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BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Water Supply Should Not Be An Obstacle To Meeting Energy Development Goals

This report disputes the common impression that the energy industry's thirst for water will create severe shortages throughout the water-short, energy-rich West. Recent evidence indicates that these predictions are unfounded or outdated and that adequate water is available for energy development through at least the year 2000.

New data shows that since the mid-1970s

- --electricity growth rates have decreased,
- --development of alternative technologies has slowed, and
- --expected water requirements for each technology have decreased.

Consequently, huge water requirements to convert resources into energy are no longer necessary.

Immediate preparation and processing of environmental impact statements which address potential and planned energy uses of water in Federal reservoirs would eliminate a major obstacle to marketing Federal water to energy projects. This action would assure that water sales for energy development could take place without interferring with existing water users.

UNITED STATES GENERAL ACCOUNTING OFFICE

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COMPTROLLER GENERAL OF THE UNITED STATES
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To the President of the Senate and the
Speaker of the House of Representatives

This report identifies the numerous changes which have occurred since mid-1970 energy/water reports predicted severe energy-caused water shortages. Since the estimates of expected growth in electricity and synthetic fuels and expected water requirements have diminished, so have predictions of water consumption. Unfortunately, these decreases have not always been recognized by Federal agencies or the public.

We hope that this report will be useful to the Congress during deliberations on energy and water policies. We also hope it will be useful in identifying a few of the locations where substantial water is stored in Federal reservoirs and is available for energy development.

We are sending copies of the report to appropriate House and Senate committees; representatives and senators from States mentioned in the report; the Director, Office of Management and Budget; and the heads of departments and agencies concerned with water or energy. We will also make copies available to interested organizations as appropriate and to others upon request.

Comptroller General
of the United States

AGC 33, AGC 912
AGC 76
AGC 620

Natural resources management
Water supply
Energy supplies
Energy industry
Water resource development

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

WATER SUPPLY SHOULD NOT BE AN OBSTACLE TO MEETING ENERGY DEVELOPMENT GOALS

D I G E S T

Oil shale development, coal gasification, coal liquefaction, nuclear power, fossil-fueled electric plants, geothermal energy, and coal slurry lines require water--sometimes lots of it.

Consequently, many reports predict that the Nation's quest for energy and mineral independence will stimulate a prolonged thirst for water and will virtually exhaust all unused water in the mineral-rich, water-short West.

However, recent evidence indicates that these predictions are unfounded or outdated and that adequate water is available for energy development through at least the year 2000. In spite of the prediction that energy developers would need all remaining Federal project water, the demand has fallen off, leaving Federal reservoirs with undelivered and apparently unwanted water.

MORE REALISTIC ASSESSMENTS OF WATER NEEDED FOR ENERGY PRODUCTION

Future water requirements for energy and mineral development are not as great as expected in the mid-1970s. Slower growth of energy use and increased reuse of water have reduced the need to divert water from other uses. New production techniques and experience have demonstrated that individual plant requirements are as much as 50 percent less than anticipated. (See chs. 2 and 3.)

Still, energy and mineral development depends on water availability. Since steam electric powerplants (gas, oil, nuclear, or coal) use more than 90 percent of the energy industry's water and generate 84 percent of the Nation's electricity, there is a close relationship between electricity

growth rates and energy-related water use growth rates. (See p. 2.) Expected electricity growth rates have been reduced up to 50 percent in the last few years. (See pp. 9 and 10.)

Although most forecasts predict that 1,000-megawatt steam plants (large enough to supply electricity to a city of 600,000) will consume about 15,000 acre-feet of water per year, operational experience demonstrates that much less is required. (See pp. 10 and 11.)

Alternative energy technologies, such as oil shale development, coal gasification, geothermal power generation, coal liquefaction, and coal slurry lines, were heralded as key contributors to the Nation's energy independence and were expected to consume a lot of water. However, because of high costs, unproven technologies, uncertain markets, and organized opposition, development of operating plants has slowed. (See ch. 3.)

Interior's mid-1970 predictions that oil shale development, coal gasification, and coal liquefaction would require 500,000 acre-feet of water per year by 1985 have been reduced to less than 35,000 acre-feet. Predictions for the year 2000 have been reduced about 50 percent. (See p. 21.)

The President's new energy initiatives should not greatly affect the availability of water. Existing estimates of future energy-related water consumption and water sufficiency are consistent with the new initiatives. In fact, the consumption estimates included in this report exceed those implied by the President's new initiatives.

In anticipation of the large energy requirements for water, the Bureau of Reclamation (now called the Water and Power Resources Service) has allocated several million acre-feet for possible sale. However, in 1978 Reclamation delivered only about 50,000 acre-feet of water to all energy developers throughout the

Colorado and Missouri Basins under long-term contracts. Many energy-related Reclamation contracts or options have been dropped, and deliveries will probably not increase much for many years. (See pp. 33 and 34.)

One new technology, transportation of coal through slurry pipelines, offers the promise of actually decreasing water consumption in water-short areas. Since coal slurry lines require only one-seventh the amount of water required by electric generation plants, local water consumption would be reduced substantially if coal slurry lines or alternate modes of transportation replaced local electricity generation. Since coal slurry lines can use water that is too contaminated or too expensive for other purposes, the technology should not have much impact on other water consumers. (See pp. 25 and 26.)

Even the water-short Upper Colorado Basin should have sufficient water for energy development until at least the year 2000. Because the Basin is blessed with a bountiful supply of mineral wealth (coal, uranium, oil shale, soda ash, etc.) and cursed with limited water, many studies assumed that the Nation's desire for energy independence would eliminate all unappropriated water. (See ch. 6.) More recent studies, however, suggest adequate water supplies in the Upper Basin through at least the year 2000. The Lower Basin, however, will continue to be plagued by water crises.

UNCERTAINTIES ONLY LIMIT THE NUMBER OF SITES WHERE DEVELOPMENT CAN OCCUR.

Uncertainties exist about the extent of energy development, the future of reclamation projects, environmental requirements, reserved water, instream flows, water rights transfers, and project development delays. However, since water requirements are modest and water supplies very large and broadly scattered, excessive water supply problems in one location will result in new site selection. With few exceptions, limited opportunities in one subbasin will simply open opportunities in another subbasin.

Tear Sheet

WHERE WILL FUTURE WATER SUPPLIES COME FROM?

Since energy growth implies additional water, the energy industry must search continuously for new supplies. The most common sources for additional water for energy development probably will be

--development of new storage facilities (an environmentally sensitive alternative),

--procurement of water rights from other water right holders such as the agricultural community (a politically sensitive alternative), or

--procurement of water stored in Federal reservoirs (project water).

Uncertainty over the continued availability of water from Federal reservoirs is discouraging energy developers from relying on Federal water. Although water is now available in Federal reservoirs throughout the energy-rich portions of the Colorado and Missouri Basins, long-term contracts between the Federal Government and energy companies are disappearing.

One reason for the reduction in demand is a question about the ability of the Government to sell water to energy developers. The Ninth Circuit of the United States Court of Appeals recently required environmental impact statements for two Federal Yellowstone Basin reservoirs for both the overall industrial water marketing program and for each individual water contract.

Since this decision might be used as a precedent, it could interfere with Interior's ability to market water from several reservoirs.

CONCLUSIONS

In spite of uncertainties surrounding the extent of energy development, it appears that development is possible without interfering with existing users or proposed water projects. Since existing Federal storage capacity is significant, water in Federal reservoirs could provide much of the supply needed for development. (See pp. 47 and 48.)

New water sales contracts would mean additional revenue that would speed repayment of Federal costs for building the projects. Expanded industrial use of existing Federal project water increases Federal revenue without the environmental, social, and political problems implicit in new construction.

RECOMMENDATIONS

To decrease the uncertainty surrounding water availability, reduce the water rights transfers, diminish the need for new storage facilities, speed the recovery of Federal expenditures, and increase the credibility of the estimates, the Secretary of the Interior should

--direct the Bureau of Reclamation to immediately begin preparation of environmental impact statements for the two Yellowstone Basin reservoirs;

--require similar environmental impact statements for other reservoirs whose marketing programs are threatened;

--update, improve, and establish unit water consumption estimates based upon more recent analyses of water requirements; and

--update and improve energy production estimates for electricity and synthetic fuels.

AGENCY COMMENTS

Both the Department of the Interior and the Water Resources Council agreed with the major thrust of the report--that sufficient water is available to satisfy the President's energy goals. Interior, to whom all recommendations were directed, concurred with each recommendation. (See app. I.)

Contents

ABBREVIATIONS

bbld	Barrels per day
bbtud	Billions of BTUs per day
BTUs	British thermal units
EPA	Environmental Protection Agency
GAO	General Accounting Office
mmcfd	Millions of cubic feet per day
Mw	Megawatts
NEPA	National Environmental Policy Act

GLOSSARY

Abandonment	Under the prior appropriation doctrine of water law, if a water right is not used, it can be lost through abandonment.
Acre-foot	The volume of water required to cover 1 acre of land to a depth of 1 foot (325,900 gallons).
Appropriation	The taking and applying of a specific amount of water for a specific use. Under the prior appropriation doctrine a State entity establishes dates for seniority rights for water use.
Beneficial use	A concept which serves as the basis for and the measure of the limit on the amount of water a water right encompasses. A water right is not established unless water can be put to beneficial use. Common beneficial uses include domestic uses, stock watering, power generation, irrigation, mining, and recreation.
Consumption	That part of water diverted which is no longer available because it has been either evaporated, transpired, incorporated into products and crops, or otherwise removed from the water environment.
Diversion	A withdrawal of water from a natural source by artificial means. Irrigation, mining, municipal, and manufacturing needs for water all require diversions.
Federal project water	Water already stored in Federal reservoirs; it is available for industrial sales and use.
Megawatt	A measure of electrical generating capacity equivalent to 1,000 kilowatts; 1,000 megawatts is sufficient to meet the electrical needs of approximately 600,000 people.

Transfer	A transfer of water rights involves the sale of those rights resulting in a change in use (for example, from irrigation to manufacturing), location of the use, or point of diversion.
Water right	Legally established right to divert and use a given quantity of water.

CHAPTER 1

INTRODUCTION

The energy crisis raises the expectation that the arid West's resources will be required to reduce energy shortages and that expanded resource development will seriously deplete already scarce western water supplies. Since the West is rich in energy and mineral resources, their depletion does not cause much public anxiety. On the other hand, water supply depletion arouses substantial emotion. Many predicted that increased water consumption needed to produce energy would degrade the environment, expand water rights conflicts, diminish agriculture's dominance, and generally decrease the quality of life.

For a number of reasons, most predictions have failed to materialize, and many assumptions used to predict the future are no longer valid. Technological advances reduced the energy and mineral developer's water requirements. Operational experience demonstrated that initial water consumption estimates were overstated. Expected rapid growth rates in electric energy demand decreased substantially. Increased water recycling and reuse diminished the need to develop new water supplies.

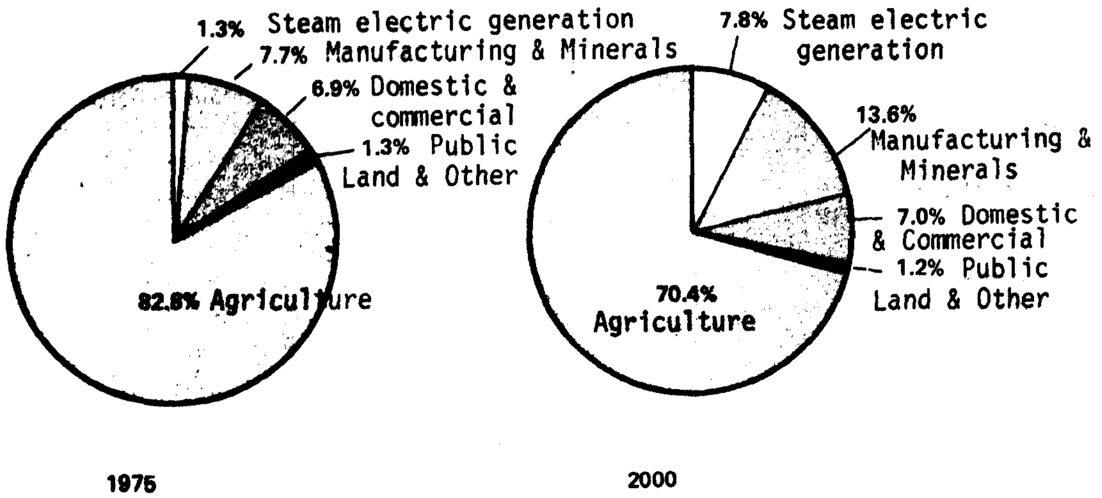
This report discusses the changing conditions that have dramatically reduced projected energy-related water demand. It also discusses existing constraints on energy and mineral developers' access to Federal project water.

WATER IS ESSENTIAL FOR ENERGY AND MINERAL DEVELOPMENT

Water is used throughout the energy and mineral production process, including mining and land reclamation, processing of minerals, transportation of raw materials or final products, refining, and conversion of resources into energy or other final products. Since water is required throughout production, additional energy development implies additional water development. When faced with water shortages, energy and mineral developers have four choices: (1) use expensive, low water-using technologies, (2) import water, (3) purchase water from other users, or (4) relocate operations to water surplus regions. Each choice means higher costs.

Since steam electric power plants supply 84 percent of the Nation's electricity, their resource requirements must be satisfied. However, although steam electric power plants consume more water than any other energy use, they only account for about 1 percent of United States consumption.

Total Fresh-water Consumption for the United States



Source: Water Resources Council.

Steam electric plants are by far the energy industry's most important water user, diverting over 90 percent of the industry's water. Whether coal, gas, nuclear energy, or oil is used to create the steam, the plants require substantial amounts of water. The plants' major water requirements, however, are not associated with producing steam; instead, almost all plants use more than 80 percent of their water for condenser cooling to increase plant efficiency. (See p. 8.)

WATER AND MINERALS OFTEN NOT LOCATED TOGETHER

If the demand for water and the supply of water were evenly distributed, few water quantity problems would exist. Unfortunately, neither demand nor supply is spread uniformly across the country. Many energy-rich sections of the country, such as the Upper Colorado Basin, have very limited water supplies but consume substantial amounts. For example, that Basin consumes 20 times the national per capita average amount of water and 125-140 times that of the Northeast, yet the area has only a fraction of the average supply available. Substantial irrigation development in the energy-rich portions of the country account for the concentration of water consumption.

Many States with high water consumption rates are the same States which will be required to support new energy development. The Bureau of Mines estimated that the five States with the most energy projects are California, Colorado, Texas, Utah, and Wyoming. Parts of each State were also designated in many studies as experiencing severe water shortages.

MANY RESEARCH REPORTS SUGGEST PROSPECTIVE WATER SHORTAGES

A wide variety of research reports and papers are available which interpret, analyze, and evaluate data and project, estimate, or guess the size of energy and water development. Many report serious shortages and conflicts as current water consumers are forced to compete with the energy interests. Others, usually those written in the past year, project no immediate or long-term water shortages in the physical availability of water and limit water development problems to other issues: air and water quality, Indian water rights, legal problems, instream flows, or fish and wildlife issues.

Unfortunately, instead of using new information, some reports simply elaborate on the conclusions found in two 1974 Federal publications. In "Project Independence," the Water Resources Council stated that:

> "The lack of adequate supplies of water, difficulties in delivering water where and when needed, water rights conflicts, and related environmental and institutional considerations pose major problems and constraints in being able to meet all of the water for energy requirements."

And in its report on "Water for Energy in the Upper Colorado River Basin," Interior said:

> "The demand for energy production in the Upper Colorado River Basin is a national demand * * *. Consequently, extensive activities are underway to develop the Upper Basin's relatively untapped fossil-type energy resources * * * it is estimated that about 870,000 acre feet of water will be needed annually for energy development in the Upper Colorado River Basin by 2000."

Although energy and mineral studies are presented as comprehensive and sophisticated analyses of a critical issue, their projections differ significantly. The studies use different data sources, assumptions, objectives, and time frames. The studies ignore significant differences in projections and do not evaluate reasons for the differences.

On May 4, 1979, we issued a report to the Congress entitled "Colorado River Basin Water Problems: How To Reduce Their Impact" (CED-79-11, May 4, 1979). The report discusses many of the issues relating to the supply and quality of water, including the possibility of and timing of future shortages. In general, we concluded that water shortages within the Basin are inevitable after the year 2000 but that there is time to plan for and manage the shortage. Fortunately, most of the energy resources are in the Upper Basin while the critical water shortages are in the Lower Basin. The present report elaborates on the water needed for energy development in the Upper Basin and other energy-rich areas of the Nation.

SCOPE OF REVIEW

To evaluate the possibility of energy-related water shortages, we analyzed data and studies associated with industry's water requirements in selected States (Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming) with predicted rapid energy and mineral growth, anticipated water shortages, and significant involvement in Federal water development. The States were selected because they have semiarid areas with substantial deposits of valuable minerals (coal, uranium, trona, copper, and potash), and they are expected to supply these minerals to the remainder of the Nation.

Generally, the analysis concentrated on statewide information (not just river basins) since State governments control both plant siting requirements (and therefore plant locations) and water rights (and therefore water allocations). We also considered basin water problems, particularly the Colorado and Upper Missouri Basins, when the basins included large sections of the above energy-rich States and when the basins were considered water shortage areas.

In addition, we analyzed steam electric plant water requirements in 3 of the 10 States which lead the Nation in projected generating capacity additions (Texas, first; Kentucky, sixth; Ohio, ninth) but which have water supplies generally considered adequate for energy development. These States were studied to determine how the relative abundance of water affected energy development.

It should not be inferred that the Upper Colorado and Upper Missouri Basins are the only locations for synthetic (liquefaction, gasification) fuel development. Additional sites are expected, particularly in the Ohio Basin. However, Upper Colorado and Upper Missouri Basin water consumption estimates are emphasized in this report because of the expected major concentration of synthetic fuel development in those basins and because synthetic fuel estimates for those basins exceed the President's national goals--even if no other development occurred.

Because much of the data published in the volumes of reports on future water problems was often conflicting, we contacted many water consumers and energy developers directly. Instead of relying on published reports, we also contacted many of the Federal and State officials directly responsible for developing information. The contacts were necessary to evaluate data-gathering methodologies.

CHAPTER 2

THOUGH STEAM ELECTRIC POWERPLANTS REQUIRE MUCH MORE WATER THAN OTHER ENERGY TECHNOLOGIES, SUPPLIES ARE ADEQUATE

Although water is required in many energy production processes, steam electric powerplants are the energy industry's largest water diverter and consumer, and their relative importance is likely to continue. Although water requirements are substantial, supplies should be ample for all planned and projected energy development since

--estimates of increased demand for electric energy are lower than previously anticipated;

--water consumption per megawatt (Mw) of capacity in steam powerplants is much less than expected;

--numerous methods are used to conserve, reuse, or recycle water supplies;

--water consumption is small relative to physical availability; and

--future development is not dependent upon availability of unappropriated or unused appropriated water.

For similar reasons, water supplies should be adequate for alternative energy technologies (see ch. 3) and mineral development (see ch. 4).

While environmental controls for air and water quality have increased water requirements for powerplants, methods are available to reduce the amount of water consumed. However, high cost and relative inefficiency will limit the use of such methods.

STEAM ELECTRIC POWERPLANTS REQUIRE MORE WATER THAN ALL OTHER ENERGY FACILITIES

Growth in electric energy consumption increases the demand for water. Since the cooling system in steam electric plants requires such a high percentage of the energy industry's water, growth in electric generation implies growth in water consumption.

Water diversions for steam electric power generation represented 95 percent of all diversions for energy production in 1975. Since most steam electric plant water diversions are returned to lakes and streams, much less water is consumed (totally depleted). Still, steam plants consume 43 percent of all water consumed by energy producers and by 2000 are expected to consume 78 percent. According to the U.S. Water Resources Council, almost 90 percent of the expected increase in energy-related water consumption is attributable to steam plants.

The historical increase in electrical generation has been about 7 percent per year. Although growth will continue, a much slower rate of growth is expected. For example, the Department of Energy estimated the 1977 generating capacity of 560,000 Mw would increase by more than 300,000 Mw by 1987, a compounded annual 4.4 percent rate of growth.

Some regions with substantial energy resources, however, can still expect substantial growth. States in the Upper Missouri and Upper Colorado Basins are examples.

Additions to Generating Capacity
01/01/78-12/31/87

State	Current capacity	Planned additions	Percent of increase
	(Mw)		
Arizona	3,371	6,565	195
New Mexico	a/2,827	a/1,868	a/66
Colorado	2,679	4,320	161
Wyoming	3,460	2,156	62
Montana	1,313	1,421	108
North Dakota	2,161	2,306	107
Utah	1,025	4,600	449
Total	16,836	23,236	138

a/Adjusted per conversation with New Mexico State Engineer.

Source: Regional Electric Reliability Councils

Steam electric power plants use a turbine to generate electricity. Since the output of the turbine is a function of the velocity of the steam passing through it, efficiency can be increased by reducing the pressure where the steam exits the turbine. To reduce the pressure, cool water is passed through a condenser to condense the steam. (See app. III.)

As the cool water flows through the condenser, the water temperature is increased. Since plants require cool water, some method must be employed to reduce existing water temperatures or to obtain additional cool water. Methods include:

--Once-through cooling. This method is generally used where large supplies of water such as rivers, lakes, estuaries, and oceans are available. Water is passed from the source through the condenser and returned some distance from the point of diversion.

--Cooling ponds. A water recycling system is generally used where water supplies are limited and suitable sites are available. Water is circulated between the pond and condenser, and heat is dissipated through the pond's surface evaporation.

--Wet-cooling towers. These systems induce an air-flow to cool the water through evaporation. (See app. III.) Water is simply recirculated between the condenser and the tower.

--Dry-cooling towers. Where water is extremely scarce, dry-cooling towers may be used. Cooling water circulates in a closed system (no evaporation) and heat is dissipated with minimal water loss in much the same fashion as in an automobile radiator.

Water consumption varies with the cooling system:

Water Consumption per 1,000 Megawatts of Generating Capactiy

Cooling system	Acre-feet per year
Wet-cooling towers	a/15,000
Cooling pond	10,000
Once-through	b/3,600
Dry-cooling towers	2,000

Source: Western States Water Council

a/This is the figure used for planning purposes; however, our review disclosed that actual consumption is significantly less. (See p. 14.)

b/There is some debate about a correct water consumption estimate for once-through systems; however, such systems are not applicable in most locations through the Colorado and Upper Missouri Basins because of a lack of large rivers or large lakes.

WATER AVAILABLE TO ACCOMMODATE FUTURE ENERGY GROWTH

Officials contacted in States anticipating relatively high levels of energy development said enough water is available to supply energy requirements. Several factors support this point of view. The rate of growth in electric demand has declined signficantly, causing utility companies to postpone or cancel planned additions to generating capacity. Operational experience has demonstrated that less water than expected is required. Water reuse and recycling have reduced the requirements for new water sources. . Energy-related water needs are small relative to physical availability of water supplies, and future energy development is not dependent upon availability of unappropriated or unused water.

Estimates of electricity growth rates fall significantly

Forecasting is not an exact science, and attempts to predict future energy and water needs are filled with uncertainty. Even so, recent indications suggest that while electric consumption is increasing, it is doing so at a much slower rate than anticipated. Current annual growth is estimated to be about 3.7 to 4.7 percent, compared to the historical rate of 7 percent. The utility industry recognizes the slower growth rate and is canceling or delaying construction of new generating plants. Even the West, where substantial steam electric power development is planned, anticipates slower growth. For example:

<u>Western States Water Council Estimates of 1990 Coal or Nuclear-Fueled Steam Electric Powerplants with Evaporative Cooling</u>

	(<u>1990 Mw capacity</u>)
1974 Study	93,000
1977 Study	64,000

<u>Steamplant water consumption much less than expected</u>

Examples abound which demonstrate that actual water consumption is less than estimated. Instead of consuming the 15-20,000 acre-feet per year per 1,000 Mw usually attributed to steam electric plants, Colorado Basin plants consume appreciably less.

In "Water for Energy in the Upper Colorado River Basin," Interior said the Navajo plant (2,310 Mw) in Arizona required 34,000 acre-feet annually for power generation. The plant, however, has operated for years and never has consumed more than 23,065 acre-feet per year. The Mohave plant in Nevada contracted with Reclamation 1/ for 30,000 acre-feet of water annually for a 1,580-Mw plant. In 1978, the contract was renegotiated, reducing maximum water use to 23,000 acre-feet. The reduction was warranted since the plant has never required more than 14,709 acre-feet (exclusive of slurry water).

Blanket projections that all steam electric powerplants will consume 15-20,000 acre-feet of water annually per 1,000 Mw are far too high. For example:

1/Although the Bureau of Reclamation is now called the Water and Power Resources Service, it will be identified as Reclamation in this report--the title of the agency at the time the review was completed.

1978 Water Consumption by Large Steam Electric Plants Using Upper Colorado Basin Water

Name of plant	Location	Capacity in Mw	1978 Water consumption	Consumption per 1,000 Mw
			(acre-feet)	
Jim Bridger	Wyoming	1,500	19,820	13,213
Four Corners	New Mexico	2,175	a/18,181	a/8,359
San Juan	New Mexico	711	7,304	10,272
Navajo	Arizona	2,310	17,943	7,768

a/Consumption will probably increase because of the installation of new fly-ash equipment.

Although 15-20,000-acre-feet estimates are still used, plant engineers are beginning to recognize reduced water requirements. One new plant water use estimate includes a consumption projection of little more than 10,000 acre-feet per 1,000 Mw. One reason cited for the reduced consumption is increased plant water reuse, resulting from zero discharge requirements (see p. 14); older plants had more evaporation per megawatt of generation than the new plant.

Actual experience and planning estimates demonstrate that 15-20,000-acre-feet projections are unnecessary. At least three reasons account for the overstated projections.

First, estimates may rely too heavily on water right procurements and not on actual use. Since utilities must assure themselves of sufficient water for maximum possible use, water right purchases exceed expected average consumption estimates. As a result, the extent of water rights should be viewed as the absolute limit of consumption and not what might be expected from normal plant operation.

Second, most plants do not operate continuously at 85-100 percent of capacity, which is frequently assumed. For example,

--in 1977, the entire U.S. generation in fossil-fueled plants (25 Mw or larger) was only 48 percent of capacity;

--in 1977, the generation in fossil-fueled plants (25 Mw or larger) in the seven study States was only 59 percent of capacity; and

--the Electric Power Research Institute estimates the average annual capacity factor for coal-fired plants to be only 62 percent.

Since water consumption is principally a function of use and not capacity, overstated utilization rates can result in seriously overstated water consumption estimates.

Third, some estimates may fail to include in projections new technological changes which have reduced consumption (see below).

Numerous methods used to conserve, reuse, or recycle water supply

Utility companies must consider environmental impacts, availability of fuel, and potential water supplies when evaluating possible powerplant sites. Given environmental compatibility and access to fuel, a variety of measures can be adopted to guarantee adequate water supplies.

For example, substantial water savings can result if dry- or wet/dry-cooling systems are used. The Wyodak Powerplant in Gillette, Wyoming, uses dry cooling because water supplies are extremely limited in the area. Instead of the 6,500 acre-feet required in a similarly sized conventional plant, the Wyodak plant will use about 400 acre-feet of water per year. One powerplant near Farmington, New Mexico, will use a combination wet/dry system, saving about 4,000 acre-feet per year.

While dry cooling offers the greatest potential for conserving water, utilities are also considering other measures. Spray-dryer sulphur removal equipment, chemical treatment of water, wastewater recycling, and improved equipment all have potential to reduce water requirements.

The reuse of municipal sewage effluent is another technique which can augment water supplies. Power companies are using, or planning to use, treated sewage effluent as cooling water in the Palo Verde plant near Phoenix, Arizona, the Wyodak plant in Gillette, and the Ray Nixon plant in Fountain, Colorado.

There are many other ways of obtaining water supplies, such as use of ground water, desalinization, weather modification, and interbasin transfers. These options, however, require resolution of substantial institutional and technical problems before they can be fully implemented.

Water consumption is small relative to physical availability

While powerplants divert large quantities of water, they only account for about 1 percent of the Nation's water consumption. Even in areas of projected energy-caused water shortages, steam electric plant water requirements are small in relation to the amounts of water available. For example, the Bureau of Reclamation estimated that over the next 35 years, 2.7 million acre-feet would be available annually from Upper Missouri River Basin reservoirs for energy development. However, the 10-year estimate for new generating additions for the entire Upper Missouri Basin is only about 100,000 acre-feet.

It should be emphasized that the 2.7 million acre-feet available for energy development is a substantial amount of water. That quantity of water would be sufficient to support almost one-third of the Nation's electricity capacity.

Even in the Upper Colorado Basin, an energy-rich but water-poor area, water requirements for steam electric powerplants are small relative to available supplies. A draft report (see source note, p. 42) to the U.S. Water Resources Council estimated that by 2000, steam electric powerplants may consume between 5.5 and 6.7 percent of all water consumed in the Basin.

Future energy development not dependent upon unappropriated water

While unappropriated or unused water is still available for energy development (see pp. 32 and 42), utilities need not depend solely on this source of water. Additional water is available in the marketplace where water rights are bought and sold.

Transfers of water rights can be relied upon to provide water for energy projects if developers are willing to pay the prevailing price. Indications are that the value of water for industrial use could be 10-100 times that of agricultural use. The disparity in value between agricultural and energy rights permits energy developers to offer sufficiently high prices for existing rights so that current holders may sell them if developers were to need more water.

For example, sponsors of the Intermountain Power Project plan to build a 3,000-Mw plant near Lynndyl, Utah. Although the plant has a planned annual water requirement of 45,000 acre-feet, no unappropriated water was available. However, a tentative agreement was recently announced whereby the project sponsors would purchase 45,000 acre-feet of agricultural water rights for $1,750 per acre-foot. Similar acquisitions of agricultural water rights have occurred at other locations.

Holders of former agricultural water rights said that such water transfers seldom reduce agricultural production to any great extent. They said that water losses are generally offset by irrigation efficiency improvements such as adoption of sprinkler irrigation, changes in cropping patterns, and improved irrigation practices. If land is taken out of production, it is usually marginal land.

ENVIRONMENTAL CONSTRAINTS AND HIGH COOLING COSTS LIKELY TO INCREASE DEMAND FOR WATER

Although steam electric powerplants use water primarily for cooling, water is also essential for operating pollution control equipment, boilers, and other plant systems. (See app. IV.) Because of environmental restrictions on thermal discharges and air pollution, the utility industry has adopted controls which have increased water requirements. Although technologies are available which can substantially reduce water consumption, widespread use of the technologies is unlikely since they are not economically competitive with existing cooling systems.

Environmental controls increase water requirements

Environmental regulations affect powerplant siting, operations, and water consumption. Water quality standards preclude widespread use of once-through cooling, causing utilities to use more water-consumptive cooling systems. Similarly, air quality standards require sulphur removal equipment whose operation consumes additional water.

Water quality standards adopted under the Federal Water Pollution Control Act Amendments of 1972 included stringent standards on thermal (heat) discharges to natural waters. The Environmental Protection Agency (EPA) has identified closed-cycle cooling (cooling towers or ponds) as the technology which is clearly the most effective means of eliminating thermal discharges and has strongly urged companies to adopt nondischarging systems. Utility companies, confronted with a limited number of suitable sites (large rivers or lakes) for once-through cooling systems, and in response to environmental concerns, have selected more expensive and more water-consumptive cooling technologies. Almost all planned powerplants and those under construction will use cooling towers or cooling ponds.

The shift from once-through cooling to cooling towers and ponds greatly increases the amount of water consumed in generating electricity. The once-through process consumes only a fraction of water consumed in cooling ponds and towers. (See p. 9.)

Other environmental requirements also increase water consumption. Utility companies have installed sulphur removal equipment--"scrubbers"--in order to meet air quality standards. Scrubbers, which have been used in powerplants for a number of years, are second only to cooling in terms of plant water consumption. (See app. IV.) Approximately 10 percent of the water consumed in a modern coal-fired powerplant is for sulphur removal. To illustrate, a 500-Mw plant will consume about 1,000 acre-feet of water per year for sulphur removal, twice the water required to mine the plant's entire coal supply. The U.S. Water Resources Council estimates that by 2000, sulphur removal will consume 414,000 acre-feet of water per year.

In addition to increasing water requirements, sulphur removal equipment reduces powerplant output 6-8 percent, creating a need for more powerplants. Consequently, scrubbers account for more water consumption than the 10 percent directly required by the equipment.

Nonconsumptive technologies are expensive

The Federal Power Commission (now the Féderal Energy Regulatory Commission) noted that arid regions should have cooling systems that reduce water use. They said development of dry-cooling towers is desirable and should be given high priority. However, because of high costs, lower efficiencies, and water availability, the utility industry has not followed the recommendation. The only large powerplant using dry cooling in the United States is the 330-Mw Wyodak plant near Gillette, Wyoming.

The cost of dry cooling is much higher than costs for other cooling systems. Based on data from the Wyodak plant, many factors increase costs, including:

--Increased construction costs. Whereas a normal evaporation cooling tower and condensing system would cost $15 per kilowatt, the Wyodak system cost $50 per kilowatt.

--Increased fuel costs. Ten percent more fuel is required for plant operations.

In general, dry-cooling towers cost about three times as much as wet-cooling towers to construct and operate. If water is readily available at a plant site, there is no economic incentive to utilize a dry-cooling system. At present, no dry-cooling powerplants are planned for the regions we studied, and only one planned plant will use a wet/dry-cooling system.

COMMENTS OF STATE OFFICIALS

Officials contacted in States where substantial growth in power generation is expected agreed that there is enough water to support energy production.

For example, Ohio officials stated that Lake Erie and the Ohio River offer an abundant and dependable water supply to that State. State and industry officials in Kentucky maintained that development of steam electric powerplants has a minor impact on water resources and foresaw no difficulty in obtaining water for future development. Texas water law gives industrial users priority over agriculture, virtually guaranteeing that water will not constrain future energy development. Officials in Montana and North Dakota also agreed that water supplies were available to support energy requirements. (See ch. 6 for a discussion of water availability in the Upper Colorado Basin.)

CHAPTER 3

SUBSTANTIAL DECREASES PREDICTED IN WATER REQUIREMENTS FOR ALTERNATIVE ENERGY TECHNOLOGIES

Alternative energy technologies such as oil shale development, coal gasification, geothermal power generation, coal liquefaction, and coal slurry lines are heralded as major contributors to the Nation's energy independence. Since the seven study States have substantial coal and oil shale deposits which could be converted into synthetic fuel, potential water shortages would be a serious setback to the Nation's attempts to achieve energy self-sufficiency. However, projected water requirements and the potential for water shortages have diminished substantially because of a

--reduction in projected energy production from these technologies and

--significant decrease in projected water requirements per unit of output.

High costs, unproven technologies, uncertain markets, and organized opposition have all contributed to declines in projected energy production from these technologies. Because development has slowed, alternative energy technologies are not likely to consume much water before 2000.

One alternative technology, coal slurry, offers the promise of actually decreasing the growth of water consumption in water-short areas. If coal slurry lines or other modes of transportation are used to move the coal to where the electricity is needed, rather than generating the electricity where the coal is located and shipping the electricity, local water consumption would be substantially reduced. In addition, since coal slurry lines can use low-quality water, they need not reduce the area's clean water supplies.

DECREASES IN PRODUCTION ESTIMATES AND INCREASES IN EFFICIENCIES REDUCE WATER REQUIREMENTS

Generally, production estimates for oil shale development, coal gasification, and coal liquefaction all have decreased in the seven States. Concurrent with this decrease in estimated production has been a more than 90-percent decrease in estimated 1985 water consumption and about a 50-percent decrease in water consumption projections for 2000.

Estimates of future energy growth published in two 1974 reports are compared below to 1978-79 energy/water studies for the Water Resources Council. 1/ The tables indicate that energy production estimates have fallen for oil shale, coal gasification, and liquefaction for both 1985 and 2000.

Comparison of 1985 Synthetic Fuel Production Estimates for Seven Western States

	1974 Study			1978-1979 Study (note a)		
State	Oil shale	Coal gas.	Coal liq.	Oil shale	Coal gas.	Coal liq.
	b/(bbld)	c/(bbtud)	(bbld)	(bbld)	(bbtud)	(bbld)
Colorado	750,000	0	0	217,000	0	0
Wyoming	0	0	200,000	0	0	0
New Mexico	0	1,250	0	0	0	0
Utah	250,000	1,500	0	83,000	0	0
Montana	0	0	200,000	0	0	0
N. Dakota	0	0	0	0	0	0
Arizona	0	0	0	0	0	0
Total	1,000,000	2,750	400,000	300,000	0	0

a/Baseline scenario: this scenario was selected for analysis because it more realistically portrays what might occur. In part, the 13(a) report for the Upper Colorado Basin pointed out that "The baseline case could be viewed as a plausible projection of the upper limit of development * * *." The accelerated case was viewed as unreasonably high.

b/Barrels per day.

c/Billion British thermal units per day.

Sources: "Water and Energy Self-Sufficiency," a staff analysis prepared for the Chairman of Committees on Interior and Insular Affairs, U.S. Senate, 1974.

Draft reports prepared for the U.S. Water Resources Council as a result of Section 13(a) of the Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C. 5912, 13(a)).

1/Original energy use projections were provided to the study participants by the Department of Energy.

Comparison of Synthetic Fuel Production Estimates for Seven States in the Year 2000

State	1974 Study		1979 Study (note a)	
	Oil shale	Coal gas.	Oil shale	Coal gas.
	(bbld)	b/(mmcfd)	(bbld)	(mmcfd)
Colorado	1,090,000	0	825,000	375
Wyoming	125,000	250	25,000	c/250
New Mexico	0	1,788	0	1,410
Utah	300,000	864	450,000	0
Montana	N/A	N/A	0	(b)
N. Dakota	N/A	N/A	0	(b)
Arizona	0	0	0	0
Total	1,515,000	2,902	1,300,000	2,035

a/Baseline scenario.
b/Millions of cubic feet per day.
c/Another 13(a) report on the Upper Missouri Basin includes a base level estimate of 292,500 bbld of coal liquefaction and 4,170 mmcfd of coal gasification. This data is not included in the table because comparable Interior data is not available for 1974. Water requirements, however, for Upper Missouri Basin synthetic fuels are included in total energy-related water requirements (see p. 21).

Sources: "Report on Water for Energy in the Upper Colorado River Basin," U.S. Department of the Interior, 1974.

(draft) "Upper Colorado River Region Section 13(a) Assessment: A Report to the U.S. Water Resources Council," Colorado Department of Natural Resources, 1979.

It is interesting to note that the recent national Presidential goals (see app. V) for accelerated synfuel development by 1990 are substantially less than the synfuel estimates for the year 2000 included in the 13(a) studies (see source note, p. 18) for the Upper Colorado and Upper Missouri Basins. While there is a difference of 10 years in the time frames, the 13(a) estimates could almost double the President's, and the President's goals are national goals--not confined to the two Basins.

Some synthetic fuel development will undoubtedly occur outside of the two Basins--probably the Ohio Basin. Since that development will reduce the pressure on the two Basins, synthetic fuel estimates in the above table are probably high.

The President has indicated that 2.5 million bbld in oil equivalent would be developed from synthetic fuel, such as oil shale, coal liquids, and coal gas, and from unconventional gas. Since between 0.6 and 1.1 million bbld are expected from biomass and unconventional gas, requirements for synthetic fuels from oil shale and coal are substantially less than the 2.5 million bbld usually suggested. Actually, the President's proposal is between 0.4 million bbld and 1.9 million bbld in oil equivalent, a figure well within the above estimate for the Upper Colorado and Upper Missouri River Basins.

In addition, recent studies reflect decreased water requirements per unit of output. The decreases are caused by both better quality of estimates and introduction of a new conversion mode, modified in situ. (See p. 22.) For example, while in 1974 Interior estimated water requirements of 17,400 acre-feet per year for a 100,000-bbld oil shale operation, 1979 studies by Colorado Energy Research Institute estimated only 7,500 acre-feet per year, and the Colorado Department of Natural Resources estimated only 11,400 acre-feet per year (per 100,000 bbld).

The combination of decreases in the rates of projected growth and reductions in estimated water requirements per unit of output has caused dramatic decreases in the estimated water requirements for alternative technologies. For example:

Comparison of Projected Synthetic Fuel Water Requirements for 1985 and 2000 for Upper Colorado and Missouri Basin Study States

Projected Water Requirements for 1985

State	1974 Study (note a) Oil shale	Coal gas.	Coal liq.	1978-79 Studies (note b) Oil shale	Coal gas.	Coal liq.
	-------(thousands of acre-feet per year)-------					
Arizona	0	0	0	0	0	0
Colorado	120	0	0	15.2-24.7	0	0
Montana	0	50	60	0	0	0
New Mexico	0	50	0	0	0	0
N. Dakota	0	30	0	0	0	0
Utah	40	60	0	5.8-9.5	0	0
Wyoming	0	40	60	0	0	0
Total	160	230	120	21.0-34.2	0	0

Projected Water Requirements for 2000

State	1974-75 Studies (note c) Oil shale	Coal gas.	1978-79 Studies (note b) Oil shale	Coal gas.
	------(thousands of acre-feet per year)--------			
Arizona	0	0	0	0
Colorado	191	0	57.75-94.05	11.25
Montana	0	(d)	0	14.93
New Mexico	0	72	0	50.00
N. Dakota	0	d/188.2	0	88.20
Utah	46	52.5	31.50-51.30	0
Wyoming	22	d/15	1.75-2.85	34.58
Total	259	327.7	91.0-148.20	198.96

a/Based on staff analysis for Senate Committee on Interior and Insular Affairs.

b/Based upon draft 13(a) reports prepared for Water Resources Council. Coal liquefaction is excluded because none was included in the 1974-75 Interior studies. Water consumption estimates of 34,580 acre-feet per year for Upper Missouri Basin liquefaction are included in all analyses of total energy-related water requirements.

c/Department of the Interior, Water for Energy Management Team.

d/Wyoming and Montana shares of Upper Missouri Basin gasification combined in North Dakota figure.

The preceding comparisons demonstrate that 1985 projections have decreased from over 500,000 acre-feet to less than 10 percent of that amount, and the estimates for the year 2000 have been cut almost in half. Energy-related water consumption estimates included in the 13(a) studies for the Upper Colorado and Upper Missouri Basins are between 325,000 and 382,000 acre-feet per year for year 2000. This estimate is less than the older predictions for 1985.

POTENTIAL FOR ALTERNATIVE ENERGY TECHNOLOGIES BY 2000 VARIES WITH PROCESS

The future of alternative energy technologies in the seven States varies with the process. There are active proposals for oil shale development, coal gasification, geothermal power, and coal slurry lines, but coal liquefaction appears to have a very uncertain future. Although some of the active proposals may be completed, many are now floundering. (See app. VI.) Those programs which are floundering because of high cost may obtain additional financing as a result of the President's proposals.

Oil shale: much promised, but prospects for commercial development uncertain

Although the forecasters of oil shale development promised a great deal, its prospects for commercialization have diminished and, as a result, so have projected water requirements. It appears that substantial Federal assistance will be required to meet the President's 1990 goals.

Oil shale deposits are located in several areas of the United States, with the richest deposits located in Colorado, Wyoming, and Utah. Using current technology, these deposits contain about 600 billion barrels of recoverable oil.

There has been a debate for a number of years about the water requirements for an oil shale industry. Although actual water requirements are not known, they will depend upon which extraction technology is used. Oil is recovered from shale by various processes, most of which involve fracturing the rock and heating it. This can be accomplished above ground or in underground (in situ) shale deposits. Adoption of a modified in situ technology should have a favorable effect on water consumption. For example, one estimate indicates that plant water consumption could be reduced 21 percent by using a modified in situ technology in lieu of surface processing. Current industry trends indicate that a technology mix featuring a combination of in situ and surface processing is likely. Any in situ use, or other technological improvements, should reduce water requirements.

A 1979 draft report to the U.S. Water Resources Council estimates that by 2000, a 1,300,000 bbld industry in the Upper Colorado Basin is possible and would consume 91,000 to 148,000 acre-feet of water per year. Even these figures may be high; the Colorado Energy Research Institute, in a January 1979 report, estimated that a 500,000 bbld oil shale industry consuming 37,500 acre-feet per year was most probable by 2000. Interior reported in its comments on our draft (see app. I) that "entirely in-situ processing could reduce the requirements to as low as 5,000 af/yr." Although there is disagreement on which figure is correct, all the new estimates are significantly lower than the mid-1970 estimates. Various sources indicate that ground water and surface water supplies will be sufficient for the initial stages of development.

No commercial production of oil shale now exists in the United States, and the time schedule for development is still in doubt. One active research and demonstration project was recently terminated because additional funding was not available. Development of oil shale in Utah has been delayed by a lawsuit between the State of Utah and the Federal Government over ownership of the land. The Federal Government was unable to sell, due to a lack of bidders, two oil shale leases thought suitable for development in Wyoming, and several companies have suspended development plans pending a more favorable economic outlook. However, Federal leases in Colorado are being actively developed in support of possible future modified in situ operations.

Coal gasification: its future is distant

Companies seeking to commercialize coal gasification systems have encountered many problems. Many interested companies have suspended their projects or have conducted only preliminary feasibility studies. Difficulties encountered to date suggest that extensive coal gasification development is unlikely before 2000.

Coal gasification is a chemical process in which coal is converted into combustible gas. The Department of Energy Commercialization Task Force noted that, although gasification technology has been available for over 25 years and a number of projects have been actively promoted in the United States in recent years, private industry has yet to build its first commercial-scale, high-BTU plant. There are problems in obtaining site approvals, uncertainties about the technology, capital supply and financing problems, and questions about marketability. Some of these problems, however, may be resolved by the President's new program.

Three commercial, high-BTU gasification projects are in the advanced planning stage. (See app. VI.) However, the two gasification projects in New Mexico have been postponed, and there is now only one project, in North Dakota, in a position to begin construction within the next few years.

Coal liquefaction: no active proposals

Coal liquefaction converts pulverized coal to a liquid fuel. Liquefaction is a proven technology used on a small commercial scale in the Union of South Africa. The economics of liquefaction appear to constrain application in the United States. The Department of Energy's projections for the coal-rich Upper Colorado region show no synthetic liquid fuel production by 2000. Commercial production of liquids from coal will probably be based upon more advanced technologies now being tested.

Geothermal energy: active proposals, but minor importance

Opportunities for geothermal development are limited, and uncertainties about exact location, magnitude, and longevity of exploitable geothermal resources hinder development. Since the geothermal industry is still in its infancy, a significant amount of additional exploration, research, and development must occur before accurate figures can be developed concerning the potential of the industry, the timing of its development, and its attendant water requirements.

Geothermal energy is the natural heat of the Earth. Where heat is concentrated in areas of the Earth's crust, similar to oil reservoirs, it is accessible and has potential commercial uses. Several geothermal reservoirs have been found in the Western United States. (See app. VI.)

Producing electricity with geothermal energy uses a lot of water. The Western States Water Council estimates that a geothermal power plant consumes 48 acre-feet of water per Mw per year, or over three times as much water per Mw as a conventional steam electric powerplant.

Coal slurry lines: problems impede further development

Although coal slurry lines are a system of transporting coal rather than generating electricity, they will have a significant impact on the water-for-energy question in the water-short, coal-rich States. Coal slurry lines require only one-seventh the water required to generate electricity in steam electric plants. Therefore, replacement of proposed electric generation plants located near the coal mines (commonly referred to as mine-mouth generation) with coal slurry lines or other means of transporting the coal could reduce local water requirements. This is especially significant in water-short areas, where many of the projected powerplants will produce electricity for export to consumers where water supplies are more plentiful. In addition, coal slurry lines can use water which is too expensive or too contaminated for other purposes.

To prepare coal for slurry pipeline transportation, the coal is ground into a powder, mixed with an equal amount of water, and pumped to a steam electric generating plant. At the generating site, the water and coal are separated, with the water used for condenser cooling and the coal used to fuel the boilers. Since the water needed to transport the coal (1 ton coal to 1 ton water) may be as small as one-seventh the water required for generation (1 ton coal to 7 tons water), additional water must be obtained near the generating site.

Coal slurry lines can use water few others want. For example, coal slurry lines could use the highly saline water in the Big Sandy River in Wyoming. Coal slurry lines can also use water that is too expensive for agriculture. Because water is more valuable to pipelines than agriculture, slurry operations can afford to pump water that is too expensive for irrigators.

The Nation's only active coal slurry pipeline is a 273-mile line from the Black Mesa mine near Kayenta, Arizona, to the Mohave Generating Station in southern Nevada. The pipeline has a capacity of 5 million tons of coal per year and requires about 3,300 acre-feet of water per year. It has operated successfully since 1970.

Although several proposals (see app. VII) for additional pipelines have been suggested, they face considerable opposition. A coalition of railroads, rail labor unions, farm organizations, environmental groups, and others have successfully hindered coal slurry development. If some of the opposition could be satisfied that slurry pipeline problems are minimal, there would be substantial interest in developing additional lines--and a possibility of reducing water consumption in water-short areas.

CHAPTER 4

MINERAL PRODUCTION REQUIRES WATER, BUT NOT MUCH

The Nation's domestic mineral production is dependent on the seven States in our study for most strippable coal, oil shale, copper, molybdenum, potash, soda ash (trona), and uranium. Water is required in each process, and adequate supplies are necessary for expansion of the industry. However, since total water requirements of the industry are relatively small, water supplies should be adequate.

The Nation's concern for energy independence has cause heavy emphasis on water requirements for energy minerals (those used as fuel), yet nonenergy minerals production is and will continue to be a more important water user in the seven States. Copper production in Arizona consumes twice as much water as all energy mineral production in the entire Colorado Basin, and copper's relative water requirements are expected to change little by 2000. Because of th importance of minerals to the energy industry, any study of future energy water requirements must also include a discussion of the adequacy of water for mineral development.

Precise information on current and estimated future water consumption for mineral production is difficult to obtain and often contradictory. The only accurate sources of data on actual consumption and future projections are the individual mining firms, but even they do not always maintain current records.

MINING REQUIRES LITTLE WATER

Although water is essential in mining and processing minerals, total water requirements of the industry are very small. In addition, it is not the mining operations which require much water; instead, the mineral industry uses most water to process the minerals. Interior estimated that the mining industry consumed less than one-half of 1 percent of western water. Even the Colorado Basin, important in providing many minerals, is expected to use only 5 percent of its water for the production of minerals.

The Colorado Basin States produce several important minerals. Wyoming is the world's largest source of natural soda ash (trona); New Mexico has the Nation's most readily available deposits of potash, with 85 percent of the Nation's production; Arizona has 65 percent of the Nation's copper production; Colorado has most of the Nation's molybdenum production; and the region has over 90 percent of the Nation's uranium production.

Although the mineral industry's water consumption in the Colorado Basin is expected to grow more than twice as fast as the Nation's, the industry's water consumption is still small compared to that of irrigated agriculture. The small amount, though increasing, should still be only about 5 percent in 2000. For example,

Comparison of Magnitude of Water Consumption for Minerals and Irrigated Agriculture in Acre-Feet Per Year

Colorado Basin	Water consumption for minerals as percent of total water consumption 1975	2000	Water consumption for irrigated agriculture as percent of total water consumption 1975	2000
Upper	1.9	4.5	90	85
Lower	3.3	5.9	88	79

Source: Water Resources Council.

Just how small the Nation's energy mineral requirements are is apparent from an analysis of coal mining water consumption. Enough coal could be mined with 200 acre-feet of water to supply all the electric needs for all the people in Wyoming. In contrast, the 200 acre-feet would irrigate less than 100 acres of alfalfa, which could feed enough cattle to produce beef for about 175 people annually.

One reason for the mineral industry's low water consumption is that it recycles the same water several times. Recycling minimizes water diversions. On the average, water in the mineral industry is reused 3.8 times in 11 western States and 2.6 times nationwide.

MINING AND PROCESSING OF ENERGY MINERALS REQUIRE LESS WATER THAN NONENERGY MINERALS

Despite all the concern about water requirements to mine energy minerals, nonenergy minerals' water requirements exceed those of the energy minerals. In fact, the 1972 Census of

Mineral Industries reported energy minerals actually discharged more water than was diverted. The importance of nonenergy minerals is also true in the Colorado Basin, where 78 percent of the water for mineral production was consumed by the nonenergy minerals. Water Resources Council data indicates that substantial nonenergy water use will continue. It estimates that in 2000, energy minerals will divert and consume a little more than 25 percent of water in the Colorado Basin used by the mineral industry.

DATA IS SPARSE AND OFTEN CONFLICTING

There is a dearth of accurate and meaningful data on water diversion and consumption by the mineral industry. Major disagreement is apparent in current water requirements for mineral extraction, and agreement on future requirements is missing.

For example, three estimates of Upper Colorado Basin mineral industry water requirements for 2000 were prepared for the Water Resources Council. Although government officials prepared each estimate for spring 1979 release, they varied markedly.

Estimator	Estimated consumption for 2000
	(acre-feet)
Colorado Department of Natural Resources Task Force	115,000
Water Resources Council	161,000
State Regional Futures (note a)	421,000

a/Prepared by State officials or Water Resourçes Council team.

Substantial disagreement on future mineral industry water requirements is common.

While it might be expected that estimators would differ in their judgments about future water requirements, current water consumption estimates for individual minerals located in small areas should be consistent. Such was not the case, even where errors in estimates were glaring and the data could be easily verified.

For example, although trona production requires more water than any other mineral in southwestern Wyoming (Green River area) and estimates can be easily verified, Federal agencies have estimated substantially different water requirements. The Bureau of Land Management, in an environmental impact statement, estimated trona water diversions of 58,900 acre-feet for the Green River area. The Water Resources Council estimated water consumption for all nonmetals (trona is a nonmetal) for the entire subbasin area as only 5,000 acre-feet. The difference in the estimates is remarkable since, to eliminate contaminated water discharges, all water diverted by the trona industry is consumed; that is, water consumption and diversions should be about equal. Actually, both agencies' figures were substantially in error since water consumption was about 14,000-16,000 acre-feet per year.

Despite the differences in the data, there is general agreement that the mineral industry uses relatively little water, and supplies are adequate both now and for several decades.

CHAPTER 5

MILLIONS OF ACRE-FEET OF WATER

LIE UNUSED IN FEDERAL RESERVOIRS

The decrease in expected energy growth rates and increases in water use efficiency discussed in previous chapters have significantly affected the availability of Federal project water. Instead of lists of potential developers, the Bureau of Reclamation has lists of reservoirs with unsold or undelivered water. In fact, millions of acre-feet of unused water are stored in Corps of Engineers and Reclamation reservoirs throughout the semiarid, resource-rich West. Many of the reservoirs are located in close proximity to large coal or other mineral deposits and have water available for immediate use.

While some reservoirs have substantial amounts of water specifically allocated for industrial (energy) use, few energy and mineral developers have ever used Federal project water. Neither geographic proximity to mineral deposits nor physical availability of an adequate water supply has resulted in much use of Federal project water, and there are not many requests for future use. Despite growing public concern about the availability of water for energy development, many Reclamation reservoirs have available water that developers either do not want or are not willing to purchase. New requirements for environmental impact statements for water marketing programs and option contracts have probably further delayed the use of Federal project water and perhaps further limited its desirability.

AT ONE TIME, DEMAND FOR FEDERAL PROJECT WATER APPEARED SIGNIFICANT

Although Federal reservoirs are already located throughout the energy-rich West, Federal studies predicted that energy-related water demand would quickly use all existing Federal project water and that additional projects would be required to satisfy future demand. Such predictions seemed especially appropriate for the Upper Missouri and the Upper Colorado Basins, two regions noted for predicted steam electric powerplant growth, for significant potential for growth of alternative energy technologies, for vast supplies of energy and nonenergy resources, and for a history of Federal involvement in water storage projects.

In the early 1970s, energy companies actively sought water in the Upper Missouri Basin to provide water for proposed steam electric powerplants, coal gasification operations, and coal slurry lines. By mid-1975, Federal agencies had received requests of more than 1 million acre-feet from three main-stem Missouri reservoirs: Fort Peck in Montana, Lake Sakakawea in North Dakota, and Lake Oahe in North and South Dakota.

There was energy-related interest in 2.6 million acre-feet of water from the Yellowstone River Basin, a subbasin of the Missouri. By 1972, Reclamation had signed contracts for 700,000 acre-feet of water from two Yellowstone Basin reservoirs, Bighorn and Boysen, and was considering requests for an additional 1 million acre-feet. In addition, a power study estimated additional demands of 800,000 acre-feet. Since Reclamation did not have the storage to provide the expected 2.6 million acre-feet of annual requirements, it recommended additional reservoirs, new water projects, and several planning studies.

Although the projected energy-related water use in the Upper Colorado Basin was not of the magnitude of that in the Upper Missouri, limited water supplies made anticipated energy development seem very significant. In 1974, Interior predicted that by 1978 contracts for water deliveries to energy companies would exceed 157,000 acre-feet and would grow to 323,000 acre-feet in 1980. Consequently, Reclamation proposed several new projects with specific water allocations which could be used by the energy developers.

To satisfy anticipated energy/water requirements in both Basins, part of the available water supply in existing reservoirs was allocated for industrial use. Water was made available from several Federal reservoirs near large coal or oil shale deposits: Bighorn, 697,000 acre-feet; Navajo, 115,000 acre-feet; Fontenelle, 228,000 acre-feet; Boysen, 85,000 acre-feet; and Ruedi, 47,700 acre-feet. Energy contractors quickly requested almost all of this water.

DEMAND FOR FEDERAL PROJECT WATER NOW VERY WEAK

The projections of rapid water development to supply the explosion in energy and mineral requirements generated considerable research, raised environmental concerns, and created fears of water shortages. However, not much of this water has been delivered. Rather than having long waiting lists for water from Federal projects, most reservoirs have been unable to sell all their industrial allocations.

Although the expectations for water development were substantial, only minor amounts have been supplied. Several years ago, Interior reported that about 1 million acre-feet were under contract to energy companies, and over 2 million acre-feet were projected for future needs. In 1978, deliveries to energy companies amounted to only about 50,000 acre-feet, and will probably not increase significantly for several years.

Even the large reservoirs with industrial allocations, with ideal locations, and with existing water contracts have been used only sporadically. The reservoirs have available water, but few contractors have requested deliveries.

Selected Reclamation Reservoirs Located in Energy and Mineral Development Areas

Region	Reservoir	Long-term industrial allocation	Active contracts	1978 water deliveries
		-----(in acre-feet per	year)-----	
Lower Missouri	a/Ruedi	b/47,700	c/0	0
Upper Missouri	Boysen	135,000	35,000	0
	Yellowtail	697,000	200,000	0
Lower Colorado	Lake Mead	d/30,000	23,000	9,053
Upper Colorado	Fontennele	228,000	120,000	19,820
	Navajo	115,250	64,250	7,353
	Powell	d/142,000	142,000	17,943
Total		e/1,394,950	584,250	54,169

a/While Ruedi Reservoir is actually in the Upper Colorado Basin, it is administered by Reclamation's Lower Missouri Region.
b/Water allocated for municipal and industrial use.
c/Although a repayment contract is signed with a conservancy district, that district will not market Ruedi water. Instead, the contract is being renegotiated with another district that will ultimately sell the water to users.
d/Current or past contracts outstanding.
e/This allocation is sufficient to support a synfuel industry several times that of the President's new energy initiatives.

Source: U.S. Bureau of Reclamation.

MANY FIRMS NO LONGER WANT FEDERAL PROJECT WATER

At one time, there were lists of prospective contractors waiting for an opportunity to obtain Federal project water. Today, time-consuming Federal requirements, a question of the Bureau of Reclamation's marketing authority, and a change in market demand have virtually eliminated new demands for project water. Instead of lists of prospective customers with development plans, Reclamation has lists of former contractors.

Nine contractors with options on 423,000 acre-feet of water from Yellowtail Reservoir have failed to extend their contracts after spending about $2 million over the 10-year option period. Each contractor listed one or more of the following reasons for failure to renew the contract:

--A weak market for synthetic gas eliminated need for water.

--The contractors could not meet Interior's requirement for a firm, detailed, and acceptable water development plan to market the water.

--Considerable uncertainty exists about Reclamation's right to market the water.

Some uncertainty about Reclamation's authority to market water should have been removed by a Federal District Court case in Montana (Environmental Defense Fund, Inc. v. Morton, 420 F. Supp. 1037 (1976)). The plaintiffs attempted to restrain Interior from any activities to contract, sell, or dispose of water for industrial purposes from Yellowtail and Boysen Reservoirs. The District Court, however, held that the Secretary of the Interior was authorized under Reclamation Project Act of 1939 to sell reclamation project water for industrial uses, that the Secretary acted within scope of his authority in granting water option contracts, and the industrial water marketing program, water option contracts, and related activities did not violate the allocation program in Yellowstone River Compact Act. The Court of Appeals recently affirmed Reclamation's authority in Environmental Defense Fund, Inc. v. Andrus, 596 F. 2d 848 (9th Cir. 1979).

Problems remain, however, and some former contractors raised questions about Reclamation's authority to market and deliver water. This issue must be resolved before any significant use of project water is possible. For example, Reclamation attempted to sell Montana Power Company 4,000 acre-feet of water from Bighorn Lake, but the State of Montana recommended denial of the request. Although the amount of water was minor (only a small fraction of the Bighorn industrial allocation), the river was to be used as the conveyance facility, and the alternative source was a new reservoir, the State still refused the permit. The State said that Reclamation would not guarantee that no one would steal the water while it was traveling downstream to the public utility. In answer, Reclamation's regional director said that the State's response invited Federal involvement in the State's water rights administration, a position contrary to Reclamation policy. As a result, the power company must build a new reservoir and Federal project water sits unused.

An additional requirement for marketing water to energy companies has recently crippled the contracting process. The Court of Appeals reversed the lower Court and the Environmental Defense Fund, Inc. v. Morton case on the issue of completing Environmental Impact Statements. It found that the National Environmental Policy Act (NEPA)

> "* * * requires preparation of environmental impact statements for the overall industrial water marketing program and for each individual option contract. These requirements are applicable even though the marketing plan and some of the option contracts were executed prior to January 1, 1970 [the date of NEPA's enactment]. Both the overall plan and the individual contracts are ongoing and require continuing attention and action."

This new requirement at least temporarily delays all water contracting on Yellowtail and Boysen Reservoirs and could threaten marketing on other projects which do not have either marketing or individual environmental impact statements.

PROTECTIVE PROVISIONS ALREADY INCLUDED IN RECLAMATION CONTRACTS

The Department of the Interior has included in water contracts with energy companies provisions which protect the environment, limit Federal financial responsibility, permit contract termination, assign specific water uses, and reduce contracts for nonuse. Some specific protective provisions in energy contracts include:

--Termination for nonuse.

"Except as hereinafter provided, the United States may terminate this contract as to water not put to beneficial use by January 1, 1982, in a coal gasification project such as proposed by the Contractor."

--Limitation on water use and storage rights.

"The water furnished shall be used by the Contractor only for industrial purposes. The Contractor shall have no holdover storage rights in the Navajo Reservoir from year to year."

--Protection of the environment.

"No water shall be diverted for such different use under this contract until an environmental statement has been completed and the Secretary shall have confirmed in writing his determination that the applicable provisions of the National Environmental Policy Act of 1969 have been complied with and the environmental impacts of the use of water for said such different use are acceptable."

--Limitation on Federal financial responsibility.

"All facilities required for taking the water to be furnished under this contract from the Bighorn or Yellowstone Rivers and putting it to use by the Contractor will be installed, operated, and maintained by the Contractor at its sole expense."

--Contract reductions for nonuse.

"The United States may unilaterally modify this contract at any time on or after the tenth anniversary of the date of this contract to reduce the maximum amount of water to be delivered hereunder to that amount which is then being put to a beneficial use for purposes contemplated herein by the Contractor."

--Protection for possible new uses.

> "If the United States shall, during the life of this contract, receive a firm offer or offers from a third party, or parties, to purchase immediately, on a permanent basis, at not less than the acre-foot charge set forth in Article 4b., all, or any part of * * * water under option * * * or, if changed conditions arise * * * and after thirty (30) days' notice in writing in advance to the Contractor, the Contractor will either agree to pay each year thereafter for those quantities in acre feet set forth in Article 3b. * * * or release to the United States so much of said quantities * * * under option."

These provisions offer substantial protection to limit Federal financial responsibility, impede speculation, and protect the environment.

In addition, new contracts would mean additional revenue that would speed repayment of Federal costs already expended to build the projects. Expanded industrial use of existing Federal project water increases Federal revenue without the environmental, social, and political problems implicit in new construction.

CHAPTER 6

UPPER COLORADO BASIN WATER SUPPLY CAN SUPPORT PROPOSED ENERGY AND MINERAL DEVELOPMENT

The Upper Colorado River Basin is a region that report after report suggests will experience energy-related water shortages. Because the Basin is blessed with a bountiful supply of mineral wealth and is cursed with limited water supplies, many studies concluded that the Nation's desire for energy independence would stimulate Basin water use and quickly exhaust all the unappropriated water.

However, even this Basin should have ample water for years. Although some reports still predict severe Upper Basin water shortages, other recent analyses suggest adequate physical water supplies for at least 25 years. 1/ The estimators have neglected important events which have delayed severe Basin-wide water shortages. The large projections of water requirements for steam electric, oil shale, coal gasification, and coal liquefaction plants have been reduced to a few hundred thousand acre-feet. Technological advances and and operational experience have significantly reduced individual plant water requirements.

Unfortunately, many people still accept the old analyses and data. Recent newspaper and magazine articles still cling to the old information, despite the availability of new data. In the year 2000, water supplies will be available to satisfy energy's thirsts, with minimal impacts on other water consumers. Even with abnormally strong growth in steam electric generation, in alternative energy technologies, and in mineral development, water supply should be adequate.

1/ For a complete discussion of the water supply situation within the Colorado Basin, see the GAO report on "Colorado River Basin Water Problems: How to Reduce Their Impact" (CED-79-11, May 4, 1979). The report identifies some studies which conclude that water shortages may appear in the Upper Basin before 2000. Those studies, however, neglect many important changes that have decreased expected water consumption.

PROJECTIONS INDICATE WATER SUPPLY SUFFICIENT FOR ENERGY DEVELOPMENT

The amount of water remaining in the Upper Colorado River Basin at any time is dependent on available flow and consumption. Various assumptions about dependable flows, consumption growth, and future developments have been used to predict conditions ranging from shortage to abundance. Consumption projections, however, have been substantially reduced in the last few years. The 1979 projections, combined with conservative flow estimates, indicate there will be sufficient water in the Upper Basin for all consumers in 2000.

Little agreement on critical flow

The precise level of Upper Colorado River Basin dependable flows must be known for adequate projections of future water availability. The long-term average virgin flow of the Colorado River at Lee Ferry, Arizona, the division point between the Upper and Lower Colorado Basins, has been estimated at 13.7 million to 18.0 million acre-feet per year. Reclamation currently estimates the Colorado River flow at Lee Ferry to be about 14.8 million.

Regardless of the total flows, all Colorado River water which originates in the Upper Basin is not available for its use. The Colorado River Compact of 1922 (see app. VIII for more information) divides Colorado River water between the Upper Basin (parts of Arizona, Colorado, New Mexico, Utah, and Wyoming) and Lower Basin (parts of Arizona, California, Nevada, Utah, and New Mexico) States. The compact allocated 7.5 million acre-feet of Upper Basin flows to each Basin.

Although the Federal Government maintains that Mexican treaty deliveries are a Federal obligation, the 1922 Compact requires each Basin to share equally in meeting deliveries. In 1944, the United States and Mexico signed a treaty requiring annual delivery of 1.5 million acre-feet of water to Mexico. Interpretation of the Colorado River Compact on Mexican treaty water allocation is disputed by Upper and Lower Basin States. Nevertheless, the Upper Basin may be required to provide up to 0.75 million acre-feet to satisfy water deliveries to Mexico.

Reclamation constructed four reservoirs in the Upper Colorado Basin to allow development of Upper Basin water projects and to regulate Lower Basin deliveries. Average annual evaporation from the reservoirs, estimated to be 0.52 million acre-feet, is credited to the Upper Basin's allocation. Consequently, as much as 8.77 million acre-feet--7.5 (Lower Basin share) + 0.75 (half of the Mexican treaty) + 0.52 (reservoir evaporation)--of the water originating in the Upper Basin may be unavailable for Upper Basin irrigation, municipal, or industrial consumption.

Depending on the virgin flow and the Mexican treaty requirements, water available to the Upper Basin (excluding reservoir evaporation) has been estimated between 5.4 million and the 7.5 million acre-feet set by the compact. Reclamation has estimated the Upper Basin share of the Colorado River at 5.8 million acre-feet. 1/ (See app. X for five projections of Upper Basin water supply.)

Estimates of future consumption vary greatly

Recent estimates of year 2000 Upper Colorado River Basin consumption are substantially less than projections of a few years ago. For example, in 1971 a Federal-State task force estimated year 2000 consumption of 7.2 million acre-feet. In 1979, another Federal-State task force estimated that in the year 2000, maximum consumption would be 5.8 million acre-feet, 20 percent less than the previous estimate.

In some cases, older estimates are still being accepted as accurate projections of future development. The range of projections published under the auspices of the Federal Government allows almost any estimate of water availability in the Upper Colorado Basin to be defended. For example, the 1971 projection of 7.2 million acre-feet consumption leaves no water remaining in the Upper Basin under four of the five assumed flow levels. However, even with conservative flow estimates, only the highest 1979 consumption projections, which include enough water to meet the President's goals, indicate that all water will be appropriated in the Upper Basin in 2000. Since even the estimators themselves do not consider these estimates as reasonably possible, the likelihood of shortages by 2000 is very remote.

The draft report on the availability of water in the Upper Colorado Basin prepared for the Water Resources Council is quite emphatic.

1/The Secretary of the Interior has used the 5.8 million acre-feet as a conservative estimate of available water and has not intended that the figure be viewed as interpretive of the Colorado Basin Compact.

"Based upon a 'worst case' set of assumptions, it is estimated that the water demands of a synthetic fuel industry (i.e., oil shale and goal gasification developments) of up to about 1.5 million barrels per day, as well as the water demands of the associated growth, could be satisfied from surface supplies without having to significantly, if at all, reduce other projected consumptive water uses in the Upper Basin."

Included on the following page is a recent analysis of future water consumption in the Upper Colorado Basin. Although the table identifies substantial increases for every sector, there will be unused water in the year 2000.

Comparison of 1975-1976 Water Consumption with Most Probable Level of Year 2000 Development for the Upper Colorado Basin

Sector	1975-1976	2000	Increase
	----------(acre-feet per year)--------		
Agriculture	2,145,000	2,736,000	591,000
Thermal electric	74,000	a/311,000	237,000
Fish and wildlife	33,000	74,000	41,000
Minerals	55,000	115,000	60,000
Municipal and industrial	45,000	97,000	52,000
Exports	764,000	1,149,000	385,000
Evaporation (note b)	528,000	700,000	172,000
Alternative energy technologies (note c)	--	a/252,000	252,000
Total	3,644,000	5,434,000	1,790,000
Water available (note d)	5,800,000	5,800,000	
Unused water	2,156,000	366,000	

a/It should be noted that because of the possibility of double counting of ancilliary services and the possibility of technological changes to improve water efficiency, the energy use estimates may be high.

b/Not included in other sectors.

c/Total water consumption for baseline synfuel projection. Includes 35,000 acre-feet for associated growth: added municipal supplies, added electricity requirements, and dust control or revegetation.

d/Bureau of Reclamation.

Source: (draft) "Upper Colorado River Region Section 13(a) Assessment, The Availability of Water for Oil Shale and Coal Gasification Development in the Upper Colorado River Basin," Colorado Department of Natural Resources, 1979.

While earlier estimates may have been appropriate when developed, 1979 depletion estimates seem to be much better representations of 2000 conditions because of

--shorter estimation period,

--improvements in estimating water requirements for new energy technologies,

--availability of new lower growth rates for electric power,

--air and water quality constraints,

--reduction in size of Reclamation projects, and

--postponement of Reclamation projects.

Both declining growth rates for electric power and air quality standards have a marked effect on steam powerplant development. For example, since 1970 the Rocky Mountain Power Area's (see map in app. IX) projected growth rates have declined 21 percent, and the Southern California-Nevada Power Area's (a potential market for electricity generated in the Upper Basin) projected growth rates have declined 52 percent.

A 1971 Federal-State study projected steam electric powerplant water consumption of 631,000 acre-feet for the Upper Colorado Basin in 2000. The 1979 Federal-State medium estimates of powerplant consumption are only 311,000 acre-feet, less than half of the 1971 projections. However, even the 311,000-acre-feet estimate could be high since EPA standards for air quality could limit potential powerplant sites and subsequently reduce power requirements for water.

Estimated consumption for Reclamation projects have also changed. For example:

--In the last 4 years, Reclamation reformulated four projects in Colorado, reducing potential consumption by 124,000 acre-feet.

--Construction funding for some Reclamation projects, such as the Savery-Pothook and Fruitland Mesa Projects, is uncertain; elimination of these projects would reduce potential consumption by 43,700 acre-feet.

Since future Reclamation projects may be subject to further delays or reductions, projections may again decrease.

Projected depletions may be overstated

Even current water project consumption estimates may overstate the net effect on the Upper Colorado Basin. At least two factors contribute to the overstatement. First, estimated steam electric powerplant consumption exceeds actual consumption rates; second, depending on the source of the water, there may not be an increase in river consumption, even with a new project.

The common estimation of powerplant consumption is 15 acre-feet per Mw of generating capacity. In the Upper Basin, actual powerplant consumption is only about 10 acre-feet per Mw (see pp. 10 and 11), 33 percent less than estimated. Using the 15 acre-feet per Mw estimate for future powerplants may significantly overstate Upper Basin consumption.

Water for new projects is available from several sources: unused streamflow, ground water supplies, or purchase of water from current water right holders. However, using ground water or purchasing existing water rights may not increase river consumption. Only new appropriations of streamflow will necessarily consume the Basin surface supply.

Water transfers from current consumers to new ones require analysis to determine the amount, if any, of new consumption. Current consumers may not use all water for which they have rights, or their use may provide return flows to the river system. Simply adding water requirements for new projects to existing consumption can overstate the impact of future developments on the Upper Basin.

If experience is an indication of future water consumption growth, projected consumption may not be as large as anticipated. For example, between 1965 and 1975, several large powerplants and irrigation projects began using Upper Basin water. Yet, the actual increase in Upper Basin consumption during the 10 years was only 7 percent, less than 1 percent per year. If this slow rate of increase continues, it would take approximately 70 years to consume the 5.8 million acre-feet that Reclamation estimates is available annually in the Upper Basin.

LEGAL CLAIMS SHOULD NOT
BE INTERPRETED AS NEEDS

All Upper Colorado River Basin water is legally allocated among the States, and legal claims exist for all water within each Basin State. Although fully allocated, actual use of Upper Basin water in 1975 amounted to only 3.7 million acre-feet, much less than the 5.8 million acre-feet of available water. Physically, water is available in the Upper Basin and, based on all but the most pessimistic projections, will be available beyond 2000.

State officials said all water available in the Upper Basin has been claimed by prospective users. Consequently, State water laws could be considered as constraints on future development. However, within the framework of State water laws, water is still available because

--legal claims have not been perfected,

--senior (and therefore superior) water rights can still be purchased from existing water consumers (see p. 14),

--some water rights have not been fully utilized, and

--some water rights were held by intermediaries (Federal or State Governments).

The provision under State water laws for the sale of water rights and change in beneficial use generally permits the economic value of water to determine its use.

FEDERAL GOVERNMENT CONTRIBUTES
TO UNCERTAINTIES

Federal policies and actions create uncertainties about the availability of water in the Upper Colorado River Basin; four such uncertainties include

--the extent of Federal energy development support,

--the future of Reclamation projects,

--the extent of environmental requirements, and

--the resolution of "reserved" water rights.

Each issue has a potential major impact on water utilization in the Upper Basin.

The timing and scope of energy developments such as coal gasification and oil shale production will be influenced by the Federal Government. Federal encouragement through favorable legislation, mandatory requirements, subsidies, or direct funding could substantially increase the water available for energy production in the Upper Basin.

Federal financial support is essential for major Reclamation projects. Whether authorized and planned Reclamation projects will be developed affects the future water supply and consumption in the Upper Basin. Reclamation projects increase the dependable water supplies, and increased dependable supplies in turn encourage investments to utilize the water.

Environmental requirements such as instream flows for fish and wildlife and air and water quality standards can affect the location and extent of new water developments. Because of varied environmental requirements, their effect on Upper Basin water utilization cannot be precisely predicted.

Federal and Indian water right reservations create uncertainties for existing and future water development. Reserved water rights are created when the Federal Government withdraws land from the public domain and reserves it for Federal purposes. Federal water reservations, such as those for Indians and National Forests, include the water necessary to satisfy the needs of the land. Most Federal and Indian reserved water rights have not been quantified. 1/ Since they have a prior right to the water, it is not clear how much water remains available to other users.

Despite all the uncertainties--or maybe even because of them--water will be available to meet expected energy requirements. Even the Upper Colorado Basin should have ample water through at least the year 2000. Since there is sufficient unappropriated water to fulfill projected developmental needs, existing water consumers need not fear the growth of energy development.

1/See GAO report "Reserved Water Rights for Federal and Indian Reservations: A Controversy in Need of Resolution" (CED-78-176, Nov. 16, 1978).

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

This report disputes the common impression that the energy industry's thirst for water will necessarily create severe water shortages throughout the water-short, energy-rich West. Disagreement with such a universally accepted premise did not result from hasty or groundless judgments; it resulted from new data. In the past several years, electricity growth rates have decreased, development of alternative technologies has slowed, and water efficiency for each technology has increased. Consequently, huge water requirements to convert resources into energy are no longer appropriate.

In spite of dated information, many recently published reports still rely on Interior's 1974 "Report on Water for Energy in the Upper Colorado River Basin." The predictions, while perhaps based on sound 1974 judgments, are no longer valid. Expected growth has failed to materialize. Anticipated development of electric generation, oil shale, and coal gasification has not occurred.

Early water consumption predictions for Missouri Basin energy development now seem incredibly poor. Compared to lofty predictions of several million acre-feet in annual water requirements, Federal project water's contributions to energy development have ground to a virtual halt. What was once thought to be an all-out war to divide the Yellowstone is no longer even a skirmish. Most industrial water rests unused in Federal reservoirs.

Mid-1970 predictions of rapid energy development were probably reasonable. The estimates were made during a period of apparent commitment to new energy sources, during periods of rapid growth in energy use, and before substantial information on actual operations was available. Federal agencies had lists of developers requesting Federal project water. A million acre-feet were requested on the main-stem Missouri; almost 2 million from the Yellowstone Basin; and studies showed even more would be requested.

The passage of time has made a great difference. In 1978 Reclamation delivered only 134 acre-feet of long-term contract water to Missouri Basin industrial consumers. No main-stem Missouri water has been delivered under long-term contracts. Bighorn Reservoir (Yellowstone Basin), once imagined as a battleground for water, has never supplied any long-term Federal project water--agricultural or industrial--to anyone. Other Reclamation reservoirs, such as Fontenelle in Wyoming and Navajo in New Mexico, have large supplies available for industrial developers, but less than 10 percent of allocations has ever been used.

Energy developers have paid millions of dollars to reserve Reclamation water and never requested any water deliveries. One developer in New Mexico pays over $300,000 per year for water rights but has never used them. It appears that energy companies are willing to pay substantial sums as a kind of water insurance policy to protect potential development but only request delivery if they can put the water to beneficial use.

It is obvious that conditions or circumstances may again change, and what appears reasonable in 1979 may not in 1980. A new oil embargo, a new surge in electricity demand, new Federal irrigation projects, or a long drought could all change water conditions. However, it is equally possible that future conditions might bring about a further reduction in water demand growth rates. There has already been use of irrigation conservation techniques (sprinklers or drip), delays in Federal water project completion schedules, and increased technological development to reduce water consumption. Other possibilities for decreased future water use in water-short regions include dry cooling, a partial return to once-through systems, or increased coal slurry use.

Two recently completed studies for the Water Resources Council support the contention that water will be available in the energy resource States through at least 2000 without much impact on current uses. The first analysis, completed as part of the Second National Water Assessment, removed both the Upper Colorado and Upper Missouri Basins from lists of areas suffering from "inadequate surface-water supplies." The second, completed by the Colorado Department of Natural Resources, reduced the energy industry's water requirements in the Upper Colorado Basin almost 50 percent below previous estimates and stated that the Basin will have sufficient water for development needs.

Unquestionably, water demands by energy companies will increase, and sometime in the future the energy-related demand for water will begin to squeeze the supply of unappropriated water. As the unused supply decreases, some current water consumers will sell water rights to industrial users.

However, since energy users require only a minor portion of total water, the change in use should be gradual, and several decades may elapse before a noticeable change in use occurs.

However, even the long-term need to transfer water rights should be delayed as long as possible. These politically unpopular transfers could be minimized if there were an increase in the availability and certainty of Federal project water for industrial users. If the energy industry could depend upon Federal project water, there would be little need to buy private water rights or to develop entirely new private storage facilities, which generally create new environmental damage.

Substantial evidence exists that energy users do not consume or divert water simply because it is available even when they have paid for it. And since water is so critical to their production process, they often purchase for potential use. Throughout the Colorado and Missouri Basins, some companies purchase Federal project water but never request delivery or request delivery only for water to fulfill immediate needs.

Despite the industries' willingness to pay for undelivered water; despite contract language which seems to protect against environmental damage, unwarranted profits, etc.; despite enormous amounts of water available in Federal projects, decisions by the Department of the Interior requiring detailed project plans and the recent court ruling have discouraged the energy industry from attempting to obtain Federal project water. At this time, contracts are being canceled at some Reclamation projects, and the process of awarding new contracts cannot proceed--at least for Yellowtail and Boysen--until Interior prepares environmental impact statements. The entire contracting process has been stopped. More important, the precedent of these two reservoirs is applied to other Reclamation reservoirs. Until environmental statements are completed, the future of Federal project water marketing is in doubt. Until this doubt is erased, the energy industry will turn to other sources to fulfill its water needs.

The most common choices for additional water are likely to be

--the development of new storage facilities (an environmentally sensitive alternative),

--the procurement of water rights from the agricultural community (a politically sensitive and socially disruptive alternative), or

--the procurement of project water from Federal reservoirs.

Which choice energy developers select may depend on the availability of Federal project water. We believe the Federal water marketing agencies should resolve the uncertainties surrounding the availability of water to energy users and encourage their use of the water.

It is entirely possible that some additional Federal storage may be necessary to meet specific energy requirements in certain locations. However, because of the existence of abundant Federal project water strategically located throughout much of the Upper Colorado and Missouri Basins, such additions should be limited to resolving site-specific problems.

It is also important that additional coordinated planning efforts be started to assure adequate supplies of water for specific sites. Since substantial lead-time may be necessary to assure that all site-specific problems are resolved or minimized, the planning process cannot stop. Although substantial water supplies exist throughout the Upper Colorado and Upper Missouri Basins, every potential site cannot be expected to have abundant water. Locations of adequate water supplies must be identified so that development and growth can be encouraged in those locations. Site-specific water shortages may not imply the need for additional water development; they may imply the need for new location for development.

In addition, the process of estimating future water requirements suffers from excessive use of unrealistic water requirements for changing minerals into energy resources and unwarranted future energy projections. Credibility should be enhanced with the updating of the estimates.

RECOMMENDATIONS

Interior should act to assure the availability of Federal project water to meet future requirements. Since Federal water project contracts and marketing programs on many Federal reservoirs are delayed until Interior completes required environmental impact statements, failure to provide these statements hinders the use of probably the best source of water needed for energy development.

In order to decrease uncertainty surrounding water availability, to reduce transfers of water rights, to diminish or delay the need for new storage facilities, to encourage the energy industry to renew option contracts for Federal project water, to speed recovery of Federal expenditures, and to increase the credibility of water estimates, we recommend that the Secretary of the Interior

--require that the Bureau of Reclamation immediately begin preparation of environmental impact statements for the two Yellowstone Basin reservoirs;

--require similar environmental impact statements for other reservoirs whose marketing programs are threatened;

--update, improve, and establish unit water consumption estimates based upon more recent analysis of water requirements; and

--update and improve energy production estimates for electricity and synthetic fuels.

AGENCY COMMENTS AND OUR EVALUATION

A draft of this report was sent to the Departments of Energy and the Interior, the U.S. Water Resources Council, the 13(a) project contractors for the Upper Colorado report (Colorado Department of Natural Resources) and the Upper Missouri report (Missouri Basin Commission), and several knowledgeable individuals in the field of water resources development. All agreed with the major thrust of the report--that sufficient water is available to satisfy the President's energy goals. Interior, to whom all recommendations were directed, concurred with each recommendation.

In addition, most respondents agreed with the suggested reasons for water supply sufficiency (reduced energy growth rates, relatively small water requirements, decreases in estimated consumption per unit of output, new technologies, and the availability of Federal project water). Some expressed doubt, however, that the general public's perception of probable energy-related shortages could be changed.

Several of those commenting stated that we had not sufficiently emphasized institutional constraints on development, such as water rights conflicts (see pp. 13, 34, 35, and 45), reserved water (see pp. 45 and 46), environmental restrictions (see pp. 14, 15, 25, 34, 35, 36, and 46), and streamflow requirements (see p. 46); that we had not stressed site-specific problems (see pp. 12, 14, 15, 34, 35, 38, 45, and 46); and that the time frame for analysis was too short (see p. 3).

However, although some of these issues represent significant problems that need resolution, they do not affect the amount of water which is physically available for the development of energy resources. Institutional constraints will determine who develops projects, when they are built, what development will occur, and where it will take place. The relatively small amount of water needed and the relative quantities available should assure adequate supplies.

Yes, there will be site-specific shortages of water. However, such problems simply emphasize the importance of substantive Federal planning that encourages development toward adequate existing water supplies. It should not be Federal policy to assure that each and every coal or oil shale deposit has water; rather, the policy should be directed toward guaranteeing adequate water to fulfill national energy goals.

We agree that the 1979-2000 time frame is relatively short, but those agencies most critical of that time frame use the same period in their analyses. Planning and development take time; delay can be expected. As Interior suggested, it may require a full 20 years to go from concept to operation.

Such comments, however, imply that water consumption estimates included in the report for 2000 are still too high. If it requires more than 20 years to plan, develop, and fully operate new projects, it will take more time to fully utilize existing unused water. Only if <u>all</u> planned irrigation, Reclamation, municipal, industrial, and energy projects are operating by 2000; and only if new technology or conservation does not decrease unit output water requirements, will water utilization estimates used in this report occur. Since such a condition is unlikely, more unused water is probably available in year 2000 than is predicted in this report.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

OCT 18 1979

Mr. Henry Eschwege
Director, Community and Economic
Development Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

This is in response to your September 14, 1979, letter to the Secretary requesting our comments on the GAO draft report, "Water Supply Sufficient to Satisfy President's Energy Goals."

The report presents an objective analysis of the physical availability of water supply for energy development in the West, and we generally concur in its conclusions. The recommendations for prompt water sale, EIS preparation and more accurate water supply/demand data, are immediate and modest. We concur in their thrust.

Since the intent of the report is to clarify public perceptions regarding water availability for energy development, we believe the report would benefit from more extensive discussion of the legal and political constraints which will affect the availability of that water. These concerns are discussed below:

While water is indeed physically available, its availability for synfuel development can, in specific areas, be seriously constrained by:

- The extent of appropriation of existing water including groundwater;

- The willingness on the part of existing water users to sell;

- The legislative, judicial and administrative decisions regarding transfer of water rights and changes in uses;

- Uncertainties with respect to the extent of instream flow requirements for fisheries, wildlife, water quality, navigation, and unsettled claims for Indian and Federal water rights.

- Physical and economic barriers to move the water to point of use, e.g., costs and delay involved with pipelines and rights-of-way.

We believe these constraints are of significant magnitude to require reference in the digest and conclusions.

In terms of required water resource project lead time, the report's 20 year time-frame represents a fairly short-range forecast. At least 20 years is needed to proceed from concept to construction and funding following current planning, environmental, and public involvement procedures and standards for water project development. As few site-specific energy developments, (with details of development methodology, energy needs, water supply identification, etc.) are in existence, a decision made today to develop site-specific water for energy projects, could not come to fruition before year 2000. National planning should proceed on a longer-term basis. The report seems to take the approach that as long as there is not a shortage by year 2000 everything will be okay. The report should recognize that present decisions on allocating current water supply will affect virtually all future water uses and the ability to change those uses.

We feel it important to point out that the overall findings of GAO's analysis should be regarded as an initial framework within which to conduct further and more extensive site specific examinations. While it may be true that total water supplies in the large geographic areas under consideration are sufficient to meet total projected energy demand, this conclusion is meaningful only as applied to specific locations for energy production.

In the discussions with your staff, it was generally agreed that once-through cooling is not a viable alternative in either the West or the East. Since the intent of the report is to clarify perceptions, we believe the extensive discussion of this technology should be deleted.

Finally, terminology frequently confuses the discussion. For example, in making the argument that past estimates of power plant water needs have been exaggerated (p. 10), the paper establishes need discrepancies by citing figures dealing with water "required", "consumed", "used", or "supply". The difference between diversion and consumption can be quite important. We suggest a careful reading of the text to correct any confusion in this regard.

Representatives of the Department have informally provided comments on the report to GAO representatives. In addition, we have enclosed a series of specific comments concerning the data and data interpretations referenced in the report.

Sincerely,

Assistant Secretary for
Policy, Budget and Administration

Enclosures

GAO Report "Water Supply Sufficient to Satisfy President's Energy Goals"

Specific Comments

The last paragraph on page iii of the Digest is misleading concerning cancellation of the Colorado and Missouri River Basin long-term contracts. That is, the commitments in the Missouri Basin (Yellowtail, Boysen) represented individual options to buy and not irrevocable contracts to buy. In addition, industry may have been discouraged as State water compact disputes, i.e., Montana and Wyoming, bloomed over the possibility of moving water from Yellowtail to the Gillette, Wyoming, coal area. The report underestimates the effects of legal and institutional constraints that may seriously affect water availability. For example, the Yellowstone River Compact of 1950 assigned 80 percent of the unused and unappropriated Bighorn River to Wyoming and 20 percent to Montana. As a consequence, there may be more than enough water to satisfy Wyoming's energy potential in the Gillette coal area, but there may be insufficient water to satisfy Montana's energy development goals.

The report fails to recognize environmental constraints of water use in areas that may have abundant coal resources. For example, perhaps half of the million acre-feet of temporarily unused agricultural water from the six Missouri River main stem reservoirs will be useable because of cumulative effects on air quality and the existing socioeconimic system's capacity to accommodate development. A basic contention of the report and the GAO report team is that future water for energy requirements in the short-term (1985) and midterm (2000) are now much less than the estimated projections in 1970. Contemporary reductions in estimates of water use are due principally to lower projections of energy needs and lower unit water requirements for production of useable energy resources due to technological advances in more efficient cooling processes for steam electric generation. Although these contentions may be valid, they are not adequately supported. For instance, the GAO team suggests that water for energy requirements needed to attain the President's energy goals are almost insignificant when compared with the amount of unused (or available) water in Reclamation and Corps of Engineers reservoirs. Scenarios of national energy demands covering the range from "highest conceivable" to "most likely" to "lowest possible" should have been developed to emphasize this point and to place demands upon available water in proper and understandable context.

In support of the overall thesis of reduced energy water demand, the report approvingly cites (p. 23) another recent report's estimates of 37,500 af/yr. for a 500,000 bbl/day oil shale industry in the year 2000. Simple extrapolation of 1979 industry figures gives a 150,000 af/yr. total for surface retorting only, which is probably high (even when compared to the GAO study-criticized 1974 DOI estimates of about 80,000 af/yr.). Entirely in-situ processing could reduce the requirements to as low as 5,000 af/yr. Clearly, single figures which purport to give the final word on this subject are premature when the actual technology mix to be used is so speculative.

A more adequate analysis and description of examples which show steam plant water consumption to be much less than expected would lend validity to the report. For instance, on page 10 it is indicated that early projection of Navajo Plant water consumption was 34,000 acre-feet (a.f.) per year for power generation but plant operation indicates that the plant "has operated for years and never has consumed more than 23,065 acre-feet per year". A similar average annual comparison was made for the Mohave plant from 30,000 a.f. of projected use to 14,709 a.f. of actual use. The text should explain the impacts of respective plant operating capacity, i.e., were they operating at maximum capacity or something less than that.

The report for the potential water demand from coal liquefaction cannot be ignored simply because an earlier study did so (for unstated reasons), especially where the GAO study is attempting to demonstrate the earlier study's inaccuracy. The later dismissal of liquefaction possibilities (p. 24) based on the absence of DOE-project production for the "Upper Colorado Region" overlooks the Yellowstone Basin's potential. A 500,000 bbl/day liquefaction industry there by the year 2000 would require up to 125,000 af/yr., increasing the study's projected requirements by 38-44%.

It may also be appropriate to mention the impacts on water availability of possible future Federal actions such as the potential influence that the Energy Mobilization Board might have in expediting the allocation and commitment of Federal water supplies for energy projects. Federal actions must be within the framework of State water rights laws, and the President has recently assured the States that he will not interfere with State water rights. There is now a greater possibility of disruption of the agricultural economy in local areas, as the purchase of existing rights may be the best alternative for a given energy company to obtain its water needs.

GAO Report, "Water Supply Sufficient to Satisfy President's Energy Goals"

Specific Comments:

Title of report misleading. The report, in fact, emphasizes Western energy development, but the title implies a report on all development throughout the United States. The title should be revised, or a more detailed analysis of energy development in the East made.

The report should include some discussion of the following major issues: quality of the water delivered to Mexico, instream flow needs for fish and wildlife, and ground water mining. The resolution of these three problems may have a substantial impact on the availability of water in the Colorado River Basin for other uses.

Page 6. The discussion of the errors in the estimates of water consumption by power plants is misleading. On page 6 it is stated that:

(1) estimates of growth rates for electric energy demand are decreasing;

(2) water consumption for power plants is much less than expected;

(3) numerous methods are used to conserve, reuse, or recycle water supplies.

The first of these is correct. However, the report leaves it very unclear why #2 is correct. Is it just because utilization is low or because the technical estimations of water use per unit of electricity produced were wrong? More likely, the problem is that we have made poor projections of energy production. If one wants a good estimate of future water use, it should be based on a future power production and not on plant capacity.

The third of these points is misleading. The power plants use closed cycle rather than open cycle cooling, which results in more consumption (about twice as much) but less withdrawal (about 50 times less). The low levels of water used reported on page 11 are not an indication of conservation but rather low demand for electricity.

Page 9. When one states water use in relation to capacity, one should state the load factor being used. Based on the best technical literature concerning water use in electric power generation, the following are reasonable estimates for 100MW plants at 85 percent load factors.

APPENDIX I

Cooling System	Acre Feet Per Year
Wet cooling towers	11,000 - 13,000
Cooling ponds	10,000 - 15,000
Once-through	7,000
Dry cooling towers	2,000

Page 10, paragraph 3. In discussing water consumption of the Mohave Power Plant, the report overlooks the fact that part of the water demand is met by recycling water from the coal slurry that supplies fuel to the plant.

Page 11, paragraph 1. The reasoning in the final sentence for reduced consumption appears faulty. Whether or not a plant is in a zero-discharge mode should have little bearing on consumptive use of water.

Page 11 (Table). For the four plants listed, the average consumption was 9,445 acre feet per year per 1000MW, which is about what one would expect at an annual capacity factor of around 60 percent.

* Page 12, paragraph 4. In discussing the Wyodak Plant, it might be worth noting that the dry cooling system is partly supported by DOE RD&D funding.

2nd paragraph
Page 15. The ~~last sentence~~ on this page suggests that once-through cooling consumes only a very small amount of water. In fact, the evaporative losses in once-through cooling are about 60 percent of the evaporative from cooling towers per unit of heating. The consumption in once-through cooling occurs in the rivers (due to the elevated water temperatures) while the consumption in cooling towers occurs on site.

Page 20, paragraph 3. The comparison of 1974 oil shale water requirements with those of 1979 overlooks the fact that the later figures are for a different conversion mode--surface processing vs. modified in-situ, respectively. The wording implies that the 1974 figures were simply overestimates by the Department of the Interior.

Page 23, paragraph 3. This discussion on oil shale, particularly oil shale leasing and operations on Federal lands, needs to be updated and several factual statements corrected: Add, "However, Federal leases in Colorado, Tracts C-a and C-b, are being actively developed in support of future modified in-situ operations.

"Shafts are currently being sunk, in-depth environmental monitoring is being carried out, and mine support facilities are being constructed. If commercial development is feasible, shale oil production could begin in the mid-1980's."

*Note: Certain page numbers and paragraph numbers changed to reflect final report.

Page 25. The report should address the fate of poor quality water at the receiving end of a slurry pipeline.

Page 34. In the first paragraph the statement ". . .a change in market demand have virtually eliminated new demands for project water" glosses over the issue of price. Perhaps the economic demand itself hasn't changed, rather the price has increased and the quantity demanded has dropped in response to that.

Page 44, paragraph 4. The conclusion that use of ground water in some cases could increase stream flow may be correct in a few instances. However, where ground water is tributary to stream flow, the more general case, stream flow is likely to be depleted by ground water pumping. Furthermore, the zero discharge requirements mean that this water will not go back to the streams.

Page 47. In the first paragraph it is stated that water efficiency has increased. It is not clear from the evidence presented that this is the case. In fact, the opposite may be true due to various environmental laws.

Page 51. Perhaps the third recommendation of the report should be broken down into the following distinct parts:

(1) Improve unit consumption estimates based on the operating experience of existing plants (unit consumption expressed in quantity of water per quantity of electricity produced).

(2) Improve projections of energy production (especially electricity).

Appendix VI. The chart on proposed projects could be revised and updated:

- "Rio Blance" should be "Rio Blanco" (Rio Blanco Oil Shale Company).
- "OXY/Ashland" should be "Occidental Oil Shale, Inc."
- The estimated 1985 production could be updated. The most recent estimate, if commercial development is feasible, is for a total of 105,000-135,000 barrels per day in 1987.

UNITED STATES WATER RESOURCES COUNCIL

SUITE 800 • 2120 L STREET, NW WASHINGTON, DC 20037

OCT 17 1979

Mr. Henry Eschwege
Director, Community and Economic
Development Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Eschwege:

Thank you for the opportunity to review the draft report titled Water Supply Sufficient to Satisfy President's Energy Goals. Our principal concern is discussed below. Detailed comments are included as an enclosure to this letter.

The GAO draft report concludes that ample water exists in this country to meet the water requirements associated with the President's Energy Goals. While this may be true at the national and to a lesser extent the regional level, the report should be careful not to infer that water supplies are readily available and developed at the subregional and local levels to satisfy the Nation's water for energy needs. We believe that many of the President's initiatives relating to new energy development can proceed, but not without careful and coordinated water resources planning.

Failure of the draft report to give visibility to this fundamental issue allows for substantial misinterpretation by the public of the difference between water sources and water systems. Due to the high degree of political interest in such matters, we strongly urge that the report stress...

- o the importance of water resources planning to meet future energy needs,
- o the importance of recognizing the lead time associated with the planning process.

We trust that these comments will be helpful in finalizing your report. If we can be of further assistance, please advise.

Sincerely,

Leo M. Eisel
Director

Enclosure

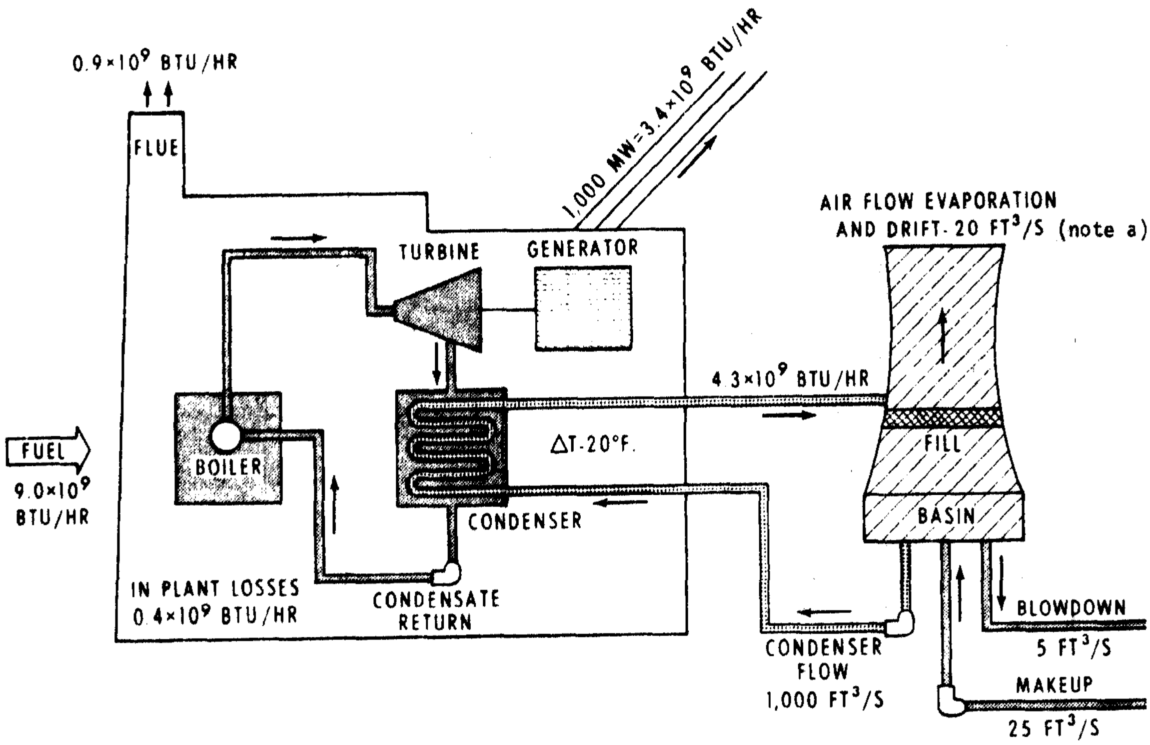
MEMBERS: SECRETARIES OF AGRICULTURE, ARMY, COMMERCE, ENERGY, HOUSING AND URBAN DEVELOPMENT, INTERIOR, TRANSPORTATION; ADMINISTRATOR, ENVIRONMENTAL PROTECTION AGENCY - OBSERVERS: ATTORNEY GENERAL; DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET; CHAIRMEN, COUNCIL ON ENVIRONMENTAL QUALITY, TENNESSEE VALLEY AUTHORITY BASIN INTERAGENCY COMMITTEES; CHAIRMEN AND VICE CHAIRMEN, RIVER BASIN COMMISSIONS

Detailed Comments on GAO Draft Report Titled: Water Supply Sufficient to Satisfy President's Energy Goals

Page	Comment
i	Include definition of "available water" in glossary.
	The statement "... it appears that (water for energy) development is possible without interfering with existing users or proposed water projects" does not fully recognize the potential conflict of instream uses.
	Depending on what studies you are referring to, the statement "more recent studies... suggest adequate water supplies in the Upper (Colorado) Basin through at least the year 2000" is not accurate at the subregional and local level.
iv	An additional item to be added under the heading "most common (water) sources for additional water for energy development..." is water conservation/water use efficiency.
v	The statement "... claims of physical water shortages caused by proposed energy development are unwarranted" is not necessarily a representative assessment at the subregional and local levels of planning.
4	The second part of the statement "... water shortages within the (Upper Colorado) Basin are inevitable soon after the year 2000, but that there is time to plan for and manage the shortage" is a key point that the draft report needs to further emphasize. It appears to be the only reference to water resources planning as a prerequisite to regional/subregional energy development.
6	The statement "water consumption is small relative to physical availability" may be true on a regional level but not necessarily true at a subregional/local level.
9	The statement "energy-related water needs are small relative to physical availability of water supplies and future energy development upon availability of unappropriated or unused water," may not be an accurate assessment for all regions and subregions.
18/19	These tables should note that the baseline energy scenario was used for the basis of comparison.

Page	Comment
19	The reported levels of coal gasification and coal liquefaction for the Upper Missouri River Basin in note a/ should be double checked.
21	Although coal liquefaction summaries have been omitted from the second table, it should be footnoted that this energy technology was included as part of the baseline energy scenario for many of the States listed.
44	The statement "...groundwater pumping could increase stream flow" is not necessarily true if the groundwater provides the only source of water to the stream.
45	Some discussion of senior/junior water rights could be included under Legal Claims.
46	The statements "...Upper Colorado Basin should have ample water through at least the year 2000. Since there is sufficient unappropriated water to fulfill projected developmental needs, existing water consumers need not fear the growth of energy development" may be an overly optimistic assessment at the subregional level.
48	The statement "two recently completed studies for the Water Resources Council support the contention that water will be available in the energy resources States through at least 2000 without much, if any, impact on current uses" again does not fully recognize the significance of instream uses.
	The Second National Water Assessment identifies portions of Upper Colorado and Upper Missouri Basins suffering from inadequate surface-water supplies. Specific water use problems identified in these regions include energy and industry resource development, crop irrigation, hydroelectric generation, and overall conflicts between instream and offstream uses.
Other:	The draft GAO report discusses in great length the Upper Missouri and Upper Colorado Section 13(a) draft assessments. Based on this information, the reader may conclude that all potential sites for nonconventional energy development (i.e., coal gasification, coal liquefaction) would be located in the Western States. This may not be true as evidenced by the draft Section 13(a) water for energy assessment now being completed by the Ohio River Basin Commission. The GAO report should acknowledge that nonconventional energy development may be considered for the Upper Missouri, Upper Colorado, Ohio River Basin, and other regions of the country.

DIAGRAM OF FOSSIL-FUELED STEAM ELECTRIC PLANTS

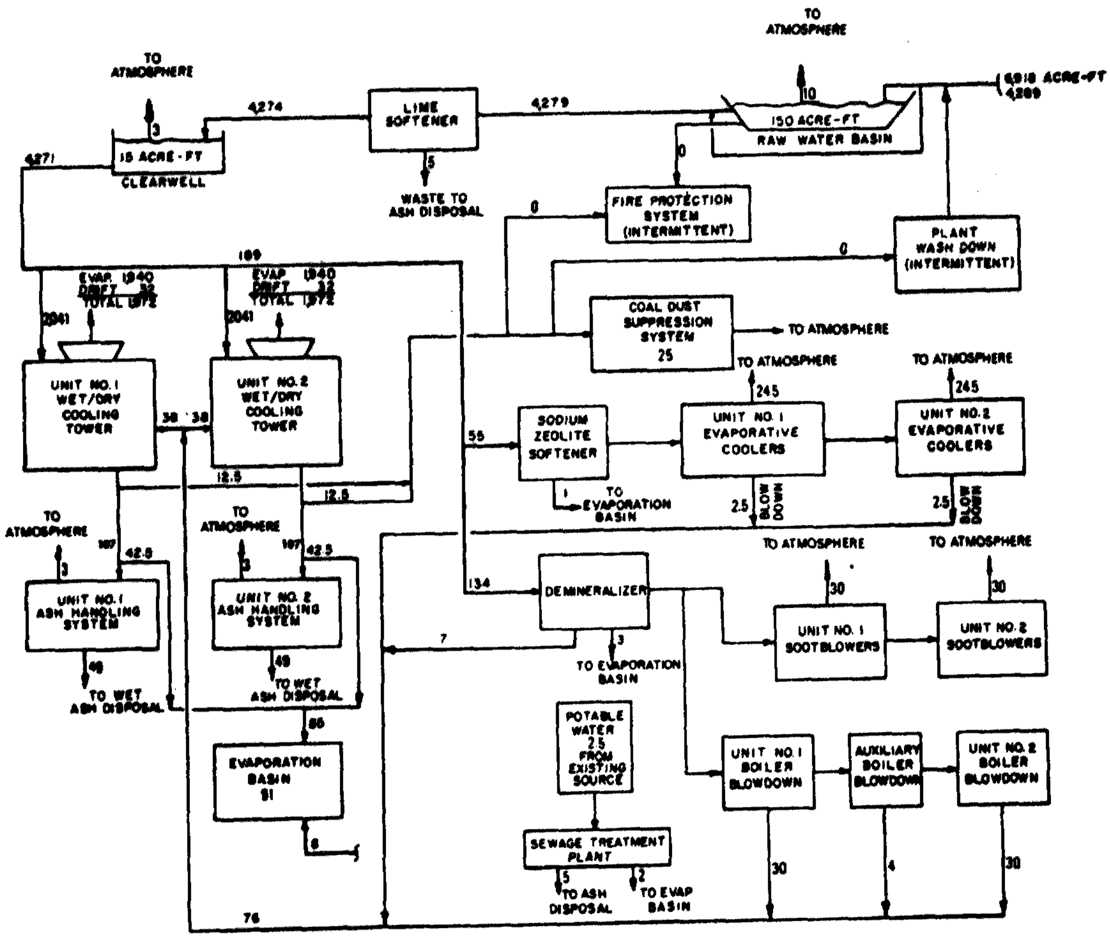


Heat balance diagram of typical 1,000-mw fossil-fueled thermal-electric plant.

a/FT^3/S = cubic feet per second

Source: U.S. Geological Survey Circular 703, Water Demands for Expanding Energy Development

WATER BALANCE FOR STEAM ELECTRIC PLANT



Note: Flow rates are in yearly averages and, unless otherwise noted, in gallons per minute (gal/min).

Source: Emery Units 1 and 2, Utah Power and Light - 860 Mw

SYNTHETIC FUELS AND UNCONVENTIONAL GAS ESTIMATES INCLUDED IN PRESIDENT'S JULY 16, 1979, INITIATIVES

	MMB/D (note a)
Coal liquids, coal gases	1.0 to 1.5
Oil shale	0.4
Biomass	0.1
Unconventional gas	0.5 to 1.0

a/Millions of barrels per day.

SUMMARY OF ALTERNATIVE ENERGY TECHNOLOGIES' PROJECTS

GEOTHERMAL DEVELOPMENT

The only geothermal powerplant in the United States is located in the "Geysers" area north of San Francisco. This facility is operated by Pacific Gas and Electric Company and has a generating capacity of 502 Mw. Further expansion is planned for the Geysers area, which by 1987 could be producing 2,000 Mw of electric power.

Another geothermal field exists in the Imperial Valley in southern California. Private concerns plan to produce electricity from wet steam in this area in the near future. The area has an estimated potential of over 4,000 Mw of electrical energy for 25 years.

Other geothermal facilities are tentatively planned in Utah, Nevada, and New Mexico. Testing and drilling is continuing, and construction of a 50-Mw unit near Roosevelt, Utah, is possible. Public Service Company of New Mexico is planning a 50-Mw plant, 60 miles north of Albuquerque, in 1982. The plant is a demonstration facility, and further expansion depends upon success of the initial unit.

At the Geysers area and the proposed New Mexico plant, all powerplant cooling water is supplied by geothermal steam condensate. In both cases, water from outside sources will not be needed. The primary water supply options for geothermal facilities in the Imperial Valley are Colorado River water, agricultural wastewater, and geothermal steam condensate.

OIL SHALE DEVELOPMENT PROJECTS

In both Utah and Colorado, several companies are in various stages of developing private and Government-owned oil shale tracts. The companies are involved in land acquisition, environmental assessments, and retort technology research. Several aboveground technologies have been tested at the pilot level and are technologically ready for commercial scale operation. In situ retorting of oil shale is still experimental and not yet ready for commercial operations.

Eight commercial projects have been announced. The projects and their estimated 1985 production include:

Proposed Commercial Projects

Western Oil Shale:
A 1978 Perspective

Group	Location	State	Est. 1985 prod. (bbld)
Rio Blanco	Tract C-a	Colo.	4,000
OXY/Ashland (note a)	Tract C-b	Colo.	7,000
White River	Tract U-a, U-b	Utah	0--Minimal
Colony	Dow	Colo.	b/48,000
Union	Parachute Creek	Colo.	9,000
TOSCO	Sand Wash	Utah	8,000
Superior	White River	Colo.	12,500
Navy/TRW	NOSR 1 and 3	Colo. and Utah	None
		c/Maximum	88,500

a/Occidental Oil Shale, Inc.
b/1985 production for the Colony project is more likely to be 10,000 barrels per day.
c/U.S. Geological Survey reported that "if commercial development is feasible, * * * a total of 105,000-135,000 barrels per day in 1987 (is possible)."

Source: "Report: Oil Shale in Colorado 1979," Colorado Energy Research Institute, January 1979.

COAL GASIFICATION PROJECTS

Several companies are planning coal gasification projects. Currently there are three high-BTU projects which might begin construction within the next few years:

1. American Natural Gas Coal Gasification Company.

   Plans are to build a 125-mmcfd (million cubic feet per day) plant in North Dakota by 1983. A second 125-mmcfd plant will follow if the first unit is successful. The 250-mmcfd plant will consume about 17,000 acre-feet of water per year from Lake Sakakawea through a 40-year contract with Reclamation.

2. El Paso Gasification Company.

   Plans call for construction of a gasification complex with an ultimate capacity of 410 mmcfd near Farmington, New Mexico. The complex will be developed in several increments beginning with a 288-mmcfd facility. Water requirements are estimated to be 10,358 acre-feet per year initially with a total requirement of 15,000 acre-feet for a 410-mmcfd complex. Water would be provided from Navajo Reservoir through a water service contract with Reclamation, which has yet to be executed.

   This project has been postponed due to inflation and coal contract problems.

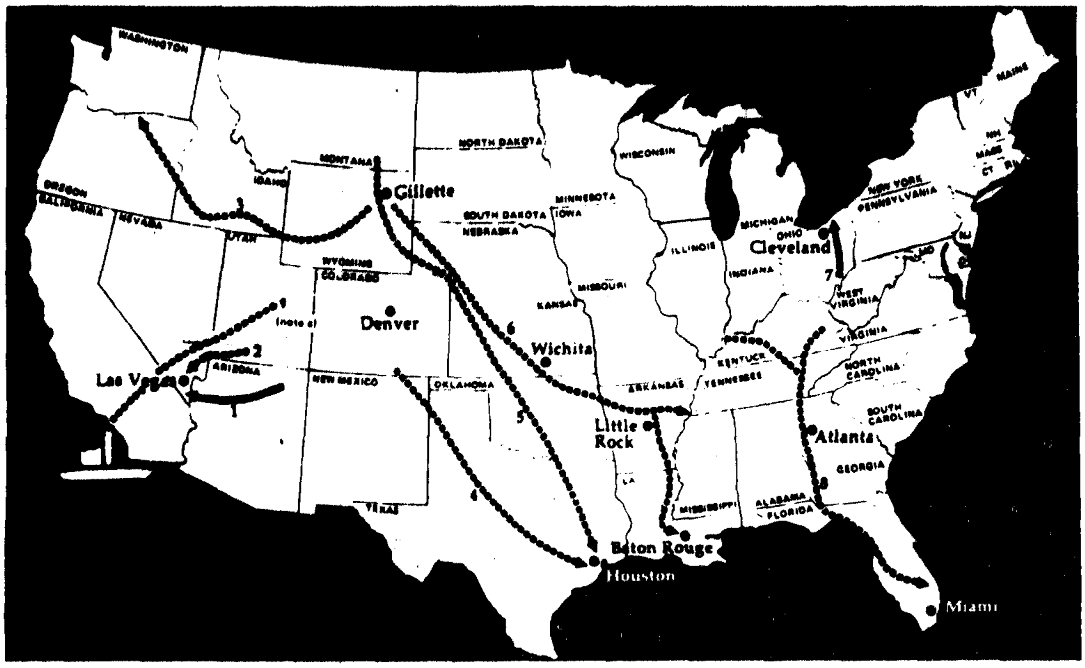
3. Western Gasification Company (WESCO).

   Plans call for construction of four 250-mmcfd units near Farmington, New Mexico. Water consumption is estimated to be 31,940 acre-feet per year. This water is to be furnished from Navajo Reservoir through an existing water service contract with Reclamation.

   This project has been postponed indefinitely because of inflation and protracted contract negotiations with the Navajo Tribal Council.

COAL SLURRY PIPELINE SYSTEMS

EXISTING PIPELINES ▬▬ PLANNED OR UNDER STUDY ••••••



PIPELINE SYSTEM	LENGTH (Miles)	ANNUAL CAPACITY (Millions of tons)	DATE OPERATIONAL (Current Estimate) (note a)
1. BLACK MESA PIPELINE	273	4.8	IN OPERATION
2. ALTON PIPELINE	183	11.6	1983-88
3. GULF INTERSTATE-NORTHWEST PIPELINE	1,100	10.0	POSTPONED
4. SAN MARCO PIPELINE	900	15.0	1983
5. WYTEX PIPELINE	1,260	26.0	1985
6. ETSI PIPELINE	1,378	25.0	1983
7. OHIO PIPELINE	108	1.3	CLOSED
8. FLORIDA PIPELINE	1,500	53.0	b/ 1985-86
9. PACIFIC BULK COMMODITY TRANSPORTATION SYSTEM	645	10.0	NO ESTIMATE

a/ ESTIMATES GIVEN TO GAO BY PIPELINE COMPANY REPRESENTATIVES.

b/ ASSUMES THAT EMINENT DOMAIN LEGISLATION (FEDERAL OR STATE) WILL BE PASSED WITHIN THE NEXT 3 YEARS.

c/ MOST LIKELY ROUTE UNDER CONSIDERATION

Source: Slurry Transport Association

SUMMARY OF UPPER COLORADO BASIN STATE WATER LAWS

The Colorado River is one of the Nation's most physically developed and controlled streams. It has also been subject to more litigation and controversy in the last 50 years than any other river. The allocation of Colorado River water is controlled by interstate compacts, international treaty, Supreme Court decisions, and Federal statues, collectively known as the "Law of the River." In addition, Federal environmental statutes and the Federal "reserved rights" doctrine affect water usage.

In the Upper Colorado River Basin, water usage is subject to State water laws. The basic features of State water laws include prior appropriation, priority dates, beneficial use requirements, changes in provisions, and severability of water use from the land.

LAW OF THE RIVER

The cornerstone of the Law of the River is the Colorado River Compact of 1922. The compact

--defined the Colorado River System as that portion of the Colorado River and its tributaries within the United States;

--divided the Colorado River Basin into two subbasins with Lee Ferry, Arizona, the division point between the Basins;

--apportioned 7.5 million acre-feet for use of each Basin;

--allowed the Lower Basin to increase its beneficial consumptive use of water by 1 million acre-feet per annum; and

--provided for the equal sharing of any deliveries of water to Mexico required by treaty and not available from unapportioned flows.

The compact provided a legal framework within which the water resources of the Colorado River Basin could be developed.

The Upper Colorado River Basin Compact of 1948 apportioned the Upper Basin's 7.5 million acre-feet among Arizona, Colorado, New Mexico, Utah, and Wyoming. The Upper Basin Compact provided guidelines for the curtailment of Basin use if necessary and the apportionment of main-stem reservoir evaporation.

These two compacts are the basis for calculating Upper Basin State shares of Colorado River water. Although other elements of the Law of the River affect water use in the Upper Basin, the compacts provide for the divisions of Colorado River water among the Upper Basin States.

STATE WATER LAWS

The use of water by individual claimants in the Upper Basin is subject to each State's water laws. The basic elements of the State water laws are similar. The unique feature of western water law is the concept of prior appropriation which is incorporated in the water laws of each Upper Basin State. The basic principles of prior appropriation are that

--water rights are acquired by diverting and putting water to beneficial use,

--water rights are property rights to the use of water, and

--water rights are ranked in chronological order: first-in-time is first-in-right.

The older the water right (the more "senior"), the more assured is the holder that water can be used. In periods of low streamflows, newer right holders ("junior" right holders) can be ordered to cease diverting water. This system provides greater certainty of water availability for senior right holders. The date of acquiring a water right establishes a priority for the right.

Establishing a water right generally involves four steps:

--Application for, and issuance of, a permit to divert.

--Diversion of water.

--Beneficial use of the water.

--Filing for, and approval of, the water right.

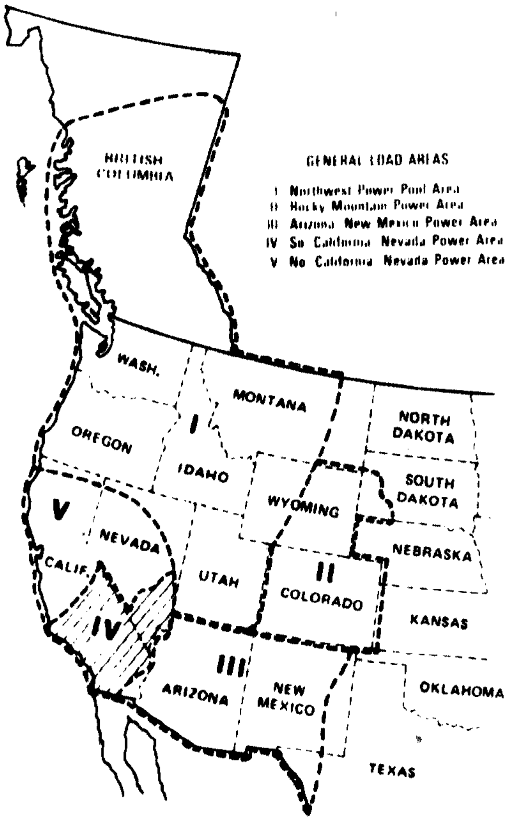
In Colorado, no permit to divert is required. All Upper Basin States prohibit a new appropriation if current water rights would be impaired.

Once a water right is established, generally it can be transferred from one owner to another, from one use to another, and from one location to another. However, each State's laws vary somewhat in this regard. Because water rights are established under State authority, they are not transferable from State to State.

Water rights are rights to put water to beneficial use. Failure to use the water can result in losing the rights through forfeiture or abandonment. These actions to establish forfeiture or abandonment have not been widely used in the Upper Basin. However, if water availability were critical, forfeiture and abandonment might gain importance.

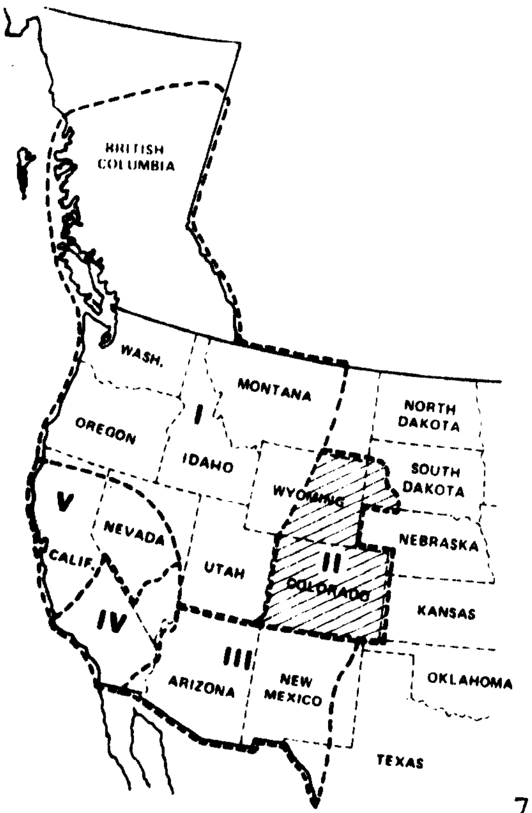
 APPENDIX IX

WESTERN SYSTEMS COORDINATING COUNCIL



SOUTHERN CALIFORNIA–NEVADA POWER AREA (SO. CAL–NEV)

ANAHEIM, CITY OF
BURBANK, CITY OF
CALIFORNIA DEPT. OF WATER RESOURCES
CALIFORNIA – PACIFIC UTILITIES COMPANY
GLENDALE, CITY OF
INTERMOUNTAIN CONSUMER POWER ASSOCIATION
LINCOLN COUNTY POWER DISTRICT
LOS ANGELES DEPT. OF WATER AND POWER, CITY OF
METROPOLITAN WATER DISTRICT/SO. CALIFORNIA
NEVADA POWER COMPANY
PASADENA, CITY OF
RIVERSIDE, CITY OF
SAN DIEGO GAS & ELECTRIC COMPANY
SOUTHERN CALIFORNIA EDISON COMPANY
STATE OF NEVADA
U.S.B.R. AT BOULDER CITY



ROCKY MOUNTAIN POWER AREA

BASIN ELECTRIC POWER COOPERATIVE
BLACK HILLS POWER AND LIGHT COMPANY
COLORADO SPRINGS, CITY OF
COLORADO – UTE ELECTRIC ASSOCIATION
LAMAR, CITY OF
PLATTE RIVER POWER AUTHORITY
PUBLIC SERVICE CO. OF COLORADO
SO. COLORADO POWER DIVISION, CENTRAL TELEPHONE & UTILITIES CORP.
TRI–STATE GENERATION & TRANSMISSION ASSOCIATION, INC.
U.S.B.R. LOWER MISSOURI REGION
U.S.B.R. UPPER COLORADO REGION
WESTERN AREA POWER ADMINISTRATION LOWER MISSOURI AREA
WESTERN AREA POWER ADMINISTRATION UPPER COLORADO AREA

APPENDIX X

SUMMARY OF FIVE ESTIMATES OF WATER AVAILABLE TO THE UPPER COLORADO RIVER BASIN STATES

1. Compact

The Colorado River Compact of 1922 apportioned the assumed annual dependable flow of the Colorado River System:

Assumed flow	16.0 + million acre-feet (MAF)
Lower Basin share	8.5 MAF
Upper Basin share	7.5 MAF

The Colorado River Compact provided for equal division of any future deficiencies caused by water deliveries required by treaty with Mexico. However, based on records available in 1922, the average flow of the Colorado River System was 18 MAF. Water deliveries to Mexico with an 18-MAF system flow would not require any reduction of consumptive use in either the Upper or Lower Basin.

The Upper Colorado River Basin Compact of 1948 gave Arizona 50,000 acre-feet per year.

The remaining Upper Basin share was allocated to:

	(percent)
Colorado	51.75
New Mexico	11.25
Utah	23.00
Wyoming	14.00

2. New Mexico

The following analysis of Colorado River System flows and Upper and Lower Basin shares that the New Mexico State Engineer provided to the Subcommittee on Energy Research and Water Resources, Senate Committee on Interior and Insular Affairs, June 12, 1975.

	(MAF)
Assumed average flows:	
Upper Colorado River system	14.0
Lower Colorado River system	1.5
	15.5
Compact apportionment	16.0
Deficiency	(0.5)
Division of deficiency:	
Deficiency	0.5
Mexican treaty deliveries	1.5
	2.0
Lower Basin share (half)	1.0
Upper Basin share (half)	1.0
Upper Basin water supply:	
Per compact	7.5
Deficiency	(1.0)
Available to Upper Basin	6.5

3. Wyoming

A study prepared in 1965 for the Upper Colorado River Commission by Tipton and Kalmbach, Inc., indicated that the average virgin flow of the Colorado River at Lee Ferry was 14 million acre-feet for 1921-64. With operation of the Colorado River Storage Project reservoirs and a virgin flow of 14 million acre-feet, the Upper Basin could use 6.3 million acre-feet while maintaining Lower Basin deliveries of 7.5 million acre-feet.

This is one of three compact water supply estimates contained in the Wyoming Water Planning Program of June 1975. The other estimates are the compact supply (see 1 above) and the Reclamation estimate. (See 4 below.)

 APPENDIX X

4. Reclamation

Reclamation estimated the average Colorado River flows to be 15 million acre feet and calculated the Upper Basin share as follows:

	(MAF)
Colorado River flows	15.00
Lower Basin share	(7.50)
Half of Mexican treaty	(.75)
Uncontrolled flows	(1.00)
	5.75

Reclamation rounds the Upper Basin share to 5.8 million acre-feet.

5. Conservative

Depending on the years selected for analysis, the average virgin flow of the Colorado River was estimated by some sources to be about 13.7 million acre-feet.

	(MAF)
Upper Colorado River Commission	13.7
Engineers from the Lower Basin States	13.7-14.0
Researchers at the Laboratory of Tree Ring Research, University of Arizona	13.5 + 0.5

Based on conservative flow estimates of 13.7 million acre-feet and half of the Mexican treaty water delivery requirement, the Upper Basin share would be:

	(MAF)
Colorado River flow	13.70
Lower Basin share	(7.50)
Half of Mexican treaty	(.75)
Upper Basin share	5.45

APPENDIX X

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We do not endorse any calculation of water available to the Upper Basin presented in this summary. This material was presented to show the range of figures available to represent Upper Basin water supply.

(080370)

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