The shortcomings of the present system lie in the failure of the various legislatures to supply the "equivalent economic values" which the state engineer can use in judging appropriation applications.

8. Groundwater

While groundwater has been heralded by some as a great source of water for energy development, others have warned of the havoc that could result from an unstructured, haphazard use of this resource.

In his well-respected 1942 water law treatise, Wells Hutchins, pointed out that "...complete coordination of surface and ground waters... remains a most difficult (problem) owing to the invisibility of subterranean waters and the mass of data required to prove satisfactorily their origin, quantity, and movements."[126]

Groundwater hydrology, replete with misinformation, misunderstandings, and mysticism, "...has always been a favorite refuge for quacks and pseudoscientists...(and) practitioners of the willow branch or the brass welding rod."[127] Nevertheless, strict attention to the quantity and quality of underground water, especially in its interrelationship with surface water flows, is called for by two national study commissions.[128,129]

As long as there were sufficient supplies of surface water, the groundwater issue was not an important one. Accordingly, Western water law developed for the allocation of surface streams almost to the exclusion of consideration of groundwater disputes. The occasional groundwater controversy was handled with a separate set of rules taken from the common law. The general common law rule, inherited from England, provided that waters beneath the land are property of the landowner who may withdraw them irrespective of the effect on others. Because this produced a harsh result on neighboring property, two modified doctrines arose; the "reasonable use rule" stated that any use is subject to the similar rights of others who would be negatively affected by an unreasonable withdrawal; an extension of this rule became the "Correlative rights doctrine," which gave co-extensive and co-equal rights to adjoining landowners. The Western appropriation doctrine for surface waters was, in some cases, applied to groundwater giving the first person to put the water to beneficial use the senior right.

As water became more and more scarce in certain places in the West, the inadequacy of this treatment of groundwater resources was made clear. The initial corrective step was to draw distinctions between underground waters tributary to natural streams and those enclosed in impervious basins. The former were the first to be reexamined because wells that removed water from tributary groundwater, by definition, affected surface rights in the stream toward which the groundwater was moving. Hydrologically speaking, such tributary groundwater is a part of the stream it feeds.[130] Wyoming's groundwater law recognizes this, as follows:

> ...where underground waters and the waters of surface streams are so interconnected as to constitute in fact one source of supply, priorities of rights to the use of all such interconnected waters shall be correlated and such single schedule of priorities shall relate to the whole common water supply....[131]

Colorado law makes the important distinction between tributary and non-tributary groundwater and applies the surface water appropriation rules to tributary water. Nontributary water is catalogued in designated groundwater basins for administration by a special commission.[132] A permit from this commission is necessary before a well may be drilled in a designated groundwater basin. The commission must deny the permit if there are no unappropriated waters in the basin, or if the proposed appropriation would unreasonably impair existing water rights from the source or would create unreasonable water waste.[133]

Wyoming law designates certain groundwater areas as "control areas" where any of the following circumstances exist:[134]

- The use of underground water is approaching a use equal to the current recharge rate.
- Groundwater levels are declining or have declined excessively.
- Conflicts between users are occurring or are foreseeable.
- The waste of water is occurring or may occur.
- Other conditions exist or may arise that require regulation for the protection of the public interest.

If there is an inadequacy of water in the designated control area, the state engineer may close the area to further appropriation, apportion a measured amount among the appropriators, shut down or reduce withdrawals by junior appropriators, specify a system of rotation of use, and for future permits--if any are granted--he may institute well spacing requirements.[135]

Montana simply includes groundwater in the statutes that allocate surface streams.[136] However, there is administrative power provided for regulating the construction, use, and sealing of wells to prevent the waste, contamination, or pollution of groundwater.[137]

A critical factor in the husbandry of groundwater resources is the "recharge rate"--the rate at which an underground basin replenishes itself after a given amount of water is withdrawn. In a truly impervious basin, the recharge rate may be zero. When one withdraws water in this situation, one is said to be "mining" the water resource. Like minerals, once it's gone, it's gone. The term "mining" is also applied to rechargeable basins where the rate of withdrawal is greater than the recharge rate. In this case, the water table lowers, allowing adjoining waters--which may be contaminated--to flow into the underground basin.

Demand placed on groundwater resources by energy companies has created political tensions in mineral rich areas. In a move still drawing hostile fire, Wyoming passed legislation providing up to 20,000 acre-ft of groundwater for use by Energy Transportation Systems, Inc., (ETSI).*[138] ETSI proposes to use the water for a coal slurry pipeline to carry Wyoming coal over 1,000 miles to power generating stations in Arkansas. The water is to come from the Madison limestone formation underlying northeastern Wyoming (and western South Dakota), brought up by wells drilled to a depth of 3,500 to 4,500 ft. According to the U.S. Geological Survey, the formation contains from 500 million to 1 billion acre-ft of water with an annual recharge rate of 100,000 acre-ft. Those legislators who voted for the measure approving the use of the water were apparently swayed by the cited recharge rate and by the claim that the water was highly saline and therefore of little use for other purposes. Both of these factors are now coming under attack. The recharge rate is under continuing study by the state,† and some Madison formation water brought up near Gillette, Wyoming, has proved to be of higher quality than that under present use for municipal purposes.[139] The matter at this point is unresolved, but the situation is illustrative of the problems faced by all the parties concerned. As a final note, because the Madison water table (which also underlies South Dakota) may be detrimentally lowered, South Dakota is contemplating a suit against Wyoming in the United States Supreme Court to halt the proposed action.[140]

---

*The legislation makes this particular use subject to the approval of the state engineer.

†See, for example, "Underground Water Supply in the Madison Limestone," Wyoming State Engineer's Office, Cheyenne, Wyoming, December (1974).

9. State Action Generally

The power of the states to control the waters flowing through or underlying their lands, vis-a-vis federal power, is discussed at length in another section. However, it is worth observing at this point that the states want as much control as they can get (preferably complete control), and, also, that they will use it. In 1974, the Montana legislature passed a sweeping three-year moratorium on further water development in the Yellowstone River Basin. The legislature's statement of policy behind the action is as follows:* [141]

> The legislature, noting that appropriations have been claimed, that applications have been filed for, and that there is further widespread interest in making substantial appropriations of water in the Yellowstone River Basin, finds that these appropriations threaten the depletion of Montana's water resources to the significant detriment of existing and protected agricultural, municipal, recreational, and other uses, and of wildlife and aquatic habitat. The legislature further finds that these appropriations foreclose the options to the people...to utilize water for other beneficial purposes, including municipal water supplies, irrigation systems, and minimum flows for the protection of existing rights and aquatic life. The legislature...declares that it is the policy of this state that before these proposed appropriations are acted upon, existing rights to water in the Yellowstone Basin must be accurately determined for their protection, and that reservations of water within the basin must be established as rapidly as possible for the preservation and protection of existing and future beneficial uses.

Accordingly, no applications will be processed for new appropriations or transfers of use until the three years are up, or until a final

---

*The moratorium expires in March of 1977.

determination of existing rights has been made.*[143] An example of the moratorium's effect is provided by the experience of the Intake Water Company. In an effort to provide 245,000 acre-ft of water for energy development, Intake proposes to construct a dam on the Powder River in Montana at a point four miles north of the Wyoming-Montana border. Twenty-one miles of the 24-mile-long reservoir will lie in Wyoming, but the proposal must await the passing of the three-year moratorium.

E. Water Requirements for Coal and Oil Shale Development

The water requirements for the production of syncrude and methanol from coal and syncrude from oil shale are different, but the amount for both types of production are large. As we have seen, the allocation of water in the West is a complex subject. Basic to the problem of allocation is the question of the amount of water that is available. This section sets projections of water demand for coal and oil shale development against available water supplies and their possible augmentation.

1. Syncrude and Methanol from Coal

Just how much water is available for coal development in the semiarid Northern Great Plains states of North Dakota, Montana, and Wyoming is an important question because of large water requirements of some of the processes contemplated for the coal once it is out of the ground. The alternative processes for coal development are given in Figure 19-3, along with the location of the processing, whether in-state or out-of-state. The alternative that requires virtually no water, of course, is the shipment of mined coal out of the region by train to

*The moratorium does not apply to projects of less than 14,000 acre-ft capacity.

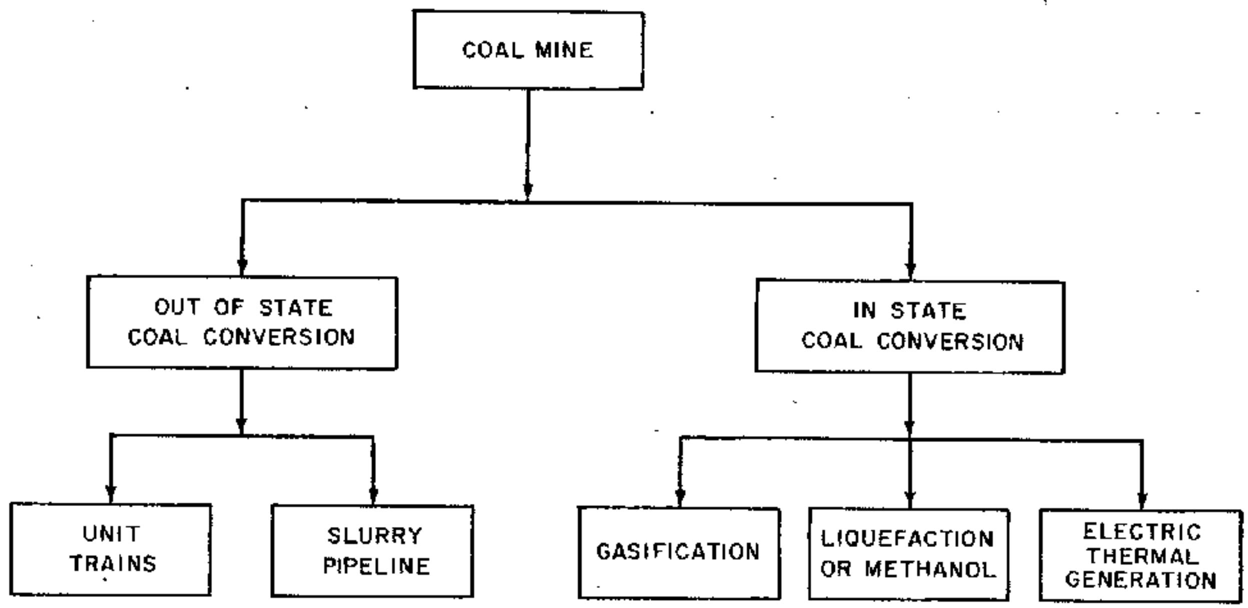


FIGURE 19-3. COAL DEVELOPMENT ALTERNATIVES, IN-STATE AND OUT-OF-STATE

water-rich areas for processing. At the other extreme is the alternative of burning the coal in a power plant located at the mine to generate electrical power, which would consume large amounts of water for cooling. The various alternative uses of coal and their associated water requirements are shown in Table 19-4.

The likelihood is that the future will see a mix of the various alternatives, and the availability or nonavailability of water at a given geographic location at a given price will be a major determinant in what particular coal utilization alternative is selected. Other factors will also go into the decision, including population impacts, jobs created, and tax assessing opportunities for state and local governments.

The major rivers that flow through the Northern Great Plains all come together to swell the Missouri River. Looking upstream from Sioux City, Iowa, one sees a net flow (the virgin flow less present day depletions) of 21,821,000 acre-ft/year. Table 19-5 reveals that, even in low water years, a net of 5,970,000 acre-ft/year of this water is available for all future uses--energy development of all forms as well as agricultural, municipal, industrial uses, and fishing habitat and wildlife improvement programs.

Projections of the Northern Great Plains Resources Program for the year 2000 show 41 gasification plants and 19,400 MW of electrical generating capacity.[143] Assuming a consumptive use (no discharge) of 9,500 acre-ft/year of water for each gasification plant and 12,000 acre-ft/year for each 1000 MW of electricity, the water required for gasification and electrical power generation in the year 2000 would total about 620,000 acre-ft/year. Water used consumptively to revegetate areas stripped to provide coal for these uses is estimated at about 31,000 acre-ft/year.[146] Projected additional agricultural consumptive use, based on 1.6 acre-ft per acre, is conservatively estimated at about

Table 19-4

ANNUAL WATER CONSUMPTION FOR VARIOUS COAL USES

Use	Facility Size	Water Required (10^3 acre-ft)	Coal Required (million tons)	Relative Water Requirement (acre-ft/million tons of coal)
Thermal electric power generation	1000 MW	12	4.5	2670
Methanol from coal	100,000 B/D	15	13	1150
Gasification	250 million SCF/D	9.5	9.5	1000
Liquefaction	100,000 B/D	29*	35	830
Slurry pipeline	25 million tons/year	18.8	25	750
Unit trains	61 million tons/year	Negligible	61†	--

*Assumes wet cooling; with dry cooling this figure could be reduced to about 12,000 acre-ft.
†The exact capacity of a system of unit trains has not been determined. The analysis assumes 61 million tons of coal could be exported by unit trains in the tenth year.

Source: References 143 and 144, and Table 4-5, Chapter 4.

Table 19-5

UPPER MISSOURI RIVER BASIN WATER AVAILABILITY AND DEPLETIONS

	Average Year (10^3 acre-ft)	Critical Year (10^3 acre-ft)
Historic flow[1]	28,321	--
Depletions for past use[2]	6,500	--
Water supply available after 1970	21,821[3]	14,200[9]
Indian requirements in Montana and Wyoming[4]	2,637	2,637
Committed to authorized Bureau of Reclamation projects[5]	1,293	1,293
Remaining water subject to Indian claims[6]	17,891	10,270
Suggested water quality control required on main stem[7]	4,300	4,300
Available for additional development by Indians and non-Indians[8]	13,591	5,970

[1]28,321,000 is an estimated value of long-time (1898-1972) average annual flow at Sioux City, Iowa, prior to any water development in the basin above Sioux City. It was derived from streamflow records adjusted for known and reported developments throughout the upper basin and the measured and estimated depletions associated with those developments.

[2]Above Sioux City 6,500,000 is a composite of water depletions for all projects in operation in 1970. Estimates include irrigation, imports, exports, land treatment measures, stockponds, rural domestic uses, evaporation from major impoundments, minerals, and mining, industrial, and municipal uses. It represents water currently consumed and no longer available to meet additional future needs.

[3]A measure of the expected average annual water production between 1898-1972 repeated, but with current uses accounted for. It is equal to the historic flow less all depletions for 1970 level of development.

[4]Compiled from inventories of land and water by consulting engineering firms under contract. Refinement in these preliminary numbers will evolve as studies continue. (Indian water requirements do not necessarily define Indian water rights.)

[5]Congress has authorized six units to be constructed by Bureau of Reclamation in the basin under the Pick-Sloan Missouri Basin Program. They are in the construction or preconstruction stage. The expected depletions above Sioux City for authorized projects total 1,293,000 acre-ft from Garrison, Oahe, and O'Neill Units.

[6]These figures are the residual flows after subtracting projected Indian claims in Montana-Wyoming and committed waters of authorized Bureau of Reclamation units from the water supply available as of 1970 level of development. These totals represent water available for further development in the Dakotas and is subject to the undetermined paramount rights of Indians in the Dakotas, for which land and water inventories have not begun.

[7]4,300,000 acre-ft is the annual equivalent of 6000 cubic ft/s currently thought to be the flow between and from main stem reservoirs required for recreation, flow maintenance, public health, and water quality control.

[8]These figures represent average and critical year water quantities available for future development in the Dakotas if water quality control flow requirements are maintained, and the demands listed in 4 and 5 are met.

[9]This value is an estimate derived from a recent operations study of the main stem reservoirs at 1970 development level. That study determined that water quality control could be maintained and also allow 9,900,000 acre-ft annually as the additional tolerable depletions which the system storage could accommodate. 14,200,000 is the sum of 9,900,000 and 4,300,000.

Source: Reference 14.

1,900,000 acre-ft/year for the year 2000.[147] Fishery habitat and wildlife improvement programs could consume about 320,000 acre-ft/year.[148] These consumptive uses are totaled in Table 19-6.

Table 19-6

PROJECTED ANNUAL CONSUMPTIVE USE OF WATER FOR THE YEAR 2000--NORTHERN GREAT PLAINS STATES

Use	Water (10^3 acre-ft/year)
Gasification and electric power generation	620
Revegetation	31
Municipal	14
Agricultural	1900
Fishery habitat and wildlife improvement	320
Total*	2890

*Total does not add due to rounding.

In addition to these projected uses are the syncrude and methanol water demands projected by the maximum credible scenario for the year 2000, shown in Table 19-7. The sum of these state demands is the total competing water figure for syncrude and methanol production (last column, Table 19-7).

Table 19-7

SYNCRUDE AND METHANOL CONSUMPTIVE WATER DEMANDS FOR THE YEAR 2000

State	Number of Liquefaction Plants	Water for Liquefaction Plants* (10^3 acre-ft/yr)	Number of Methanol Plants*	Water for Methanol Plants* (10^3 acre-ft/yr)	Number of Coal Mines to Support Those Plants*	Water for Coal Mines* (10^3 acre-ft/yr)	Total Water Needs (10^3 acre-ft/yr)
Wyoming	13	377	13	195	81	12	584
Montana	11	319	10	150	66	9.9	479
North Dakota	0	0	21	315	76	11.4	326
Total†							1390

*Plant size and resource requirements from Tables 6-3, 6-6 (Chapter 6).
†Total does not sum due to rounding.

The sum of all these competing uses must then be compared to the earlier available water figure of 5.97 million/year.

	10^3 acre-ft/year
Demands other than syncrude and methanol	2890
Syncrude and methanol	1390
Total	4280

The conclusion is that there is enough water available in the upper Missouri River system to support the maximum credible scenario for syncrude and methanol production in that region while still meeting projections for all other demands.

This conclusion is not entirely valid, however, because the geographical distribution of the water is not coincident with the distribution of the coal resource. Typical of this situation is the Powder River Basin of northeastern Wyoming and southeastern Montana where the maximum credible scenario has sited the major coal effort for these states. This area is extremely coal-rich and markedly water-poor. One of the water facts of life of the entire region becomes very clear very quickly; the flows in the rivers are seasonal, ranging from a maximum in the late spring to a minimum (in some cases zero) flow in the late summer and fall, as illustrated by the historic Yellowstone River Basin flows shown in Figure 19-4. To control flooding at times of high flow and to provide water for release in dry seasons, the storage reservoirs listed in Table 19-8 have been constructed on many of the region's rivers. The prime impetus for their construction was to provide a reliable source of water for irrigation of agricultural land in the dry season. Some of these existing storage areas could, perhaps, be tapped to provide water

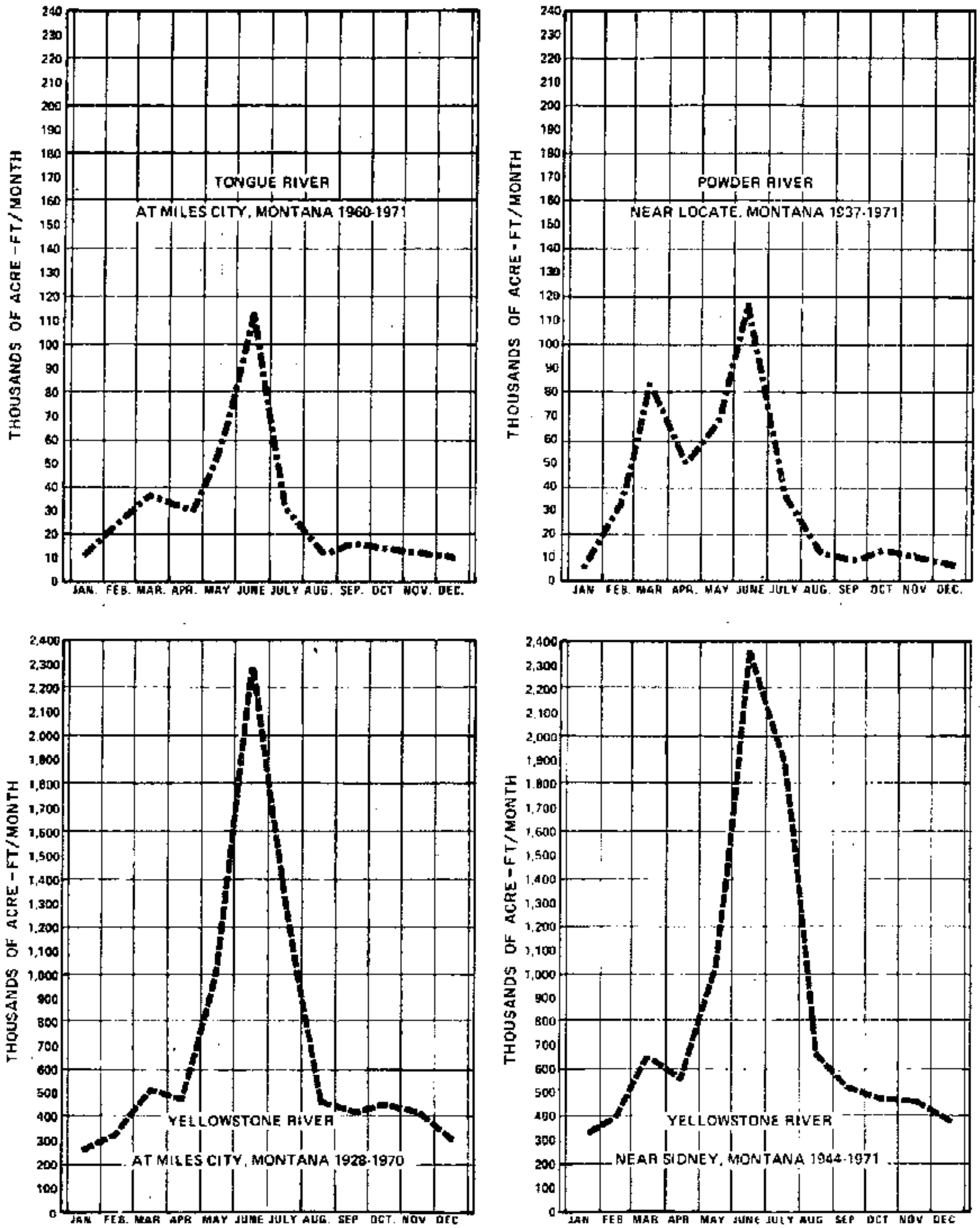
Table 19-8

MAJOR RESERVOIRS THAT AFFECT STREAM FLOWS IN THE NORTHERN GREAT PLAINS

		Storage (thousand/acre-ft)				
Stream	Reservoir	Inactive and Dead	Active	Flood Space	Total	Uses*
Missouri	Fort Peck	4300	10,900	3700	18,900	R, FC, Irr., N, P, M, I
	Lake Sakakawea	5000	13,400	5800	24,200	R, FC, Irr., N, P, M, I
	Oahe	5500	13,700	4300	23,500	R, FC, Irr., N, P, M, I
Milk	Nelson	18.7	66.8	--	85.5	R, Irr.
Clarks Fork	Cooney	0	24.4	--	24.4	R, Irr.
Wind-Bighorn	Bull Lake	0.7	151.8	--	152.5	R, Irr.
	Pilot Butte	5.4	31.5	--	36.9	P, Irr.
	Boysen	252.1	549.9	150.4	952.4	R, FC, Irr., P, M, I
	Buffalo Bill	48.2	373.1	--	421.3	R, Irr., P
	Bighorn	502.3	613.7	259.0	1,375.0	R, FC, Irr., P, M, I
	Upper Sunshine	1.0	52.0	--	53.0	Irr., S, D, I
	Lower Suhsine	1.9	54.9	--	56.8	Irr., D, S, P, I
Powder	Lake DeSmet	0	239.0	--	239.0	R, Future Industry
Tongue	Tongue	5.9	68.0	--	73.9	R, Irr., M, I
Heart	Dickinson	1.2	5.5	--	6.7	R, Irr., M, I
	Heart Butte	6.8	69.0	150.5	226.3	R, FC, Irr., M, I
Grand	Bowman-Haley	4.3	15.8	72.9	93.0	R, FC, M, I
	Shadehill	58.2	30.0	269.6	357.8	R, FC, Irr.

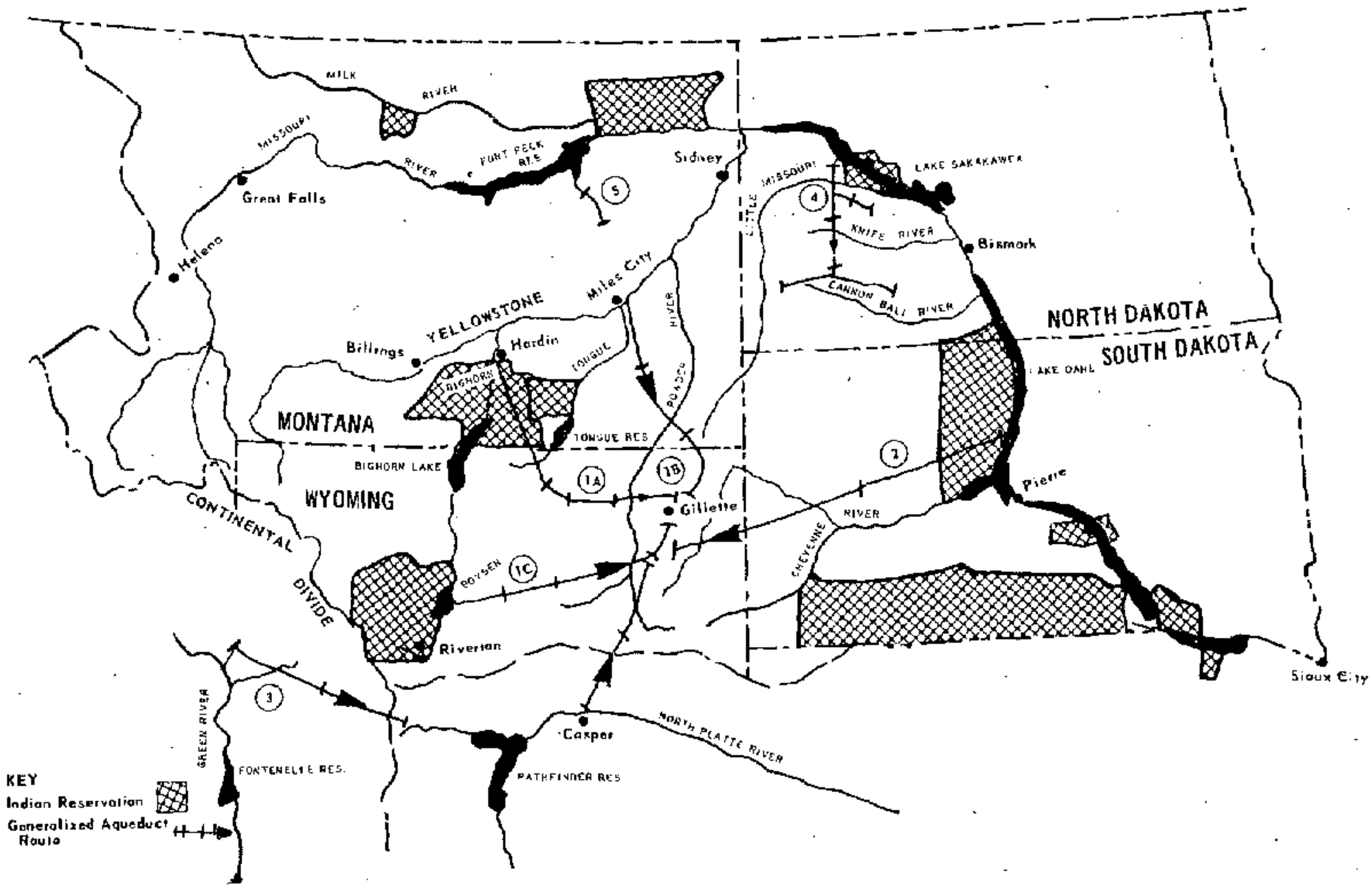
*R = recreation (includes fish & wildlife), FC = flood control, Irr. = irrigation, N = navigation, P = power, M = municipal, I = industrial, S = stockwater, D = domestic.

Source: Reference 149.



Source: Reference 144

FIGURE 19-4. HISTORIC YELLOWSTONE RIVER BASIN FLOWS for energy development as described below. Consideration may also be given to building additional impoundment facilities--with the impetus for construction this time being the storage of a water supply for the year around operation of various coal processing plants. The storage development potential for rivers close to the Gillette, Wyoming, coal resource focal point is not impressive vis-a-vis the projected amounts of water needed. Table 19-9, which is a summary of surface water resources available or subject to development, shows that the Powder River and Tongue River reservoirs could only provide a total of 131,000 acre-ft/year, far short of Wyoming's projected need of 584,000 acre-ft/year for syncrude and methanol. For this reason, major aqueduct pipelines would be necessary to bring in water from the reservoirs listed in Table 19-8. Construction of these water conveyance lines could make it unnecessary to construct several small capacity (but close-in) reservoirs. Figure 19-5 shows several ways of bringing water from where it is to where it will be needed. Route 1C could bring up to 135,000 acre-ft/year to the coal region. Route 1A could transport up to 435,000 acre-ft/year. However, under the latter alternative, there would not be enough water remaining for other demands, including the full 6000 cubic ft per second flow necessary to preserve instream values. (See Table 19-5, Note 7.) For this reason, route 1B may be more acceptable in that the diversion is at a point farther downstream where an equivalent amount of withdrawal would have a lesser impact because the 6000 cubic ft per second standard would be met. Another alternative is route 2, which could provide water from Lake Oahe in South Dakota, although the distance involved would represent significant pipeline construction costs. This alternative has been challenged by the state of South Dakota, which insists that Lake Oahe water should be reserved for future irrigation needs in the state. The South Dakota Attorney General, William Janklow, has said on this issue, "Let them try and take that water away from us--they'll need a federal marshal along every mile if they want to build that pipeline."[151]



Source: Reference 75

FIGURE 19-5. MAJOR POTENTIAL DELIVERY SYSTEMS, NORTHERN GREAT PLAINS COAL RESOURCE REGION

Table 19-9

SUMMARY OF INDUSTRIAL WATER RESOURCES
FOR THE UPPER MISSOURI RIVER BASIN

	Water (acre-ft/year)			
	Available		Potential	
	Montana	Wyoming	Montana	Wyoming
Bighorn and Wind Rivers				
Boysen Reservoir		85,000		50,000
Bighorn Lake	262,000	435,000		254,000
Little Bighorn Reservoir			40,000	
Powder River				
Moorhead Reservoir			57,000	51,000
Hole-in-the-Wall Reservoir				20,000
Tongue River				
Tongue River Reservoir			60,000	
Other development with major storage				60,000
Yellowstone River				
Main stem (with regulation by offstream reservoirs, or Allenspur)			1,356,000*	344,000†
Shoshone River				
Modification of Buffalo Bill Reservoir				50,000
Green River				
Importation and diversion				108,000
Total	262,000	520,000	1,513,000	937,000

*About 1.7 million acre-ft would remain in the Yellowstone River for other future development and for minimum flows.
†Wyoming's share of Clarks Fork Yellowstone River.

Source: Reference 150.

A final alternative would be to take water from the Fontanelle Reservoir on the Green River over the Continental Divide to the North Platte River, and then remove it from the North Platte at the place where the river passes closest to the coal resource. Routes 1A, 1B, and 1C raise the institutional restriction of the Yellowstone River Compact, which forbids any signatory state (Wyoming, Montana, and North Dakota are signatory states) from moving water out of one basin into another (e.g., out of the Bighorn River Basin into the Powder River Basin) without the consent of the other states. Route 2 avoids this problem, but, as previously mentioned, it is expensive and it invites a hostile response from South Dakota. Route 3 avoids the institutional problem inasmuch as the Upper Colorado River Basin Compact (the Green River is a tributary of the Colorado River) does not constrain interbasin transfers. Removal of this high quality water, however, would exacerbate the salinity problem of the lower Colorado River states.

Referring to Figure 19-5, Route 4 would provide water from Lake Sakakawea for the processing of North Dakota coal, and Route 5 would bring main stem Missouri River water to coal development sites in northeastern Montana. These routes appear to have fewer political or institutional problems associated with them.

South Dakota is also a major factor in one of the options depicted in Figure 19-3, the transportation of coal from the Powder River Basin to distant processing points via coal slurry pipeline. Present proposals call for obtaining the water for the slurry from deep wells, which tap into the geologic Madison limestone formation underlying the Powder River Basin. However, the Madison aquifer, reported as having as much as 1 billion acre-ft of water, also underlies western South Dakota. Extensive pumping in Wyoming may lower the water table or cause a drop in the quality of the water presently being pumped out of the Madison formation by South Dakota citizens. South Dakota has pledged to go to court to challenge the large-scale pumping envisioned for the coal slurry pipeline option.[161]

A number of organizations have begun to plan for the future of this region in general, and in the utilization of the region's coal in particular, but there has been no integration of the planning process. Energy companies are filing plans for construction of small storage reservoirs that will satisfy their particular water-for-energy needs, but that, it may be argued, runs counter to the interests of local citizens with other needs for that water, interests of the state concerned, interests of the region as a whole, and national interests.

2. Syncrude from Oil Shale

The maximum credible scenario projects 20 large (100,000 B/D) oil shale plants by the year 2000. At a water scaling factor of 16,000 acre-ft/year for each such plant, the total water required for the 20 plants would be 320,000 acre-ft/year. Because the oil shale resource lies in the Upper Colorado River Basin, this water requirement must be met from supplies in that basin.

The total water available to the Upper Colorado River Basin states for all uses is conservatively estimated to be 5.8 million acre-ft annually.*[152] Present uses (including reservoir evaporation) require 3.71 million acre-ft per year.[153] Projected increases in annual demand for the year 2000 are shown in Table 19-10. If the increase in water demand of 2.75 million acre-ft/year is added to the 3.71 million acre-ft/year of present use, the total demand for the year 2000 would be 6.46 million acre-ft/year.

*Some figures are as high as 6.3 million acre-ft/year; see Reference 155.

Table 19-10

PROJECTED INCREASE IN WATER DEMAND FOR THE UPPER COLORADO RIVER BASIN

Category of Use	Increase in Water Demand (10^3 acre-ft/yr)
Municipal	750
Environmental (fish, wildlife, recreation, water quality)	150
Agricultural (primarily irrigation)	800
Mineral production	115
Coal fired electric generation	475
Coal gasification	140
Syncrude from oil shale	320
Total	2750

Source: Reference 154.

Clearly if there is but 5.8 million acre-ft/year of water available to the Upper Basin, there would not be enough water under the projected demand to accommodate all users. A Department of the Interior study, which projected an oil shale development amounting to only three-fourths that of the maximum credible scenario, indicates that the water shortfall will occur in the early 1990s.[156]

There is little hope of increasing Upper Basin supplies at the expense of the Lower Basin. The Lower Basin of the Colorado has committed its full share of water available to it under the 1922 Colorado River Compact, considering its present demands and projected plans for energy (and other) development.

Although water supplies can be increased through snowpack augmentation (i.e., winter cloud seeding resulting in greater water runoff in the spring), the estimates of the increase range only from 6 to 9 percent.[157] A proportionate increase in the Upper Basin supply would thus be from 350,000 to 520,000 acre-ft/year--not enough to meet the projected deficit of 660,000 acre-ft/year.

The allocative formula of the Upper Colorado River Basin Compact of 1948 further demonstrates the foreseeable shortages on an individual state basis within the Upper Basin. Under the maximum credible scenario Colorado's Rio Blanco and Garfield counties experience the bulk of oil shale development. The 1948 Compact, after allocating 50,000 acre-ft/year to Arizona, gives Colorado 51.75 percent of Upper Basin water, or 3.00 million acre-ft/year. The Compact operates to require the water for Colorado's oil shale development to come from its allocated Upper Basin share. The result is that Colorado will experience a projected water resource shortfall by the early 1990s when the 3.00 million acre-ft/year figure of available water will be surpassed by in-state demand.[158]

The MCI projects a maximum oil shale development effort in the Piceance Basin of northwestern Colorado. In the southern part of the Basin, surface water will have to be transported to the oil shale site. In the northern part of the basin, close to the White River drainage system, a different situation exists. There, groundwater will have to be pumped at the outset of mining operations to keep the mine itself dewatered; indications are that this water will be initially of sufficient quantity and quality for retorting and refining needs, in addition to meeting water requirements of crushing, mining, and processed shale disposal.[159] Depending on the salinity, the water may also meet drinking water and sanitation needs.[160] However, as the water table lowers, the quality of the pumped water will deteriorate and fewer and fewer productive uses can be made of the water. Thus a twofold problem appears; excess "unsatisfactory" water will have to be disposed of in a way that avoids contaminating surface waters and water of a satisfactory quality will have to be obtained from a surface source to meet the needs of the operation.

The White River produces about 610,000 acre-ft of water per year. However, claims on the parts of Utah, other downstream states, the federal government, and Indians through whose reservations the river flows--in addition to prior appropriation claims of agricultural interests--leave little, if any, of this water available for oil shale development.[161]

Even in areas where surface water rights are granted, some means will have to be provided to transport the water from the source to the mining operation. Because ice formation in winter would hinder transport via canals, buried pipelines appear to be necessary.[162] Atlantic Richfield, e.g., has filed for 50,000 acre-ft/year of White River water, proposing to transport the water 36 miles through a 48-inch diameter pipeline.[163]

Oil shale developers have also filed water claims for Colorado River water, seeking to pump the water over the Book Cliffs to the Piceance Creek drainage area. It has been pointed out that this would be a very expensive lift system.[164]

To illustrate the degree of the allocation problem, the total claims made on Colorado River water flowing near the oil shale resource area exceed the entire flow of the river during some seasons.[165]

If the allocative dilemma is resolved, the magnitude of the demand forecast makes it clear that for White River and Colorado River water to be available for year around oil shale operations, additional water development projects will be necessary to store the disproportionate spring flow; in the spring, 60 percent of the White River's annual flow occurs in 120 days.[166]

There is a continuing investigation into the method of syncrude production from oil shale by in situ processes in which the shale is mined and crushed underground through blasting and is then retorted in place. The raw shale oil product is pumped out for further processing. From a water standpoint this process is particularly attractive because total water needs are thought to be about one-fourth those of "conventional" processing.[167] (Water savings result because shale does not have to be wet down or slurried in the mining, crushing, or retorting phases of the operation; moreover, because the process takes place underground, there is no need for dust control, or for compacting spent shale in the disposal phase, which is the most water intensive aspect of all.[168]) However, the in situ process is considered to be in an experimental phase and it is not clear that it will ever be a viable alternative to present water intensive processes.[169]

Assuming that the forecasts are accurate and that the predicted shortfall does occur, the answer will be to increase the water supply and/or to reconsider from an institutional point of view where the available water supplies should go. It has been pointed out that snowpack enhancement to augment spring runoff water will ease the problem but will not solve it. Interbasin transfers, e.g., from the Columbia River, are costly and politically unpalatable. More efficient agricultural methods will save some water, but state laws which operate to encourage the profligate use of a water right will have to be changed. The market transfer of water rights from agricultural use to energy development use is possible if laws unfettering such transfers are implemented (see Section D). It will be important to do this in a knowing way so that the desired amount of agriculture production is preserved. If freely spent "energy" dollars buy up all of agriculture's water rights, land reclaimed through Bureau of Reclamation projects and irrigation over the years will revert to its original condition. This will, of course, have a profound effect on the local society, which developed as an "agricultural culture." Because such decisions have both a regional and national character to them, as well as a profound local impact, some kind of mechanism will be necessary to make intelligent choices for all concerned.

F. Coal Transport: Pipeline versus Rail

There are going to be hard choices in the coal-rich states on the Northern Great Plains concerning the best use of their precious water resources. Because coal-burning electric power plants and coal conversion technologies such as gasification and liquefaction are water intensive processes, serious consideration is being given to transporting the coal out of the region for use or processing in locations with sufficient water resources.

There is great demand for coal at long distances from western coal fields. For example, utilities in Texas and Arkansas, hard-pressed by oil and gas shortages, and eastern utilities, faced with clean-air constraints on the use of high-sulfur eastern coal, are interested in having western coal carried to their boilers for electric power generation.

The question is how best to transport the huge quantities of coal. The two practical alternatives are transport (1) by railroad, and (2) by coal slurry pipeline.

The policy of the United States is to move away from dependence on foreign oil. To that end, the U.S. Senate in 1974, passed a bill calling for all oil-burning electric power generating plants to convert to coal. An amendment to that law, sponsored by Senator Henry Jackson (D. Wash.), precipitated the present debate over railroads versus coal slurry pipelines. The amendment proposed to give to slurry pipeline companies the federal power of eminent domain, whereby the pipeline companies could acquire the necessary rights-of-way to lay the pipe from coal producing areas to the consumer. The measure died in the House of Representatives of the 93rd Congress for want of time. Reintroduced in the 94th Congress, it was referred to the Committee on Interior and Insular Affairs, where it remains with little likelihood of being brought to the floor.*

1. Coal Slurry Pipelines

In a coal slurry system, coal at the mine mouth is pulverized into particles as fine as or finer than ground coffee. The resultant powder is then mixed with water in a one-to-one ratio with water producing a slurry with the consistency of cream. This coal slurry is pumped through a pipeline, which is laid underground and which surfaces at pumping stations located at about one-hundred-mile intervals. At its destination, the slurry is "dewatered" (usually by centrifuge). The transport water can be used as "make-up" or cooling water in a liquefaction, gasification, or power generating plant operation.† In an electric power plant, the moist powdered coal is readily usable by the boilers.

Coal slurry pipelines are not a new idea. In London in 1914, a short pipeline of 1950 ft served to transport coal from Thames River barges to a nearby boiler plant. In 1958, a 108-mile coal slurry pipeline was built to move coal from the Ohio coalfields northward to Cleveland. In full operation, that line carried over one million tons of coal per year. There is a 273-mile pipeline currently carrying five

*Private communication.

†Slurry water must be treated before plant use at the delivery end. However, the cost of the energy product is relatively insensitive to this added expense.

million tons per year from a Peabody Coal Company mine in northeastern Arizona to a steam plant in southern Nevada. This line, known as the Black Mesa pipeline, is owned by the Southern Pacific Transportation Company.

There are many attributes of a coal slurry pipeline transport system that have gained it attention:

- The pipeline is underground, and is therefore
  - Environmentally unobtrusive
  - Relatively invulnerable to damage
  - Not affected by severe weather or low ambient temperatures.
- The pipeline is extremely reliable.
- The pipeline can follow a straight path through steep and rugged terrain.
- Pumping stations are run on electricity, which can be generated by domestic coal.
- Operation is not labor intensive (a factor that means both limited vulnerability to labor disputes and limited exposure to inflation escalation).
- The coal slurry mixture is nonflammable (an obvious safety feature).
- The coal can be washed of unwanted impurities during slurry preparation.

A coal slurry pipeline gains still more attention when it is compared with coal carriage by rail:

- For an equal amount of coal, a pipeline consumes 20 percent less energy than rail transport.[170]
- Rail transport requires increasingly precious petroleum to power the diesel locomotives.
- Land dedicated to rail lines is not usable for other purposes (compared with the restored land over a buried pipeline).
- There is a lower product loss with the pipeline.

- There is a higher industrial injury/death rate per ton-mile for movement by rail.
- A rail line typically must traverse a 10 percent or more greater distance in reaching the consumer (because of accommodations made for terrain).
- Subject to economies of scale, it is significantly cheaper to move coal by pipeline.

For the proposed 1000-mile coal slurry pipeline from the Powder River Basin in Wyoming to Pine Bluff, Arkansas, the savings over rail are estimated at one-third to one-half, or $14 billion over a 30-year period.*

2. Railroad Transport of Coal

The response by the railroads to the challenge of the coal slurry pipeline has been both defensive and competitive.

The defensive arguments are fundamentally ones of survival: "Whatever benefits may be found in the slurry pipeline are greatly outweighed by the price to be paid through the weakening of our railroad system."[172] There is concern that "...the cream will be skimmed from the railroads' business leaving the remaining customers with the very real prospect of wholesale abandonment of lines no longer economically viable."[173] There is fear that loss of coal traffic of nearly-bankrupt eastern railroads to slurry pipelines will be the final blow to the survival of the railroads.

---

*"...or fourteen billion dollars our customers need not and would not pay through their monthly electric bills."[171] (These are apparently dollars current to the year the expense is incurred; and this figure is also apparently not discounted to a present value.)

On the competitive side, the railroads claim they are ready now to handle greater coal traffic; that long-term coal carrying contracts spurred by energy demands will enable the railroads to attract the investment capital needed to build new hopper cars and new, heavy-duty locomotives, and to repair trackage and roadbeds showing wear. The railroads boast of the "pipeline-like" unit trains, which may consist of more than 100 high-capacity coal cars with an individual weight of as much as 110 tons, made of lightweight aluminum to maximize the payload. The unit train is indeed a major cost-saving advance from traditional single-car shipments in mixed trains. High-horsepower locomotives provide the power for the mile-long string of hopper cars, loading at one point of origin and unloading at a single destination. To make the unit train cost-effective, long-term contracts of 10 years or more, large-volume shipments per train and per year, and a single destination are all necessary.[174,175]

Outside railroad circles, there is concern that (1) the railroads cannot, in fact, handle the prospective increased coal-carriage even with extensive roadbed rebuilding and great investment in new equipment and (2) that an all-out carriage effort would be at the expense of impaired movement of other freight and passengers.[176]

3. Critical Factors

The proposed large-volume transfers of coal from western producing areas to major consumers would appear to represent a shining opportunity for the operation of unit trains. In fact, Montana went from near zero unit-train shipments in 1968 to 7.7 million tons in 1972. The 1972 figure represents 94 percent of the coal shipped out of the state. But the vast coal movements contemplated raise questions even for the acclaimed unit train. The proposed Wyoming-Arkansas slurry pipeline is designed to move 25 million tons per year to a single destination. Taking into account the empty return trip for the railroad alternative, this corresponds to 20-unit train trips per day. On the delivery route, the constant flow of high-payload trains could cause serious roadbed maintenance problems. Any down-time for maintenance would cut into the system's reliability.* In the words of one utilities executive, "...this is what concerns (the utilities): the capability to deliver continuous, reliable service..."[178] By way of contrast, the reliability of the Consolidated (Ohio) slurry pipeline was 98 percent, and that of the Black Mesa pipeline, 99 percent.[179]

The railroads make the point that slurry pipelines use scarce western water to carry the coal through the pipe. The Wyoming to Arkansas line will use 15,000 to 20,000 acre-ft per year. The pipeline people respond with the observation that the water used will be saline water from deep-water wells (3500 ft to 4500 ft) drilled into the Madison geologic formation which, according to the U.S. Geological Survey, contains from 500 million to 1 billion acre-ft of water with an annual recharge rate of 100,000 acre-ft.† The salinity, and the cost of the water as a result of drilling, make it unattractive for competing purposes. By way of rejoinder, the pipeline supporters point out that if trains were to carry the coal foreseen in the projected doubling of coal output by

---

*Under a combination of restrictions including maintenance, classification, and scheduling, "...the average freight car moves both loaded and empty, only 56 miles a day."

†There is dispute as to the salinity issue and as to the recharge ratio on this Madison formation water. One drilling near Gillette, Wyoming, brought up water with a saline concentration of only 500 parts per million (ppm), better quality water than that presently being used for municipal purposes in Gillette. The recharge rate is under continuing investigation. (Telephone interview with Mr. Paul Rechard, Department of Water Resources, University of Wyoming, Laramie, Wyoming, March 12, 1975.)[179]

1985, the locomotives would burn an additional 2.5 billion gallons of diesel fuel per year.*[175]

Another resource issue is the competing demand for steel represented by these two modes of energy transport. The buildup of each mode would require large amounts of steel.† The proposed Wyoming-Arkansas slurry line, for example, calls for 460,000 tons of steel. Whatever comparative railroad figure is used, it must include the cost of replacing cars, locomotives, and track worn out during an equivalent 30-year operating period. An electric utility spokesman has put that figure at 795,000 tons of steel.[180] The Project Independence Blueprint study made the point that the overall projected railroad need of 16 million tons of steel compared closely with the figure needed for all-out pipeline construction and therefore, it concluded, "...for the critical investment and construction items there is in general little basis to choose between the modes."[176] However, this does not take into account the multiple-use character of railroads. Not that coal cars can be used for other purposes, but rather that (1) an increased trackage network with well maintained roadbeds could support increased freight car and passenger car traffic, and (2) the business boom experienced by the railroads through coal-related growth might allow the fiscal flexibility to respond to other freight and passenger demands.

---

*The coal liquefaction scenario (Chapter 6) scale factors show that if the locomotives were powered by synthetic fuel derived from coal, this would require 33 million tons of coal per year.

†However, the percentages are not overwhelming vis-a-vis other U.S. competing steel demands. Of the 111 million tons of steel produced in the U.S. in 1973, 3.2 million tons went to rail transportation and 0.85 million tons went into the manufacture of pipe for pipelines.

The "all of one or all of the other" approach taken so far for the sake of comparing the two modes has served to highlight their attributes, shortcomings, and important differences. As will be argued later, the more likely approach involves a well reasoned mix of the two modes to meet the nation's needs.

4. Eminent Domain for Pipeline Right-of-Way

Before reasoning the mix, one is faced with the essence of the Jackson amendment: providing the slurry pipeline companies with the federal power of eminent domain. Acquisition of a right-of-way is a matter of settled law. If one wishes to traverse another's private property, one must negotiate with the owner and strike a bargain. If accord is reached, a document is drafted, executed, and in many states, recorded as a kind of property right: right-of-way across another's land by virtue of and for the purposes stated in the agreement. Of course, the seeker of the right-of-way can make an outright purchase of the property if that is desirable, or if that is the only alternative.* Right-of-way across public lands may be a matter of negotiated fee or of legislative grant, where a public purpose described in law is accommodated. In dealing with an owner of private property, that owner can thwart the progress of right-of-way attainment by refusing to bargain. Thus, for example, wherever the proposed route crosses the private property of a railroad, the railroad might well refuse to negotiate.† The likelihood of impasse becomes clear in the proposed Wyoming-Arkansas slurry pipeline, which would cross railroads at 44 points.

---

*A right-of-way across private grounds may also be acquired by prescriptive easement; i.e., through long-term, undisturbed use. In the large-scale operation contemplated, however, such an accomplishment is unlikely.
†Since the pipeline company represents head-on economic competition to the railroads, this is to be expected.

Consistent with the Fifth Amendment to the U.S. Constitution, individual states and the federal government have the power to grant the right of eminent domain to pipeline companies when just compensation is paid, and where the taking is in the public interest. There are statutes in many states giving to oil and gas pipeline companies the power of eminent domain for the purpose of securing rights-of-way within that particular state for the building, maintenance, and operation of their pipelines. These statutes also proffer the right to construct the lines along or across public highways, railroads and streams, and across public land.* Federal legislation permits the Secretary of the Interior to grant easements of way for oil and gas pipelines over public lands of the United States, and over Indian lands.[182,183] The federal power of eminent domain is given to natural gas companies,[184] and during the Second World War (and through 1947), it was given for the construction of oil pipelines.[185]

Organized, vehement opposition by the railroads would very likely thwart a state-by-state effort by the coal slurry pipeline proponents to secure reasonably consistent eminent domain authority. Each state would have different strings attached to its grant of the power, even if the power were granted. Railroad opposition to petroleum pipelines starting back in the 19th century is enlightening on this point.

5. Railroad Opposition to Pipelines

In 1846, the first successful oil pipeline was built of two-inch wrought iron pipe. It covered a distance of five miles from Pit Hole, Pennsylvania, to the Miller Farm railroad station.[186] The

---

* See, e.g., Reference 181.

railroads favored these lines, which fed oil from drilling areas to railroad loading racks for rail transshipment. As the pipelines extended to greater distances, cutting into railroad oil-carrying business, the railroads refused to allow them permission to cross their tracks. To remedy the situation, the Pennsylvania and Ohio legislatures, in 1872, passed laws granting pipelines the power of eminent domain in their acquisition of rights-of-way. Thus, the pipelines could, by law, cross under the railroad tracks. The success of the oil pipelines was clear and convincing: the railroads were forced to reduce their rates.

In 1958, the Consolidated Coal Company's coal slurry pipeline was put into operation, carrying over one million tons per year from the Ohio coal fields to utilities in Cleveland. When this pipeline was opened, railroad coal-carrying rates were $2.63 per ton, rising later to $3.47 per ton. The successful operation of the pipeline resulted in a reduction in railroad rates to $1.88 per ton.*[187]

The success of this pipeline led to a proposal in 1959 to build a coal slurry pipeline from West Virginia to eastern seaboard generating plants. The proposal was never implemented because of railroad opposition to efforts at obtaining rights-of-way from the state legislatures concerned.

The next efforts were made in Congress where, on March 21, 1962, bills were introduced simultaneously into the House and Senate to confer the federal power of eminent domain on coal slurry pipeline companies.[189] The bills died, as a result of intense, organized railroad opposition.

---

*It has been asserted that this pipeline success created the impetus for the railroad introduction of the unit train concept.[188]

6. Pipeline Regulation

Coal slurry pipelines, as do the railroads, come under the control of the Interstate Commerce Commission (ICC) by virtue of Section 1 of the Interstate Commerce Act.[190] As such, the pipeline companies, once operating, must maintain reasonable rates, avoid discrimination, file tariffs of rates and charges, submit to regulations of rates, "...and otherwise conduct their business in the manner of a federally regulated common carrier."[191] The Black Mesa Pipeline Company files its reports with the ICC and is regulated by the ICC. However, pipelines operating strictly intrastate engaged solely in transporting wholely owned coal to wholely owned storage or processing facilities would not come under ICC regulation.[192]

7. Pipeline Impact on Railroads

To better understand the relative impact of slurry pipeline competition on the railroads, a look at some statistics may be helpful. In 1974 western railroads carried 15.5 percent of the nation's total coal carried, while eastern and southern railroads carried 84.5 percent.[193] Burlington Northern, by far the largest coal-carrying western railroad, carried 4.7 percent of the nation's total-coal-carried, while owning 5.3 percent of the nation's hopper cars. The second ranking western railroad, Union Pacific, carried 1.9 percent of the nation's coal, while owning 2.4 percent of the nation's hopper cars. By regional comparison, the eastern leader, Penn Central, carried 14 percent of the nation's total, while owning 16.5 percent of the nation's hopper cars. In the category of coal-carrying, Burlington Northern and Union Pacific (the West's largest coal carrying railroads) rank sixth and thirteenth, respectively. In ownership of hopper cars owned, they rank sixth and tenth, respectively.

Figure 19-6(d) illustrates that the overwhelming concentration of major coal-carrying rail lines and linkages lies in the eastern half of the United States.

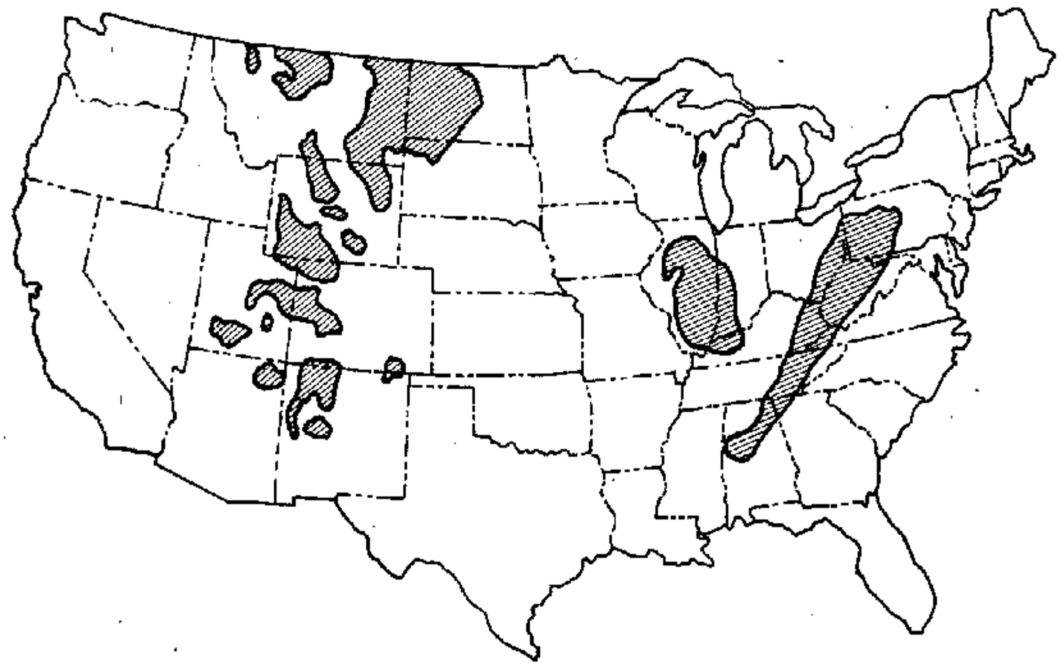
Coal has not been the major factor in development of western railroads, whereas for some eastern railroads, coal accounts for as much as 50 percent of their business. Thus, for the most part, western railroads would be losing potential coal-carrying business to a competing coal slurry pipeline, whereas eastern railroads could lose both potential and existing coal-carrying business. Loss of that existing coal traffic could mean bankruptcy for the marginal eastern railroads. It happens that the proposed major coal slurry pipelines (e.g., Wyoming to Arkansas; Colorado to Texas) lie predominantly in the western half of the United States. And the paths of the proposed lines appear not to strike a redundant path with existing rail lines.

Because, as Figures 19-7(a) and (b) show, moderate-volume, short slurry pipelines are less economically competitive, there is proportionately less economic demand in the eastern sector to construct pipelines. In addition, eastern pipelines would most likely strike a redundant path with existing rail lines of the fiscally strained eastern railroads. This is because of the high density of eastern coal-carrying rail lines, as illustrated in Figure 19-6(d).

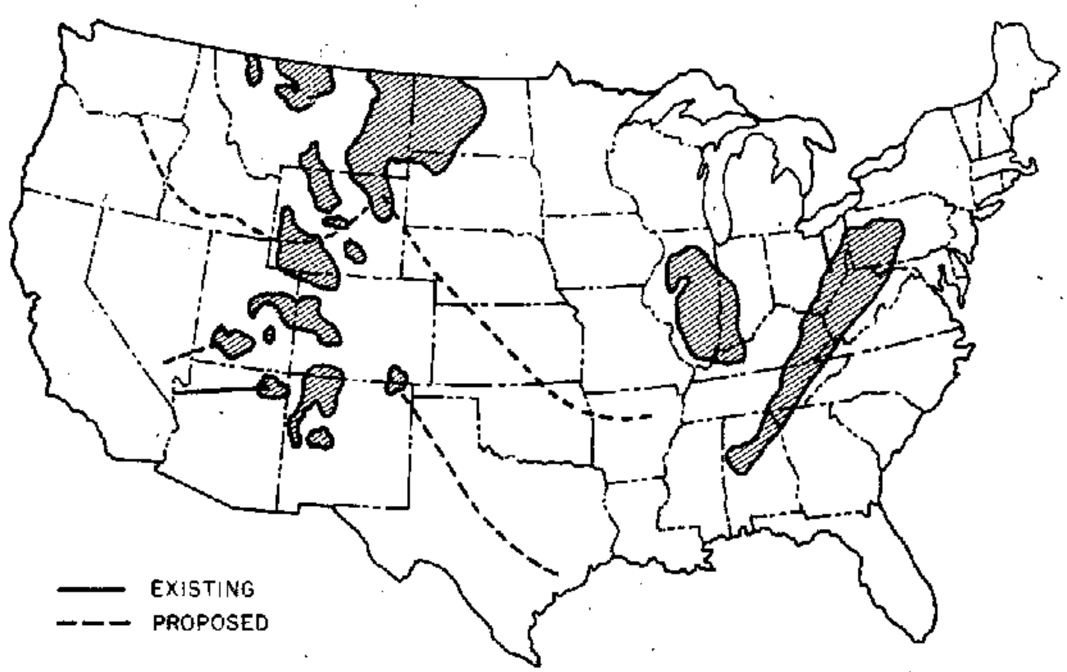
8. Proposed Resolution

The slurry pipeline/railroad tension may be viewed from two public policy standpoints. On the one hand, slurry pipeline technology should be immediately utilized:

> "Growing efficiency in transportation requires that new technological opportunities be seized promptly. With a constantly changing technology, the lag between average practice and the best possible practice is critical....

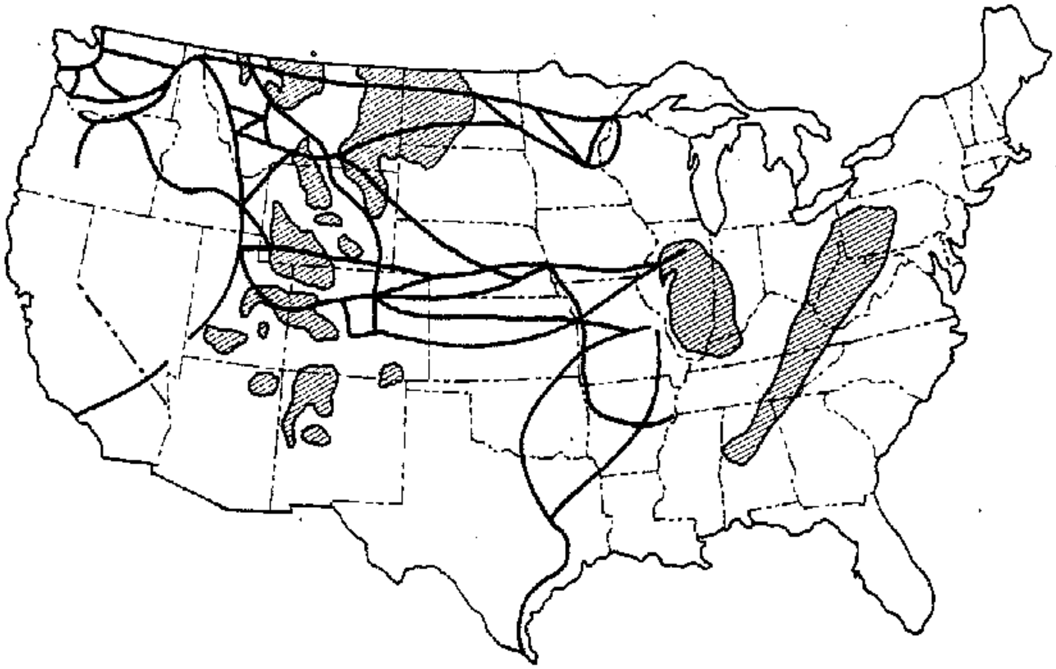


a. Location of Major Coal Deposits

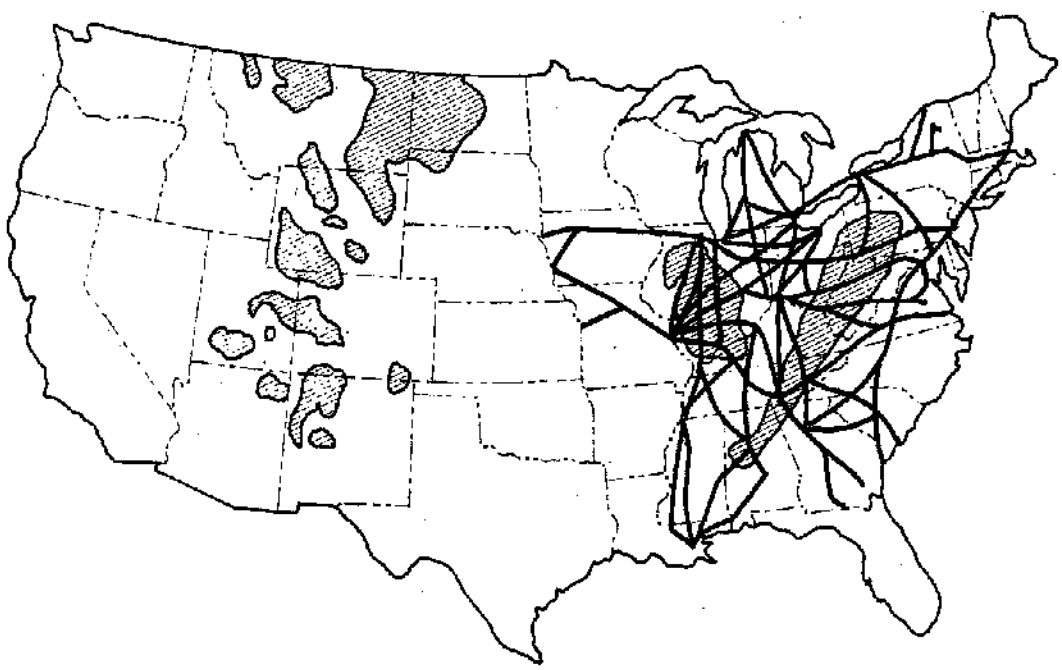


b. Existing and Proposed Coal-Slurry-Pipelines

FIGURE 19-6. COAL DEPOSITS IN RELATION TO TRANSPORTATION FACILITIES

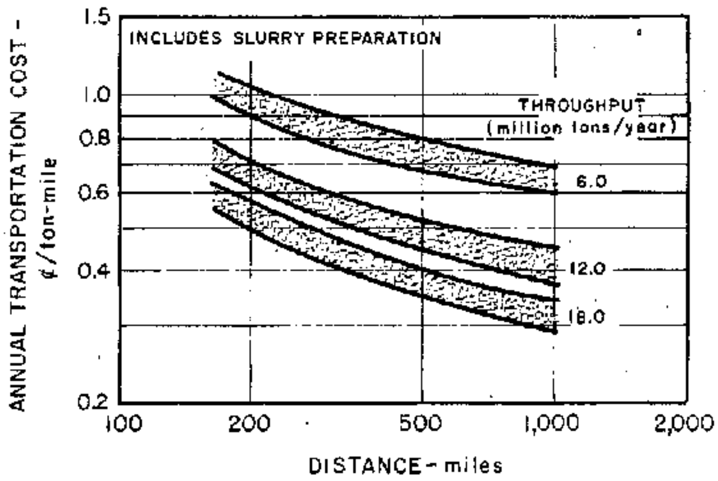


c. Major Western Coal-Carrying Railroads

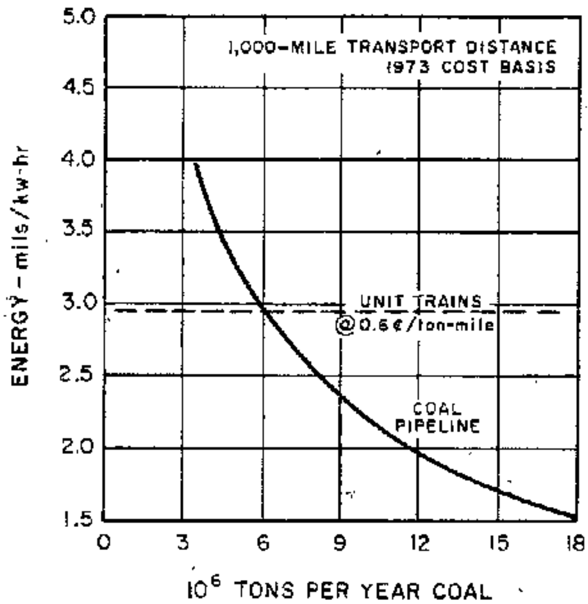


d. Major Eastern Coal-Carrying Railroads

FIGURE 19-6. Continued



a. Coal-Slurry-Pipeline Transportation Costs



b. Coal Energy Transmission

Source: Reference 195

FIGURE 19-7. ECONOMICS OF COAL SLURRY TRANSPORTATION

Prompt adoption of new technological opportunities enhances the returns to the public...from private initiative in innovation."*[134]

On the other hand, this kind of efficiency must be contrasted with the broader purposes served by governmentally preserving and supporting a multiuse rail service (passenger movement, freight movement, defense network) that might otherwise die in a pure, free market setting. Thus, in light of the need to consider these dimensions, while at the same time seeking to meet the nation's energy needs, eminent domain power might be granted only in cases where (1) the economics of a pipeline are attractive compared with other transportation alternatives, (2) construction would not strike a redundant path with existing rail lines, and (3) operation of the slurry pipeline would not result in an economic death blow to a neighboring railroad coal hauler. In the same spirit and form of the proposed Jackson Amendment, this additional formula would be applied by the Secretary of the Interior prior to his authorizing the exercise of eminent domain power by a particular project.†

---

*Ironically, these remarks were directed at encouraging expanded use of the unit train concept.

†"The power of eminent domain granted pursuant to this title shall be subject to regulations promulgated by the Secretary of the Interior to insure that the exercise of such power by a carrier is compatible with the public interest. Said regulations shall require that, prior to the exercise of any carrier of the power of eminent domain, the Secretary shall find...that the project--

(1) would help meet national needs for coal utilization;
(2) is superior to available alternate means of transportation of coal;
(3) may be impeded or delayed unless granted the power of eminent domain; and
(4) involves no significantly greater disruption to the environment than other modes of transportation or utilization of the coal resources involved."[136]

It may well be that the projected doubling of coal production by 1985 will create considerable coal-carrying and other business for all railroads even as slurry pipelines are built. For example, railroads will handle short hauls to liquefaction, gasification, and power plant facilities; unit trains will be used to haul western coal to intermodal transfer points on waterways, such as Duluth, Minneapolis-St. Paul, and St. Louis;* general growth in the Rocky Mountain and Northern Great Plains states will be reflected in increased general freight revenues; and finally, increased coal-carrying business by eastern railroads may take them far enough along economically that consideration can be given to increasing slurry pipeline construction through an easing of eminent domain restraint.

G. Summary

The Western water problem is centered around the oil shale region located principally in the Piceance Basin, in the Upper Colorado River Basin, and coal-rich Powder River Basin of northeastern Wyoming and southeastern Montana. The following are major issues in both regions:

- Available water supply and augmentation potential
- Competing demands and their alternatives
- Projected energy development
- Energy development alternatives
- Federal control or influence
- Indian water rights
- State laws and interests
- Interstate river basin compacts

---

*Burlington-Northern studied slurry pipelines for possible use from the Great Plains coal area to Duluth and St. Louis for intermodal transfer to barge transportation. Their study rejected the idea in favor of movement of the coal by rail.[197]

1. <u>Water Availability</u>

Irrespective of institutional factors which may inhibit a given water-seeker from securing the water he needs, nature provides a limit in terms of the annual precipitation. In the coal-rich Northern Great Plains region, from a total quantity standpoint, there is probably enough water to support a major coal development effort--including coal liquefaction and methanol production. However, the coal and the water locations are not congruent. As a result, the coal will have to be transported to the water, or water will have to be brought to the coal by aqueducts combined with water storage facilities.

In the oil shale region of Colorado, projected real* water uses will consume all the available annual precipitation. Thus, for maximum oil shale development, water would have to be shifted from other demands to oil shale development.

2. <u>The Federal Interest</u>

The federal government has a complex role in the water area. Because it has claims to water to support the land which it owns (50 percent of the land of the western states), it is a disburser of water from reclamation projects, and it has broad constitutional power to control (if it sought to exercise it) the allocation of virtually <u>all</u> the nation's water. These latent powers overshadow state and private water-use decisions. The federal government is also the promise-keeper for the Mexican Treaty of 1944, which promises 10 percent of the Colorado River's annual flow to Mexico in perpetuity.

---

*As distinguished from "paper" water rights, which are claimed but not used.

3. Indian Water Rights

Indian claims to western water also present a serious issue. Indian water rights extend at least as far back as the time of the various treaties forming the existing reservations. Unfortunately, the amounts of water under these Indian rights are generally in dispute, and it appears that separate court proceedings will be necessary to determine the amounts in each case. Finally, Indian claims are clearly not subject to the law of the states in which the reservations lie.

4. State Water Laws

Neither the federal power over water, nor Indian water rights is subject to state control. If the federal power were fully exercised, the states would be preempted and left with no allocative powers except those given them by the federal government.

In the absence of federal exercise of that sweeping power, the states have developed varying systems to apportion their water. The humid eastern states rely on the riparian doctrine of water law, inherited from England, by which lands bordering streams have the right to use the flowing water subject to the considerations of downstream users. The water-poor western states developed the appropriation doctrine, which awards water to the individual who diverts the water from the stream for a beneficial use, and in the event of water shortage, the water right secured earliest in time prevails.

Wyoming has a permit system to help keep records of water rights. Colorado has recently introduced a recordation mechanism, but not before more water rights were established than there is water in the rivers of the state. Montana's concern over who would get what amounts of water, and for what purposes, caused it to establish a three-year moratorium, to expire in 1977, on the issue of new water rights.

A significant problem in the state law area in terms of water for energy development is the transferability of a water right. The degree to which a water right can be bought and sold, the degree to which the purpose of the water right can be changed (e.g., from agricultural use to energy development use), time restrictions on when the water can be taken (e.g., agricultural needs are typically summer needs while energy development needs would be year around), restrictions on the point of diversion and the point of application of the water (including the interbasin transfer problem), and the advisability, from the state's standpoint, of having all agricultural water rights bought up by energy development companies, all bear on the subject of transferability.

States are now recognizing the need to reserve certain amounts of water for in-stream values such as recreation, fish life, and water quality. Whatever water is used for this purpose will have to come from the available supply and this will worsen the problem of shortfall.

The large projected water demands have placed a strain on state laws relating to groundwater use. Only very recently has there been a move to protect the water table from haphazard exploitation and contamination. The groundwater issue is so new that recharge rates of these underground reservoirs are generally unstudied and unknown.

5. Interstate Allocation of Water

The U. S. Supreme Court is the potential arbiter of the respective water rights of two states with a river that forms their common border and of the rights to water from a river that flows through two or more states. The Supreme Court and the U. S. Congress have encouraged the states concerned to develop formulas for sharing the water--subject to Congressional approval of the agreements.

In the areas considered in this study, there are four such interstate compacts: the Colorado River Compact of 1922; the Upper Colorado River Basin Compact of 1948; the Belle Fourche River Compact of 1943; and the Yellowstone River Compact of 1950. These compacts in no way delimit federal or Indian water rights. Accordingly, they could be rendered moot if full federal power were exercised over the nation's water. In the absence of the exercise of that power, the allocative formulas have been operable.

Particular problems with the compacts relate to the fairness of the formulas themselves and the numbers used, especially because the compacts were made long before the region became a focal point for energy development. For example, Colorado's annual contribution to the Colorado River is over 11 million acre-ft per year, but the state is allocated only about 3 million acre-ft per year. Because Colorado is the primary oil shale development area, the state is angry that it is being forced, essentially, to shift agricultural water to energy development use as a result of its meager allotment under the compacts.

Another institutional barrier may be seen in the Yellowstone River Compact, which prohibits interbasin transfers without the consent of all signatory states. This could prevent transfer of water into the Powder River Basin--rich with coal but short of water--even from nearby river basins such as the Bighorn or Yellowstone.

6. Transport of Coal: The Slurry Pipeline Issue

Planners looking at the total impact of a major coal conversion program in the Northern Great Plains are attracted by the possibility of transporting the coal out of the region for processing elsewhere. An intense political battle is being waged over the granting of eminent domain power to pipeline companies so that they can construct the pipelines to these distant processing points. The chief opponent to pipelines is the railroad lobby because railroads want to reserve coal transportation to themselves. Impressive arguments can be presented in favor of each of the means of transport. It is a water-related matter because the pipelines would use large amounts of western water to form the slurry, although the amount of water is far less than if the coal were converted in the region. Economics appear to favor the pipeline, while the railroads argue that they face bankruptcy without the coal-carrying business and that the country needs its railroads to cary people and other commodities.

To sum up, there is at present no comprehensive effort on the part of the Congress to deal with the difficult political value questions implicit in the question of water for energy development in the West. There is no hint of action going beyond the joint study of the Northern Great Plains Resource Program and the Environmental Impact studies for the Colorado oil shale region. The water sought for energy development is vital to the way of life of the western states. The economic base, and the very culture of Colorado, Wyoming, Montana, and North Dakota could be greatly altered if the region's energy-rich resources are developed without a comprehensive water plan.