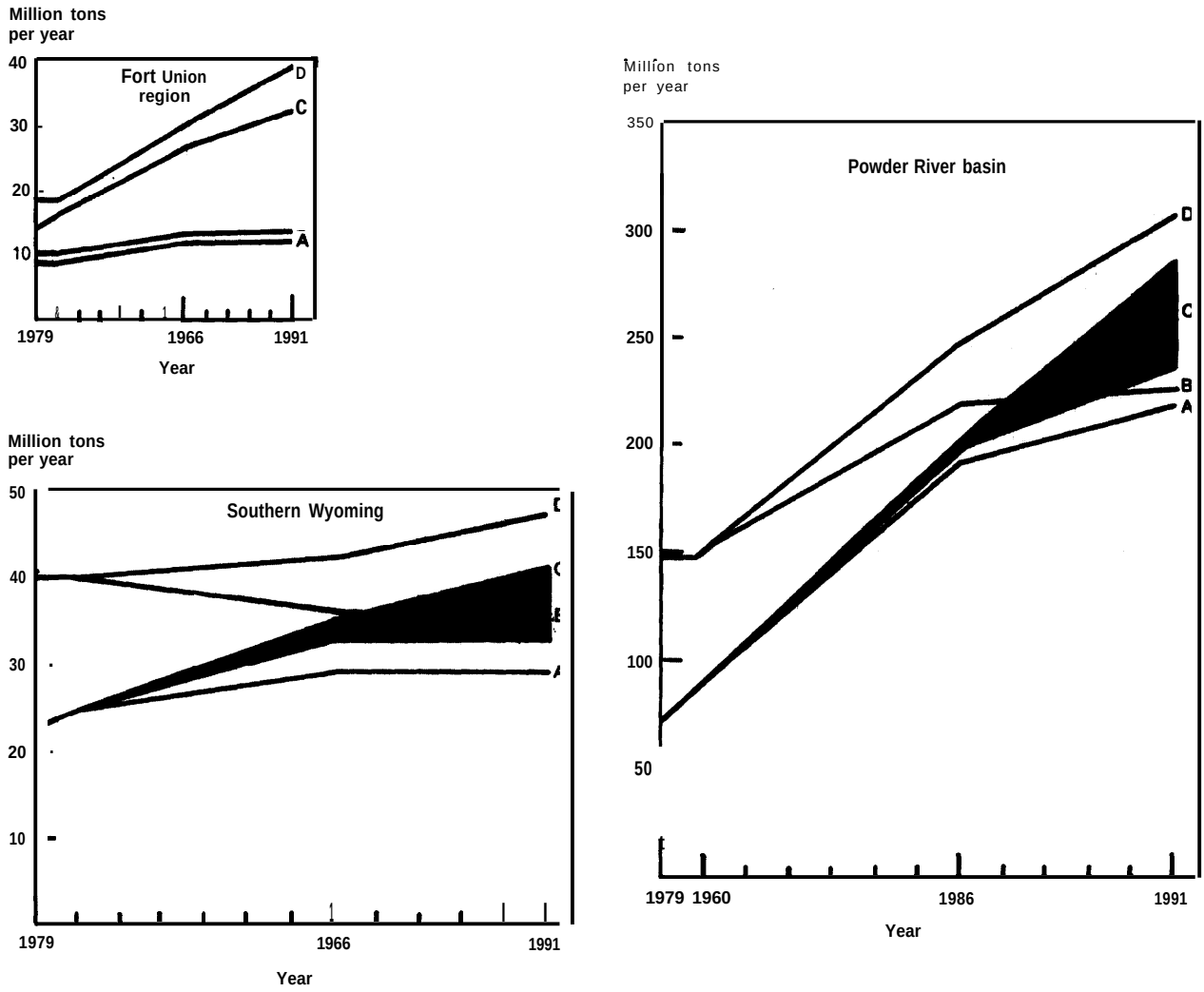
Figure 27 summarizes the potential production and planned capacity of all mines with Federal leases (including undeveloped leases) in the Fort Union region of North Dakota and Montana, the Powder River basin of Montana and Wyoming, and the coalfields of southern Wyoming. The upper capacity lines (lines D) in this figure represent OTA's estimate of the maximum coal production from Federal mines that could be achieved in these three regions under strong market conditions.

Several features of figure 27 should be noted:

1. The Powder River basin will continue to increase in importance as a coal-producing region, By 1991, Federal mine production in the Powder River basin could account for about 80 percent of Federal mine production in these three States. *
2. All estimated Federal mine production for 1991 for the Powder River basin comes from currently approved mines and from undeveloped leases with favorable development potential. (Undeveloped leases with uncertain develop-

*Because of the importance of the Powder River basin in Federal coal production, the development potential and production prospects of all Federal coal leases in this region are examined in more detail in ch. 7.

Figure 27.-Planned Capacity and Potential Production of All Mines With Federal Leases in the Powder River Basin, Southern Wyoming, and Fort Union Region



A: Lessee's planned annual production from Federal mines in currently approved mine plans only

B: Lessee's planned annual capacity for Federal mines in currently approved mine plans only

C: The sum of *A,* **above,** Plus estimates of potential production from Federal mines in pending mine plans and from presently undeveloped Federal leases

D: Planned annual capacity for all Federal mines, including Federal mines in pending **mine plans and presently undeveloped Federal leases**

SOURCE. Office of Technology Assessment.

ment potential contribute no production through 1991.) The large range in estimated production from undeveloped leases arises from demand uncertainty. However, several undeveloped leases in the basin have contracts for delivery of coal before 1990.

3. By 1991, the capacity of Federal mines in the Powder River basin could be as high as 310 million tons per year. According to the lessees' plans, the overcapacity in presently operating Federal mines in the Powder River basin, which was greater than 75 million tons per

year in 1979, will diminish to nearly zero by 1991,

4. The maintenance of total capacity of Federal mines in southern Wyoming depends on the development of new mines, Although capacity of presently operating mines is projected to decrease over the next 10 years, their production will probably not decline, Most of the range in production arises from uncertainty in the pace of a synfuels project.
5, The potential increase in production and capacity of Federal mines in the Fort Union region will occur largely from mines in North Dakota with leases in currently pending mine plans. Undeveloped leases are not likely to contribute more than 1 million tons per year by 1991. Federal mine production in the Montana portion of the region is likely to remain constant at 0.3 million tons per year.

The following subsections summarize the data presented in table 47 by State.

North Dakota.—Production from Federal mines with approved mine plans in the Fort Union region of North Dakota was 8,5 million tons in 1979. In 1986, these mines are projected to produce 12 million tons, a level of production that should remain constant through 1991. Production from Federal mines with mine plans pending was almost 6 million tons in 1979 and is expected to increase to 15 million tons in 1986 and to 20 million tons in 1991. Production of perhaps 1 million tons can be expected from undeveloped leases in North Dakota by 1991. Total production from Federal mines in North Dakota could reach 32 million tons by 1991,

Montana.—Production from mines with Federal leases in Montana in 1979 was 27.4 million tons, Virtually all of this production (27.1 million tons) came from the Powder River basin; production from a small Federal mine in the Fort Union region of Montana accounted for the balance. According to the lessees' plans, 47 million tons of coal will be produced in 1986 from mines with Federal leases already developed in the Montana Powder River basin. Production from the Montana leases in the Fort Union region is scheduled to remain at 0.3 million tons through 1991.

OTA estimates that 1.6 million tons of coal could be produced in 1986 and close to 9 million tons in 1991 from undeveloped Federal coal leases in the Montana portion of the Powder River basin. Lessee plans call for production of 49 million tons in 1991 from Federal mines in approved mine plans. If these estimates and plans are realized, production from Federal mines in Montana would reach 58 million tons per year in 1991. There are no leases with pending mine plans in Montana.

Wyoming.—Coal production from mines with Federal leases in the four regions of Wyoming— the Powder River basin, Hanna Field, Rock Springs Field, and Kemmerer Field—totaled 67.5 million tons of coal in 1979. Two-thirds of this production (44.5 million tons) came from the Wyoming portion of the Powder River basin. By 1986, according to the lessees' plans, production in this basin from Federal mines that now have approved mine plans will increase to 144 million tons. OTA estimates that an additional 10 million tons could be produced from undeveloped leases in the basin in 1986, giving planned and estimated production of 154 million tons in 1986. By 1991, production could increase to 225 million tons with 170 million tons coming from Federal mines that now have approved mine plans and 56 million tons from undeveloped leases.

Twenty-three million tons of coal was produced from mines with Federal leases in southern Wyoming in 1979. The lessees plan that production from currently operating mines will increase to 29 million tons in 1986 and remain constant through 1991. OTA estimates that production from currently undeveloped leases and leases in pending mine plans in this region could reach 6 million tons by 1986 and 12 million tons by 1991, for total southern Wyoming Federal mine production of 35 million tons in 1986 and 41 million tons in 1991.

Quality of Coal Under Lease

Of the 9 billion tons of recoverable coal reserves under lease in the Powder River basin, 7 million tons are subbituminous C, and 1.3 billion tons are subbituminous B.* There are small reserves of subbituminous A in the Montana portion of the Powder River basin. There are also Federal lignite reserves under lease in the Powder River basin. Several Federal mines and leases in southern Wyoming have reserves of bituminous coal, however most of the Federal reserves in southern Wyoming, including most of the reserves on undeveloped leases, are subbituminous. All Federal reserves in the Fort Union region are lignite.

Most of the Federal coal in the Powder River basin and the coalfields of southern Wyoming is low sulfur (i.e., less than 0.5 percent sulfur). Only one Federal mine in the Powder River basin produces coal with a sulfur content of over 1 percent.

Production and Consumption of Coal: Powder River Basin, Southern Wyoming, and the Fort Union Region

Coal seams in the Powder River basin typically range from 25 to 120 ft in thickness. Because of the thick seams which lie fairly close to the surface, all mines in the Powder River basin are surface mines. Large quantities of coal can be extracted at low cost from these mines. On a Btu basis, Powder River basin coal mine-mouth prices are the lowest of all coals, ranging from $0.42 to $0.65 per million Btu (see table 28). In addition, the mines in the Powder River basin are large. The Belle Ayr Mine in Wyoming is presently the largest coal mine in the United States; it produced 15 million tons in 1980. Four other mines in the basin are scheduled to reach a design capacity of 20 million tons per year or more by the end of the decade.

Steeply pitching, multiple coal seams are common in southern Wyoming where the recoverable reserves are usually much smaller and the stripping ratios higher than in the Powder River basin. Also, unlike the Powder River basin, underground mining has a long continuous history in southern Wyoming. Two underground mining operations in southern Wyoming, the Vanguard No. 2 and Carbon No. 1 mines, currently include Federal coal deposits.** Longwall mining techniques are being used or will be used to increase coal recovery at both of these mines to about 75 percent of minable reserves.

Surface mining in southern Wyoming is more complex and more costly than in the Powder River basin because of the steeply pitching and multiple coal seams. At some mines, such as the Elkol-Sorensen Mine which includes Federal reserves, combinations of draglines, truck/shovel operations, and dozer/scraper teams are used to develop large multiple open pits with depths that may reach 1500 ft. Up to 12 seams are mined at Elkol-Sorenson with an aggregate coal thickness of 300 ft and dips of 170 to 220. Another Federal mine in southern Wyoming, the Black Butte Mine, contains 13 coal seams ranging in thickness from 3 to 35 ft. Eleven pits will eventually be developed at Black Butte.

In the Wyoming portion of the Powder River basin, most Federal mines are compact units with little, if any non-Federal coal interspersed with the Federal reserves. Consequently, mining operations in this area involve predominantly Federal reserves. The occasional sections of State and fee coal are developed with the Federal reserves. By 1986, the Federal portion of coal production from these mines is expected to increase to well over 90 percent from the 1979 level of 49 percent. In southern Wyoming and in the area around Colstrip, Mont., on the other hand, most leased areas of Federal coal are checker-boarded with non-Federal coal and all LMUs include both Federal and non-Fed-

*The following Btu ranges are associated with different coal quality: 1 - Bituminous-high volatile A (greater than *14,000* Btu), B *(14,000* to *13,000* Btu), C *(13,000* to *12,000* Btu): *2-* Sub bituminous—A *(12,000* to 11,000 Btu), B (1 1,000 to *9,500* Btu), C *(9,500* to *8,300* Btu); and *3-* Lignite *(8,300* to *5,500* Btu).

**Another underground Federal coal mine in this area, the Stansbury Mine, closed in early 1981 but is expected to reopen later in the decade.

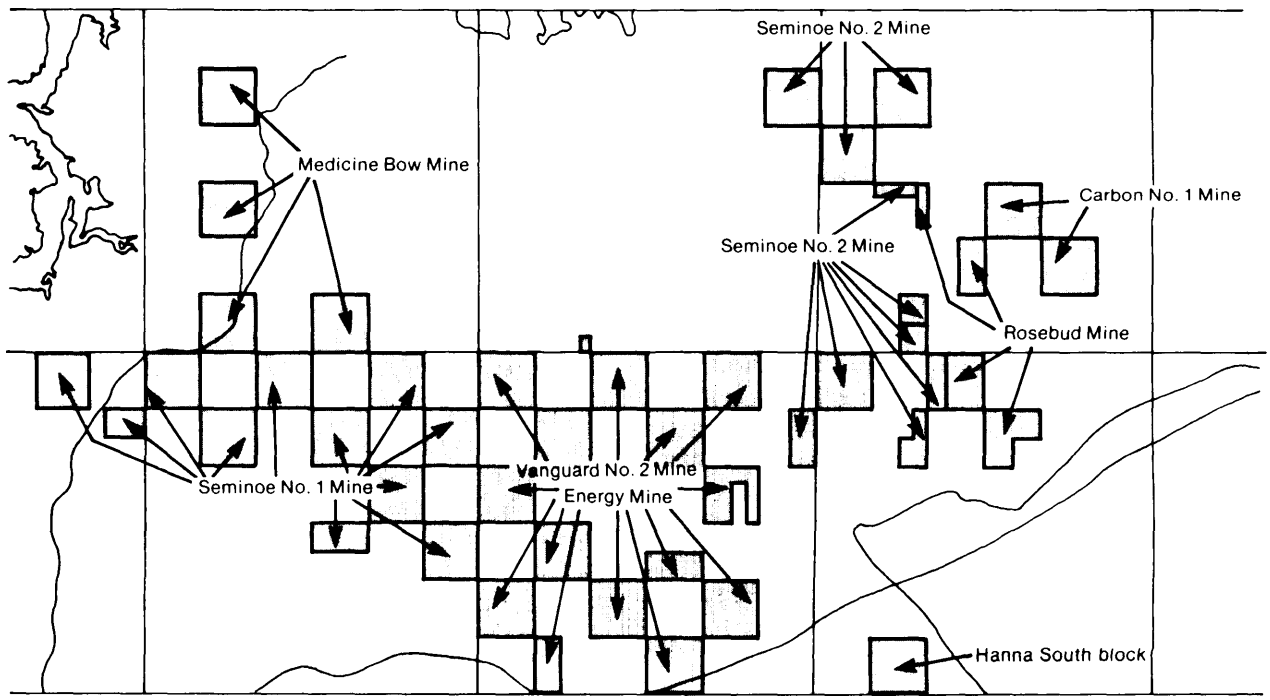
eral reserves. Orderly and efficient mining can be difficult where only part of the Federal coal reserves within the extended mine plan area are leased. These two patterns of reserve development are shown in figure 28, which illustrates patterns of Federal leaseholdings in southern Wyoming, and in figure 29, which illustrates patterns of Federal leaseholdings in the Wyoming portion of the Powder River basin.

Approximately 25 billion to 35 billion tons, about two-thirds of the Nation's lignite reserves, are found in the Fort Union region of North Dakota. The coal seams in this region seldom dip more than a few degrees. Typically, the North Dakota lignite operations are surface mines designed to produce 2 million or more tons of lignite per year. Although a few specialized or older smaller mines remain in operation, the trend recently has been toward large-scale operations.

Reclamation and environmental issues are expected to affect Federal coal development in the Powder River basin, southern Wyoming, and the Fort Union region, For example, at Colstrip, Mont., fugitive dust levels presently exceed ambient air standards and future mine expansion will have to address and minimize air quality impacts. In southern Wyoming, where the climate is more arid, fugitive dust problems may have to be addressed at some mines, However, air quality concerns are not likely to deter Federal coal production significantly over the next 10 years in either the Powder River basin or southern Wyoming. Air quality is an important issue in the Fort Union region of North Dakota where the possible lack of sulfur dioxide ($S0_2$) increments may delay development of some leased Federal coal. These issues are discussed in more detail in chapter 10,

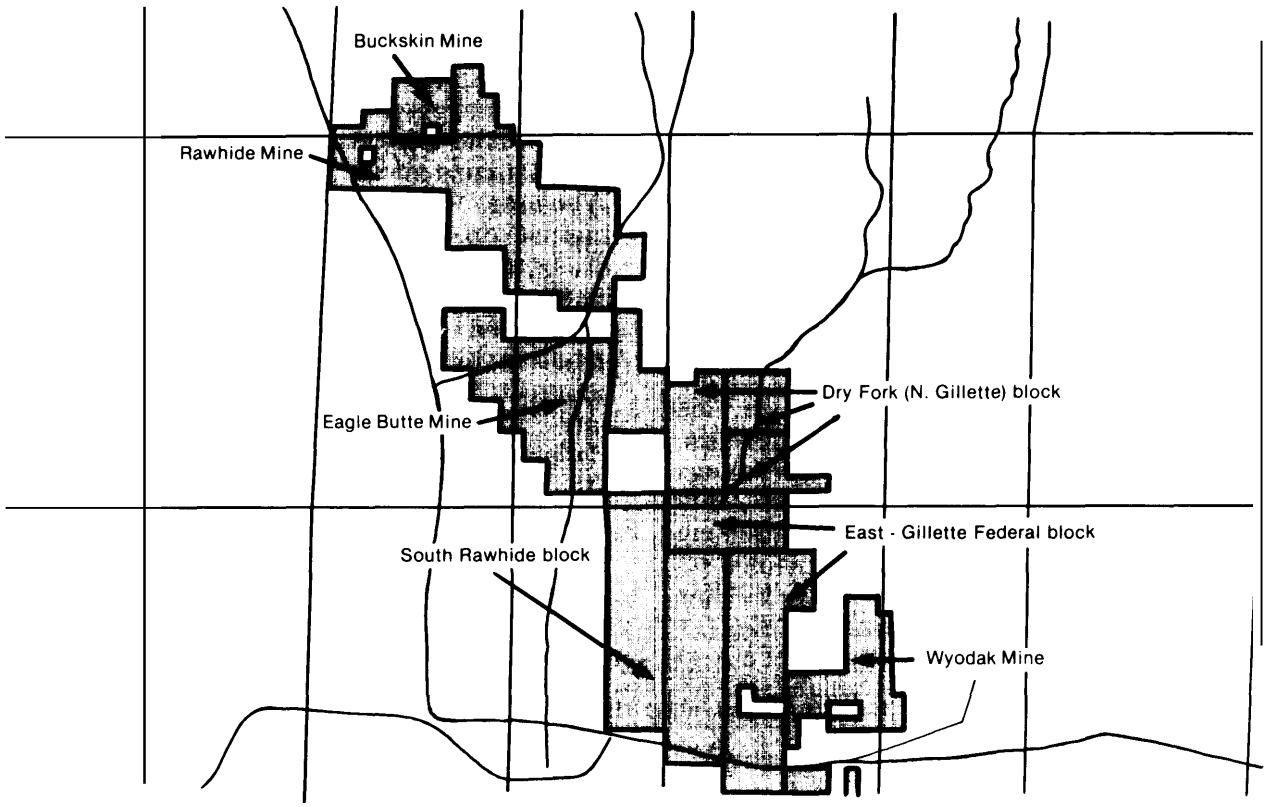
The availability of water and the impact of mining operations on water quality have not

Figure 28.— Federal Leases in the Hanna Basin, Southern Wyoming



SOURCE Off Ice of Technology Assessment.

Figure 29.—Federal Leases in the Powder River Basin, North of Gillette, Wyo.



SOURCE: Office of Technology Assessment.

generally been a major factor affecting coal mine development in the Powder River basin. However, such considerations could become important if onsite powerplants or synthetic fuels projects are extensively developed. Scarcity of water in the Gillette area of the Powder River basin, for example, justified the expense of constructing the first dry cooling tower in the United States at the Wyodak Power Plant. Competition for limited water supplies may ultimately affect the extent of coal mining in portions of southern Wyoming. In this area, mines need water for dust control and use in mining facilities and also for the irrigation of reclaimed lands.

Substantial quantities of topsoil, adequate rainfall, and a relatively flat terrain enhance the potential for successful reclamation in North Dakota. Nevertheless, reclamation efforts have not been uniformly successful in North Dakota. Mining in environmentally sensitive woody draws in the west-central region of the State has been delayed pending development of satisfactory reclamation plans, Reclamation efforts in North Dakota must also take into account sodic soil problems.

At present, Federal coal development in southern Wyoming and the Fort Union region affects no alluvial valley floors. In the Powder River basin, however, Federal coal production or expansion of Federal mine capacity could be affected in some cases if it is determined that adequate reclamation plans cannot be developed for alluvial valley floors, Of the 9.2 billion tons of Federal recoverable reserves under lease in the Powder River basin, approximately 700 million tons could be affected to some extent by alluvial valley

floor considerations; less than 100 million tons of these may be prohibited from mining, however.

Although alluvial valley floors are not an important constraint on mine development in North Dakota, they are given careful consideration in mine permitting. Mining can be complicated in the Fort Union region because of large amounts of water that can seep into the mine pit. In cases where this seepage occurs through the highwall, there have been problems of instability and spoil pile slumping which cause inefficient and potentially dangerous mining conditions.

Concern about the protection of wildlife habitat has resulted in minimal prohibition to mining and production of Federal coal. In southern Wyoming, protection of raptor habitat has resulted in some changes in mining plans and has contributed to the loss of 5 million tons of reserves at one mine. Unless endangered species are found to reside on a proposed mine site, it is unlikely that significant amounts of recoverable reserves will be lost because of wildlife concerns.

Because most mines in the Powder River basin have large surface reserves, thick coal seams, and a low stripping ratio, Powder River basin coal is the cheapest coal to mine in the country. The capacity of a typical mine in the Powder River basin is larger than the capacity of most other surface mines located in the West and in other regions of the country, This high volume production and low production costs are well suited to long-term utility contracts. However, the heat content of Powder River basin coal is relatively low compared to coal produced in the Rocky Mountain coal province.

Electricity generation is the largest market for coal mined in Wyoming and Montana, with the main areas of demand in the South-Central and Midwest regions of the country. Demand for coal produced in Wyoming and Montana is expected to increase as demand for electricity increases in these regions. Conversions to coal-fired utility burners, particularly in the South-Central region, may further increase the demand for coal produced in the Powder River basin. Industrial demand for coal mined in the Powder River basin is expected to be relatively small over the next 10 years.

The availability, cost, and reliability of rail transportation to the Midwest and South-Central regions of the country are important factors in coal mine development in Wyoming and Montana. Transportation costs are already an important component of the delivered price of Wyoming and Montana coal, running as high as 70 percent in the Midwest (see table 28). Transportation costs are expected to rise still further over the next decade.

In general, leases in southern Wyoming and the Wyoming portion of the Powder River basin are closer to rail lines than leases in the Montana portion of the Powder River basin. Rail costs to the Midwest are lower for southern Wyoming coal than for Powder River basin coal; total delivered price on a per-Btu basis for southern Wyoming coal is competitive with Powder River basin coal in some areas, despite the higher mine-mouth cost of the southern Wyoming coal (see table 28).

Coal slurry pipelines could become an option for transporting coal from the Powder River basin over the next 10 years but development of slurry pipelines may be constrained by restrictions on water export. One slurry pipeline company, the Energy Transportation Systems, Inc. (ETSI) has obtained permission from Wyoming to export water. This pipeline is planned to have a capacity of 25 million tons per year. However, the State of Montana has decided that use of water for slurry pipelines is specifically not a beneficial use of water.

Lignite, which is mined in the Fort Union region, has a low-Btu value, high moisture content, and large concentrations of impurities. Consequently, the Federal coal mined in this region will generally be used close to the mine site. The characteristics of the lignite render its transportation both difficult and costly, requiring special hopper cars and spe-

cial facilities for loading and unloading. Despite its poor quality, however, lignite has proved to be an acceptable fuel when used in properly designed, coal fired units. All powerplants currently planned or under construction in North Dakota will use lignite onsite.

Development Status of Federal Coal Leases in North Dakota, Montana, and Wyoming

There are 68 leases in 33 approved mine plans in the Federal coal regions of North Dakota, Montana, and Wyoming (table 48). These leases cover about 149,000 acres and contain 5.7 billion tons of recoverable reserves. Nearly 70 percent of the leases in currently approved mine plans in this three-State area (47 leases in 23 mine plans) are located in Wyoming. These Wyoming leases cover about 110,000 acres and include 4.7 billion tons of recoverable reserves. The Powder River basin of Wyoming contains 24 of these 47 leases in 12 mine plans on about 56,000 acres with 4.4 billion tons of recoverable reserves. Twelve leases in five approved mine plans are located in the Montana portion of the Powder River basin. These 12 leases cover over 29,000 acres and contain 0.8 billion tons of recoverable reserves.

Nine Leases are included in six pending mine plans in North Dakota and Wyoming. No leases are in pending mine plans in Montana. The five Wyoming leases in three pending mine plans will be analyzed with undeveloped leases.

Sixty leases not in mine plans are located in North Dakota, Montana, and Wyoming. The large majority of these undeveloped leases (47 leases, 26 blocks) are located in Wyoming. These Wyoming leases cover nearly 96,000 acres and contain 3.6 billion tons of

Table 48.—Acreage and Reserves Under Lease by Development Status

	Approved mine plans				Pending mine plans				No mine plans			
	Number Of leases	Number of plans	Acres	Recoverable reserves[a]	Number of leases	Number of plans	Acres	Recoverable reserves[a]	Number of leases	Number of blocks	Acres	Recoverable reserves[a]
North Dakota												
Fort Union	8	4	8,655	0.12	4	3	5,283	0.10	8	7	4,754	0.05
Total	8	4	8,655	0.12	4	3	5,283	0.10	8	7	4,754	0.05
Montana[b]												
Fort Union	1	1	960	S	—	—	—	—	2	1	5,096	H
Powder River basin	12	5	29,252	<0.83	—	—	—	—	3	3	1,739	LM
Total	13	6	30,212	0.83	–	–	–	–	5	4	6,835	0.37
Wyoming[c]												
Powder River basin	24	12	55,681	4.4	4	2	9,599	0.53*	30	16	67,185	3.4
Hanna Field	15	6	23,927	0.07	—	—	—	—	1	1	640	0.23**
Rock Spring Field	5	3	24,983	0.18	—	—	—	—	8	4	23,183	
Kemmerer Field	3	2	5,602	S	1	1	1,408	*	8	5	4,865	0.016
Total	47	23	110,193	4.7	5	3	11,007	0.53	47	26	95,873	3.6
Totals	68	33	149,060	5.7	9	6	16,290	0.62	60	37	107,461	4.0

S = small reserves (zero to 30 million tons)
LM = low to medium reserves (30 million to 100 million tons)
HM = high to medium reserves (100 million to 180 million tons)
H = high reserves (over 180 million tons)

*Powder River basin reserves combined with Kemmerer Field reserves to preserve confidentiality.
**Hanna Field reserves combined with Rock Spring Field reserves to preserve confidentiality. Reserves for the Hanna Field lease are small

[a]In billions of tons.

[b]THREE SMALL LEASES IN THE BULL MOUNTAIN/YELLOWSTONE AREA ARE NOT LISTED IN THIS TABLE. THE LEASES COVER 240 ACRES AND HAVE VERY SMALL RESERVES. ONE LEASE IS IN A PRODUCING MINE. THE OTHER TWO ARE UNDEVELOPED LEASES.
[c]TWO SMALL LEASES IN THE BIGHORN BASIN ARE NOT LISTED IN THIS TABLE. THE LEASES COVER 200 ACRES, AND HAVE VERY SMALL RESERVES. BOTH ARE UNDEVELOPED.

SOURCE: Office of Technology Assessment.

recoverable reserves. Two-thirds of these leases (30 leases, 16 blocks) with 3.4 billion tons of recoverable reserves are located in the Powder River basin.

Leases With Approved Mine Plans and Leases in Pending Mine Plans*

Figure 30 shows the lessees' plans for capacity, total production, and production of Federal reserves from mines with Federal leases in North Dakota, Montana, and Wyoming. The dominance of the Powder River basin is apparent. Although coal production from Federal mines in each of these regions is expected to increase in the coming decade, the greatest increase is expected in the Powder River basin where, in 1986 total capacity and production of mines with Federal leases may be six times the total capacity and production of mines with Federal leases in southern Wyoming. Production of Federal reserves from these mines in the Powder River basin could be over 14 times that from Federal reserves in southern Wyoming in 1986. In 1991, the Powder River basin will continue to account for the largest capacity and production of coal from Federal mines in these three States and in all the Federal coal States.

Table 49 shows the acreage and recoverable reserves of Federal coal leases in approved mine plans in North Dakota, Montana, and Wyoming and pending mine plans in North Dakota. (The five leases in pending mine plans in Wyoming are not included in this table, because they are analyzed with undeveloped leases, below.) Total mine plan acres in this table refer to the total area permitted for mining as of early 1981. These data include Federal, State, and private surface areas used for mining activities and associated disturbances such as stockpiles, plant facilities, and buffer zones. Total mine plan acreage will change as mining operations expand to realize future production goals. The total mine plan acreage figures in table 49 do not include proposed amendments. However, amendments have already been submitted to the Office of Surface Mining for the expansion of mining activities at approximately 20 percent of the mines with Federal leases in Wyoming.

Federal lease acres refers to the surface acreage under which Federal coal is located. However, the Federal Government does not necessarily own all (or any) of the surface under which Federal coal lies. Thus, it is possible (and is indeed the case at the Caballo Mine in the Powder River basin) that the Federal Government could own no surface acreage in a mine plan even though most of the coal produced at the mine is extracted from Federal reserves. Moreover, not all the acreage of a Federal lease will necessarily be included in a mine plan.

Table 50 identifies the current and projected capacity and production, as reported by the lessees, for mines with Federal leases in North Dakota, Montana, and Wyoming. The portion of production that is expected from Federal reserves at these mines in the next 10 years is also included in table 50.

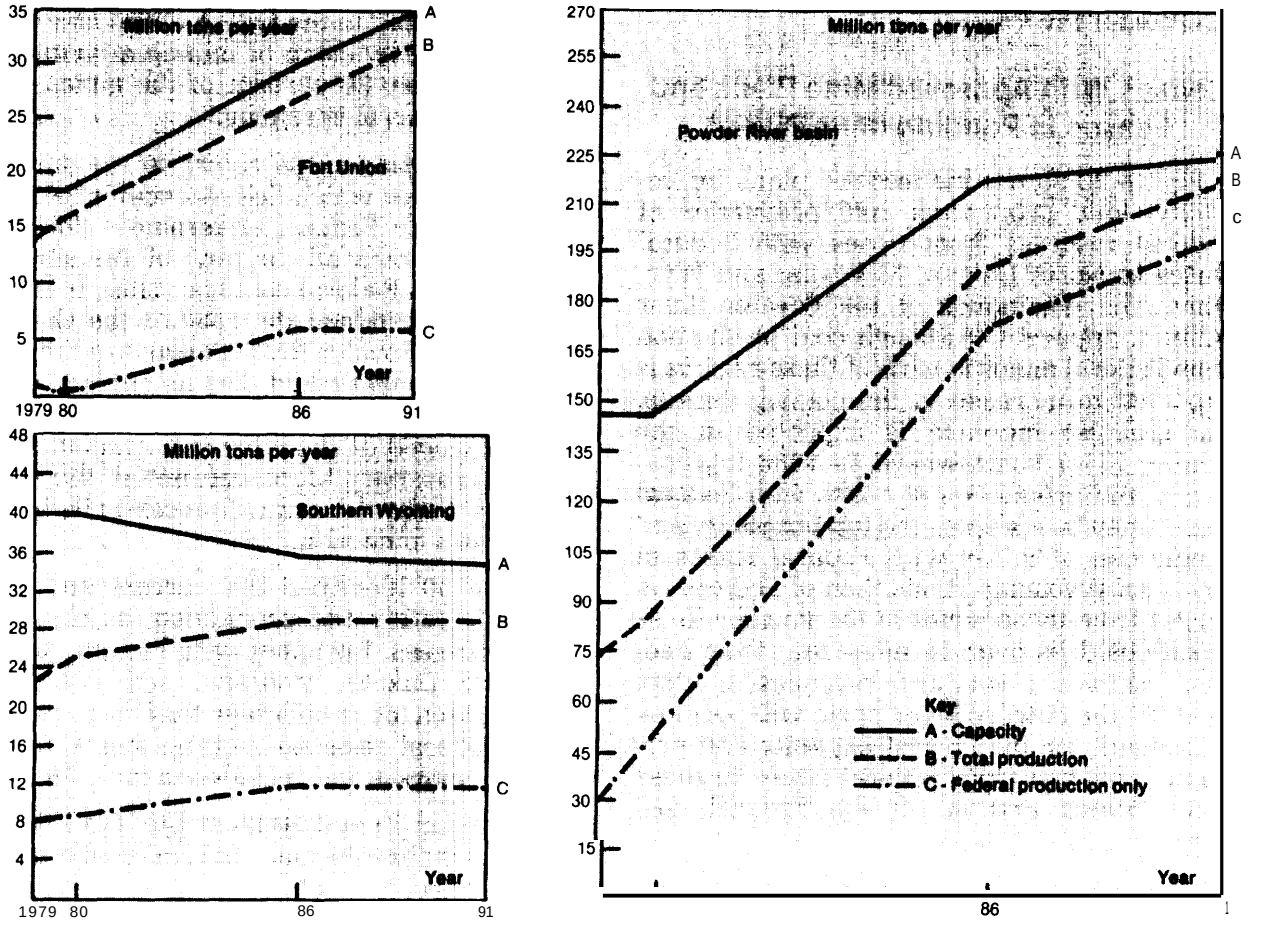
As tables 49 and 50 illustrate, the Powder River basin has the most Federal coal production, the greatest potential capacity, the most leased and permitted mine plan acreage, and the largest reserves of any of the major Federal coal regions studied in this report.

Powder River Basin

Twenty-four of the 36 leases in 12 of 17 approved mine plans in the Powder River basin are located in Wyoming; the remaining 12 leases in five approved mine plans are located in Montana. The large majority of reserves (over 80 percent) are located in the Wyoming portion of the Powder River basin as is the largest amount of recent and potential production. Production of coal from mines with Federal leases in the Wyoming section of the basin is expected to become more important during the next 10 years. The total capacity of mines with Federal leases in the

*Five leases in three pending mine plans in Wyoming are omitted from this section and are discussed in the section Undeveloped Leases, below.

Figure 30.—Lessee Projections of Capacity, Total Production, and Federal Production From Mines With Federal Leases: Fort Union Region, Powder River Basin, and Southern Wyoming (leases in approved and pending mine plans only)[a]



[a]Five leases in three pending mine plans in Wyoming are not included In this figure They are considered with the undeveloped leases later in this chapter

SOURCE: Office of Technology Assessment.

Powder River basin is currently 3.7 times that of Federal mines in southern Wyoming and 8 times that of Federal mines in the Fort Union region.

The capacity of mines with Federal leases in the Powder River basin has not been fully used in recent years. In 1979, these mines could have produced 76 million tons more coal; in 1980, 60 million tons more coal. Mine capacity is expected to increase by nearly 50 percent between 1980 and 1986 (i.e., from 148 million to 220 million tons) and then remain relatively constant through 1991. This is because of the opening of several new large mines (e.g., Buckskin, Coal Creek, Rojo Caballos) and to the expansion scheduled for existing mines (e.g., Black Thunder, Eagle Butte, Rawhide). However, according to the production estimates of the lessees, the overcapacity of currently operating and permitted Federal mines in the Powder River basin will diminish to 15 percent in 1986 and to 3 percent in 1991.

Annual production from Federal reserves in the Powder River basin is becoming increasingly important, particularly in Wyoming. Federal reserves accounted for only 42 percent of total production from mines with

Table 49.—Summary of Mine Plan and Federal Lease Acreage and Recoverable Reserves: Approved and Pending Mine Plans in North Dakota, Montana, and Wyoming[a]

State/region	Number of leases	Number of mine plans	Total mine plan acres	Total Federal lease acres	Total mine plan reserves[b] Underground[c]	Surface	Total	Federal mine plan reserves[b] Underground	Surface	Total	Total Federal lease reserves[b] Underground	Surface	Total
Approved													
North Dakota													
Fort Union	8	4	—	8,655	0	0.14	0.14	0	0.06	0.06	0	0.12	0.12
Montana													
Fort Union	1	1	—	960	0	s	s	0	s	s	o	s	s
Fort Union totals	9	5	–	9,615	0	–	—	0	–	–	0	<0.15	<0.15
Montana													
Powder River basin	12	5	19,080	29,252	0	0.48	0.48	0	0.40	0.40	0	0.8	0.8
Wyoming													
Powder River basin	24	12	83,141	55,681	0	4.5	4.5	0	4.2	4.2	0	4.4	4.4
Powder River basin totals	36	17	102,221	84,933	0	5.0	5.0	0	4.6	4.6	0	5.3	5.3
Southern Wyoming													
Hanna Field	15	6	57,037	23,927	LM	<0.2	-0.2	LM	LM	0.07	LM	LM	0.07
Rock Springs Field	5	3	66,227	24,983	LM	<0.4	0.4	Small	<0.18	0.18	Small	<0.18	0.18
Kemmerer Field	3	2	5,901	5,602	0	0.13	0.13	0	s	s	o	s	s
Southern Wyoming totals	23	11	129,165	54,512	LM	<0.7	0.7	LM	<0.3	0.3	LM	<0.3	0.3
Pending													
North Dakota													
Fort Union	4	3	–	5,283	Small	0.07	0.07	Small	0.02	0.02	Small	0.10	0.10

[a]THERE ARE TWO MINE PLANS WITH FEDERAL LEASES IN PRELIMINARY PERMIT REVIEW IN THE WYOMING POWDER RIVER BASIN, I.E. SOUTH RAWHIDE (1 LEASE) AND ANTELOPE (3 LEASES) AND ONE IN THE ROCK SPRINGS FIELD OF SOUTHERN WYOMING, I.E. , SOUTH HAYSTACK (1 LEASE) NO DECISION IS EXPECTED ON THESE PRELIMINARY REVIEWS UNTIL 1982 BECAUSE OF THE EARLY STAGES OF DEVELOPMENT OF THESE THREE MINE PLANS, DATA FOR THIS TABLE WERE UNAVAILABLE THESE LEASES ARE CONSIDERED IN THE FOLLOWING SECTION ON UNDEVELOPED LEASES

[b]In billions of tons.

[c]Underground mining occurs at the Vanguard #2 Mine in the Hanna Field. When strippable reserves are depleted at this mine In 1984, underground operations will meet all contractual commitments even though underground reserves are small Underground mining also occurs at the Carbon #1 Mine in the Hanna Field The Stansbury Mine in the Rock Springs Field, closed early in 1981, was also an underground operation Stansbury may be reopened later in the decade

Key to reserve ratings:
S = small reserves (zero to 30 million tons)
LM = low to medium reserves (30 million to 100 million tons)
HM = high to medium reserves (100 million to 160 million tons)
H = high reserves (over 180 million tons)
NSR = no surface reserves

SOURCE Off Ice of Technology Assessment.

Federal leases in the basin in **1979.** By **1991,** Federal reserves will account for 92 percent of production from Federal mines averaged over the Powder River basin and almost 100 percent of production from Federal mines in the Wyoming section of the basin.

Southern Wyoming

Twenty-three Federal leases in eleven approved mine plans are located in southern Wyoming. These mine plans include over 129,000 permitted acres and contain 0.7 billion tons of recoverable reserves, of which only 0.3 billion are Federal. Recoverable reserves at three mines, Vanguard No. z, Carbon No. 1 and Stansbury,* are suitable for underground mining. The capacity of mines with Federal leases in southern Wyoming is expected to decrease 12 percent by the end of the decade, although production is expected to increase by 26 percent during this period. Utilization of capacity is expected to increase from 58 percent in 1979 to 83 percent in 1991. Federal reserves are expected to ac-

*Slansbury closed early in 1981 but is expected 10 reopen later this decade.

Table 50.—Federal Mine Capacity and Federal Mine Production Prospects: Approved and Pending Mine Plans in North Dakota; Approved Mine Plans in Montana and Wyoming[a]

			1979[b]			1980[b]			1986[b]			1991[b]		
	Number of mine plans with Federal leases	Number of Federal leases in these plans	Federal mine capacity	Actual Federal mine production	Federal production only	Federal mine capacity	Actual Federal mine production	Estimate of Federal production	Projected Federal mine capacity	Projected Federal mine production	Projected[c] Federal production	Projected Federal mine capacity	Projected[c] Federal mine production	Projected[c] Federal production
North Dakota														
Fort Union(A)[c]	4	8	10	8.5	1.0	10	8.9	0.6	13	12	3	13	12	3
Fort Union(P)[d]	3	4	7	5.6	0	7	7.0	0	17	15	2	23	20	3
Montana														
Fort Union	1	1	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Fort Union totals	8	13	18	14	1.3	18	16	0.9	30	27	6	35	32	6
Montana														
Powder River Basin	5	12	36	27	8	36	25	10	52	46	29	52	49	31
Wyoming														
Powder River Basin	12	24	112	45	22	112	63	—[f]	169	144	142	175	170	170
Powder River Basin totals	17	36	148	72	30	148	88	–	220	191	171	226	219	201
Hanna Field	6	15	14	10.7	4	14	9.0	–	11	10	4	9	8	3
Rock Springs Field	3	5	19	7.2	4	19	10.4	—	18	13	7	19	15	7
Kemmerer Field	2	3	7	5.1	0.1	7	5.7	–	7	6	1	7	6	2
Southern Wyoming totals	11	23	40	23	8	40	25	—[f]	36	29	12	35	29	12

[a]FIVE LEASES IN THREE PENDING MINE PLANS IN WYOMING ARE NOT INCLUDED IN THIS TABLE. THEY ARE CONSIDERED WITH THE UNDEVELOPED LEASES IN TABLE 53. THERE ARE NO PENDING MINE PLANS IN MONTANA. ONE SMALL MINE IN THE BULL MOUNTAIN/YELLOWSTONE REGION OF MONTANA IS NOT INCLUDED IN THIS TABLE.
[b]ALL PRODUCTION AND CAPACITY ESTIMATES IN MILLIONS OF TONS PER YEAR; TOTALS MAY NOT ADD BECAUSE OF ROUNDING. SEE SECOND FOOTNOTE ON P. 114 FOR DISTINCTION BETWEEN FEDERAL MINE AND FEDERAL PRODUCTION. FEDERAL MINE PRODUCTION INCLUDES FEDERAL PRODUCTION.
[c]Approved mine plans.
[d]pending mine plans.
[e]With few exceptions, these production pprotections are derived from lessees' mine plans,
[f]Total Federal coal production in Wyoming in 1980 was 33 million tons.

SOURCE: Office of Technology Assessment.

count for about 40 percent of production through 1991 in the Hanna Field; approximately 50 percent in the Rock Springs Field; and about 15 to 30 percent in the Kemmerer Field.

Fort Union Region

Nine leases in five approved mine plans are located in the Fort Union region of North Dakota and Montana. Eight of these leases in four approved mine plans located in North Dakota contain 0.12 billion tons of recoverable reserves. The one lease in an approved mine plan in Montana has small recoverable reserves.

In 1979, mine capacity for the North Dakota leases in approved and pending mine plans was 17 million tons per year; for the one Montana lease, only 300,000 tons per year. Annual production from these mines in 1979 was 14 million tons per year, of which about 1.3 million tons was from Federal reserves.

The contribution of Federal reserves to total production from mines with Federal leases in North Dakota is small because usually the Federal coal was leased in order to "fill out" a logical mining unit containing large amounts of non-Federal coal. Only 25 percent of the coal reserves in North Dakota are owned by the Federal Government—the lowest percentage of federally owned coal in the six major Federal coal States. Moreover, several Federal leases in North Dakota have

either been mined out or are close to being mined out,

Most of the increase in total production and Federal production from Federal mines in North Dakota over the next decade is expected from mines currently in pending plans. By 1991 the capacity of mines with Federal leases in the Fort Union region is estimated at about 35 million tons per year. Total production could increase to 32 million tons per year, but production of Federal reserves will be a comparatively small proportion of this total (about 6 million tons).

Undeveloped Leases

Table 51 presents acreage and reserves information for the undeveloped leases in North Dakota, Montana, and Wyoming. The Wyoming portion of the Powder River basin contains 65 percent (nearly 77,000 acres) of the total acreage and contains over 85 percent (3,9 billion tons) of the recoverable reserves for the undeveloped leases located in these States. There are only about 80 million tons of underground recoverable reserves on undeveloped leases in these three States; all are located in southern Wyoming.

Assessing the Development Potential of Undeveloped Leases in North Dakota, Montana and Wyoming: Review of Property Characteristics

Environmental, transportation, and market factors were reviewed to assess the development potential of undeveloped leases in North Dakota, Montana, and Wyoming. However, before considering these factors, OTA reviewed information on the reserves, coal quality, and geologic features of these leases. This section summarizes the property characteristics of undeveloped leases in this three-State area. The review of the property characteristics of undeveloped leases emphasized the following four questions: 1) does the tract form a viable mining unit (i.e., is it compact and contiguous)? 2) does the tract have sufficient reserves to support an economical mine? 3) is the coal of suitable quality for current or potential markets (i. e., heat content

Table 51.—Acreage and Reserves of Undeveloped Leases:[a] North Dakota, Montana, and Wyoming

State/region	Total number of leases	Total number of lease blocks	Total Federal acres	Total[b] recoverable underground reserves	Total[b] recoverable surface reserves	Total[b] recoverable reserves
North Dakota	8	7	4,754	0	0.05	0.05
Fort Union	8	7	4,754	0	0.05	0.05
Montana	5	4	6,834	0	0.37	0.37
Fort Union	2	1	5,096	0	H	H
Powder River basin	3	3	1,739	0	LM	LM
Wyoming	52	29	106,880	0.08	4.1	4.1
Powder River basin	34	18	76,784	0	3.9	3.9
Hanna Field	1	1	640	0	S	S
Rock Springs Field	8	4	23,183	0.08	0.14	0.22
Kemmerer Field	9	6	6,273	very small	0.04	0.05
Totals	65	40	118,468	0.08	4.5	4.6

S = small reserves (zero to 30 million tons)
LM = low to medium reserves (30 million to 100 million tons)
HM = high to medium reserves (100 million to 180 million tons)
H = high reserves (over 180 million tons)

[a]INCLUDES FIVE LEASES IN THREE PENDING MINE PLANS IN WYOMING. SEE TABLE 48 FOR THE ACREAGE AND RESERVES OF THESE FIVE LEASES EXCLUDES FOUR SMALL LEASES, TWO IN WYOMING AND TWO IN MONTANA. SEE FOOTNOTES b AND C, TABLE 48.

[b]In billions of tons.

SOURCE: Office of Technology Assessment.

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not too low, sulfur and ash not too high)? and 4) are the coal seams sufficiently thick and, where surface mines are involved, is the ratio of overburden to seam thickness sufficiently low to be economically minable?

Powder River Basin and Southern Wyoming.—The following technical criteria were used in OTA's examination of the property characteristics of undeveloped leases in the Powder River basin and the coalfields of southern Wyoming.

There are three major uses for Western coal—offsite electric power generation, onsite electric power generation, and, potentially, synfuels production. For export steam coal in the Powder River basin and southern Wyoming, a mine needs to produce at least 1 million tons a year for a 30-year period. Thus, the minimum reserve requirement for a mine developed for export steam coal in these areas was set at 30 million tons.

Four million tons of annual production are generally required for 30 years (120 million tons of recoverable reserves) to supply an onsite electric generation plant (l,000 MW). Production of at least 6 million tons per year for 30 years (180 million tons of recoverable reserves) was set as the minimum requirement for the development of a mine for onsite synfuels production.

Because of high transportation costs, coal produced in these two regions for export out-of-State should have an average heat content of 8,000 Btu/lb for surface mines and 10,000 Btu/lb for underground mines. Coal with a lower heat content could be mined for onsite power generation or synthetic fuels production, but would be uneconomical to transport over any distance.

The 1970 and 1979 New Source Performance Standards (NSPS) for SO_2 were used as a basis for evaluating the sulfur content of coal in the Powder River basin and southern Wyoming. Generally, coal with less than 0.63 lb sulfur/million Btu will meet the NSPS without scrubbing, assuming 95 percent conversion of sulfur to SO_2. Sulfur content of less than 1.0 lb sulfur/million Btu will meet the 1979 NSPS requirement with partial scrubbing. Coal used onsite may have a higher sulfur level, but it should not exceed 2.0 lbs/million Btu in order to meet Wyoming's emission standard of 0.2 lb of SO_2 per million/Btu.

Ash is less critical than sulfur in the assessment of coal quality in Montana and Wyoming, but a high ash content can raise the cost per Btu of transporting coal to other States to an uneconomical level. Coal for export in the Powder River basin should have a maximum ash content of 10 percent; in southern Wyoming maximum ash content can be 12 percent since this coal usually has a higher heat content. Ash levels greater than 12 percent were considered acceptable for onsite conversion.

The seam thickness in existing mines in the Powder River basin ranges from 35 to 110 ft. Twenty ft was considered the minimum seam thickness for a developable property in the Powder River basin. The minimum seam thickness in southern Wyoming was set at 15 ft for surface mines and at 5 ft for underground mines.

Seam dip is not especially important in the Powder River basin since seams in this region are relatively flat. However, seam dip is an important factor in mine development in southern Wyoming where coal seams dip as much as 900. While surface mines can be developed with a seam dip up to 250, 13°, to **15°** is considered the maximum seam dip for efficient coal recovery in underground mines.

Maximum average overburden thickness for coal mined in the Powder River basin is usually less than 130 ft. The maximum stripping ratio for this coal is usually 2.5. A maximum average overburden of 175 ft and a maximum average stripping ratio of 3.5 was considered acceptable for mines that will use coal onsite.

Fort Union Region.—Federal coal leases in the Fort Union region are rarely contiguous units or contiguous with one another. A single

lease in the Fort Union region is often divided into several different tracts interspersed with fee coal. For this reason a company rarely acquires a Federal lease in North Dakota when it does not control the mining rights of the intervening coal property or lease sections. In addition, the minimum reserves required for mine development are rarely found in any one Federal coal lease. While this can and does occur in other States, in North Dakota it is the rule. Furthermore, variations in coal quality characteristics such as heat content are relatively unimportant in North Dakota because all the coal is of such quality that, in general, only development for use onsite or at a nearby facility is practical.

Limitations of Property Characteristics as a Measure of Development Potential.—Undeveloped leases with unfavorable property characteristics usually were found to have unfavorable development potential; similarly, leases with favorable property characteristics usually were found to have either favorable or uncertain development potential. However, in some cases other factors caused a different classification. Several illustrative examples are discussed below.

Lessee plans to incorporate the lease into an approved mine plan or existing mining operation.—In the Powder River basin, the Phillips Creek (1) lease block in Converse County, Wyo., has coal of low heat content and high ash content in thin seams. Nevertheless, it is adjacent to the Dave Johnston Mine which is scheduled to deplete its reserves in the late 1990's. The lease block was recently acquired by the Pacific Power & Light Co. (PPL) from SunEDCo and is likely to be integrated into the Dave Johnston logical mining unit. However, the Phillips (2) lease, recently acquired by the same lessee, and with similar poor property characteristics, is unlikely to be developed by itself and is unlikely to be integrated into an established mining operation.

Lessee plans to develop a synthetic fuels facility or onsite power generation.—Because of low heat content and high sulfur and ash, the Cherokee lease in southern Wyoming will probably not be developed to export coal to other States. However, the lease has sufficient reserves to support either an onsite synfuels project or electric generation plant. The site may eventually support both operations, since a synfuels project and a powerplant have been proposed by the lessee. The Cherokee lease, therefore, has favorable development potential contingent on the construction of a facility onsite to use the coal.

Lessee integrates the lease with non-Federal coal.—The two CX Ranch leases in the Montana portion of the Powder River basin both have small Federal reserves; without additional coal, neither of these leases would be likely to be developed. However, the lease held by Consolidation Coal Co. has been integrated with State and private fee coal already held by the company, and Consolidation is proposing an exchange of Indian coal for unleased Federal coal adjacent to the area. The transfer may be completed by the end of 1984. Because of these additional reserves, the lease has favorable development potential.

The other lease, held by Peter Kiewit Sons, Inc., also has been integrated with good quality fee coal and also has favorable development potential.

Other considerations.—Some undeveloped leases have unfavorable development potential even though they have excellent quality coal. For example, the Deadman lease includes some of the highest quality coal in the State of Wyoming; it has high heat content, low sulfur and ash, and adequate seam thickness. However, the Deadman lease lacks the reserve base needed to develop an economical new mining operation and is located in an area isolated from adequate transportation. Furthermore, underground mining operations required to develop this lease would be difficult because the seams on the lease dip as much as 250. For these reasons, the development potential of this lease is unfavorable despite high coal quality.

Results of Analysis of Development Potential

Table 52 summarizes the development potential of the 65 undeveloped leases (40 blocks) in North Dakota, Montana, and Wyoming. This total includes the 5 leases in pending mine plans in Wyoming which were analyzed as undeveloped leases. Thirty-eight leases (18 blocks) in this three-State area have favorable development potential. These leases contain 3.5 billion tons of recoverable reserves and cover over 69,000 acres. Eleven leases (eight blocks) in these States have uncertain development potential. These leases account for over 760 million tons of recoverable reserves and cover over 37,000 acres. Finally, 16 leases (14 blocks) in these States, covering over 11,000 acres have unfavorable development potential. However, the **310** million tons of recoverable reserves associated with these leases are less than 10 percent of the recoverable reserves contained on the 38 leases with favorable development prospects.

The Wyoming portion of the Powder River basin has the most reserves on undeveloped Federal coal leases in this area. The 3.9 billion tons of undeveloped recoverable Federal reserves in the Wyoming portion of the basin is nearly seven times larger than the combined undeveloped Federal reserves of southern Wyoming and the Fort Union region and about 40 times larger than the undeveloped Federal reserves in the Montana portion of the basin. Furthermore, less than 1 percent of the undeveloped reserves in the Wyoming portion of the Powder River basin have unfavorable development potential and over 80 percent have favorable development potential. The leases with unfavorable development potential in the Wyoming portion of the Powder River basin have poor property characteristics and little chance of being integrated with another coal property. The owners of the leases have given no indication that they will be developed. Two of the leases are authorized for trade under provisions of Public Law 95-554. * The undeveloped reserves in the Wyoming portion of the Powder River

*See ch. 9 for a discussion of exchanges.

Table 52.—Summary of Development Potential of Undeveloped Leases: North Dakota, Montana, and Wyoming[a]

	Favorable development potential				Uncertain development potential				Unfavorable development potential [a]			
State/region	Number Of leases	Number of lease blocks	Acres	Recoverable reserves[c]	Number of leases	Number of lease blocks	Acres	Recoverable reserves[c]	Number Of leases	Number of lease blocks	Acres	Recoverable reserves[c]
North Dakota.	1	1	320	s	3	2	3,912	LM	4	4	522	S
Fort Union	1	1	320	s	3	2	3,912	LM	4	4	522	S
Montana	2	2	1,198	LM	1	1	541	LM	2	1	5,096	H
Fort Union	0	0	0	0	0	0	0	0	2	1	5,096	H
Powder River basin	2	2	1,198	LM	1	1	541	LM	0	0	0	0
Wyoming	35	15	67,627	3.5	7	5	33,425	0.67	10	9	5,828	S
Powder River[b] basin	24	10	43,690	3.2	6	4	32,178	0.66	4	4	916	S
Hanna Field.	1	1	640	S	0	0	0	0	0	0	0	0
Rock Springs Field	5	2	18,951	H	0	0	0	0	3	2	4,232	S
Kemmerer field[b]	5	2	4,346	LM	1	1	1,247	S	3	3	680	S
Totals.	38	18	69,145	3.5	11	8	37,878	0.76	16	14	11,446	0.31

[a] TWO SMALL UNDEVELOPED LEASES IN THE BIGHORN BASIN OF WYOMING AND TWO SMALL UNDEVELOPED LEASES IN THE YELLOWSTONE/BULL MOUNTAIN AREA OF MONTANA HAVE BEEN OMITTED FROM THIS TABLE AND THE FOLLOWING DISCUSSION. THE LEASES HAVE VERY SMALL RESERVES AND UNFAVORABLE DEVELOPMENT POTENTIAL.
S = small reserves (zero to 30 million tons)
1 M = low to medium reserves (30 million to 100 million tons)
HM = high to medium reservs (100 million to 180 million tons)
H = high reserves (over 180 million tons)

[b] FIVE LEASES IN THREE PENDING MINE PLANS IN WYOMING (FOUR LEASES IN TWO PENDING PLANS IN THE POWDER RIVER BASIN AND ONE LEASE IN THE KEMMERER FIELD) ARE INCLUDED IN THIS TABLE. ALL HAVE FAVORABLE DEVELOPMENT POTENTIAL. SEE TABLE 48 FOR THE ACREAGE AND RESERVES OF THESE LEASES.

[c] In bllions of tons

SOURCE: Office of Technology Assessment

basin represent a substantial pool of new coal production for the 1980's.

The three coalfields with Federal coal leases in southern Wyoming have 18 undeveloped leases (11 blocks), covering 30,000 acres and containing nearly 300 million tons of recoverable reserves. Less than 10 percent of these reserves, in six small leases with poor property characteristics, have unfavorable development potential.

Ten undeveloped leases are located in the Fort Union region. These leases cover 9,850 acres and contain over 0.3 billion tons of recoverable reserves. Two leases with unfavorable development potential in the Montana portion of the Fort Union region contain most of these reserves. Of the four leases with unfavorable development prospects in the North Dakota portion of the region, two were mined out before passage of the Surface Mining Control and Reclamation Act of 1977. Since no mine plan was submitted to the Office of Surface Mining they were classified as undeveloped. The lease with favorable development potential (located in the North Dakota portion of the Fort Union region) has very small reserves of leonardite, an oxidized form of lignite. Development of two of the three leases with uncertain development potential hinges on the availability of adequate transportation (see ch. 8).

Production Prospects for Undeveloped Leases With Favorable and Uncertain Development Potential

Table 53 summarizes the production prospects of undeveloped leases with favorable or uncertain development potential in North Dakota, Montana and Wyoming. Production from leases with unfavorable development potential is assumed to be zero through 1991.

Under favorable* market conditions, currently undeveloped leases in Wyoming, Montana, and North Dakota could produce nearly 78 million tons of coal in 1991. Nearly 65 million tons of this production, or over 80 per-

*See ch. 5 for a discussion of these conditions.

Table 53.—Summary of Production Prospects for Undeveloped Leases With Favorable or Uncertain Development Potential: North Dakota, Montana, and Wyoming

State/region	Leases/ lease blocks	Production prospects for 1986[a] Ranking[b] (number of leases/lease blocks)		Estimated mine capacity	Estimated production (millions of tons)	Production prospects for 1991[a] Ranking[b] (number of leases/lease blocks)		Estimated mine capacity	Estimated production (millions of tons)
North Dakota									
Fort Union	4/3	Favorable:	1/1	0.05	0.01	Favorable:	1/1	0.05	0.05
		Unfavorable:	3/2	0	0	Uncertain:	3/2	1.9	0 to 1.0
Montana									
Powder River basin	3/3	Uncertain:	1/1	7	0 to 1.6	Uncertain:	2/2	12	0 to 8.8
		Unfavorable:	2/2	4	0	Unfavorable:	1/1	0	0
Wyoming[c]									
Powder River basin	30/14	Favorable:	5/3	10.7	5.6 to 7.6	Favorable:	7/4	31	17 to 28
		Uncertain:	7/3	9	0 to 1.9	Uncertain:	8/4	38	0 to 28
		Unfavorable:	18/8	0	0	Unfavorable:	15/6	0	0
Hanna Field	1/1	Favorable:	1/1	0.6	0.4 to 0.6	Favorable:	1/1	0.6	0.3 to 0.6
Rock Springs Field	5/2	Favorable:	1/1	2	1.3 to 2.0	Favorable:	1/1	2	1.1 to 2.0
		Unfavorable:	4/1	0	0	Uncertain:	4/1	5	0 to 5.0
Kemmerer Field	6/3	Favorable:	5/2	3.5	2.2 to 3.5	Favorable:	5/2	4.5	2.6 to 4.5
		Unfavorable:	1/1	0	0	Unfavorable:	1/1	0	0

[a]Leases with unfavorable development potential are not included in this table because such leases necessarily have unfavorable production prospects for 1986 and 1991.
[b]Ranking refers to production prospects for 1986 or 1991. Some leases with favorable or uncertain development potential may have uncertainties surrounding their being in production by 1986 or 1991, or may be unlikely to be in production until after 1986 or 1991. Such leases have uncertain or unfavorable production prospects for 1986 or 1991.
[c]Figures include five leases in three pending mine plans: four leases in two pending mine plans in the Powder River basin and one lease in one pending mine plan in the Kemmerer Field.

SOURCE: Office of Technology Assessment.

cent, could come from the Powder River basin. Under weak market conditions, production from currently undeveloped leases in the three-State area is likely to be only about 21 million tons in 1991, with about 17 million tons (81 percent) coming from the Powder River basin.

The wide range of 17 million to 65 million tons in estimated production from Powder River basin undeveloped leases in 1991 is caused by demand uncertainty. Delivery of 17 million tons of coal in 1991 from presently undeveloped leases in the Powder River basin has been contracted for; markets would have to be developed for the rest. All leases with uncertain development potential in the Powder River basin have unfavorable production prospects for 1986 and 1991 (see ch. 7).

In southern Wyoming, production from 12 presently undeveloped leases is estimated to range between 4 million and 12 million tons by 1991. The lower production could be achieved by 1986; much of the remainder depends on the pace of development of a planned synfuels facility. Presently undeveloped leases will be the only source of new Federal mine capacity in southern Wyoming.

A Federal mine containing a small leonardite lease in North Dakota may be producing 50,000 tons per year by 1991, and one lease block in North Dakota with uncertain development potential because of transportation uncertainties may be producing up to 1 million tons per year by 1991.

Diligence

Diligent Development Analysis

The Mineral Leasing Act of 1920 provides that each Federal coal lease is held subject to the conditions of diligent development and continuous operation. In 1976, DOI issued regulations defining diligent development for Federal coal leases as actual production of coal in commercial quantities from the lease or from the logical mining unit (LMU) of which the lease is a part by June 1, 1986 or within ten years after the lease is issued, whichever is later. Leases that do not meet this minimum production requirement can be canceled. Under certain conditions, the period for producing the minimum amount for achievement of diligence can be extended for up to 5 years to June 1, 1991, for leases issued before passage of FCLAA.

Enforcement of DOI's diligent development requirements for pre-FCLAA leases is an important issue in the management of existing leases, not only because of the controversy involving the applicability of the regulations, but also because of the potential administrative requirements on DOI in handling requests for extensions or approvals of enlarged LMUS, and cancellations. Moreover, after 1986, new Federal leases cannot be issued to any lessee, including a pre-FCLAA lessee, who is holding a lease from which he has not produced coal in commercial quantities during the previous 10 years,

OTA made a rough comparison of its estimates of future production from Federal leases with DOI's diligent production requirements to determine: 1) how many leases are likely to meet diligence by 1986, and 2) assuming that extensions were granted in many cases under the existing guidelines, the likelihood for other leases meeting diligence by 1991. The following sections summarize briefly the results of OTA's diligence analysis. See chapter 9 for a description of the issues related to current diligent development regulations.

Comparison of Production From Federal Leases and Diligent Development Requirements

OTA compared the planned and estimated production from existing Federal leases with the minimum production requirements set by the 1976 DOI regulations defining diligent development for pre-FCLAA leases. The analysis covered the 502 leases in the Southern Rocky Mountain and Northern Great Plains regions including about 30 post-FCLAA leases issued as production maintenance, hardship, or bypass leases associated with active mines. * Almost all of these post-FCLAA leases will meet diligence as part of the larger mining operations,

OTA used mine plan data and information from mine operators and Government agencies. Each approved or pending mine plan or each undeveloped lease block was considered to be an approximate logical mining operation. (The term approximate logical mining operation was used so as not to confuse mine plan and lease block units with designated or approved LMUS as defined by DOI regulations.) In assessing a lessee's prospects for meeting diligence, OTA used the Federal mine production estimates presented earlier, In deriving these production estimates, OTA considered many variables that could, in turn, affect the lessee's ability to meet diligence, such as the amount and quality of reserves, mine type, transportation availability, and present and projected coal demand (see ch. 2 of this report for further discussion of the methodology used in reaching production estimates).

In conducting this analysis, OTA made the following assumptions:

1. The mining operations will meet the mine plan production schedules or, if no mine plan is available, the mining operations will meet OTA's estimated production schedule. OTA estimated the earliest feasible year for commercial production for leases without plans.
2. The reserves and production from the approximate logical mining operations (either the total mine plan area or the Federal lease block) were used in assessing prospects for meeting diligence. Mines were presumed to meet diligence for all Federal leases in the unit if they produced at least 2½ percent of the total mine plan reserves by 1986 or 1991. (Without detailed information on the mining sequence and geometry for each mine, OTA was not able to calculate compliance on a lease by lease basis).
3. All leases with planned production and those undeveloped leases with favorable or uncertain development prospects that are likely to start producing in 10 years were assumed to receive extensions of the diligence period to 1991 if they did not produce enough to meet diligence by 1986. Under current diligence guidelines, some mines, particularly small- and medium-sized underground operations producing under 2 million tons per year, might have difficulty qualifying for extensions. Nevertheless, it was assumed for purposes of this analysis that they would be able to negotiate an extension. OTA estimates that the number of new mines and leases that are likely to be producing by 1991 and that could not qualify for an extension under a broad interpretation of the diligence guidelines is very small,

The results of OTA's analysis for leases in the six major Western Federal coal States are described in the following sections.

Diligent Development in Colorado, New Mexico, and Utah

Southern Rocky Mountain region States (Colorado, New Mexico, and Utah) have 360 Federal coal leases. Over 60 percent (221 leases) of the leases in this region are included in currently approved or pending mine plans. Of the remaining 139 leases without mine plans, OTA's analysis identified 96 leases that potentially could be producing by

*See the Oklahoma section at the end of this chapter for a discussion of diligence prospects for Oklahoma leases.

1991. The results of OTA's diligence analysis are summarized in table 54 and figure 31. The analysis shows that by 1986, all 113 of the leases in approved mine plans, 22 leases in pending mine plans and one undeveloped lease will probably have satisfied the production requirements for diligence. By 1991 another 110 leases could possibly meet diligence, assuming that the lessees receive extensions to the diligence period. A total of 246 leases, (68 percent of the leases) with 73 percent of the Federal lease reserves in the Southern Rocky Mountain region could meet, or surpass, the production requirements for diligence by 1991.

The percentages of leases and reserves in each diligence category are relatively evenly distributed for the region as a whole (see fig. 31), however, there is much less correspondence between reserves and leases meeting diligence when these percentages are calculated on a State basis, as shown in figure 32.

In Colorado, about 80 percent of the leases and 93 percent of the lease reserves could possibly meet diligence; however, half of the reserves contained in only 26 percent of the leases are uncertain to meet diligence because of uncertainties in the pace and scale of proposed development. The 19 percent of the leases in Colorado that are unlikely to meet diligence contain only 7 percent of the Federal lease reserves.

In New Mexico, nine leases, 31 percent of the leases in the State, are unlikely to meet diligence. These leases, however, contain less than 1 percent of the Federal lease reserves. Thus, in New Mexico, 69 percent of the leases with over 99 percent of Federal reserves under lease are expected to meet diligence.

In Utah, about 40 percent of the leases in the State and 44 percent of the lease reserves are unlikely to meet diligence by 1991. Most of the lease reserves (1.4 billion tons) in Utah that will not meet diligence are contained in 61 leases on the Kaiparowits Plateau that could be producing by 1991 but which are unlikely to do so and, in any event, will not have produced enough to meet diligence by 1991. Most of the leases and reserves in active, proposed, or potential new mines in central Utah (95 leases—roughly 46 percent of leases and reserves in the State) will probably achieve diligence by 1991.

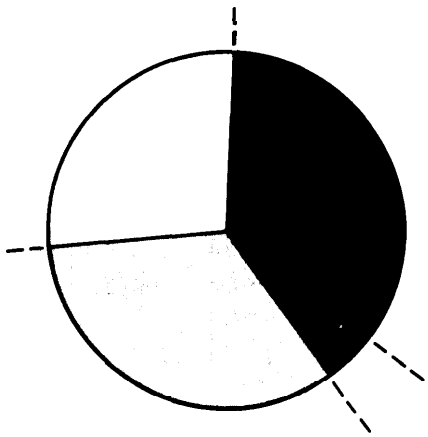
Table 54.—Analysis of Prospects for Meeting Diligent Development Requirements by 1986 or 1991: Federal Leases, Mining Units, and Recoverable Reserves in Colorado, New Mexico, and Utah (all reserves in millions of tons)

				Likely to achieve diligence by 1986			Likely to achieve diligence by 1991			Uncertain to achieve diligence by 1991			Unlikely to achieve diligence by 1991		
	Number			Number			Number			Number			Number		
State	Of leases	of mining units	Recoverable reserves	of leases	of mining units	Recoverable reserves	of leases	of mining units	Recoverable reserves	of leases	of mining units	Recoverable reserves	of leases	of mining units	Recoverable reserves
Colorado	127	66	2,234	64	25	871	6	3	71	33	19	1,133	24	19	157
Approved plans	54	19	724	54	19	724	0	0	0	0	0	0	0	0	0
Pending plans	21	11	455	9	5	142	6	3	71	5	2	241	1	1	0
No plans	52	36	1,055	1	1	6	0	0	0	28	17	892	23	18	157
New Mexico	29	15	447	17	4	314	1	1	38	2	2	93	9	8	2
Approved plans	9	2	169	9	2	169	0	0	0	0	0	0	0	0	0
Pending plans	9	3	183	8	2	145	1	1	38	0	0	0	0	0	0
No plans	11	10	95	0	0	0	0	0	0	2	2	93	9	8	2
Utah	204	56	3,253	55	17	835	8	4	206	60	12	773	81	23	1,439
Approved plans	50	14	792	50	14	792	0	0	0	0	0	0	0	0	0
Pending plans	78	11	1,270	5	3	42	8	4	206	29	2	351	36	2	671
No plans	76	31	1,191	0	0	0	0	0	0	31	10	423	45	21	768
Total region	360	137	5,934	136	46	2,020	15	8	315	95	33	2,000	114	50	1,598
Approved plans	113	35	1,685	113	35	1,685	0	0	0	0	0	0	0	0	0
Pending plans	108	25	1,907	22	10	329	15	8	315	34	4	597	37	3	671
No plans	139	77	2,341	1	1	6	0	0	0	61	29	1,408	77	47	927

NOTE: Reserves columns may not add to totals because of independent rounding.

SOURCE: Office of Technology Assessment.

Figure 31 .— Diligent Development Summary for the Southern Rocky Mountain Region (percent of reserves)



Key	Number of leases	Percent of leases	Reserves[a]	Percent of reserves
Likely to meet diligence by 1986	136	36	2.0	34
Likely to meet diligence by 1991	15	4	0.3	5
Uncertain to meet diligence by 1991	95	26	2.0	34
Unlikely to meet diligence by 1991	114	32	1.6	27

[a]Billions of tons.

SOURCE: Office of Technology Assessment

Leases That Are Likely To Meet Diligence by 1986

In the Southern Rocky Mountain States, **136** leases with a total of **2** billion tons of Federal reserves—about 34 percent of the Federal reserves under lease in the region— are likely to have met diligence by 1986. All of the mines are expected to meet continuous operations requirements and to be mined out within 40 years at planned production rates.

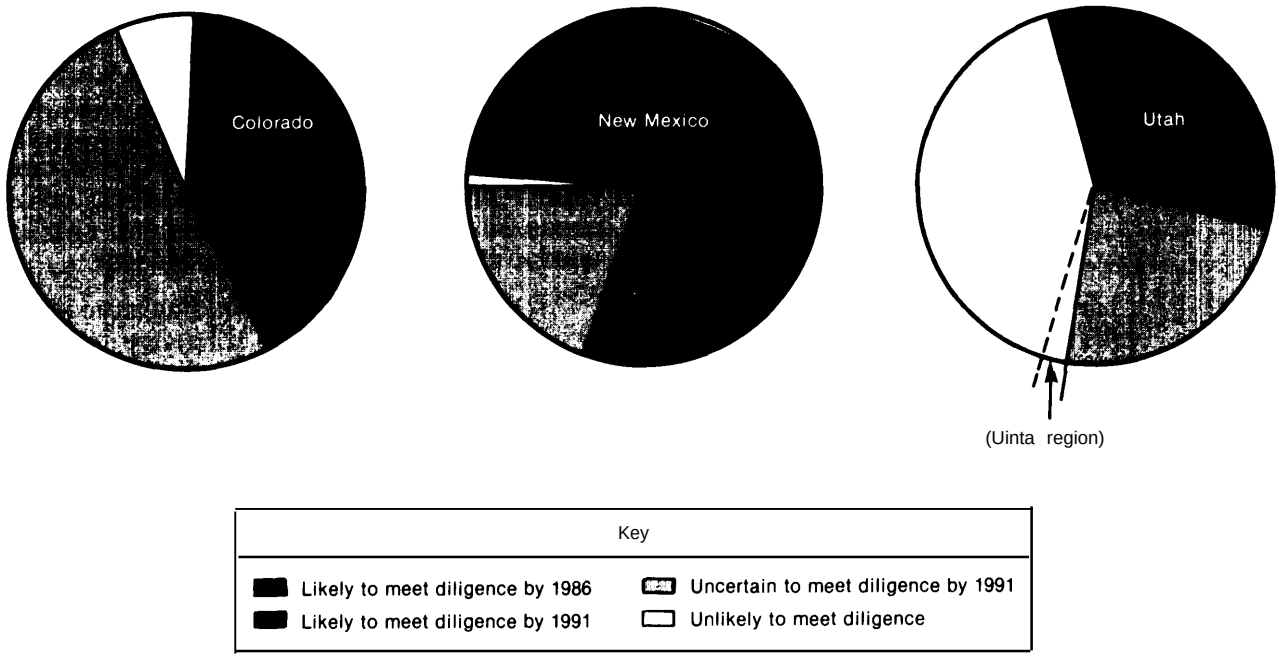
According to projected production schedules contained in the mine plans, all of the 113 leases included or associated with the 35 mines with approved mining plans will have met diligence for the total mine plan reserves by June 1, 1986. Many, if not most, of these mines have already produced this amount and many of the individual leases have, in fact, already produced enough to meet diligence. In those cases where leases have not produced the minimum amounts by 1986, the lessees could either request extensions or approval of enlarged LMUs combining both currently producing and nonproducing mine areas so that aggregate production can be used to meet the diligence requirement.

Another 22 leases in 10 pending mine plans are also likely to achieve diligence by 1986 according to mine plan production schedules. One currently undeveloped lease in Colorado is expected to begin production before 1986 and thus, will meet diligence. It is possible that other undeveloped leases could achieve diligence by 1986 by inclusion with DOI approval in adjacent active mining units owned by other lessees through assignment or operating agreements. This would involve fewer than 10 leases in the Southern Rocky Mountain region because of the requirement that all areas in an approved LMU must be contiguous.

Leases That Are Likely To Meet Diligence by 1991

By 1991, 15 more leases in eight mines with a total of 315 million tons of Federal lease reserves are expected to meet diligence requirements. These eight mines, including six leases in Colorado, one in New Mexico, and eight in Utah, represent 4 percent of the leases and 5 percent of Federal coal reserves in the region. All of these leases are in proposed mine plans currently under review. At least three mines are not scheduled to begin commercial production until 1986 or later. The eight mines include two small mines that are being reopened on previously mined leases, one new, large surface mine, and one mine that would combine surface and underground recovery methods. Another mine is a captive operation that would supply a new powerplant that has been delayed, and still one other has been suggested by proponents as one of the suppliers for a proposed coal gasification plant in Utah. The remaining two

Figure 32.- Diligent Development Summary for Federal Lease Reserves in Colorado, New Mexico, and Utah[a]



[a]See table 54 for amount of reserves.

SOURCE: Office of Technology Assessment.

mines are underground operations that will sell to utilities and industrial users.

Leases That Are Uncertain To Meet Diligence by 1991

OTA found that 95 leases in 35 approximate logical mining operations with about 2 billion tons of recoverable Federal reserves may not meet diligence requirements by 1991. Roughly 26 percent of the leases and 34 percent of the leased reserves in the Southern Rocky Mountain region could possibly achieve diligence by 1991; however, OTA found that these leases face some uncertainties regarding the pace or scale of proposed mining activities or in defining the LMU reserves. There are several reasons why some of these leases might not meet diligence: The date of initial production for some mines is uncertain because of delays in construction of associated electric powerplants or transportation systems. For several lease tracts with very large underground reserves in multiple seams, it is difficult to predict how many seams will eventually be included in the LMU reserves, since that determination will, in part, depend on the sequence of mining. Perhaps the greatest uncertainty is that the development plans of several lessees with large tracts of good quality minable reserves have not yet been announced. Production from captive mines that are planned as replacement capacity for existing operations is dependent on exhaustion of the economically recoverable reserves in existing mines. In some cases, the new captive mines are not contiguous with the existing operations, so they could not be combined with producing mines to meet diligence under current law.

Utah has 60 leases that are uncertain to meet diligence by 1991 including 28 leases in the proposed Alton surface mine with over 200 million tons of recoverable Federal reserves. The Alton Mine alone contains one

quarter of all the leases and 30 percent of the reserves that are uncertain to meet diligence in the three-State area. The difficulties in Alton's proposed development plans are discussed earlier in the chapter and in the Utah appendix.

Colorado has 33 leases in 18 units that might not meet diligence, including two pending mine plans. One of these, Arco's Mt. Gunnison Mine, has a large amount of recoverable reserves in multiple seams, It is possible that the logical mining unit reserves could be defined by the U.S. Geological Survey as less than the total reserves by including only the seams commonly mined in the region. If so, the mine could meet diligence by 1991, and perhaps, even by 1986, since at least one lease in the mine has already produced coal,

Leases That Are Unlikely To Meet Diligence by 1991

Nearly one-third of the leases in the Southern Rocky Mountain States, 114 leases, with 1.6 billion tons of Federal reserves in 60 mining units, are unlikely to achieve diligent development. These include 37 leases that are in three proposed new mine plans—one small mine in Colorado and two mine complexes on the Kaiparowits Plateau in Southwestern Utah. Sixty-eight leases that are unlikely to meet diligence by 1991 are located in southwestern Utah. A total of 61 Kaiparowits leases in six blocks with 1.4 billion tons of reserves have some potential for development according to OTA's analysis, But even if the lessees began production by 1987 (probably the earliest feasible date), it is unlikely that they would be able to produce enough to meet diligence by 1991 because of the large amount of reserves involved. Moreover, it is unlikely that a new coal transportation system connecting Southwestern Utah with potential markets will be operational by 1991. The remaining 53 leases in the three-State region are unlikely to meet diligence because they are unlikely to be mined in the next decade. These nonproducing leases include many abandoned small mines and other leases that do not have enough good quality minable reserves to sustain viable independent mining operations and are not located adjacent to other active mines.

Diligent Development in North Dakota, Montana, and Wyoming

The results of the analysis on diligent development are summarized in table 55 for the coal regions of Wyoming, Montana, and North Dakota. Figure 33 summarizes the results for the Powder River basin, The first diligence requirement (production of 21/z percent of LMU recoverable reserves by 1986/ 1991) is the only one summarized in the table; with few exceptions, LMUs which are likely to meet this requirement appear likely to meet the additional requirement of continuous operation and appear likely to be mined out in 40 years.

The diligent development analysis for Wyoming, Montana, and North Dakota has reached the following conclusions:

1, Over 60 percent of the leases containing nearly 70 percent of the reserves under Federal lease in these three States are likely to either meet diligence in 1986 or in 1991,
2. For the Powder River basin, demand for coal is the dominant factor in whether leases containing about 1.2 billion tons of recoverable reserves will meet diligence by 1991.
3. Over 90 percent of the 1.5 billion tons of recoverable reserves contained in leases unlikely to achieve diligence by 1991 in the Powder River basin are suitable only for onsite synfuels development; and nearly 40 percent (0.6 billion tons) are suitable only for in situ gasification, assuming that technology is developed.
4 For southern Wyoming, leases containing most of the reserves should meet diligence by 1986 under expected market conditions, The principal uncertainty in whether leases containing essentially all of the reserves will meet diligence by 1991 is the pace of development of a synfuels project.

Table 55.—Diligent Development Summary

State/region	Total number of leases/ lease blocks	Total Federal lease recoverable reserves (billions of tons)	Likely to achieve diligence by 1986	Likely to achieve diligence by 1991	Uncertain whether will achieve diligence by 1991	Unlikely to achieve diligence by 1991	
						Favorable or uncertain development potential	Unfavorable development potential
North Dakota	20/14	about 0.6[b]	about 0.2[b]	S	LM	—	S
Fort Union			(12/7)[c]	(1/1)	(3/2)		(2/2)
Montana	3/2	—[b]	—[b]	—	—	—	H
Fort Union			(1/1)				(2/1)
Total	23/16	about 0.6[b]	about 0.2[b]	S	LM		H
Fort Union			(13/8)[c]	(1/1)	(3/2)	—	(4/3)
Montana - Yellowstone & Bull Mountain	3/3	S	S	—	—	—	S
			(1/1)				(2/2)
Montana	15/8	0.9	0.8	—	<0.1	<0.1	—
Powder River basin			(12/5)		(2/2)	(1/1)	
Wyoming	58/30	8.3	4.0	1.7	1.2	1.5	S
Powder River basin			(27/13)	(8/4)	(8/4)	(1 1/5)	(4/4)
Total	73/38	9.2	4.8	1.7	1.2	1.5	S
Powder River basin			(39/18)	(8/4)	(10/6)	(12/6)	(4/4)
Wyoming	2/2	S	—	—	—	—	S
Big Horn basin							(2/2)
Wyoming	16/7	0.07	0.07	—	—	—	—
Hanna Field			(16/7)				
Wyoming	13/7	0.4	>0.2	<0.2	<0.2	—	S
Rock Springs Field			(5/3)	(1/1)	(4/1)		(3/2)
Wyoming	12/8	0.06	>0.03	<0.03	—	S	S
Kemmerer Field			(4/3)	(4/1)		(1/1)	(3/3)
Total	41/22	0.5	>0.3	<0.2	<0.2	S	S
Southern Wyoming			(25/13)	(5/2)	(4/1)	(1/1)	(6/5)

Key to table:
1) All reserves are in billions of tons.
2) All reserves are Federal reserves under lease; LMU reserves, if they include non-Federal coal are larger.
3) "Likely (uncertain, unlikely) to achieve diligence by 1986 (1991)" refers to likelihood that 2½ percent of LMU reserves will be produced by 1986 (1991).
4) In columns 4 through 8, the upper number in each row is Federal reserves under lease; e.g., in the Montana portion of the Powder river basin, 0.8 billion tons of Federal reserves under lease are likely to meet diligence by 1986.
5) In columns 4 through 8, the lower set of numbers in each row is number of leases/number of lease blocks; e.g., in the Montana portion of the Powder River basin, 12 leases in five lease blocks are likely to meet diligence by 1986.

[a]These leases generally have poor development potential because of small reserves, low coal(quality and difficult mining conditions,
[b]Reserves in the Montana and North Dakota portions of the Fort Union region have been combined to preserve confidentiality.
[c]In addition, two leases were mined out before the passage of SMCRA. Because no mine plans were filed for these leases they were classed as undeveloped. Because no further production will occur from the leases, they have unfavorable development potential. However, because their reserves have been mined out, they have met diligence already.

S = small reserves (zero to 30 million tons)
LM = low to medium reserves (30 million to 100 million tons)
HM = high to medium reserves (100 million to 180 million tons)
H = high reserves (over 160 million tons)

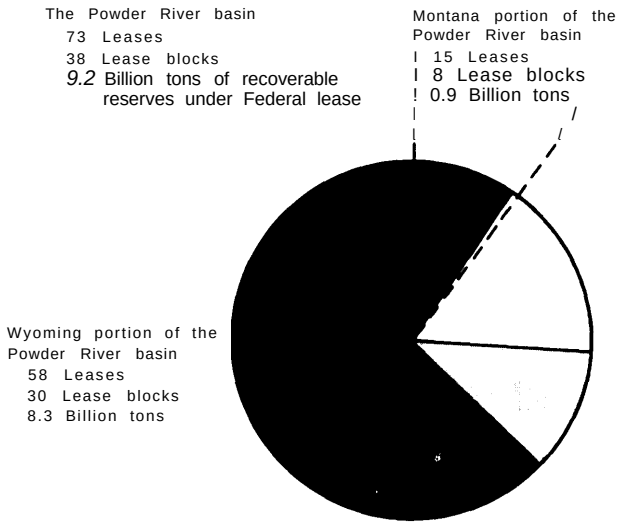
SOURCE: Office of Technology Assessment.

5. In the Fort Union region, all leases in approved and pending mine plans (with about 40 percent of the Federal reserves under lease in the region) are likely to meet diligence by 1986. However, only one very small undeveloped lease is likely to meet diligence even by 1991. Adequate transportation constitutes an uncertainty in whether two other leases will meet diligence by 1991.

Powder River Basin

As table 55 and figure 33 indicate, there are 73 leases in 38 lease blocks in the Powder River basin of Wyoming and Montana. Federal reserves under lease total 9.2 billion tons in the Powder River basin, of which 10 percent, or 900 million tons, are in the Montana portion. Seventy percent of the recoverable reserves under lease in the Powder River basin, or 6.5 billion tons, are likely to meet

Figure 33.— Diligent Development Summary for the Powder River Basin



Key	Reserves[a]	Percent of reserves
Likely to achieve diligence by 1986:	4.8	52%
Likely to achieve diligence by 1991:	1.7	18%
Uncertain whether will achieve diligence by 1991:	1.2	13%
Unlikely to achieve diligence by 1991:	1.5	16%

[a]Billions of tons.

SOURCE: Office of Technology Assessment.

diligence by 1986 or 1991. Thirteen percent, or 1.2 billion tons, are uncertain to achieve diligence by 1991 and 16 percent, or 1.5 billion tons, are unlikely to achieve diligence by 1991,

With two exceptions, the 18 lease blocks in the Powder River basin likely to achieve diligence by 1986 are associated with producing mines or are in approved mine plans. With one exception, all these lease blocks presently have contracts to deliver coal by 1986 or earlier. * Of the four lease blocks** likely to achieve diligence by 1991 but not by 1986, only South Rawhide does not presently have contracts for coal delivery before 1991. (Contracts are one of the criteria for granting diligence extensions).

The six lease blocks*** which are uncertain to achieve diligence by 1991 are all undeveloped; none of them presently has contracts for 1991. However, all the lease blocks have favorable development potential, and the lessees are working to develop their properties. Applications for extensions to diligence are expected to be filed for all of these blocks. Five of the six lease blocks are being planned as large surface mines, with capacities of 5 million tons per year or more, and would thus probably qualify for a diligence extension under the second (large mine) extension criterion. The sixth has a planned capacity of 4 million tons per year. However, the level of demand for Powder River basin coal is an important factor in their achieving diligence. If demand in 1991 is at the OTA high demand scenario level of 275 million tons per year, all of these lease blocks would likely meet diligence by 1991. However, if demand in 1991 is at the OTA low demand scenario level of 163 million tons per year, it is possible that none of these lease blocks will even go into production by 1991. (See ch. 7 for a description of the OTA high and low demand scenarios for Powder River basin coal.)

Six undeveloped lease blocks are unlikely to achieve diligence by 1991 even though they do not have unfavorable development potential. Production on four of these (Lake deSmet, Bass Trust, Belco, Gulf [l&z)) is contingent on synfuels development; for three of the four, production is contingent on in situ gasification development. Although little development activity has occurred on the fifth

*PPL is conductng a feasibility study to determine whether or not its Phillips Creek (1) leases should be integrated with the Dave Johnston Mine. According to a company spokesman, the leases are likely to be added to the mine, in which case, even though the leases themselves are unlikely to be mined until 1991 or later, they would meet diligence as part of the logical mining unit. North Antelope Coal Co, 's North Antelope lease does not yet have an approved mine plan but has a contract for 1984 delivery of coal.

**South Rawhide, Rochelle, Antelope, Rojo Caballos. In the case of South Rawhide. the lessee may blend its coal with the output from the existing Rawhide and Caballo Mines, reducing production at these two mines, if contracts cannot be obtained for South Rawhide itself. Diligence could then be achieved for all three mines: for Rawhide and Caballo by 1986: for South Rawhide by 1991.

***Dry Fork, East Gillette Federal, N. Rochelle, CX Ranch (Consol), CX Ranch (PKS), Wildcat.

(East Wyodak), the lessee (Peabody) has strongly stated its intent to develop the property. The sixth lease, Pearl, is in Montana. The lessee, Shell, spent considerable sums on development, including the preparation of an environmental impact statement, before suspending activity. Shell declares it will resume development once markets strengthen. All six are expected to file for diligence extensions. Finally, four undeveloped lease blocks with unfavorable development potential are unlikely to meet diligence.

Southern Wyoming

As table 55 states, there are a total of 41 leases in 22 lease blocks in the three coalfields of southern Wyoming. These leases contain over 500 million tons of recoverable reserves. Leases containing over 300 million tons of reserves are likely to achieve diligence by 1986 and several mines are likely to meet diligence by 1991. The lease block whose achievement of diligence is uncertain for 1991 is being planned for synfuels.

Development Potential and Production Prospects of Federal Coal Leases in Oklahoma

There are 46 Federal coal leases located in the Oklahoma portion of the Western Interior coal region; the region also includes the States of Arkansas, Kansas, Missouri, and Iowa. There are no Federal coal leases in the latter four States. Total coal production in Oklahoma in 1979 was 5 million tons, or 40 percent of total Western Interior production and over three times the total production of the State a decade ago. However, Federal reserves accounted for only 0.3 million tons of Oklahoma production in 1979.

Approximately 80 percent of the leased Federal coal in Oklahoma is of high metallurgical quality that is used primarily to produce coke for domestic steel production. Virtually all of the increase in Oklahoma coal production over the last 10 years has been noncoking coal. Although metallurgical grade coal can be blended with steam coal to generate electricity, it is unlikely that any new mines with Federal leases in Oklahoma will be developed to sell metallurgical quality coal primarily for blending for steam-electric generation. Weak demand is expected for metallurgical quality coal over the next 10 years. Captive mining operations, where the parent company produces steel or cement, and sales to foreign buyers appear to be the main source for Federal coal development in Oklahoma throughout the 1980's.

Status and Production Prospects of Leases in Approved Mine Plans in Oklahoma

There are seven leases in five approved mine plans in Oklahoma (see table 56). One of the seven leases was relinquished in 1980 because of the increase in royalty at the time of readjustment. Production on another lease has been interrupted because of labor disputes. The reserves remaining on this lease can support less than 5 years of commercial production. The remaining five leases in approved mine plans or associated with operating mines are currently producing coal or are scheduled to produce coal in the near future. However, only two of these leases in one mine plan are expected to produce coal continuously over the next 10 years. These two leases are likely to meet diligence by 1986 or 1991. Of the remaining three leases in approved mine plans, the reserves on one are expected to be depleted by 1984, and the reserves on the other two by 1986.

Status and Development Potential of Undeveloped Leases and Leases in Pending Mine Plans in Oklahoma

Thirty-eight leases (20 blocks) of the 46 leases in Oklahoma are not included in mine

Table 56.—Status and Development Potential of Undeveloped Leases in Oklahoma

Status of leases
Approved mine plans:
7 leases
5 mine plans
8,668 acres
6 million tons recoverable reserves
Underground: 5.4 million tons
Surface: 0.6 million tons
Pending mine plans:
1 lease
1 mine plan
680 acres
Small underground recoverable reserves
No mine plans:
38 leases
20 lease blocks
64,698 acres
179 million tons recoverable reserves
Underground: 169 million tons
Surface: 10 million tons
Development prospects: undeveloped leases
Uncertain development prospects:
23 leases
7 lease blocks
38,334 acres
104 million tons recoverable reserves
Unfavorable development prospects:
15 leases
13 lease blocks
26,360 acres
75 million tons recoverable reserves

SOURCE. Office of Technology Assessment,

plans (table 56). None of these leases are expected to be brought into commercial production by 1991. The production prospects for the one lease included in a pending mine plan are also unfavorable during this period, although the owner of Federal and fee coal now being mined near this property has expressed interest in acquiring this lease.

Over **90** percent of the recoverable reserves on undeveloped leases are underground reserves. Twenty-five of these leases (8 blocks) have uncertain development potential for 1991; the remaining undeveloped leases have unfavorable development potential for 1991. There are three main reasons for the unfavorable production prospects of these leases: 1) a depressed metallurgical coal market, 2) difficult and costly underground mining conditions, and 3) a high Federal royalty relative to royalties charged for fee coal in the State.