THE GEOLOGICAL SURVEY OF WYOMING

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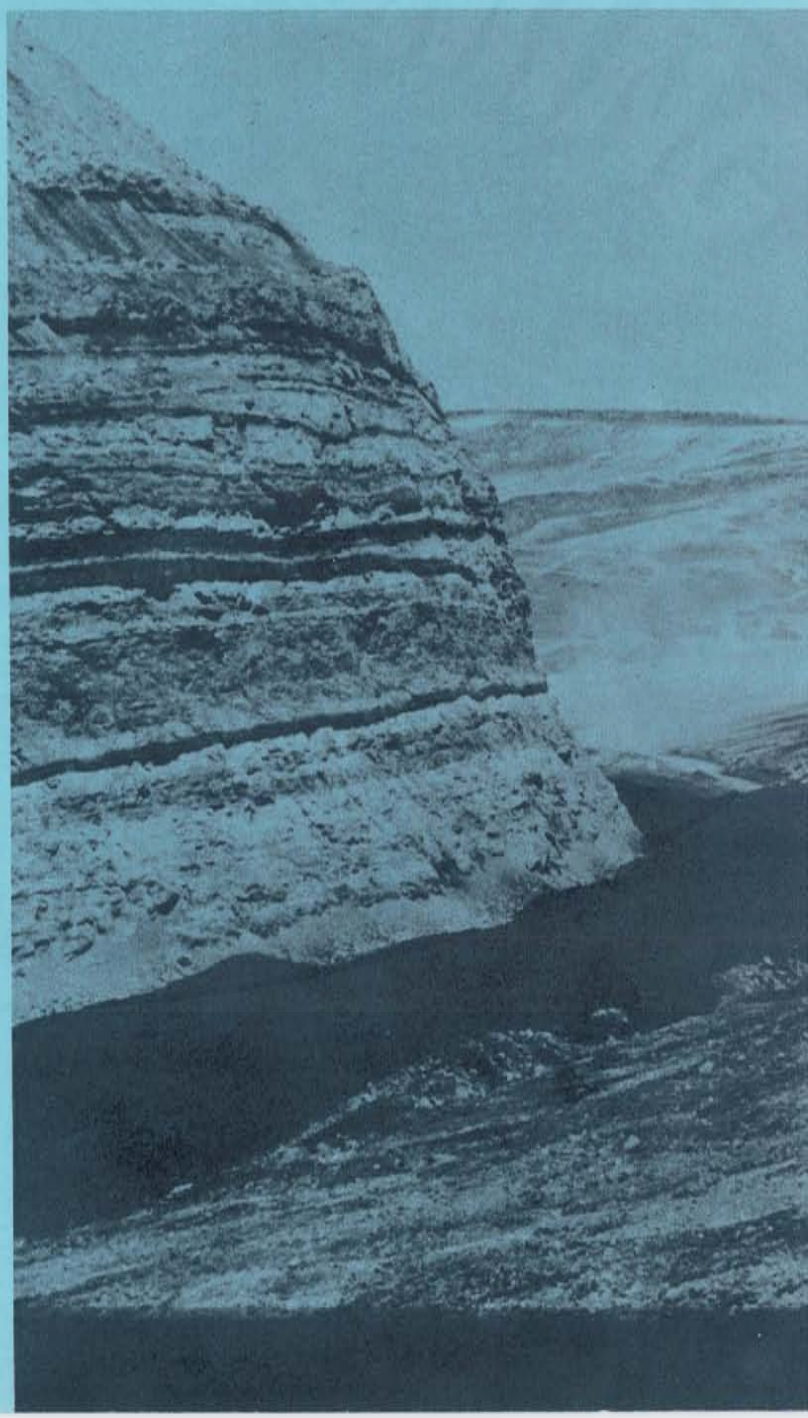
STATE-OWNED COAL LANDS IN WYOMING



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ABOUT THE COVER: Kemmerer Coal Company's Sorensen mine in Lincoln County, Wyoming.

ABSTRACT

Wyoming has retained mineral rights under at least three million acres of the 4.2 million acres of State land. Of these three million acres, 1.3 million acres are underlain by coal with about 1.2 million acres under lease. There are, however, no small scale mineral ownership maps that accurately depict the location of all State coal lands or leases. Accurate locations must come from records and plats in county and State offices.

Most State lands are limited to one or two isolated sections per township. These are usually the State school sections 16 and 36 but, in some cases, other sections have been substituted. Large, contiguous blocks of State coal land are common only in Johnson, Sheridan and, to a lesser degree, Converse counties.

The quantity and quality of coal resources beneath State land is very poorly defined. Similarly, detailed resource information, including quantity and quality, is lacking for all but one or two of the State coal leases.

Two recent resource estimates suggest that the total coal resources underlying State-owned coal land may be on the order of 32-58 billion tons with 13-16 billion tons of that recoverable by surface and/or underground mining techniques. Neither of these estimates presents resource data in a way that would allow calculation of resources under specific tracts of land. This kind of precision awaits a tract by tract study.

On January 1, 1976, seventy-one lessees held 1,353 State coal leases that totaled nearly 1.2 million acres. Twenty of these leaseholders, however, controlled 90 percent of the acreage. Additionally, seventeen of the 71 lessees are actively engaged in coal mining in Wyoming or plan to open new mines in the near future. Only five of the largest lessees are included in these seventeen.

Although rentals from State leases have increased each of the past five years, they will probably level out or increase only slightly over the $575,488.75 collected in 1965. Presently, State coal lands lease for 50 cents an acre for the first five years and $1.00 an acre for the sixth through tenth year or renewal thereof.

Production of coal from State leases has always been small. For instance, only one 640 acre lease is currently in production. Royalties on old leases will remain at seven percent of the gross output until the lease is renewed. Leases with commercial discoveries of coal rent for $1.00 an acre, but these are actually advance royalty payments and are reported as royalties. Over the past five years, royalty collections, including advance royalties, have fluctuated from $3,330 in 1971 to $250,132.69 in 1973. Similar fluctuations can be expected in the future.

COAL MINERAL RIGHTS IN WYOMING

Coal ownership in Wyoming is vested in four major classes of owners: Federal and State government, private and Indian lands. Although a precise breakdown of mineral ownership into these various classes is not currently possible, the relative acreage belonging to each can be estimated.

Table 1 shows that the Federal government owns approximately 46 percent of the coal lands in Wyoming and is the largest single mineral owner. The private sector, which includes the Union Pacific Railroad, utilities, corporations and individual citizens, is the next largest owner class with 41.5 percent, followed by the Indians (7.5%) and the State of Wyoming (5%).

Table 1: Coal ownership classes in Wyoming

CLASS	PERCENT OF TOTAL COAL LANDS	AREA IN MILLIONS OF ACRES
FEDERAL GOVERNMENT[1]	46.0%	11.8
PRIVATE SECTOR[2]	41.5%	10.6
INDIAN[3]	7.5%	1.9
STATE GOVERNMENT[4]	5.0%	1.3
TOTAL[5]	100.0%	25.6

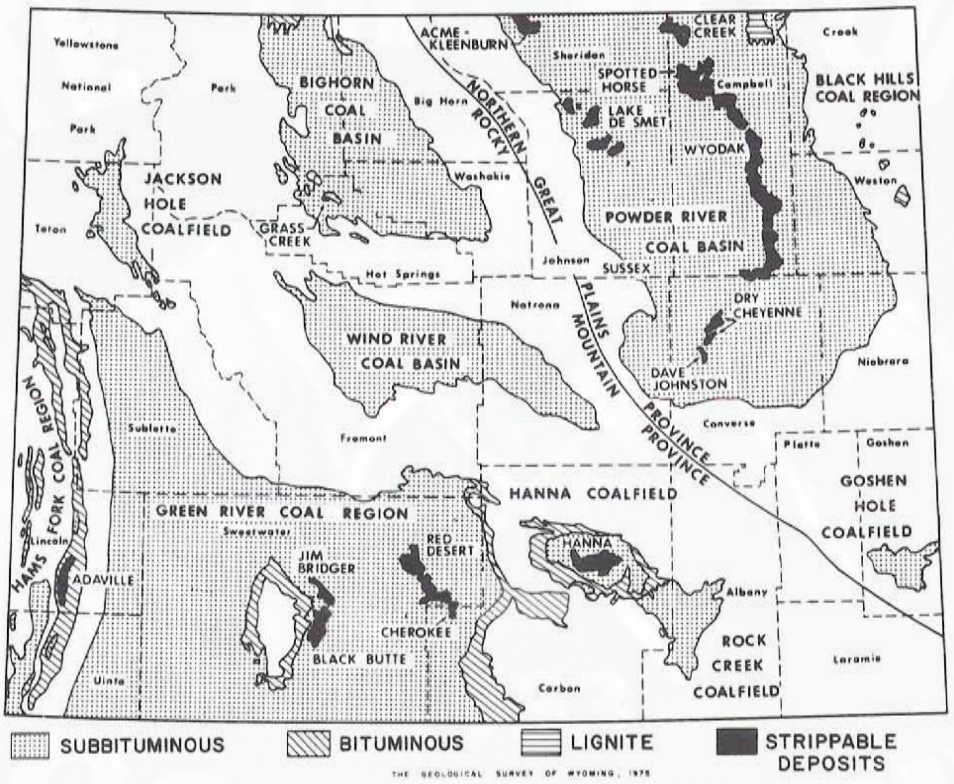
[1]U.S. Department of Interior, 1975
[2]Computed by subtracting Federal, Indian, and State coal lands from 25.6 million acres
[3]Assumed to be equal to Indian-owned surface lands
[4]Wyoming Geological Survey estimate based on Wyoming Department of Public Land estimate of mineral rights acreage
[5]Acreage within coal-bearing areas (Berryhill, et al., 1950)

STATE-OWNED COAL RIGHTS

Wyoming has retained the mineral rights to about 75 percent or an estimated three million acres of the 4.2 million acres of State land. Mineral rights under the other 1.2 million acres of State lands either were never owned by the State or were sold or traded prior to 1920. In 1920, the State stopped selling its mineral rights although some surface rights are still sold or traded.

Because coal does not underlie all State land, State coal land is much smaller in acreage than the estimated three million acres of State mineral land. State-owned coal land is estimated at 1.3 million acres or five percent of the total acreage underlain by coal (Table 1). This estimate assumes that Wyoming has retained all coal rights on tracts that lie within coal-bearing areas (Figure 1). Although this assumption may not be entirely accurate, State land now under coal lease (1.2 million acres in 1975) is very near the estimate. Additionally, the State Land Commissioner has publicly stated that virtually all of Wyoming's State coal land is under lease (Casper Star-Tribune, June 19, 1975).

Figure 1: Coal-bearing areas of Wyoming



LOCATION OF STATE-OWNED COAL LANDS

With few exceptions, State coal lands are checkerboarded across Wyoming, absent only in the National Parks, National Forests and the Wind River Indian Reservation. Although most of the State land is restricted to "school lands" (sections 16 and 36 of each township), the Carey Act, substitutions and land trades have locally modified this pattern. The most notable exceptions are found in Johnson, Sheridan and, to a lesser degree, Converse counties where numerous large, contiguous blocks of State coal land has been assembled over the years.

There are no small scale maps that accurately depict the location of all State coal land. A land status map of Wyoming, published by the United States Bureau of Land Management (1967), only approximates the location of State coal rights since it reflects neither mineral ownership nor changes in surface status since 1967. There are, however, some larger scale maps of the Powder River Basin and Carbon County area of Wyoming that show State mineral land along with Federal and private land (Bureau of Land Management, 1972-73). Unfortunately, there are no similar maps for other areas of the State.

Commerical maps that show State coal leases are available for the Powder River Basin and southern Wyoming, but they only show leased State land and do not reflect changes since their publication (Cameron Engineers, 1973; 1975).

Accuracy beyond what is available on these generalized maps must be acquired from the records of county and State offices. Because such an undertaking is beyond the scope of this report, the percentage of the total State-owned coal lands that fall within each coal-bearing area was estimated

using the Bureau of Land Management's 1967 land status map. This estimate shows that 49.5 percent of the estimated 1.3 million acres of State coal land is located in the Powder River Coal Basin. Table 2 lists the State-owned coal land within each of the coal-bearing areas in decreasing order of abundance.

Table 2: State-owned coal lands within each coal-bearing area

COAL-BEARING AREA	TOTAL COAL-BEARING ACREAGE[1]	STATE-OWNED COAL ACREAGE[2]	PERCENTAGE OF COAL LANDS OWNED BY THE STATE	PERCENTAGE OF ALL STATE-OWNED COAL LANDS
POWDER RIVER BASIN	8,612,000	646,000	7.5%	49.5%
GREEN RIVER REGION	10,016,000	317,000	3.2%	24.3%
BIGHORN BASIN	2,576,000	131,000	5.1%	10.0%
WIND RIVER BASIN	1,990,000	94,000	4.7%	7.2%
HAMS FORK REGION	584,000	49,000	8.3%	3.8%
ROCK CREEK FIELD	318,000	37,000	11.7%	2.8%
HANNA FIELD	723,000	19,000	2.6%	1.5%
GOSHEN HOLE FIELD	204,000	10,000	5.0%	0.8%
BLACK HILLS REGION	81,000	1,000	0.8%	0.1%
JACKSON HOLE FIELD	530,000	0	--	--
TOTAL	25,634,000	1,304,000	5.1%[2]	100.0%

[1]All classes of owners: Federal, State, private, Indian
[2]Average percentage of coal lands owned by the State

WYOMING COAL RESOURCES

Coal is the most abundant and potentially one of the most valuable mineral resources in Wyoming. Coal-bearing rocks, which underlie about 41 percent of the State's land area or 25.6 million acres, contain an estimated 936 billion tons of coal (Table 3). Of these resources, the United States Bureau of Mines estimates less than 6 percent or 53.3 billion tons are minable with today's mining techniques and current economic conditions (Table 4). Figures on this potentially minable coal come from information published in various maps and reports of the U. S. Geological Survey, the U. S. Bureau of Mines and the Geological Survey of Wyoming. The reserve base will change with new mining techniques and economics and as new and more detailed geologic and mining reports are available.

Figure 2 is included to clarify the nomenclature used to describe coal resources of the United States, and to show the relationship between the terms resource and reserve.

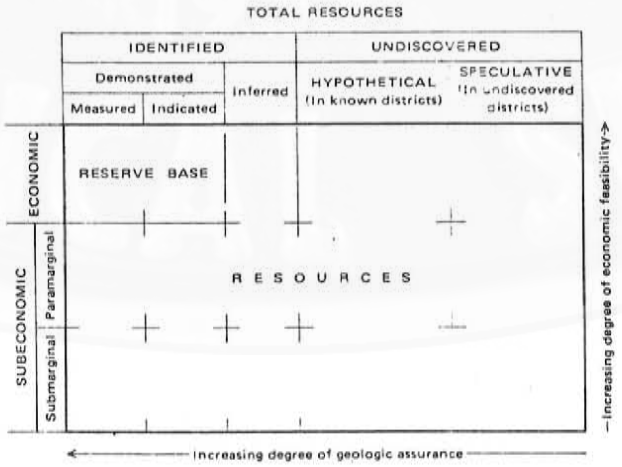


Figure 2: Nomenclature for coal resources and reserves (Averitt, 1975)

Table 3: Total estimated remaining coal resources in Wyoming, January 1, 1974 (Averitt, 1975)[1]

IDENTIFIED RESOURCE	Overburden 0-3000 feet	BITUMINOUS	12,703
		SUBBITUMINOUS[2]	123,240
		TOTAL	135,943
UNDISCOVERED RESOURCE	Overburden 0-3000 feet	HYPOTHETICAL RESOURCES IN UNDISCOVERED AREAS	700,000
	Overburden 3000-6000 feet	ADDITIONAL HYPOTHETICAL RESOURCES IN DEEPER STRUCTURAL BASINS	100,000
IDENTIFIED AND UNDISCOVERED RESOURCE	Overburden 0-6000 feet	TOTAL IDENTIFIED AND HYPOTHETICAL RESOURCES	935,943

[1] All figures in millions of tons. Estimates include beds of bituminous coal generally 14 inches or more thick; beds of subbituminous coal generally 2.5 feet or more thick; to overburden depths of 3000 and 6000 feet. Figures are for resources in the ground.

[2] Contains some small resources of lignite.

Table 4: The reserve base of coals in Wyoming by mining methods (Hamilton and others, 1974)[1]

MINING METHOD	RESERVE BASE IN BILLIONS OF TONS
UNDERGROUND	29.5
STRIP	23.8
BOTH METHODS	53.3

[1] The reserve base is a selected portion of the identified resources believed suitable for mining by 1974 methods and economics.

STATE-OWNED COAL RESOURCES

With few exceptions, there is no easy, accurate way to separate the coal resources or reserves that underlie State-owned lands from the total resource estimates for Wyoming, which are tabulated on a township basis. Although a few published geological reports are detailed enough to permit recalculation of resources underlying given tracts of land, this kind of detail covers no more than one percent of the known coal-bearing areas of Wyoming. This percentage or about 256,000 acres is almost exclusively limited to portions of the State's known strippable coal deposits (Figure 1).

About 20,000 acres or 1.5 percent of the State's coal land lies in these detailed, mapped areas (Table 5). The coal resources in another 72.5 percent of the 1.3 million acres of State coal land is described in less detailed geological reports from which at least some qualitative estimates of resource potential can be made. There are essentially no published reports describing the coal resources in the remaining 26 percent of Wyoming's State coal lands. Additionally, the coal on approximately 233,000 acres of these undescribed areas is concealed under varying thicknesses of noncoal-bearing rocks.

Table 5: Status of coal resource information on State-owned coal lands in Wyoming

RESOURCE INFORMATION	ACREAGE OF STATE-OWNED COAL LANDS	PERCENT OF TOTAL STATE-OWNED COAL LANDS
MAPPED IN ENOUGH DETAIL TO ALLOW EASY, ACCURATE RECALCULATION OF RESOURCES FOR INDIVIDUAL TRACTS OF LAND	20,000	1.5%
MAPPED; BUT NOT IN ENOUGH DETAIL TO ALLOW EASY, ACCURATE RECALCULATION OF RESOURCES	945,400	72.5%
NOT MAPPED AT ALL	339,040	26.0%

In a few instances, holders of State leases have provided the Commissioner of Public Lands with classified exploration data on specific coal leases. Apparently, no more than two or three State coal leases have been described in this way, and the data is held "confidential".

Because a precise estimate of the coal resources held by the State of Wyoming has never been attempted, two first order approximations are presented in Table 6.

In 1975, the Sierra Club estimated that existing State coal leases were underlain by 32.1 billion tons of coal (Hicks, 1975). The estimate was derived by the following equation:

$$\left[\begin{array}{l}\textit{Average seam thickness in Powder River Basin (40 ft)}\end{array}\right] \times \frac{1{,}700\ t}{\text{Acre-ft}} \times \left[\begin{array}{l}\textit{Acres of State coal leases in Powder River Basin (250,000 acres)}\end{array}\right] + \left[\begin{array}{l}\textit{Average seam thickness in all other coal-bearing areas (25 ft)}\end{array}\right] \times \frac{1{,}770\ t}{\text{acre-ft}} \times \left[\begin{array}{l}\textit{Acres of State coal leases in all other coal-bearing areas}\end{array}\right] = \left[\begin{array}{l}\textit{Total State-owned coal resources}\end{array}\right]$$

Table 6: Rough estimates of Wyoming's State-owned coal resources and recoverable reserves.

	SIERRA CLUB ESTIMATE (1975)	WYOMING GEOLOGICAL SURVEY PRORATED ESTIMATE
ESTIMATE OF TOTAL COAL RESOURCES UNDERLYING STATE COAL LANDS (0-6000 feet of overburden)	32.1 billion tons	57.5 billion tons
ESTIMATE OF RECOVERABLE RESERVES UNDERLYING STATE COAL LANDS[1]	16.0 billion tons	13.0 billion tons

[1]This recoverable reserve is not equivalent to "reserve base" since no specific economic limitations are implied. It is simply an educated guess at what percentage of the total resource might be recoverable by conventional mining methods.

Obviously, this estimate is only as accurate as the approximation of an average seam thickness. Such an average must be regarded as an educated guess at best, but it should be a conservative estimate.

The Wyoming Geological Survey used another approach to derive an estimate of coal resources on State land. The estimate involved prorating the resource estimates for each coal-bearing area by the percentage of State-owned coal lands in each area and resource category. A generalized equation is shown below:

$$\sum \left[\begin{array}{l} \textit{Identified coal resources in a coal-bearing area} \\ \times \\ \textit{Percentage of the identified resource lands held by the State in that area} \end{array} \right] + \left[\begin{array}{l} \textit{Undiscovered coal resources in that coal-bearing area} \\ \times \\ \textit{Percentage of the undiscovered resource lands held by the State in that area} \end{array} \right] = \textit{Total State-owned coal resources}$$

The Survey's approach estimates that 57.5 billion tons of coal underlie State coal lands (Table 7). This estimate assumes that the coal resources are uniformly distributed throughout each coal-bearing area, an obvious oversimplification.

In the Sierra Club estimate, recoverable reserves were estimated at half the total resource or 16 billion tons. The Wyoming Geological Survey estimated recoverable reserves were equal to 13.0 billion tons or roughly half the identified resource (see footnote under Table 7). This latter method is the conventional rule-of-thumb used to convert total resources to recoverable reserves. It could not be applied to the Sierra Club estimate since that estimate did not distinguish between identified and undiscovered resources.

When these two estimates are compared with a detailed estimate of the coal underlying nine 640 acre State coal leases adjacent to active or proposed mines, the estimates seem very conservative. Those nine State leases are underlain by an estimated identified resource of 846 million tons, 349 million tons of which is probably recoverable. The nine leases, incidentally, represent 0.5 percent of the total acreage leased by the State.

From this discussion and the results shown in Table 6, it is obvious there are no precise estimates of the coal resources which specifically underlie State coal lands.

More importantly, resource estimates such as these do not really locate any of the estimated tonnage. For example, there is currently no way to tell how much of the estimated State-owned resources or reserves in the Powder River Basin underlie a given tract of land in that area. Only a detailed tract by tract resource evaluation such as the one done on the nine State leases will provide such data. There has never been a study of this type done on State-owned land to determine coal resources or, for that matter, the resources of any other mineral.

CHARACTERISTICS OF WYOMING COALS

The rank of Wyoming coal ranges from lignite to high volatile A bituminous. Lignite, however, only occupies a very small area in the northeastern corner of the Powder River Basin. Bituminous coals are also sparsely distributed. They are restricted to the Black Hills region and portions of the Hanna Coal Field, Green River region, Hams Fork region and the Bighorn Basin. The highest ranked bituminous coals, high volatile B and A, only occur in the Hams Fork region. Subbituminous coals predominate and

Table 7: Estimate of State-owned, original, in-place coal resources in millions of tons

	A	B	C	D	E	F	G	H
	TOTAL IDENTIFIED RESOURCE	PERCENT STATE COAL LANDS	ESTIMATE OF IDENTIFIED STATE-OWNED RESOURCE (A x B)	TOTAL UNDISCOVERED RESOURCE	PERCENT STATE COAL LANDS	ESTIMATE OF UNDISCOVERED STATE-OWNED RESOURCE (D x E)	ESTIMATE OF TOTAL STATE-OWNED RESOURCE (C + F)	ESTIMATE OF RECOVERABLE STATE-OWNED RESERVE (50% of C)
POWDER RIVER BASIN	110,219	7.5%	8,266.0	450,000	7.5%	33,750	42,016.0	12,570.0[1]
GREEN RIVER REGION	15,956	1.4%	223.0	250,000	3.3%	8,250	8,473.0	111.5
HAMS FORK REGION	4,874	7.9%	385.0	49,500	8.7%	4,306	4,691.0	192.5
WIND RIVER BASIN	876	19.3%	169.0	25,000	4.0%	1,000	1,169.0	84.5
BIGHORN BASIN	582	6.3%	37.0	25,000	4.0%	1,000	1,037.0	18.5
HANNA FIELD	3,917	2.6%	101.0	0	--	0	101.0	50.5
ROCK CREEK FIELD	305	11.7%	36.0	0	--	0	36.0	18.0
BLACK HILLS REGION	41	0.8%	0.3	0	--	0	0.3	0.2
GOSHEN HOLE FIELD	0	--	0	500	5.0%	25	25.0	0
JACKSON HOLE FIELD	121	--	0	0	--	0	0	0
TOTAL	136,891		9,217.3	800,000		48,331	57,548.3	13,045.7

[1]Because recent reports on the Powder River Basin will shift large percentages of the undiscovered resource estimate into the identified category, this estimate was modified from the usual procedure. One-half of the State-owned undiscovered resource was added to the identified State-owned resource before multiplying by 50%.

are found in all the major coal-bearing areas of the State except the Black Hills region. Figure 1 shows the surface distribution of lignite, subbituminous, and bituminous coals in Wyoming. Table 8 shows the basis for classifying coals into these ranks.

Economically, sulfur content, heat value, ash content and thickness are the four most important characteristics of Wyoming coal deposits. Low sulfur coals are relatively abundant in Wyoming. The U. S. Bureau of Mines estimates that more than 99 percent of Wyoming's identified coal resources contain less than one percent sulfur, and about one-half of that is less than 0.7 percent sulfur. Ninety-six percent of the State's known strippable resources contain less than two percent sulfur (U. S. Bureau of Mines, 1971).

Because of slightly different depositional environments, Wyoming's Cretaceous coals generally exhibit slightly higher sulfur contents than the Tertiary coals. There are exceptions. In fact, the highest reported sulfur contents in the State are in Tertiary coals of the Green River region. They locally contain up to five percent sulfur. Published analyses of Wyoming's Cretaceous coals, however, usually range from 0.9 to 2.0 percent sulfur, compared with 0.3-0.9 in Tertiary coals (Glass, 1975b).

Because heat values are commensurate with coal rank, they vary widely across the State. The older bituminous and higher ranked subbituminous coals, which crop out in the Black Hills region, the Hanna Field, the eastern and northern portions of the Hams Fork region as well as around the margins of the other basins and the Rock Springs Uplift, range from 9,000 to 13,000 Btu/pound on an as received basis. The younger, subbituminous coals, which usually occupy the more central portions of the coal-bearing areas, exhibit much lower as received heat values, averaging 8,000 to 8,500 Btu/pound. Lignites in the northeastern portion of the Powder River Basin have even lower heat values, usually less than 6,500 Btu/pound.

Most Wyoming coals are relatively low in ash with an average as received ash content of five percent by weight. Reported ash contents normally range between four and ten percent, but can exceed 20 percent.

The minimum coal thicknesses included in estimates of Wyoming's coal resources are 14 inches for bituminous coals and 2.5 feet for subbituminous coals. Although there are thinner coals, they are not included in resource estimates. Normally, Wyoming's bituminous coals are less than ten feet thick. Many subbituminous coals, on the other hand, exceed 20 feet in thickness. Subbituminous coals greater than 100 feet thick are mined in the Kemmerer Field of the Hams Fork region as well as in the Gillette and Powder River fields of the Powder River Basin. The maximum documented thickness of coal in Wyoming is a 220 foot thick subbituminous coal seam near Lake De Smet in Johnson County.

Since coals from undiscovered resources are not sampled and analyzed, discussion of average coal quality only applies to identified resources. Investigators then extrapolate data from the identified resources to the undiscovered resources. Because higher ranked coals of Cretaceous age extend beneath most of the basinal areas of Wyoming, many of the deeper, undiscovered deposits may actually be higher quality (higher rank) than the resources calculated for the younger, shallower coal deposits. Conversely, these higher ranked deep coals might also be higher sulfur coals since Cretaceous coals normally contain more sulfur than Tertiary coals.

Table 8:Classification of coals by rank

Class	Group	Fixed Carbon Limits, % (Dry Mineral-Matter-Free Basis)		Volatile Matter Limits, % (Dry, Mineral-Matter-Free Basis)		Calorific Value Limits, Btu per Lb (Moist,[b] Mineral-Matter-Free Basis)		Agglomerating Character
		Equal or Greater Than	Less Than	Greater Than	Equal or Less Than	Equal or Greater Than	Less Than	
I. Anthracitic	1. Meta-anthracite	98	..	..	2	..	..	Nonagglomerating
	2. Anthracite	92	98	2	8	..	..	
	3. Semianthracite[c]	80	92	8	14	..	..	
II. Bituminous	1. Low volatile bituminous coal	78	86	14	22	..	..	Commonly agglomerating[e]
	2. Medium volatile bituminous coal	69	78	22	31	..	..	
	3. High volatile *A* bituminous coal	..	69	31	..	14,000[d]	..	
	4. High volatile *B* bituminous coal	..	..	..	..	13,000[d]	14,000	
	5. High volatile *C* bituminous coal	..	..	..	..	11,500	13,000	
						10,500	11,500	Agglomerating
III. Subbituminous	1. Subbituminous *A* coal	..	..	..	..	10,500	11,500	Nonagglomerating
	2. Subbituminous *B* coal	..	..	..	..	9,500	10,500	
	3. Subbituminous *C* coal	..	..	..	..	8,300	9,500	
IV. Lignitic	1. Lignite *A*	..	..	..	..	6,300	8,300	
	2. Lignite *B*	..	..	..	..	..	8,300	

*Source: American Society for Testing and Materials.

[a] This classification does not include a few coals, principally nonbanded varieties, which have unusual physical and chemical properties and which come within the limits of fixed carbon or calorific value of the high-volatile bituminous and subbituminous ranks. All of these coals either contain less than 48% dry, mineral-matter-free fixed carbon or have more than 15,500 moist, mineral-matter-free Btu per lb.

[b] Moist refers to coal containing its natural inherent moisture but not including visible water on the surface of the coal.

[c] If agglomerating, classify in low-volatile group of the bituminous class.

[d] Coals having 69% or more fixed carbon on the dry, mineral-matter-free basis shall be classified according to fixed carbon, regardless of calorific value.

[e] It is recognized that there may be nonagglomerating varieties in these groups of the bituminous class, and there are notable exceptions in high volatile *C* bituminous group.

COAL MARKETS AND SUPPLY

Prior to the 1960's, Wyoming's dominant coal market was the railroad, but it demanded the highest ranked subbituminous or bituminous coals with high heat values. When the railroad phased out the steam locomotive in the 1950's, the major market for Wyoming coal was also eliminated. It wasn't until the late 1960's that power plant demands for low sulfur coal provided a new market and revived the State's coal industry.

Production from Wyoming's coal mines now goes to power plants in no less than ten states, extending as far east as Ohio (Figure 3). By 1980, annual coal production is expected to quadruple from the 23 million tons mined in 1975 to an estimated 96 million tons. By then, power plants in 16 states including Oklahoma, Texas, Arkansas, Louisiana, Idaho and Oregon will burn Wyoming coals.

Currently, coal mining companies are concentrating their efforts in Wyoming's subbituminous coal deposits. There are several reasons for this, but the important one is the greater availability of subbituminous coal. The subbituminous coals crop out over a much larger area of the State than the higher ranked coals, which generally crop out in narrow zones around the margins of the coal-bearing areas. The larger outcrop area of the subbituminous coals increases the chances of finding easily mined, shallow resources. Similarly, Wyoming's subbituminous coals are more likely to be thicker than bituminous coals, which seldom exceed ten feet in thickness.

Another desirable characteristic of Wyoming's subbituminous coal deposits relates to the dip or attitude of the coal beds. Because bituminous coals crop out around the structurally more complex margins of the coal-bearing areas, they frequently dip more steeply than the flatter-lying subbituminous coals. Since flat-lying coal beds are easier and less costly to mine, especially by strip mining techniques, they are in greater demand than steeply dipping seams that are usually mined by underground mining techniques.

A final attribute that might also help to explain the seemingly inordinate interest in the lower ranked Wyoming coals is their sulfur content. To meet emission standards, power plants require as low a sulfur content as possible. Consequently, coal companies are also concentrating their exploration and development on low sulfur coals. Because most of Wyoming's subbituminous coals are of Tertiary age, they are generally lower in sulfur content than the higher ranked, Cretaceous coals, and, therefore, are of greater interest to the mining companies. For comparison, Table 9 shows the quality and thicknesses of coals actively mined in various portions of the State.

Figure 3: Current and announced markets for Wyoming coal

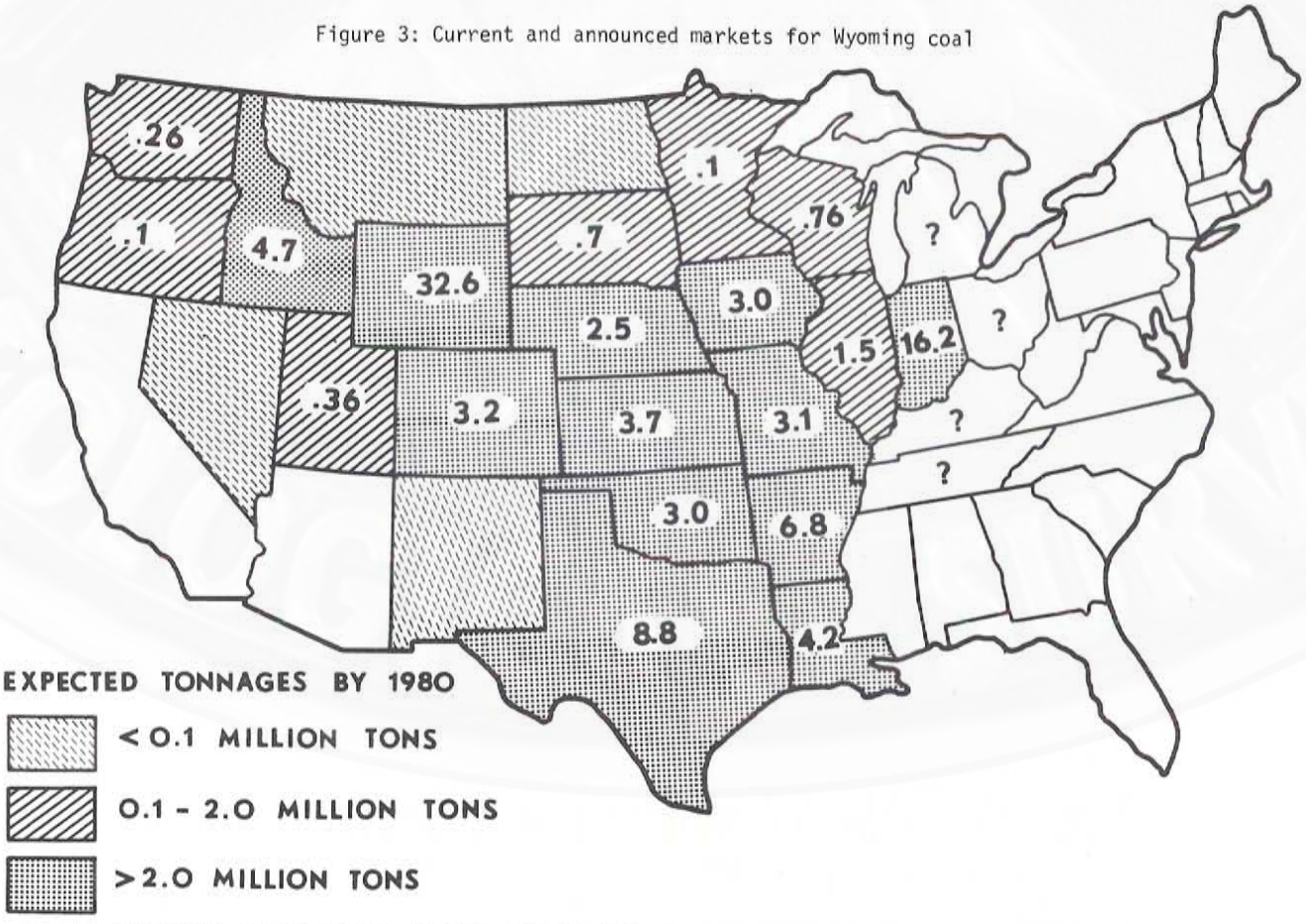


Table 9: Wyoming Coal Characteristics

GEOGRAPHIC AREA	RANK	BED THICKNESSES (FEET)	MOISTURE[1] (%) (AR)	ASH[1] (%) (AR)	SULFUR[1] (%) (AR)	HEAT VALUE[1] (BTU/LB.) (AR)
NORTHEASTERN WYOMING	Lignite Subbituminous[1] Bituminous[1]	Max.: 220 Range[1]: 12-125 Aver.[1]: 70	Range 20.3-29.8 Average 26.3	Range 4.4-11.4 Average 7.9	Range 0.45-0.6 Average 0.54	Range 8,200-9,700 Average 8,300
SOUTHERN WYOMING	Subbituminous[1] Bituminous[1]	Max.: 50 Range[1]: 4-35 Aver.[1]: 20	Range 10.2-20.5 Average 12.4	Range 4.2-12.2 Average 7.1	Range 0.4-0.9 Average 0.52	Range 9,350-11,700 Average 10,500
WESTERN WYOMING	Subbituminous[1] Bituminous	Max.: 110 Range[1]: 5-110 Aver.[1]: 16.5	Range 20.4-20.9 Average 20.8	Range 3.0-4.8 Average 4.5	Range 0.6-0.7 Average 0.6	Range 9,500-10,200 Average 9,600
NORTHCENTRAL WYOMING	Subbituminous[1] Bituminous	Max.: 50 Range[1]: 7-20 Aver.[1]: 13	Range 12.1-12.8 Average 12.5	Range 3.7-9.0 Average 6.3	Range 0.4-0.55 Average 0.48	Range 10,800-11,400 Average 11,100

[1]Beds currently mined

Table compiled by Wyoming Geological Survey, February 1975

CHARACTERISTICS OF COAL ON STATE-OWNED LANDS

Although Wyoming holds coal rights to lands overlying lignite and bituminous coal, the majority of the State's acreage immediately overlies subbituminous coals. This is expected since subbituminous coals crop out over more area than bituminous or lignitic coals. Bituminous coals, however, occur at moderate to great depths below the shallower subbituminous coals.

Chemical analyses of coals sampled from State coal lands are available in published reports, but they are rare. Usually coal quality information must be extrapolated from sampling sites adjacent to State lands. However, since 91% of the identified coal resources in Wyoming are subbituminous, it can be assumed that roughly the same percentage of the State-owned identified resources would also be that rank.

STATE COAL LEASING

Title 36 of the Wyoming Statutes, 1957, gives the Board of Land Commissioners authority to lease State-owned coal rights. This legislation also sets forth the leasing terms and authorizes the Board to promulgate rules and regulations for the implementation and enforcement of the law.

Persons interested in acquiring a State coal lease must file an application along with the required fees and one year's advance rental. Accepted applications are awarded on a first come, first serve basis for a term of no more than ten years. Preferential rights of renewal are guaranteed to any lessee that is mining coal on the lease or is preparing to open a mine. If a coal lease is not in production at the time of renewal, the Board can, in the best interests of the State, auction or request bids from other applicants. The original lessee then has the right to match the best offer.

With the written consent of the Board of Land Commissioners, a lessee may assign all or part of a lease to another party. If the lease is assigned to a corporation, the corporation must be qualified to do business in Wyoming.

Leases are normally limited to contiguous blocks or non-contiguous areas within a single township. No lease, however, can exceed 1,280 acres. The maximum acreage or number of leases issued to an individual lessee is left to the Board's discretion.

A State coal lease is termed a prospecting lease until a commercial coal discovery is reported or until coal is mined. In the former case, the rental on a lease with a commercial discovery of coal is set at $1.00 per acre. This rental is, in essence, an advance royalty payment. In the latter case, once a mine is opened, the lease converts to an operating lease and royalties are assessed against all production.

RENTALS ON STATE COAL LANDS

State coal prospecting leases presently rent for 50 cents an acre for the first five years and $1.00 an acre for the sixth through the tenth year or renewal thereof. When a commercial discovery of coal is documented, the rental automatically goes to $1.00 an acre. The rental on this commercial discovery, however, goes into a permanent fund and is actually an advance royalty payment.

Table 10 shows that rentals on prospecting leases have steadily increased over the last five years with the largest jump occurring between 1973 and 1974. That increase marked the Board's decision

to double the old rental rates of 25 cents and 50 cents. Since nearly all the State-owned coal lands are leased, future rental income should level off or increase only slightly.

For comparison, rentals on Federal coal leases are normally:

1st year: 25¢/acre
2nd - 5th year: 50¢/acre
6th - 20th year: $1.00/acre

Some more recent Federal rentals, however, are $1.00 an acre for the first through fifth year, and $5.00 an acre for the sixth through the twentieth year.

Rentals, paid to private mineral owners, on the other hand, are extremely variable, but $1.00 or more an acre is not uncommon.

Table 10: Rental and royalty payments on State-owned coal lands[1]

FISCAL YEAR	NUMBER OF LEASES	ACREAGE LEASED	RENTALS	ROYALTIES[2]	TOTAL RENTALS AND ROYALTIES
1970-1971	--	--	$192,880.50	$3,330.00	$196,210.50
1971-1972	944	846,539.54	$219,023.25	$107,581.12	$326,604.37
1972-1973	--	--	$307,084.75	$205,132.69	$512,217.44
1973-1974	1,394	1,156,773.68	$323,571.50	$25,370.13	$348,941.63
1974-1975	1,331	1,170,633.66	$575,488.75	$61,132.49	$636,621.24

[1]Data compiled from the Annual Reports of the Wyoming Department of Public Land

[2]Includes advance royalties paid on leases with commercial discoveries ($1.00 an acre)

ROYALTIES ON STATE COAL LEASES

Coal mined from a State coal lease is subject to royalty payments. Royalties for older leases are set at seven percent of a mine's gross output or five cents a ton, whichever is larger. More recent leases or lease renewals, however, are assessed at eight percent of the gross output or a minimum of 25 cents a ton. Additionally, once a commercial discovery of coal is reported, rental on that lease converts to the status of an advance royalty of $1.00 per acre. This rental or advance royalty goes into a permanent fund and is reported along with actual royalties from operating leases.

Over the past five years, royalty income from State coal leases has fluctuated from a low of $3,330 in 1970 to a high of $205,132.69 in 1972 and then back down again (Table 10). The lower royalty income collected in 1970, 1973, and 1974 consists only of advance royalties paid on the leases with commercial discoveries of coal. The higher payments in 1971 and 1972 reflect not only the advance royalties, but also royalties from actual production on State leases. The production royalties paid during 1971 and 1972, incidentally, were for coal mined on a single 640 acre tract leased to Humac, Inc. in Converse County. This operating lease is now inactive and has been assigned to another lessee. In 1975, another 640 acre tract leased to Rosebud Coal Sales Company in Carbon County was converted into an operating lease. Revenues from this production will appear in the 1975-1976 fiscal report of the State Land Commission. Royalties will probably continue to fluctuate from year to year at about the same levels they have.

Again for comparison, Federal royalties are scaled so that rates increase with the duration of a lease. Royalty rates for the first ten years generally range from ten cents a ton to 17.5 cents a ton. Rates between the eleventh and twentieth years of a lease are usually 20 cents per ton. The Department of Interior has proposed a change in these rates which would make most future Federal royalties equal to eight percent of the sale value of the coal and not less than five percent (U. S. Department of Interior, 1975).

Royalties charged by private mineral owners probably range from a few cents a ton to as much as $1.00 a ton. Other private royalties may be as high as ten percent of the coal's sale value.

STATE COAL LEASES

At the end of 1975, there were 1,363 State coal leases scattered over nineteen Wyoming counties. Table 11 shows that the bulk of the leases were issued in Campbell, Sweetwater, Sheridan, Carbon, Converse and Johnson counties. In acreage, the leases totaled 1,117,655.77 acres. Sweetwater County leads the State in leased acreage with 196,217.6 acres followed by Campbell, Sheridan and Johnson counties.

There are currently 71 individual leaseholders, ranging from individuals or groups of individuals to large corporations. Furthermore, Table 12 shows that the largest twenty lessees in the State control more than 90 percent of the leased State coal acreage. This leaves less than 115,000 acres to divide among the 51 smaller leaseholders. In any given county, the largest leaseholder controls no less than 20 percent of the State coal lease acreage in that county. Statewide, Carter Oil Company holds 14 percent of the State-owned coal mineral rights or 152,655.19 acres.

Of the 71 State leases, seventeen are considered producing companies, which either have active coal mines in Wyoming or have announced firm intentions to start mining before 1980. These seventeen leaseholders control about 31 percent of the leased acreage or 343,264.9 acres (Table 13). Four of these companies, Carter Oil Company, Ark Land Company (Arch Mineral Corporation), Kemmerer Coal Company and Atlantic Richfield control 90 percent of the acreage held by producing companies. Of the four, however, only Carter Oil holds State leases

Table 11: State coal leases in Wyoming (December 31, 1975)

COUNTY	NUMBER OF LEASES	ACREAGE LEASED	NUMBER OF LESSEES	AVERAGE ACREAGE PER LESSEE	ACREAGE LEASED BY LARGEST LESSEE	PERCENT OF ACREAGE HELD BY LARGEST LESSEE	NAME OF LARGEST LESSEE	NUMBER OF LESSEES HOLDING 90% OF ACREAGE
ALBANY	32	25,634.62	7	3,662	16,204.88	63%	Consolidation Coal Company	5
CAMPBELL	223	195,426.08	25	7,817	68,866.95	35%	Carter Oil Co.*	6
CARBON	165	124,488.38	21	5,928	25,478.58	20%	Kemmerer Coal Co.	11
CONVERSE	160	120,378.19	21	5,732	33,795.90	28%	Western Standard Corp.	11
CROOK	2	1,920.00	1	1,920	1,920.00	100%	GKM & Co.	1
FREMONT	26	22,010.17	7	3,144	8,425.97	38%	Robert W. David	5
GOSHEN	23	19,580.69	1	19,581	19,580.69	100%	Discovery Oil Ltd.	1
HOT SPRINGS	21	14,672.82	4	3,668	9,983.22	68%	Consolidation Coal Company	3
JOHNSON	152	125,486.98	16	7,843	32,940.00	26%	Mapco, Inc.	7
LINCOLN	22	17,860.14	8	2,232	5,666.33	32%	Ark Land Co.	6
NATRONA	25	18,760.00	4	4,690	15,360.00	82%	DOL Resources, Inc.	3
NIOBRARA	13	11,160.39	2	10,840	10,840.39	97%	American Coal Co.	1
PARK	1	640.00	1	640	640.00	100%	Robert W. David	1
SHERIDAN	218	167,917.75	19	8,838	64,236.61	44%	Mapco, Inc.	4
SUBLETTE	1	320.00	1	320	320.00	100%	Ark Land Co.	1
SWEETWATER	216	196,217.60	22	8,919	45,331.45	23%	Wlm. M. Wilson & Co-owners	8
UINTA	32	23,155.00	7	3,308	7,680.00	33%	Ark Land Co.	6
WASHAKIE	1	1,280.00	1	1,280	1,280.00	100%	Consolidation Coal Company	1
WESTON	39	30,209.76	6	5,035	14,835.52	49%	American Coal Co.	5
TOTAL	1,363	1,117,665.77	71	15,741	152,655.19	14%	Carter Oil Co.	20

*Lessee with active coal mines or announced plans for mines in that county of Wyoming (mines not necessarily on State lands)

Table 12: Twenty largest State coal leaseholders[1]

	NAME	NUMBER OF LEASES	ACREAGE LEASED	LOCATION OF MAJOR LEASES BY COUNTY	NUMBER OF COUNTIES[2]
1	CARTER OIL (CARTER COAL MINING CO.)	158	152,655.19	Campbell, Sheridan & Johnson	4
2	MAPCO, INC.	148	138,226.88	Sheridan, Johnson, Campbell & Converse	5
3	ARK LAND CO.[3]	90	84,253.35	Sweetwater & Carbon	9
4	DOL RESOURCES, INC. (DISCOVERY OIL LTD.)	109	79,740.07	Goshen, Natrona, & Campbell	10
5	WILLIAM M. WILSON AND CO-HOLDERS	86	65,907.03	Sweetwater & Carbon	8
6	CONSOLIDATION COAL CO.	79	65,682.04	Sweetwater & Albany	7
7	R. A. HANESWORTH AND CO-HOLDERS	105	62,884.13	Sweetwater & Carbon	7
8	STOLTZ, WAGNER AND BROWN AND TIPPERARY RESOURCES	61	62,120.35	Campbell & Johnson	3
9	KEMMERER COAL COMPANY[3]	41	40,391.65	Carbon & Sweetwater	3
10	WESTERN STANDARD CORP.	47	36,114.07	Converse	3
11	AMERICAN COAL CO.	56	35,371.02	Weston & Niobrara	5
12	ATLANTIC RICHFIELD[3]	32	32,757.73	Campbell	2
13	LUCY L. WOODWARD	29	31,928.75	Carbon & Sweetwater	3
14	RICHARD B. LAUDON	27	24,135.10	Campbell	4
15	MOBIL OIL CORP.	21	21,482.29	Johnson	3

(Continued on next page)

(Table 12 continued)

16	TEMPORARY CORP.	28	20,025.35	Johnson & Converse	4
17	PAGE T. JENKINS	17	12,960.00	Converse	1
18	STOLTZ, WAGNER AND BROWN	10	12,480.00	Sweetwater & Fremont	2
19	PACIFIC POWER AND LIGHT CO.[3]	14	12,320.00	Converse & Carbon	3
20	DON J. LEEMAN AND CO-HOLDERS	19	11,162.73	Converse, Johnson & Weston	7
		1,177	1,002,597.73[4]		

[1]These twenty companies control more than 90 percent of the leased State coal acreage
[2]The total number of counties in which the lessee holds State coal leases
[3]Producing companies which have active or proposed mines in Wyoming
[4]Fifty-one other lessees hold 186 leases totaling 115,068.04 acres

adjacent to its own active or planned mines. It turns out that none of the seventeen largest producing lessees is currently mining coal on a State lease. Instead, production on State lands has been limited to one producing lessee with a single tract of 640 acres.

It is interesting to note that only five of the twenty largest State leaseholders are among the thirteen companies that control 90 percent of the leased Federal acreage in Wyoming (Table 14). These five State lessees are Carter Oil, Atlantic Richfield, Ark Land Company, Pacific Power and Light, and Kemmerer Coal Company. Combined, these same five companies hold 37 percent of the leased Federal acreage and 29 percent of the leased State acreage or 30 percent of the leased State and Federal coal acreage.

Before continuing, it should be pointed out that there are at least 18,000 acres under State coal lease that fall outside the boundaries of the known coal-bearing areas in Wyoming. One can only speculate on the reasons these lands were leased. One explanation is that the boundaries of the known coal-bearing areas are not accurate. In some cases this possibility cannot be overlooked since some boundaries are not defined by published reports. Other areas, however, offer little or no possibilities of containing coal. In these cases, it is possible that the lessee has misunderstood or ignored the geology of the area and leased land because of its proximity to coal-bearing rocks. A third explanation could be that a lessee who was unable to find any other State lands available for coal lease, in desperation, leased whatever mineral lands were still available. There are other explanations as well. Whatever the case , when seemingly noncoal-bearing lands are leased for coal, there is reason for query and investigation if the State is to accurately estimate its total coal resources.

OPERATING STATE COAL LEASES

For perhaps a decade, no more than one State coal lease has been in production at any one time. Most recently, Rosebud Coal Sales Company actively mined coal on a 640 acre State lease in Carbon County. This was the only operating lease in 1975, and it may not be active in 1976.

There are, however, 5,760 acres of leased State coal lands adjacent to various active or proposed coal mines in Wyoming. There is every likelihood that some if not all of these lands will be mined over the years. There is other leased acreage that occurs in minable blocks in Johnson and Sheridan counties, but no mining plans have been announced.

The remaining State leases consist of isolated sections often very far from existing mines. These leases will probably only be mined in conjunction with mines on adjacent Federal leases or on private lands. Alone, most are too small and too isolated to be logical mining units.

Table 13: Ownership status of State coal leases in 1975

OWNERSHIP CATEGORY	NUMBER OF LESSEES	NUMBER OF LEASES	PERCENT OF LEASES	ACREAGE	PERCENT OF ACREAGE	NUMBER OF OPERATING LEASES
PRODUCING LESSEE[1]	17	374	27%	343,264.90[2]	31%	1[3]
NONPRODUCING LESSEE	54	989	73%	774,399.87	69%	0
ALL LESSEES	71	1,363	100%	1,117,665.77	100%	1

[1]Includes any company that is mining coal in Wyoming or which is planning to open a mine before 1980. Mines are not necessarily on State leases.
[2]Four companies control 90 percent of this acreage. Another six producing companies each only hold a single lease of 640 acres.
[3]This single operating lease is only a 640-acre tract.

Table 14: Thirteen largest Federal coal leaseholders (1975)[1]

		NUMBER OF LEASES	ACREAGE LEASED	LOCATION OF LEASES BY COUNTY
1.	PACIFIC POWER AND LIGHT COMPANY[2]	15	27,145.74	Converse, Sweetwater, Carbon
2.	SUN OIL COMPANY[2]	5	24,598.03	Sweetwater, Campbell, Converse
3.	RICHARD D. BASS	1	20,700.71	Campbell, Sheridan
4.	PEABODY COAL COMPANY[2] (ROCHELLE COAL CO.)	8	19,761.11	Campbell, Sweetwater
5.	CARTER OIL COMPANY[2]	4	15,570.5	Campbell
6.	ARK LAND COMPANY[2]	10	11,815.99	Carbon
7.	ATLANTIC RICHFIELD[2]	3	11,684.31	Campbell
8.	TEXACO	5	9,417.85	Johnson
9.	KERR-McGEE CORPORATION[2]	5	8,695.19	Campbell
10.	ENERGY DEVELOPMENT COMPANY[2]	1	8,683.30	Carbon
11.	GULF OIL CORPORATION	5	6,693.51	Sheridan, Campbell
12.	KEMMERER COAL COMPANY[2]	6	6,584.81	Lincoln
13.	AMAX COAL COMPANY[2]	2	5,880.31	Campbell
		70	177,231.36[3]	

[1] These thirteen leaseholders control more than 90% of the leased Federal coal acreage

[2] Producing companies which have active or proposed mines in Wyoming

[3] Sixteen other lessees hold 22 leases totaling 21,748.79 acres

COAL RESOURCES UNDERLYING STATE COAL LEASES

No one has published an estimate of the coal resources specifically underlying State coal leases as a whole or by individual tracts. Preliminary resource and reserve estimates under State-owned coal lands, however, were given earlier. Since most of these State-owned coal lands are leased for coal, those estimates are roughly equivalent to the tonnage estimated to underlie State coal leases (Table 6). Again, there is no way to separate the tonnage under individual leases from such estimates.

Because considerable data is available on the 5,760 acres of State coal lands adjacent to active or planned mines, a rough estimate of the tonnages underlying those State lands is possible. Approximately 846 million tons of identified resources underlie them, of which 366 million tons is probably recoverable. This estimate only covers 5,760 leased acres or 0.5 percent of the total leased State land.

REGULATION OF EXPLORATION ON STATE LEASES

Although many if not a majority of the State coal leases have been drilled one or more times through the years, the State has apparently acquired little or no exploration information on its leases. In fact, no State agency specifically approves or monitors exploration of State coal leases unless the lessee uses earth-moving equipment such as dozers. In the case of dozer exploration, the lessee must get a permit from the Wyoming Department of Environmental Quality.

In contrast, a Federal coal lessee must have his exploration plan approved by the Regional Mining Supervisor of the United States Geological Survey before he begins. Tantamount to that approval is a requirement that copies of all drill hole data, including locations, lithologic descriptions and geophysical logs must be given to the Mining Supervisor. Private landowners generally require similar drillhole information when their lands are drilled.

REGULATION OF MINING ON STATE LEASES

The mines on State leases are permitted through the Department of Environmental Quality just like mines on any other lands within Wyoming's jurisdiction, including mines on Federal and private lands. Reclamation plans must be submitted along with mining applications. Most applications for mining State leases will be submitted as an integral part of a larger mining permit application. There is currently no requirement for the Department of Environmental Quality to single out the State-owned

portions of a mining permit for special handling.

There also are no published listings that show which State leases are in production or will soon be in production. This type of information, however, could be obtained from the Office of the State Land Commissioner.

INSPECTION OF STATE LEASES

The closest that Wyoming Statutes come to providing for specific investigations of State coal leases, beyond routine inspections of active mines by the State Mine Inspector or the Department of Environmental Quality, is contained in Section 36-77 of Title 36. That section authorized the Board of Land Commissioners to require the State Geologist or any State mine inspector to visit a State lease and make a report on the findings of that visit. Such inspections are not required unless they are requested by the Board.

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