WESTERN COAL: ENERGY vs AGRICULTURE

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Development of western coal by strip mining uses land now in agricultural production, but the amount so used is not large relative to the total land resource. The cost of reclaiming mined land is substantially higher than the value of agricultural benefits, but other benefits, not measured, help offset costs.

Western coal reserves are one of our more important national energy assets, especially since the oil embargo of 1973. But, the potential use of western coal has created some controversy. One concern frequently expressed in the west relates to the competition between coal mining and agriculture for land and water resources. In its most extreme form it may be paraphrased, "strip mines will destroy so much farm land that our food base will be jeopardized."

For the purpose of this article the "Western United States" consists of two regions: (1) the Northern Great Plains (NGP) including Montana, North Dakota, South Dakota, and Wyoming; and (2) the Rocky Mountain (RM) including Arizona, Colorado, New Mexico, and Utah. Coal production areas were delineated, each consisting of one or more counties having significant coal reserves of nearly similar rank and quality.[1] This article is concerned only with surface mining, because there is relatively little surface area disturbed with underground mining, and therefore not much effect on agricultural operations. It is recognized that the supply of water for irrigation might be affected if coal from underground mines were processed in the area. Reserves of strippable coal in the west are very large, especially in Montana and Wyoming (Table 1). The total for the two regions is 86 billion tons, 63 per cent of all strippable reserves in the United States (U.S. Bureau of Mines).

Several agencies have made projections of future coal production. While there is a wide variation in specifics, most forecasters agree that production will increase substantially throughout the rest of this century. In this analysis a projection characterizing a fairly large increase in production is used so as to present a "worst case" type of analysis. Accordingly, the data selected were adapted from the Western Coal Monitoring System (U.S. Federal Energy Administration). Very large increases in production are projected, especially in Wyoming and Montana. For the eight states, total production from surface mines would increase sevenfold in 25 years.[2] These projections pose different implications for resource demands because of varied characteristics of the coal deposits and the land surface. In Wyoming, where coal seams are very thick, only 11.1 acres of land would be required for a million tons of coal, but more than 70 acres per million tons are required in Arizona and New Mexico because the seams are not as thick. No mining is projected in South Dakota because the seams are thin and reserves are relatively small.

Because there is concern over the impact of coal development, it is appropriate to project what would happen to the agriculture of the area if coal production were to increase at the rates suggested. The impacts are associated with the surface characteristics of the land, its present use, the ownership pattern and the population density.

The coal areas vary greatly from one to another in terrain, in climate, in people, in resources, and in economic activity, including agriculture. The terrain varies from the gently rolling plains of the western Dakotas to the high, rugged, and colorful mountains of Colorado. The climate varies from cold to subhumid in the northernmost areas to hot and arid in parts of Arizona and New Mexico, with extreme seasonal and daily temperature variations. Much of the land is in public ownership and is used only for foresty and/or grazing; most of the farm land, however, is privately owned.

The coal areas are sparsely populated, and there are no metropolitan centers (over 50,000) within their boundaries. There were only five cities over 20,000 in the coal areas in 1970 (U.S. Census of Population). The total population in 1970 was about 850,000; the average density was 3.8 persons per square mile.

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[1] *The Regions and Coal Production Areas were established for a broad study of energy and its impacts on rural America now under way in the U.S. Department of Agriculture, (Barse) and (Whetzel).*

[2] *Similar data published in a trade journal show somewhat higher totals for 1986. (COAL AGE, February, 1978, pp. 118-134).*

Table 1. Strippable Coal Reserves and Anticipated Surface Mine Production in Western States, 1975-2000

State	Strippable reserves[1]	Anticipated Production[2] Average Annual 1975	1976-85	1986-2000	Total 1975-2000	Land needed per million tons[3]
	millions of tons					acres
Montana	42,562	22	58	101	2,119	27.5
N. Dakota	15,995	9	36	82	1,590	59.5
S. Dakota	427	0	0	0	0	142.9
Wyoming	23,843	23	143	251	5,235	11.1
Arizona	350	7	12	12	307	77.7
Colorado	584	4	14	19	425	56.2
New Mexico	2,258	8	24	44	911	71.7
Utah	262	0	4	8	149	55.2
Total	86,281	73	291	517	10,736	

[1]*U.S. Bureau of Mines.*
[2]*U.S. Federal Energy Administration.*
[3]*From Whetzel, June 1976 and October 1976.*

Agriculture is the principal land use in most of the coal areas. Farms occupy about 95 per cent of the land area in the coal counties in North Dakota and South Dakota (Table 2, Column (1).[3] In Utah less than 10 per cent of the land area is in farms. Most of the farms are large, the average size for the two regions is 2,865 acres (Col. 2). The smallest farms — in acres — are in Utah and Colorado and the largest are in Arizona and New Mexico.[4] Harvested crops account for less than one-eighth of the farm land, except in the North Dakota areas, where the principal crops are spring-seeded grains, mostly wheat. In the other areas most of the farm land is pasture or range. Irrigated land constitutes a relatively small part of the total acreage, ranging from less than 0.5 per cent in Arizona and the Dakotas to 11 per cent in Colorado. Irrigated land is considerably more important to the agricultural economy than the number of acres suggests, because most of it is used to produce feed grains and forage for livestock ranches. Livestock are a more important source of income than are crops in all the coal areas except those in North Dakota and northeastern Montana.

When the rate of mining activity increases, land is used for the mine itself (i.e., the pit from which the coal is dug and the spoil piles), for permanent mine facilities, for coal conversion plants, and transportation facilities. To estimate how much would be used for coal development it is assumed that the land disturbed by the mining process is inversely proportional to the thickness of the coal seam, as shown in the last column of Table 1. It is further assumed that reclamation is accomplished as required by law, and that mined land would be out of production only during the mining and reclamation process; that land used for power plants or other conversion or processing facilities would not be reclaimed during the period of analysis; and that in each coal area the land to be disturbed has productive capacity equal to the average of the farm land therein.

The total land used for energy production would be about 190,000 acres, over 58,000 acres of which would be in Wyoming (Table 2, Col. 8). However, the value of production lost would be considerably less in Wyoming than in North Dakota (Col. 7). The loss in farm production would be $830,000 in North Dakota, while in Arizona it would be only $15,000. The 1974 total farm sales for the coal areas are shown in Col. 10, and the sales lost are expressed as a percentage of the total for each area in Col. 11. The highest loss in relative terms would be 0.59 per cent in Utah and 0.41 per cent in Wyoming. In North Dakota, where the largest total loss would occur, the relative loss would be only 0.15 per cent of farm sales in the coal counties.

The foregoing analysis shows that western coal development poses relatively little threat to the agricultural productive capacity of any one of the coal areas, and almost none when viewed on a state or national scale. This statement is based on the assumption that in each area only average land would be used for coal development, whereas in some areas the land used might be better than average. Even so, the basic premise is sound; the prospects for significant loss of productive capacity are slight.

[3]*The term "farm" is used in its broadest sense to include livestock ranches.*

[4]*In these two areas most of the "land in farms" is grazing land on Indian Reservations, which are classified as "abnormal farms" and not included in the farm size average.*

Table 2. Farm Size, Major Land Use, and Impact of Coal Mining on Agricultural Production

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
State (coal producing part only)	Land area in farms 1974	Average farm size 1974	Major Use of Farm Land-1974 Harvested crops	Other crop land	Pasture and range	Land irrigated	Farm sales per acre 1974	Land for energy production	Annual value of product lost	Total farm sales 1974	Farm sales lost
	per cent	acres	per cent	per cent	per cent	per cent	dollars	acres	1,000 dollars	1,000 dollars	per cent
Montana	88.4	3,775	10.2	8.6	81.2	.9	13.63	25,970	252	307,112	.08
N. Dakota	94.7	1,196	33.0	24.2	42.8	.3	28.27	32,260	830	548,029	.15
S. Dakota	95.5	2,614	12.6	5.9	81.5	.1	10.09	0	0	63,925	0
Wyoming	56.9	6,682	3.1	1.6	95.3	2.9	5.73	58,080	327	79,627	.41
Arizona	75.7	13,260	.1	.3	99.6	.1	1.36	11,140	15	26,091	.06
Colorado	28.6	1,529	10.5	7.4	82.1	11.1	24.12	15,820	217	116,441	.19
New Mexico	70.6	5,541	.6	1.1	98.3	.6	3.03	40,150	99	25,217	.39
Utah	9.8	1,213	6.8	6.3	86.9	9.5	18.94	7,410	136	23,007	.59
Total/ Average	66.7	2,396	11.1	8.2	80.8	1.4	12.43	190,830	1,876	1,189,449	.16

(1) Land in farms as a per cent of total land area.

(2) Farms over $2,500 gross income.

(3) thru (6) Major use as a per cent of land in farms.

(5) Includes some woodland, farmsteads, etc.

(7) Total sales of crops and livestock divided by land in farms.

(8) Acreage out of farm production in average year for 1975-2000. Includes land actually mined plus a 10% overrun, each acre of which is assumed to be out of production for 5 to 10 years depending on location. Land for auxiliary mine facilities and coal conversion plants assumed to be 800 acres per mine.

(9) Acres (Column 8) multiplied by farm sales per acre for each coal area separately.

(10) Gross sales in 1974 from counties in coal production areas.

(11) Column (9) as a per cent of Column (10).

Sources: Columns (1) thru (7), and (10) from 1974 Census of Agriculture. Column (8) computed from Table 1.

However, the loss of agricultural land may be less important than the possible loss of irrigation water. Since most of the irrigated land is used to produce feed grains and forage crops, the loss of irrigation water on a large scale would have a significant depressing effect on some of the nearby livestock ranches.

The full consequences of using scarce supplies of water for coal development are extremely difficult to predict because each mine location may have a different set of variables, both as to supply and demand. In terms of demand, the amount of water for coal development depends on a number of variables, including the mode of conversion. With electrical generating plants, the demand varies with the type of cooling system — dry cooling takes the least; wet cooling takes the most. Consumptive use depends on the rank of coal. For lignite in a wet cooled plant it would be about 1700 acre feet annually per million tons, for sub-bituminious about 4000 acre feet, and for bituminous about 5200 acre feet.[5] For coal gasification the amounts would range from about 900 acre feet per million tons of lignite to about 1750 acre feet for bituminous. For transport by slurry pipeline about 700 acre feet per million tons were required in the only pipeline now operating in the U.S. (BARRONS). For mining and shipping the coal out by rail the water required is so small as to be insignificant from a regional standpoint.

To illustrate the possible maximum amount of water needed, it was assumed that all of the coal production projected in Table 1 would be processed in wet cooled thermogenerators. The amount of water required was calculated using the constants indicated above (lignite for North Dakota, sub-bituminous for the other states). The most water would be needed in Wyoming and Montana, and in each case the amount would be more than is now being used for irrigation (Table 3). Comparing the amounts indicated in the table points out the need for considering water availability when plant sites are being

[5]*Adapted from NGPRP data. Water used is a function of heat produced, and the lower ranks of coal, lignite and sub-bituminous, produce less heat per ton than bituminous.*

Table 3. Irrigation Water Used in 1974, and assumed Maximum Use for Energy Development

	Irrigation water used 1974	Maximum water for energy 1986-2000		Irrigation water used 1974	Maximum water for energy 1986-2000
	—1000 acre feet—			—1000 acre feet—	
Montana	334	419	Arizona	35	50
N. Dakota	76	222	Colorado	1198	79
S. Dakota	5	0	New Mexico	70	182
Wyoming	698	1041	Utah	286	33

chosen, and for considering the most water-efficient modes of energy conversion or transportation,

Supplies of water also vary widely, depending on location. In most of the coal areas in North Dakota and northeastern Montana ample supplies of water are available from the main stem of the Missouri River, and most of the likely mine locations are close enough so that pipeline transport of water is probably feasible (NGPRP). New mines in southeastern Montana and northern Wyoming would likely have to obtain water from the Yellowstone River or its tributaries, and it is likely that more storage would be required, or it might be necessary to import water from other river basins.

In the RM region the situation is similar — water is scarce in all the coal areas though actual competition may not be serious. In Arizona for example, all the coal reserves are located in the northeastern corner of the state where little or no irrigation is practiced. In northwestern New Mexico the irrigated land is located in a river valley near the coal fields, and some of the land in the Navajo Irrigation Project (now under construction) is actually underlain with coal, but at sufficient depth to make strip mining infeasible. Competition for water is likely here because the only source of supply is the San Juan River. Elsewhere new coal development will not be likely to occur in irrigated areas, nor in areas where irrigation is likely to develop.[6]

The statement that increased coal development will not compete seriously for land is true enough but it evades a major concern that is environmental in nature. Many people who live in the western areas where coal reserves are abundant are inclined to resist new mining because they see the prospects for an influx of new people as a threat to a life style characterized by "wide open spaces, clear skies, and friendly people."

It is recognized that all or part of the damage to the land can be corrected by a land reclamation program, and this is now required by both state and federal laws. Most of the laws applicable in western states have apparently been drawn without much regard to the cost to society or the benefits derived. A benefit-cost comparison is appropriate if land reclamation is to be justified on the basis of a national need for farm products. Ideally a B/C ratio should be calculated for each mine separately because there are likely to be wide variations in both costs and benefits from one location to another.

One recent study shows a range in reclamation costs from \$2000 to \$9200 an acre for western mines (Leathers). State average costs per acre range from \$2600 in Colorado to \$4700 in Montana; the corresponding annual equivalent costs are \$172.53 and \$311.89 per acre (Table 4).[7] Direct agricultural benefits — the value of agricultural production saved assuming full restoration — range from \$1.63 per acre in Arizona to \$28.27 in North Dakota. The excess of costs over such benefits range from \$148 to \$298 per acre.

Estimates of benefits other than those shown in Table 4 are not readily available, partly because of the need to be site-specific. In addition, it is difficult to estimate the probable effects of reclamation, to decide which effects are benefits, and to determine how to measure each effect in monetary terms. Since some of the benefits cannot be monetized even by using proxy values, the above benefit-cost comparison is only a partial measure at best. Thus it is worthwhile to list some of the items that should be considered in addition to the values shown in the table:[8]

(1) Creating higher agricultural land use capability. In some areas it is possible that grazing land could be converted to cropland by the mining and reclamation process. (In preparing the data in Table 4 it was assumed that land use after mining would be the same as before.)

(2) Reducing or eliminating damage to the quality of water downstream. Such damage could be caused by excessive sedimentation or by leaching toxic chemicals from spoil piles, i.e., acid mine drainage.

[6]*Although water might be physically available in a given location, there might be legal and other institutional barriers to its use. A discussion of such problems is beyond the scope of this article.*

[7]*Another recent study found costs of about \$6,800 per mined acre in North Dakota (Gronhovd).*

[8]*It should be noted that coal development will result in some detrimental effects that are not likely to be corrected by land reclamation and should therefore be properly classified as mining costs. One such effect is the severance damages suffered by the operator whose farm is cut into two or more parcels by the mining process. Another is the loss in farm income while land is out of production but later reclaimed. A third is the loss of a local aquifer destroyed by the mining process. Other unreclaimable effects may also occur.*

COAL PRODUCTION AREAS
(with strippable reserves)

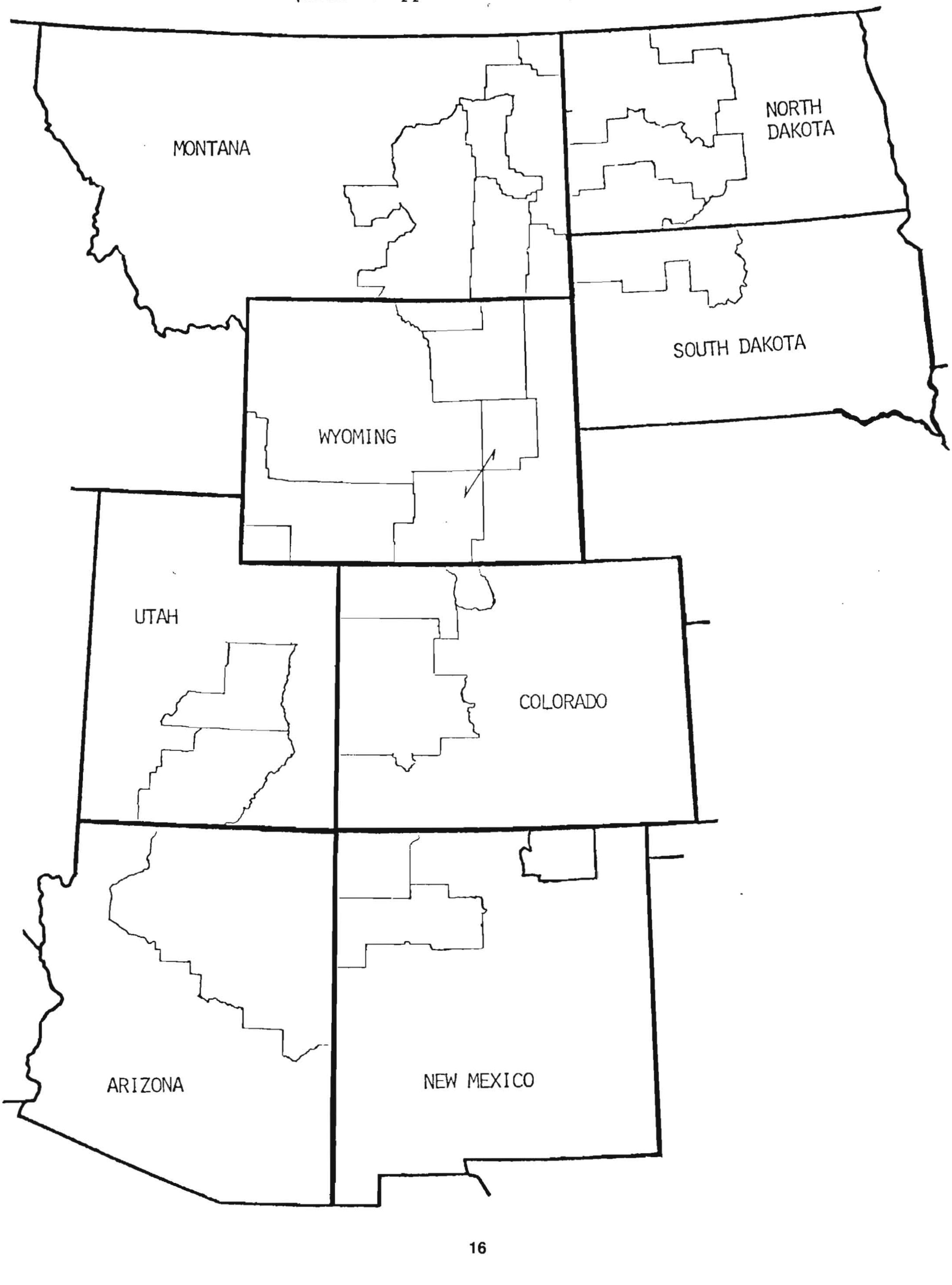

Table 4. Reclamation Costs and Agricultural Benefits

State[1]	Estimated Reclamation Costs: Initial cost per acre of land[2]	Estimated Reclamation Costs: Annual equivalent cost per acre[3]	Annual agricultural benefits per acre[4]	Excess of costs over agricultural benefits
	dollars			
Montana	4,700	311.89	13.63	298.26
N. Dakota	4,200	278.71	28.27	250.44
Wyoming	3,300	218.98	5.73	213.25
Arizona	2,900	192.44	1.36	191.08
Colorado	2,600	172.53	24.12	148.41
New Mexico	2,900	192.44	3.03	189.41

[1]*No estimates were available for South Dakota or Utah.*
[2]*From Leathers, Table 6, Page 111.*
[3]*Capital recovery factor, 100 years at 6.625%, the rate now used for evaluating federal water resource projects.*
[4]*Value of crops and livestock sold in 1974, from Table 2.*

(3) Restoring damaged wildlife habitat. Values from this type of benefit tend to be inversely related to the proportion of cropland at the mine site, because cropland usually has relatively low wildlife values.

(4) Restoring the aesthetic character of the landscape.

(5) Creating new wildlife or recreational resources by planting shrubs and trees or by building lakes or ponds.

The analysis supports two general conclusions. First, surface mining of coal in the west poses no threat to our national food supply as the amount of land needed is very small in relation to the total available. Water requirements for coal development would be sufficient to reduce production somewhat in a few local areas, but not enough to be significant on a state or national level. Therefore, those who use an implied threat of a reduced food supply as a reason to forbid further coal development in the west are indulging in a serious distortion of facts.

Second, the cost of reclaiming mined land is many times higher than the agricultural benefits, and therefore reclamation must be justified on environmental values, many of which are difficult or impossible to quantify, except subjectively. When one says, "there is no way to measure the negative value of a landscape dominated by rows of ugly spoil piles," he may be trying to convince his listeners that the spoil piles must be reclaimed no matter what the cost. On the other hand, he may be saying that since the negative values cannot be measured, they are so small that they can be ignored. Society cannot afford to accept either viewpoint blindly. The optimum position no doubt lies somewhere between the two extremes.

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