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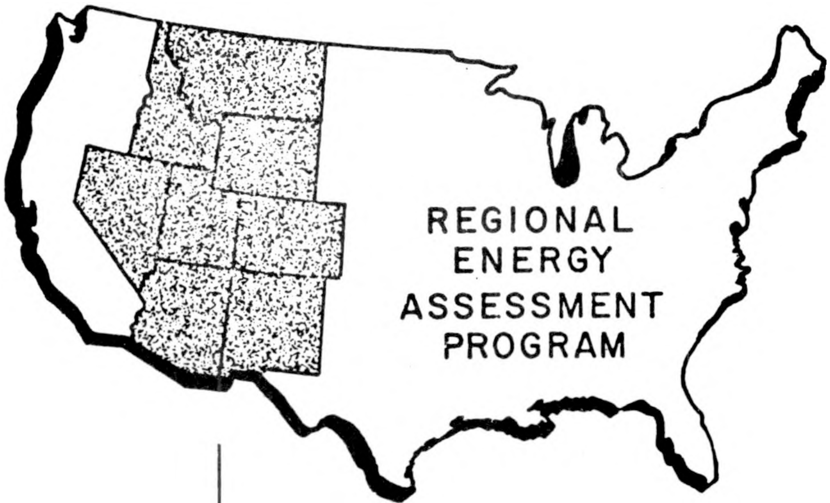

An Assessment of Water Resources in Utah and Nevada for a Proposed Electric-Power Generating Station

by

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CONTENTS

FIGURES

TABLES

AN ASSESSMENT OF WATER RESOURCES IN UTAH AND NEVADA FOR A PROPOSED ELECTRIC-POWER GENERATING STATION

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ABSTRACT

This report was part of a multidiscipline coal and transportation study conducted for the California Department of Water Resources to determine the feasibility and practicality of siting a 1000-MW, coal-fired, electric-power generating station in the desert regions of southern California, southeastern Nevada, or east-central Utah by 1983.

The scope of this report is limited to consideration of water resources in desert regions of Nevada and Utah and includes assessments of the availability and accessibility of enough water (15,000 acre-ft) to support the process and cooling requirements of a 1000-MW coal-fired generating station, and of the legal and administrative constraints on appropriation and use of water in both states.

Part I deals with Nevada: the availability of surface water resources in the Colorado River Basin, the agricultural water rights market, groundwater administration, and selected groundwater basins that seem promising for industrial development. Part II deals with ground and surface water availability in Utah, primarily in Carbon and Emery Counties, and with the Colorado River salinity control program in eastern Utah which suggests possible collateral industrial development. Part III deals with the prospects for water transfer between California and the other two states.

I. NEVADA

Introduction

Impact of the Kaiparowits Decision. The hotly contested issue of the proposed 3000-MW Kaiparowits project in southern Utah was resolved in April 1976 by the development consortium's decision to abandon the project, ostensibly because of spiraling costs and the spectre of continued delays resulting from opposition by environmental pressure groups. A number of conclusions can be drawn from that decision. One is that the interests of electric utility companies, either individually or as part of a development consortium, may best be served with minimum delays when their expansion plans involve sites as remote as possible from population centers and areas of established recreational or scenic value. A pattern may emerge in the Southwest wherein electric utilities propose project sites in isolated desert regions, thus minimizing potential environmental opposition and the costly delays that inevitably accompany such opposition. Furthermore, such a strategem may be advantageous economically, even though more front end costs may be necessary in the form of railroad spurs or transmission interties. These "additional" costs, however, must be weighed against multiplying costs occasioned by years of delay.

Such planning is indeed being examined and implemented today by some utility companies in the western states, and its potential advantages have helped guide some aspects of the research underlying this report. The Sierra Pacific Power Company, for example, which serves most of northern and central Nevada, recently conducted a comparative site analysis for a proposed 500-MW coal-fired generating station.[1] Most of the conventional criteria seemed to favor a site in the Carson Desert just west of Reno. It was believed, however, that the use of groundwater for the plant would harm the nearby Stillwater Wildlife Management Area and Stillwater National Wildlife Refuge and that environmental opposition, therefore, would be intense.[2] Consequently, the site selected was in a more remote part of Nevada, the Treaty Hill site near Battle Mountain. This choice, however, will mean constructing about 180 miles of new 230-kV transmission lines west to Reno and south to the company's substation near Austin, Nevada. Transmission costs are presently estimated to be $50,000/mile.[2] Although the company's battle for the project which is based entirely on the use of groundwater is not over, the choice of site probably enhances the prospects for eventual success with minimal delay, and, in the long term, ensures greater economy. Other companies may well take similar approaches to the problem of siting power generation facilities in the western states.

Study Area in Nevada. The Nevada part of the study was devoted to approximately the southeastern third of the state because of the proximity of the well-established corridor through which power generated in that part of Nevada could be transmitted to southern California. Another, less substantial, corridor crosses the Sierra Nevada Range west from Reno.

The Union Pacific Railroad enters Nevada east of Caliente, crosses the southern tip of Nevada near Las Vegas, and enters southern California (Fig. 1). This is the route by which coal is brought from Utah to supply Nevada Power Company's 360-MW Moapa generating facilities. Another rail line, the Nevada Northern, links the Ely area with the Western Pacific Railroad at Shafter and the Southern Pacific Railroad at Cobre. The Southern Pacific line will supply coal from central Utah to the Sierra Pacific plant mentioned above.

In addition to the two rail lines and transmission corridor, there are a number of groundwater basins in the southeastern third of Nevada which appear to have great potential for development. As a number of these basins are discussed in greater detail later, a word of background may be in order.

In examining Nevada's future electric power requirements, the State Division of Water Resources analyzed groundwater resources in the state that would be available to support electric-power generating stations. Because of the limited and already appropriated surface water supplies in Nevada, additional agricultural and industrial expansion in the state's economy will depend heavily on development of groundwater aquifer systems. During its survey, the Division of Water Resources identified several hydrographic regions in the state which can provide enough groundwater, under administrative guidelines set forth below, for 1000-MW of electric-power generating capacity.[3] These groundwater basins in the southeastern third of Nevada are in the Colorado River Basin, the Central Region, and the Great Salt Lake Basin (Fig. 2). Their specific locations and identifications are shown by Fig. 3.

Although most of this region (parts of Nye, White Pine, and Lincoln Counties) is quite remote, there are small communities whose already established social infrastructure may support a thermal-electric project. A socio-political analysis of a hypothetical generating station in the region is provided in another section of the composite study of which this report is only a part.

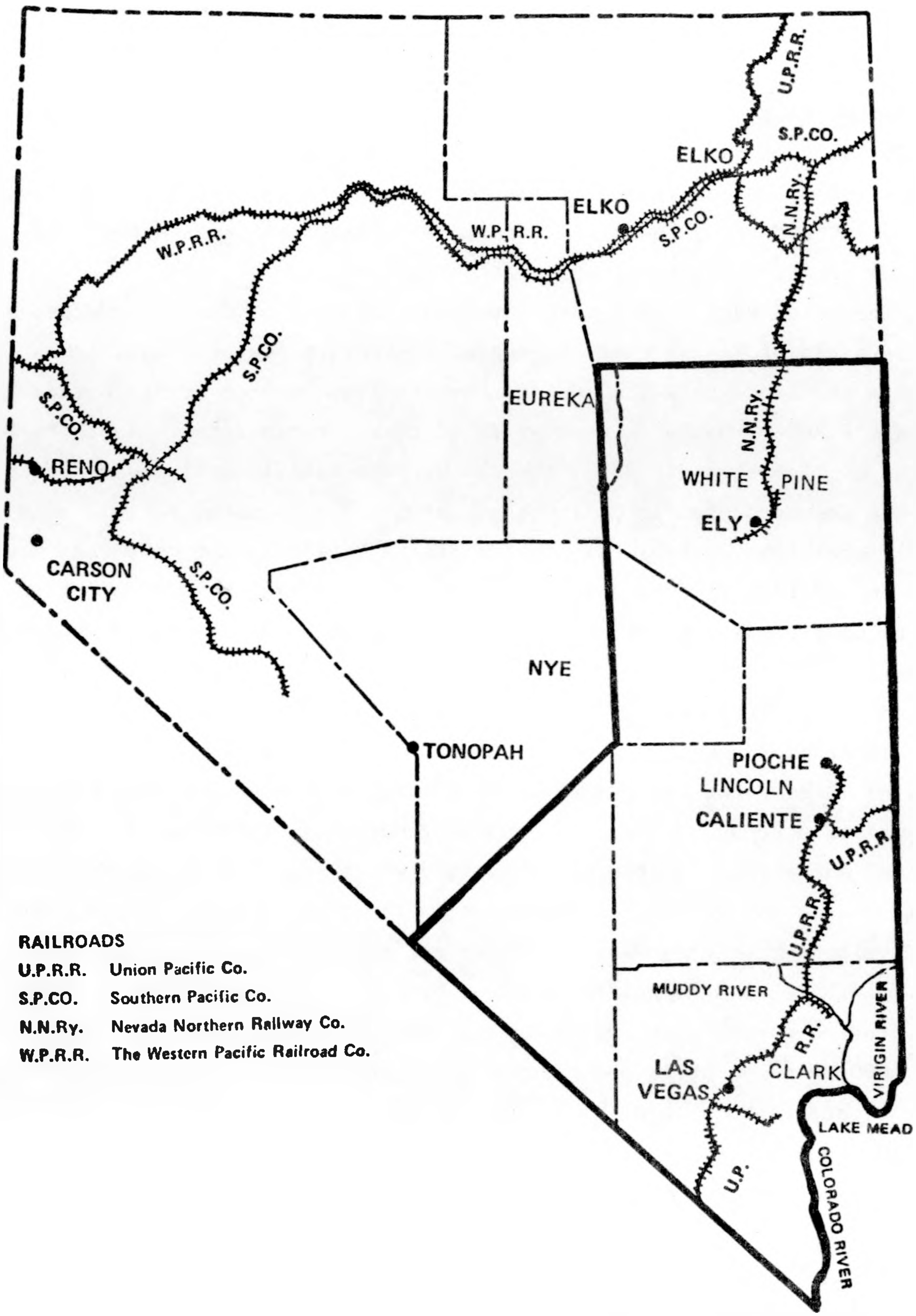

Fig. 1. Study Area in Nevada.

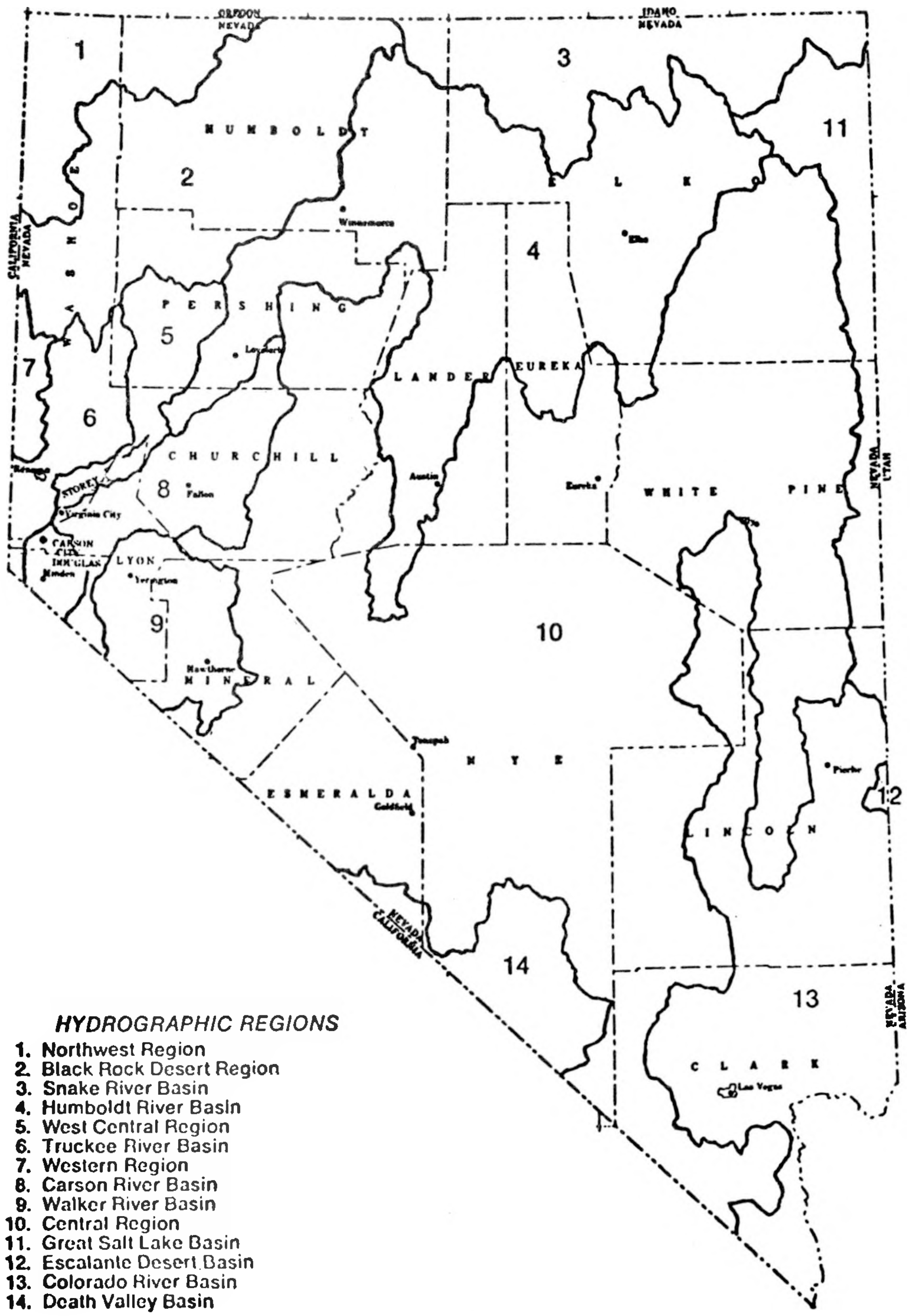

Fig. 2. Hydrographic Regions of Nevada.

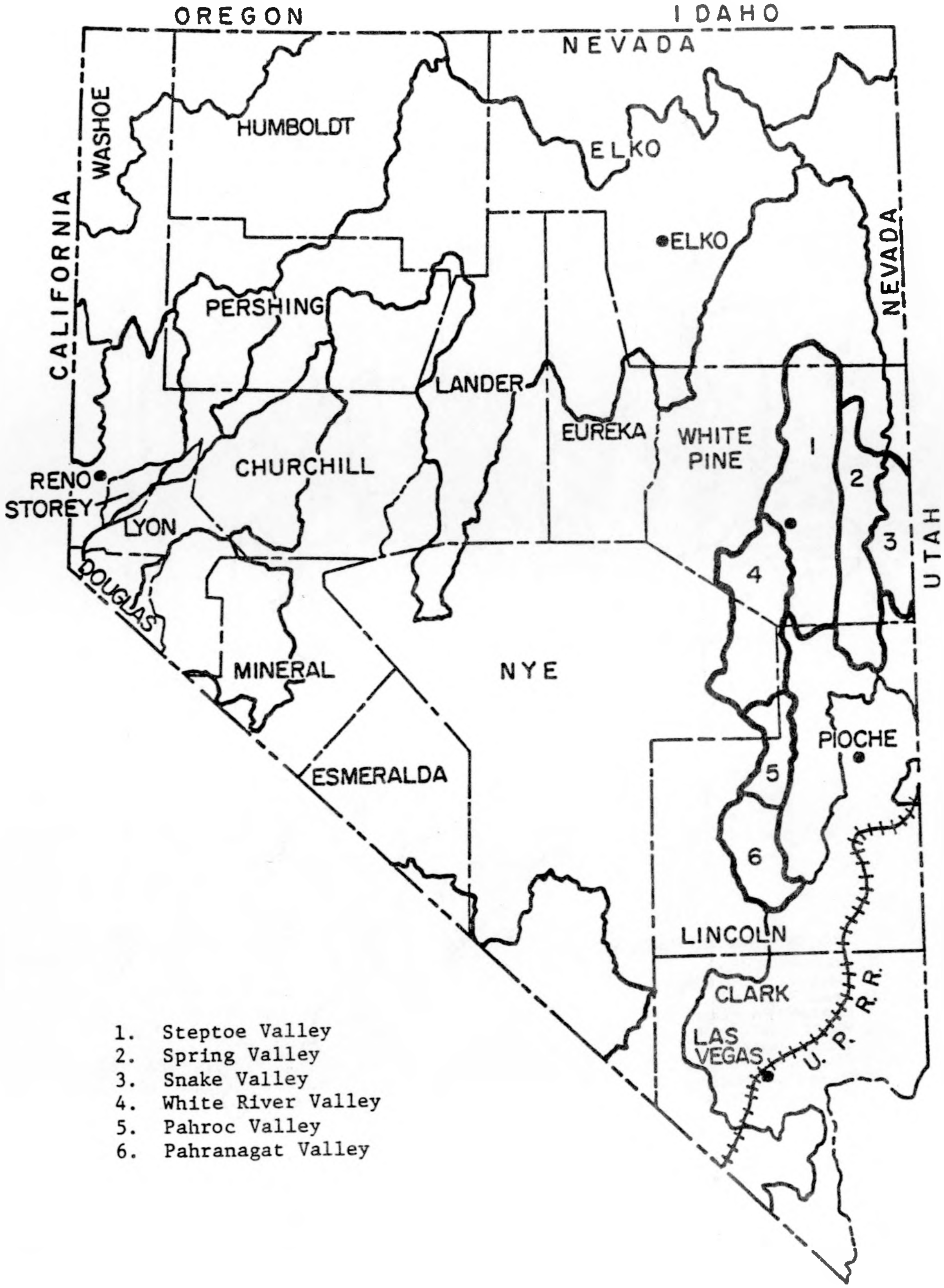

Fig. 3. Favorable Groundwater Basins

Nevada Groundwater Administration and Water Law. Only two points of Nevada state water law, relative to the purpose of this report need be mentioned. Following an interlude of 13 years, 1872-1885, during which state water law was based on riparian rights, Nevada has held to the doctrine of prior appropriation. As in most states and territories of the arid West, the courts found that the riparian doctrine did not serve the wants and needs of the people in mining, agriculture, or industry.[4] Subject to supply and existing rights, water may be appropriated for any beneficial use. Upon the State Engineer's finding that the intended appropriation will not infringe upon the value of existing rights or is otherwise detrimental to the public interest, he is required by statute to approve the new application.

One particular aspect of groundwater appropriation should be noted. The State Engineer's general policy is to limit groundwater withdrawals from any basin in Nevada to an amount equal to the "perennial yield" of the basin. This means the amount of groundwater that could be withdrawn for an indefinite period without causing a permanent depletion of water stored in the aquifer system or causing deterioration in quality. Typically, perennial yield in an open groundwater system is calculated by the amount of water annually discharged from the system through springs, evaporation from bare soil, and transpiration by phreatophytes. Note that the perennial yields of the basins identified in Fig. 3 have been found adequate to support a 1000-MW generating station.

Some consideration has been given to the effects of planned and temporary overdevelopment of basin aquifer systems in order to achieve a "take-off" in economic growth within a particular region. Such a strategy has been used in Utah and New Mexico to achieve economic benefits. In Nevada also, groundwater withdrawals in Clark County have rapidly depleted the aquifer system underlying the Las Vegas Valley.[5] By 1970, the withdrawal rate in Clark County was three times the systems natural recharge rate, but the general policy on groundwater use in Nevada is as stated above.

Possible Institutional Constraints. In response to the Kaiparowits Environmental Impact statement, particularly the sections on power transmission corridors across Nevada, the Clark County Regional Planning Council recently adopted a position that might affect any new proposed power generating station in the southern part of the state. The adopted policy states, in part:

Ideally, no new power lines should be considered within the Clark County region for the sole purpose of interstate transmission of power, except in the Laughlin area--south of Davis Dam. However, in case of reciprocal benefits to Nevada and surrounding states, this policy can be modified by the Council.[6]

Also in Nevada, as in other western states, there is a growing feeling that energy produced primarily for out-of-state marketing ought to be taxed. In Nevada this is coming to mean that power produced for interstate transmission must also have a fractional market within Nevada. Current legislation* in Nevada gives the State Public Service Commission discretionary authority in granting construction permits so that any interstate power project using Nevada's natural resources (water?) may be required to market within the state an amount of power not exceeding that which is exported.[7] Thus, the Nevada PSC may stipulate that up to half of an interstate project's power output be marketed within Nevada.

Availability of Surface Water Resources

Colorado River System. The 1928 Boulder Canyon Act, clarified and extended by the U. S. Supreme Court in the case of Arizona vs California et al. (1963), allocates 300,000 acre-feet of mainstream water from the Colorado River to Nevada.[8] Nevada thus is entitled to this water in addition to that in the two principal Colorado River tributaries in Nevada, the Virgin River and the Muddy River.

Until recently, most of Nevada's consumptive entitlement of mainstream Colorado River water was allowed to flow downstream because southern Nevada's water needs were easily supplied by groundwater withdrawal. Population explosions in Clark County, however, have compelled the state to start making the full 300,000 acre-ft Colorado River entitlement accessible for beneficial use. This is being done through the Southern Nevada Water Project, a joint undertaking of the State of Nevada and the Bureau of Reclamation.

The completed project, undertaken in two phases, is to provide bulk water delivery to the municipal distribution systems of Boulder City, North Las Vegas, Henderson, the Las Vegas Valley Water District, and Nellis Air Force Base.[9]

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*Nevada Revised Statutes, Chapter 704, The Utility and Environmental Protection Act, Section 704.892.

The first stage, completed in 1971, provides 132,000 acre-ft. By 1981 it is hoped that the second stage, providing an additional 166,800 acre-ft, will be complete. Then Nevada's complete Colorado River entitlement will be put to use.[10]

Note that unlike many projects, the Southern Nevada Water Project is not one that will provide much surplus water for new industrial and agricultural uses and against which new appropriations can be charged. Rather, it will make the municipalities of southern Nevada less dependent on a rapidly diminishing groundwater system. No project water is committed to agriculture and, probably, none will be committed to new industrial projects such as power plants beyond the municipalities concerned.

Nevada water authorities have recently acknowledged the tightness of the surface water supply budget, including the Southern Nevada Water Project. A water rights summary of the Colorado River Basin in Nevada, excluding the Virgin and Muddy Rivers, notes that total contracts for both surface and groundwater, including contract options on the second stage of the Southern Nevada Water system, amount to 600,000 acre-ft/yr. The maximum supply under full Colorado River development, on the other hand, is estimated to be only 470,000 acre-ft/yr including return credits.[11] The anticipated deficit of some 130,000 acre-ft will be erased gradually by various means, including reduction of groundwater rights and by the decreasing temporary allocations to some uses such as the Mojave Generating Station.[12]

Thus, despite the Southern Nevada Water Project and full development of the Colorado River in Nevada, the water budget instead of having any surplus, is fully appropriated at best. Furthermore, as in virtually all western states, it is not clear whether the 27,000 acre-ft allocated to the Fort Mojave Indian Reservation is the reservation's final legitimate entitlement, for although the Supreme Court sustained the federal government's claims for the reservation in 1963, those rights were not quantified.[13] Therefore, any assertions about water budgets in Nevada or elsewhere rest upon great uncertainties due to unquantified federal reserved rights for Indian reservations, many cases of which are presently in the courts.

All of this is not to say, however, that there is no surface water available in southern Nevada. It does mean that a new applicant for water will probably have to enter the marketplace for existing rights.

The Muddy and Virgin Rivers. The Muddy River issues primarily from springs in the upper Moapa Valley and flows about 25 miles before entering Lake Mead.

The Muddy, with an annual flow of about 46.5 cfs (34,000 acre-ft/yr) is one of the main Colorado River tributaries in southern Nevada.

It is most unlikely that the State Engineer would grant new permits for water from the Muddy River. It is already over-appropriated, and new users who get water from the system do so by acquiring existing rights. Nevada Power Company's Reed Gardner station uses a small amount of water from the river acquired from existing agricultural rights, but the company has had to supplement this supply from wells.[14] The State Engineer has not approved recent applications for water in the aquifer system that sustains the Muddy River Springs and the Muddy River.[15]

The Virgin River is an interstate stream, flowing through parts of Utah and Arizona, as well as Nevada. In Nevada, the principal use for the water is agricultural, there being no significant industrial development. Most of the land being farmed is in the Mesquite-Bunkerville area along the river near the Utah border.

Because the Virgin River is an interstate stream, the greatest uncertainty about it is Nevada's impending apportionment negotiations with Utah and Arizona. Very little of substantive importance in the negotiations has occurred to date, because the committee was just recently authorized. Whatever apportionment scheme the state commissions arive at must be ratified by the respective legislatures, and Congress must then ratify the interstate compact. This promises to be a time-consuming procedure; a similar Truckee River interstate compact between Nevada and California is now experiencing rough sledding in Congress.[16]

Nevertheless, despite what may be a pervasive tendency in the Nevada Division of Water Resources to withhold new permits for appropriating Virgin River waters until an interstate apportionment scheme is defined, the State Engineer has not declared the basin closed, although estimates are that the only available "surplus" water from the stream in Nevada would be flood waters,[16] a very unpredictable and uncertain supply, particularly as there are no storage facilities on the stream.

The State Engineer has not received new applications for permits on the Virgin for several years, so there are no recent precedents for predictions about new applications. As is always the case, a new application would have to be considered in the light of existing rights. Given the on-going apportionment discussions with Utah and Arizona, the prospects for a new application for Virgin water seem very problematical but not necessarily impossible.

Industrial and Municipal Sewage Effluent. The Allen Station of what has been called the Warner-Allen Project* will use for cooling water about 37,000 acre-ft of municipal and industrial sewage effluent from the Las Vegas Valley. Nevada Power Company received the effluent water by a contract with Clark County which was subject to final approval by the State. The effluent costs Nevada Power 26¢/1000 gal (about $85/acre-ft) not including the costs of transportation 25 miles to the project site.[14]

This quantity of sewage effluent is only about half that available from the system. The suggestion has been made that the remaining effluent might be an attractive "new," though limited, source of water. In fact, however, the Colorado River Commission of Nevada has already filed for the rest as return flows to the Colorado River (after treatment) to be credited against Nevada's compact apportionment. So this water is already included in the Commission's demand and supply projections of the water rights summary mentioned earlier.

The Agricultural Water Rights Market. From the discussion above, it seems probable that the only access to surface water in southern Nevada is through acquisition of existing agricultural rights. For the Virgin River, however, even this seems improbable. In the Nevada part of the stream, only 4,000 acres are under cultivation in the Mesquite-Bunkerville area. Even this relatively small water commitment (less than 40 sec-ft) is of such poor quality, "too thin to plow but too thick to drink," that reverse flushing of the headgates and canals is necessary after each irrigation. With more attractive options available for obtaining industrial water (as discussed in the next section), the Virgin River is particularly unattractive.

The Muddy River, on the other hand, is a possible source of surface water available through the market place. For the last eight years, water has been diverted from agricultural to municipal and industrial use. Nevada Power Company, for example, has acquired water through two means. By purchasing a ranch, they acquired about half their water requirements (1500 acre-ft) for the Moapa Valley generating station. The rest, about 2000 acre-ft, they got by leasing winter agricultural water at approximately 5¢/1000 gal.[14] Agricultural water

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*The Warner-Allen Project is a proposed power development involving Nevada Power Company, the Los Angeles Department of Water and Power, and the city of St. George, Utah. Two coal-fired generating stations, one in the Warner Valley near St. George and the Allen Station about 25 miles northeast of Las Vegas are envisioned. Coal for each station will be provided by slurry from the Alton coal field north of Kanab, Utah.

from the irrigation companies in Moapa Valley is still being diverted for other uses, as land developers are acquiring farm and ranch lands for subdivision.

Access to surface water in southern Nevada is possible but tightly circumscribed. Hence, the attractiveness of unappropriated water in certain groundwater regions of eastern and southern Nevada, three of which are described below.

Potential Groundwater Basins

The projected role of groundwater resources in the future industrial and agricultural expansion of Nevada's economy is mentioned earlier in this report. Of the several groundwater regions in Nevada, those identified in Fig. 3 are among the most promising for future development. For ease of analysis, the hydrographic areas numbered 1-3 are considered together as they constitute about half of White Pine County. Areas 4-6 comprise most of the White River Valley and also are considered as a group.

Eastern White Pine County. White Pine County (county seat at Ely) is a sparsely populated region (1970 census 10,150) of eastern Nevada which, in many respects, seems ideally suited for industrial activities. The mining sector of the county's economy, which is dominated by Kennecott's copper mine and smelter operations, accounts for 35% of total county employment (18.9% of state mining employment) and 43% of the county payroll, more than twice as much as any other occupation.[17] The county thus has an established industrial tradition that may make siting power generation facilities there less problematical than elsewhere. Furthermore, from the perspective of this inquiry, the eastern half of the county has a very favorable hydrologic system that underlies the three hydrographic regions of concern: Steptoe, Spring, and Snake Valleys.

Steptoe Valley. This valley, hydrographic area 1 in Fig. 3, is the location of Ely, McGill, and Ruth, the principal communities of White Pine County and the center of the county's copper mining activity. Steptoe Valley extends from its southern boundary northward 110 miles to the bedrock narrows five miles north of Currie in Elko County. Between drainage divides, the valley is about 30 miles wide near McGill, but is usually less than 20 miles wide. Altitudes vary from 5800 ft at the valley floor to 11,890 ft in the mountains east of McGill.[18]

Duck and Steptoe Creeks are the principal streams and, with others of intermittent flow, account for the approximately 28,000 acre-ft of runoff to the valley lowlands.[18] Half this quantity, however, is diverted from Duck

Creek by pipeline to meet copper production needs at McGill.

Next to its mineral resources, the valley's most valuable resource may be the very large amount of water stored in the valley-fill reservoir. The most recent State and USGS analysis suggests that five million acre-ft may be stored in the top 100 ft of saturated alluvium.[19] Furthermore, the water is quite accessible. The static ground water level is about 50 ft near Ely and probably less than 100 ft throughout most of the valley. The groundwater level in the northern part of the valley is inferred to be as shallow as 10 ft throughout much of the area.[20]

As discussed earlier, however, perennial yield--the amount of water equivalent to the area's natural recharge or discharge from the system through springs and evapotranspiration--is a more accurate estimate of unappropriated water available for use under current Nevada water administration. Steptoe Valley's perennial yield is about 70,000 acre-ft/yr. Note that this figure is for the whole valley; if 70,000 acre-ft were withdrawn annually from a single area, water levels there would be lowered significantly.

Water-consuming industrial facilities in this or any hydrographic region of Nevada should be sited in areas within the hydrographic region where the natural discharge is highest. In Steptoe Valley, such an area might be the Duck Creek fan northwest of McGill. The natural discharge is relatively great compared to that of other areas studied, and the radius of measurable pumping influence would be restricted on three sides by wet lowlands that would act as recharge boundaries.[18] It is quite likely that a properly spaced well field in this area could provide 15,000-20,000 acre-ft/yr for several decades.

Spring Valley. Just east of Steptoe Valley, Spring Valley is defined by the north-trending Schell Creek and Snake Mountain ranges. Although Spring Valley may be as good, perhaps even better, than Steptoe in terms of water availability, in other respects, it is clearly inferior for potential industrial development. This is due primarily to its relative remoteness. Although remoteness was touted in the introduction of this report as being a distinct advantage, in comparison with Steptoe Valley which has an established industrial tradition, a rail line, and an existing social infrastructure, Spring Valley seems a less likely candidate region for industrial siting.

Primary existing access to the valley is U.S. Highway 50 east from Ely across Connors Pass (altitude 7722 ft), and U.S. Highway 93 north from Pioche. There are no significant established communities in the valley. The total population of the entire 1700 square miles consists of less than 100 people in scattered ranch families.[21] Railroad access to the valley could be established, either north from the Union Pacific line at Pioche or south from the Western Pacific line at Shafter.

The surface hydrology of Spring Valley is characterized by 13 perennial creeks with a combined flow of about 50 cfs (22,000 acre-ft/yr), half of which is diverted for irrigated agriculture and stock watering.[22]

Like Steptoe, Spring Valley also has a very large amount of water in ground storage. The top 100 ft of saturated alluvium is estimated to contain 4.2 million acre-ft.[22] In the geographic center of the valley, on a line directly east from Ely, static groundwater levels are less than 10 ft; they deepen, within 30 miles north and south of the valley's center, to an inferred depth of about 200 ft.[22]

Spring Valley's perennial yield is estimated to be 100,000 acre-ft/yr, as great as that of any hydrographic region in Nevada. The phreatophytes are dominated by large expanses of greasewood and rabbitbrush. Salt grass, meadow grass, and "swamp cedar" are less important.[22] The occurrance of the "swamp cedar" in the valley lowlands is indicative of wet areas in the basin floor and the shallow water table, for swamp cedars generally are found only in the higher, subhumid mountain areas.

The water can be expected to reflect the dominance of calcium, magnesium, and bicarbonate, the poorest quality water generally occurring in the center of the valley, the area of highest natural discharge and shallow water levels. Even here, however, existing stock wells produce water with less than 1000 parts per million of mineral content.[22]

The hydrologic balance of Spring Valley is virtually pristine, compared to that of other areas of the state and the arid West. The reconnaissance study of the area summarizes:

> The surface-water and ground-water flow systems in Spring Valley have been modified only to a minor extent by the activities of man. The principal change has been the diversion of somewhat more than 8,000 acre-ft of streamflow for irrigation. In effect, this diversion has modified the system only to the extent of putting to beneficial use this amount of water that formerly was consumed by native vegetation and evaporation on the valley floor.[22]

Snake Valley. Still further east in White Pine County, along the Utah border, is Snake Valley, part of the Great Salt Lake Basin that extends well into Utah. Like Spring Valley, the Snake Valley is remote. Rail access might be achieved south from the Western Pacific line at Wendover, or west from the Union Pacific line near Delta, Utah. This implies up to 75 miles of new rail construction for a facility sited in the Nevada part of the basin. For a Utah-sited facility, however, the Snake Valley might hold some promise. The valley extends into Utah at a point just west of Sevier Lake about 55 miles from Delta.

To judge from the hydrologic reconnaissance work in the valley, water is not a limiting factor for further development. The recoverable groundwater stored in the top 100 ft of saturated alluvium is estimated to be at least 12 million acre-ft.*[23] Near Baker, Nevada, static groundwater levels are commonly less than 50 ft. Because dependable surface water and spring supplies in the Snake Valley are fully utilized, primarily by scattered ranches, further development would be predicated upon the perennial yield, estimated to be about 80,000 acre-ft/yr.[23] Although utilization of this groundwater is certainly possible, its extensive development in either Utah or Nevada certainly would require the cooperation of the other state, because the hydrologic linkage is clearly established.

The White River Basin. The second principal area of southeastern Nevada where enough water to support a 1000-MW generating station probably could be obtained is the White River Basin, regions 4-6 in Fig. 3. This valley is a long tongue of the Colorado River drainage basin. The White River proper is inconsequential in the lower 2/3 of the basin, because it is virtually consumed within 60 miles of its head, well within the boundaries of hydrographic region 4. The river channel, dredged during the Pleistocene epoch when the climate was more humid than at present, merely serves to give an identity to the entire drainage basin.

White River Valley. The northern-most hydrographic region of the basin, region 4 in Fig. 3, is called the White River Valley. There is no industrial activity in the part of the White River Valley in White Pine County. All the water taken from the river and its principal tributary, Ellison Creek, is devoted to irrigation and other ranching uses. Over the years, the maximum flow

*The Nevada part of the valley has an estimated storage of 1.3 million acre-feet.[19]

reaching the valley lowland near Preston is estimated to be only about 4 sec-ft, and the average flow is about 2 sec-ft.[24]

Agriculture in the valley depends, as would any potential industrial development, on supplementary ground water sources. The valley aquifer system, in both White Pine and Nye Counties, is estimated to contain 4.9 million acre-ft, about as much as any hydrographic region in the state. The amount estimated to be available for appropriation, however, is only about 37,000 acre-ft.[19] The average static ground water level in the Preston-Lund area is about 50 ft. Logs and well performance show that aquifers suitable for development of large-capacity wells occur at depths of 15-50 ft.

Pahroc Valley and Pahranagat Valley. These hydrographic regions, 5 and 6 in Fig. 3, constitute the middle part of the White River channel. Taken as a whole, this is a very beautiful area of primarily agricultural activity. Pahranagat Valley is a center of range livestock growing and dairy farming that centers primarily around Hiko, Crystal, and Ash Springs. These springs annually discharge about 25,000 acre-ft and are the principal sources of water in the valley.[25] In contrast, natural ground water discharge in Pahroc Valley is negligible. Most of Pahranagat and all of Pahroc Valley are used for livestock range. Other than the springs mentioned, there are no other significant surface water sources in either valley.

Reconnaissance studies estimate that the top 100 ft of saturated deposits contain 1.3 million acre-ft in Pahroc Valley and 1.7 million acre-ft in Pahranagat. Static ground water levels in Pahroc tend to be quite deep, averaging perhaps 300 ft, whereas in Pahranagat, as the several springs suggest, they are much more shallow, usually less than 50 ft throughout the length of the White River channel.

Because of the shallow water table in Pahranagat, the natural discharge by evapotranspiration--the perennial yield--is estimated to be about 25,000 acre-ft.[25] This amount would be subject to new appropriation without interferring with already adjudicated rights. Although an early study by the Nevada Department of Conservation and Natural Resources[25] suggested that the perennial yield of Pahroc Valley may be less than 3,000 acre-ft, a more recent analysis estimates it to be about 21,000 acre-ft/yr.[26]

Although the perennial yield in either valley is apparently barely enough to sustain a 1000-MW generating station, these yields are for the valleys as a whole; any single well field of reasonable dimensions probably would not, by itself, yield the required amount of water under the present state water administration rules. Furthermore, as the political science portion of this composite study suggests, Pahranagat Valley residents would be much less enthusiastic than those in other study areas about a proposed power plant, so the possibility of acquiring supplemental existing rights would be very problematical.

Summary

Table I summarizes some of the important hydrologic features of the basins discussed above. From the point of view of gross water availability in aquifer systems, each could meet the water requirements of a 1000-MW generating station. However, the three valleys of eastern White Pine County obviously have much higher potential for industrial development than do the valleys of the White River Basin. For this preliminary survey, perhaps the most important comparisons to be made from the table are the perennial yields and water table depths in each hydrographic region.

The apparent superiority of the regions in eastern White Pine County is particularly important when correlated with information derived in the socio-political part of this study. There also, it appears that as far as eastern and southern Nevada are concerned, White Pine County may be among the most promising site locations for a steam-electric plant. Well established industry serves as the economic base in the Ely area; a railroad brings coal from central Utah; the environmental opposition to a steam-electric plant is potentially less in Steptoe Valley than elsewhere; and it may be possible to acquire existing surface water rights, supplemented, perhaps, by well water.

The valleys of the White River Channel, on the other hand, are clearly of secondary potential in terms of possible ground water availability, and there seems to be less inclination on the part of the agricultural interests of the basin to part with their water rights. Furthermore, a steam-electric plant in the basin would necessitate significant new railroad construction.

Given the tightly circumscribed availability of surface water in Clark County and southern Lincoln County, and the badly overdrawn ground water system in the Las Vegas Basin, White Pine County, and particularly Steptoe Valley, may warrant closer analysis as potential sites for a steam-electric plant.

TABLE I

HYDROLOGIC CHARACTERISTICS OF SELECTED BASINS

Hydrographic Basins	Perennial Yield (AF/yr)	Storage, AF (Top 100 ft)	Approximate TDS Range (ppm)	Typical Well Yields (gpm)	Static Ground Water Level (ft)
1. Steptoe	70,000	5,000,000	195-800	500-1500	50-100
2. Spring	100,000	4,200,000	150-1000	500-2000	10-200
3. Snake	80,000	1,300,000	175-800	150-3600	10-100
4. White River	37,000	4,900,000	300-1000	300-1800	>50
5. Pahroc	20,000	1,300,000	400-2200	200-1800	>300
6. Pahranagat	25,000	1,700,000	400-2200	200-1800	10-300

Source: Refs. 15, 18-25.

II. UTAH

Introduction

Impact of the Kaiparowits Decision. There can be no question but that the decision by Southern California Edison and San Diego Gas and Electric to abandon the Kaiparowits project caused great anger and disappointment among Utah officials and those citizens whom the project would have most directly affected.

As noted below and in the socio-political part of this study, most Utahns are firmly committed to development of the state's natural resources. Following the Kaiparowits decision, Utah Governor Calvin Rampton (on KSL Radio, Salt Lake City, April 15, 1976) vowed that in the future the politics of delay and indecision that helped kill the Kaiparowits project would be countered more effectively. Perhaps then, future energy projects such as steam-electric plants may enjoy an even stronger spirit of accomodation from Utah officials, if development plans evolve more circumspectly than the Kaiparowits project apparently did, with due regard for environmental concerns.

Perhaps one of the most significant results of the Kaiparowits decision is the emergence of the "energy corridor" concept and the present examination of that concept by a commission that Governor Rampton appointed. For this report, the energy corridor seems to offer the greatest potential among other development possibilities for power plant siting in Utah. The corridor will be discussed below in connection with the Green River.

One might think that abondonment of the Kaiparowits project would lead to a sudden surplus of water in Utah, as the 102,000 acre-ft project allotment was returned to the state's water budget. Such is not the case, however. Table II shows the water budget of Utah's apportionment of the Colorado River system.

TABLE II

WATER BUDGET OF THE COLORADO RIVER SYSTEM IN UTAH (AS OF NOVEMBER 1975).[a]

	Units 1,000 acre-feet
Apportionment	1,438 (based on 6.3 million acre-feet available to upper basin)
Present Depletion (1975)	693
Main Stem Reservoir Losses	120
Total depletion	813
Unconsumed water	625
Committed water[b]	580
Water available for future development	45

[a] Source: Dee C. Hansen, "Water Available for Energy - Upper Colorado River Basin," Address to ASCE Convention, Denver, Colorado, November 1975. As of January 1977, the figures remain substantially the same with one exception: the allotment to the Kaiparowits Consortium will be reduced from 102,000 acre-ft to 30,000, thus possibly making an additional 70,000 acre-ft available for future development. Personal communication from Stan Green, Utah Water Rights Division, January 18, 1977.

[b] Water for use of which the State Engineer has approved permits such as the Central Utah Project. The Kaiparowits entitlement is included in this category.

Thus, with the Kaiparowits water returned, Utah has about 150,000 acre-ft of unallocated water from the Colorado River system. However, there are over one million acre-ft of applications, mostly by the energy industry.[27]

Elsewhere in Utah, in the Great Basin drainage west of the Colorado system, the Sevier River basin is fully appropriated and ground water permits are issued only for preferred uses and with carefully guarded limitations. In that part of the Great Basin drainage bounded by Nevada, the Sevier River, and the Virgin

River basin, no ground water permits are being issued. Clearly in this area overdraft of the aquifer system is occurring, as there has been about one ft of ground subsidence in the Milford area.[28] Only along the southern border regions of Utah does it appear that significant additional quantities of water might be developed from the Navajo Sandstone formation. This possibility is covered in greater detail later.

State Water Administration. Utah, with an agrarian heritage like that of other western states, has traditionally given high priority to the agricultural use of water. Thus, Governor George D. Clyde could tell the Idaho Bureau of Reclamation in 1961 that water use in the west should continue to be ordered as follows: (1) direct human consumption, (2) irrigation, (3) industrial uses, (4) nonconsumptive use such as power generation and recreation.[29] Clyde was probably expressing the sentiments of most westerners who would assent to the same priorities today, particularly as regards agriculture and industry.

In Utah, however, it is important to gauge the importance of what might be seen as a minirevolution in thought about water use priorities. Less emphasis is placed on agrarian tradition, and more on economic development. The value of water in uses such as recreation, aesthetics, and the maintenance of biologic communities has also increased relative to traditional uses. However, it is the emphasis on economic development that is pertinent to this report. A recent state water planning document remarks:

> Since the provision of increased opportunities for employment and income to the State's residents is considered to be one of the major concerns to the State, plans for water use, in general, should be directed toward assuring that water will be available for those uses which offer the greatest promise of such opportunities. In general, it is believed that this will accrue from municipal and industrial type water uses.
>
> The Board [of Water Resources] considers the use of water for the irrigation of new lands to be relatively less advantageous to the State under conditions now existing than some possible alternative uses. Utah has some 4,000,000 acres of new land which could be irrigated if water were available. However, the remaining unused water supply, even if fully dedicated to the irrigation of new lands, would be far from adequate to serve this area. Moreover, it is clear that farm sizes are increasing and the proportion of Utah's citizens who could be employed in agriculture by the irrigation of new lands is decreasing. At the same time, in much of the State, the existing economy, principally agricultural, has been predicated upon a water supply greater than reasonably can be expected. For this and other reasons, a steady decline in the economy of these areas is occurring.[30]

The socio-political part of this study deals with cultural factors that also underscore the increasing emphasis on and desirability of industrial development. Although, since World War II, Utah and other western states have experienced dramatic economic growth in nonagricultural sectors, Utah's emphasis on water for industrial use may be exceptional in the west. Its importance should not be missed.

It is this philosophy, perhaps, that embodies the state's "public interest" aspect of water doctrine. Utah, an appropriation state like most western states, accepts priority of filing, however, as only one criterion for approving or disapproving an application for water. In addition to filing priority, the State Engineer of Utah takes into account the degree to which the proposed project--be it agricultural, industrial, or something else--is perceived to be in the public interest.[27] The state water planning document cited earlier remarks:

> ...there are opportunities to guide the use of those rights (555,000 acre-feet), which are approved but not yet consumed. Much of the water is held by public agencies, including the Board of Water Resources, and the development can be altered according to State policies and according to what is determined to be in the public interest. (Ref. 30, p. 39, emphasis added).

In addition to this "public interest" aspect of a proposed project, the State Engineer may also take into account the degree of progress in the planning for a project. Thus, it is not necessarily true that a new applicant for water in Utah will be standing in line behind earlier applicants for a total of over a million acre-ft. The 1975 Utah Legislature failed to approve legislation that would codify this "public interest" concept into law, so it is presently merely an administrative ruling.

Allied with the "public interest" aspect of Utah water administration is the State requirement that appropriators show "due diligence" in any construction necessary to put the water to its intended use (Ref. 30, p. 24). Applications which the State deems are not being pursued may be eliminated, thus restricting any tendency to speculate or lock-up water rights.

A final feature of Utah water administration to be noted is the 1976 provision for fixed-time applications. As opposed to granting water rights in perpetuity, this provision allows for use of a given quantity of water for a fixed period, after which the use right reverts to the state.

These features of Utah water administration--the public interest aspect with its several criteria, due diligence, and fixed time applications--all give great flexibility to the water application process in the State, as well as signifying some interesting nontraditional pertubations in western water administration.

The Agricultural Water Rights Market. Generally, the potential for acquiring existing surface agricultural water rights in Utah may be greater than in many other states, because of many Utahns' strong desire to create new economic opportunities. This potential for acquiring existing rights is particularly strong in areas such as Carbon and Emery Counties where much farming is already a marginal enterprise. The socio-political part of this study deals in greater detail with local attitudes, but, inasmuch as Carbon and Emery Counties figure prominently in the following section of this report, some comments are in order here.

Carbon County presently has 12,344 acres of irrigated cropland; Emery County, 38,604 acres. The mean annual consumption for irrigation has been about 112,410 acre-ft, but it may decrease as energy projects come on line.[31] Utah Power and Light's existing and planned steam-electric plants are by far the biggest industrial uses of water in the area. In some instances, UP&L has simply purchased rights. In Emery County, the company has acquired water through 40-yr leases. Within the next decade, there is projected to be a 2500-MW increase in generating capacity in Emery County, requiring perhaps 40,000 acre-ft of water that will come from present agricultural uses.[31]

Fundamental to the success of potential energy developers in the Carbon and Emery County area has been establishment of rapport between developers and farmers and recognition of the rights and best interests of each. A spokesman for UP&L has attributed much of the company's success to corporate concern for the regional environment and the well-being of the agricultural districts. It is believed, for example, that the amount of water UP&L uses at their Huntington plant will be offset by that saved through their investment in lined irrigation canals.[32]

Similarly, the backers of the 3000-MW Intermountain Power Project (IPP) in Wayne County, Utah, seem to recognize that their own best interests are served while working with the agricultural interests. The Fremont River in Wayne County will supply part of the project's water needs, but apparently only if the IPP consortium ensures that agricultural interests aren't severely affected against their will and helps to make irrigation more efficient. Part of the water the project will use will come from a 50,000 acre-ft entitlement that the state awarded to the Wayne County Conservancy District. At present the district's farmers tend to use far more water from the Fremont River than is required early in the irrigating season as a hedge against low water later in the season. IPP intends to finance a 50,000 acre-ft in-stream or off-stream storage facility to provide late season water for the farmers. IPP will receive 25,000 acre-ft for the power plant from this conservation measure (IPP's remaining water requirement will come from ground water development).[33]

What we noted here, then, is that there are probably many means of acquiring agricultural surface water rights for energy development in central Utah. However, the ability and willingness of a development company to ensure that the best interests of agricultural districts are also served is probably crucial.

Availability of Surface Water Resources

As noted, west of the Colorado River Basin in Utah, surface water sources are fully appropriated. This is true for both the Sevier River and Virgin River Basins. The latter is the proposed site for the Utah part of the Allen-Warner project, and the status of the Warner Valley Plant, to judge by the environmental impact statement, is problematical indeed because of the water question. Therefore, in this section we deal only with the Colorado River Basin in Utah.

The Energy Corridor Concept and the Green River. Perhaps the most coherent, and certainly the most articulate, strategy for energy development in Utah to emerge in the wake of the Kaiparowits decision is the proposal for an industrial or energy corridor in the 60-mile stretch roughly paralleling U.S. Highway 50 between the communities of Price and Green River (Fig. 4).

The concept is most prominently associated with George R. Hill, former dean of the College of Mines and Mineral Industries at the University of Utah and now at the Electric Power and Research Institute, Palo Alto, California. Hill generally kept the concept out of public discussion while decisions about the Kaiparowits project were pending.

As envisioned, the energy corridor is similar, in most respects, to the energy park concept that received national attention in the past two years. Basically, it involves exploitation of resources within a reasonably defined geographic area, suggesting possible collocation of industrial facilities with power plants, and implies that the environmental impact will be more restricted than that from the same level of development in more widely dispersed locations.

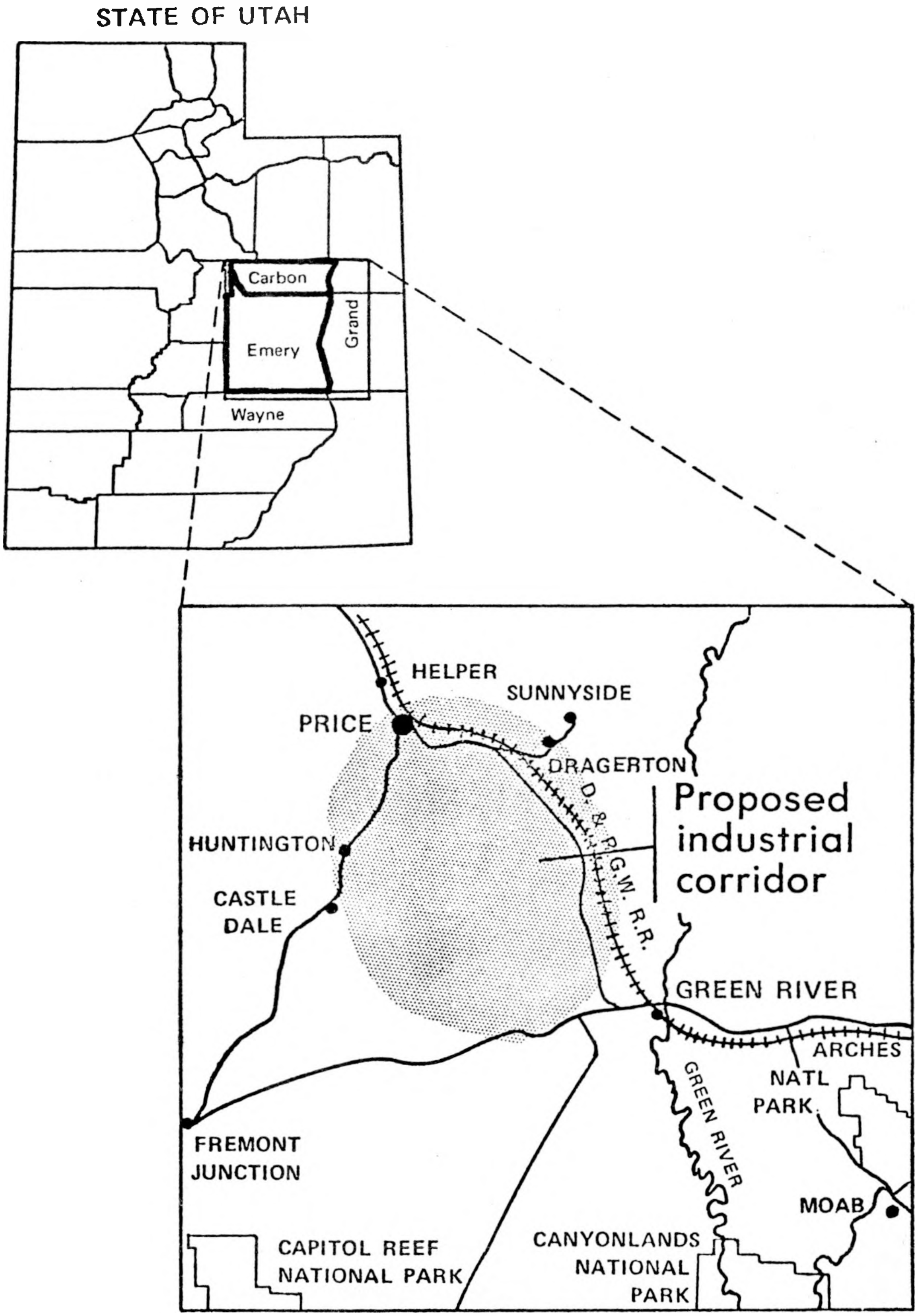

Fig. 4. Proposed Industrial Corridor in Utah.

Hill believes that industrial development along the corridor might consist eventually of 3000-6000 MW of generating capacity built up in units of 500-1000 MW per plant. Associated with the power industry might be coal conversion plants as well as ancillary industries such as chemical and electrochemical plants.[34] The fuel for the energy corridor would come from the surrounding Book Cliffs, Emery, or Wasatch low-sulfur bituminous coal fields, and the water would come from the Green River.

The corridor is viewed as being an area where the environmental impact is potentially lower than in other areas of the state. Green River, at the southeast corner of the corridor has a population of about 1100; Price at the northwest corner has a population of about 7000. The 60 miles in between is mostly desert and relatively free of any scenic or recreational value. There are two small communities, Wellington (pop. 1100) near Price and Woodside (pop. less than 50) nearer Green River. Conversations with environmentally conscious Utahns reveal a much greater sympathy for energy development in this area than elsewhere in Utah, particularly farther south. As noted, residents of the corridor region are eager for greater industrial development.[35]

Utah Power and Light has for some time, and independently from George Hill, viewed the corridor region as having very high development potential. Their idea of the region, however, is more of an inverted "U" (Fig. 5) with Price at the apex and bordered on the east and northeast by the Book Cliffs and on the west by the Emery and Wasatch coal fields. The region thus defined would extend to the Intermountain Power Project site in Wayne County.

Utah Power and Light has already conducted preliminary site studies for possible plant locations at Green River, Woodside, and Wellington. Their assessment of the available coal resources in this inverted "U" suggests that there is enough to sustain an 8000-MW generating capacity in addition to that supplied by their Emery and Huntington stations.[32]

The limiting factor is, of course, availability of water to sustain continued energy development. The Green River is part of the Colorado River system in Utah, so water appropriated from it will be part of the state's Colorado system budget described earlier. The Green River has a flow of approximately 4.5 million acre-ft at its junction with the Colorado. Major appropriations from the Green River in Carbon and Emery Counties are 220 cfs for Green River City, 60 cfs for the Green River Canal Company, and 50,000 acre-ft for Utah Power and Light.[36]

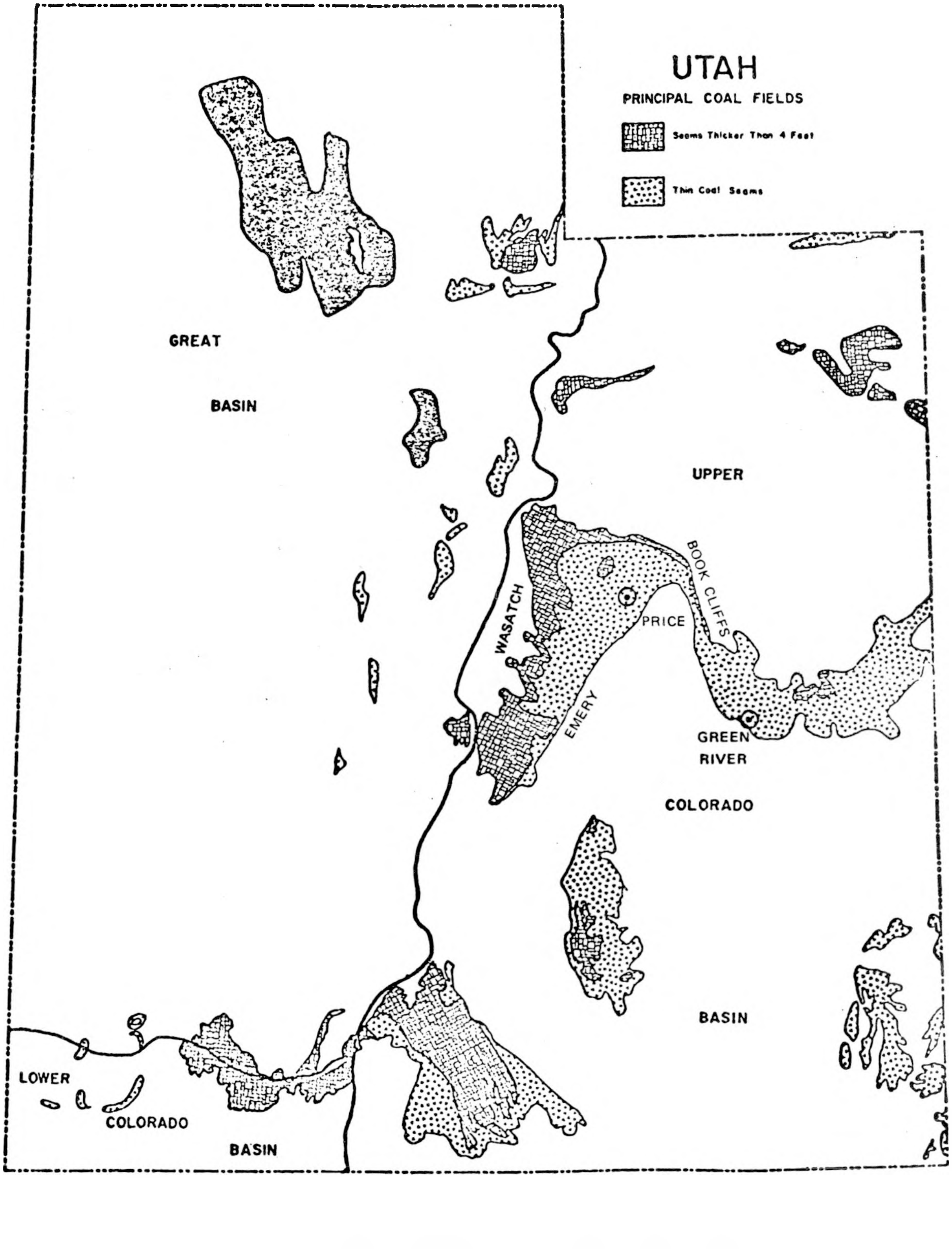

Fig. 5. Utah Coal Fields. Source: Ref. 30.

Far more important than trying to analyze a water balance for the Green River in Carbon and Emery Counties is to bear in mind the implications of the flexibility in state water administrative policies described earlier, particularly "the opportunities to guide the use of those rights.... which are approved but not yet consumed... The development can be altered according to state policies and according to what is determined to be in the public interest."[30] Utah water authorities could make water from the Green River available for energy projects in the proposed corridor region, if they deemed the projects to be properly conceived and in the public interest.[37]

The industrial corridor concept is now before a special committee that is studying energy policies with a view towards developing Utah's resources and putting to beneficial use for the citizens of Utah water that is now flowing downstream to California. Whether or not the energy corridor concept is officially endorsed as a development strategy for the state, the very real potential for expanded energy development in Carbon and Emery Counties should not be obscured.

Colorado River Salinity Control. A less likely method for acquiring water for energy production near central Utah coal fields is the Bureau of Reclamation's Colorado River Water Quality Improvement Program to reduce agricultural, municipal, and industrial economic loss from excessive salinity in the lower basin. Locations of approved and planned salinity control projects are shown in Fig. 6. Projects for which studies have been completed or are under way include Paradox Valley and Grand Valley, Colorado; Crystal Geyser and La Verkin Springs, Utah; and Las Vegas Wash, Nevada.

Potential project locations are the San Rafael and Price Rivers in Carbon and Emery Counties. The estimated total dissolved solids that the Price, San Rafael, and Dirty Devil Rivers contribute to the Colorado River are 240,000; 190,000; and 200,000 tons, respectively.[38] The Bureau of Reclamation estimates that control programs could eliminate 80,000 - 100,000 tons of salt from each river annually. Salinity concentrations at the Imperial Dam would thereby be reduced 7-9 mg/l for each of the three rivers, decreasing salinity-induced damage in the lower basin by approximately $5.29 million annually ($230,000 per mg/l).[38]

The heart of the salinity control project plan would be diversion of some quantity of each river through a desalting plant or an evaporation pond. Annual

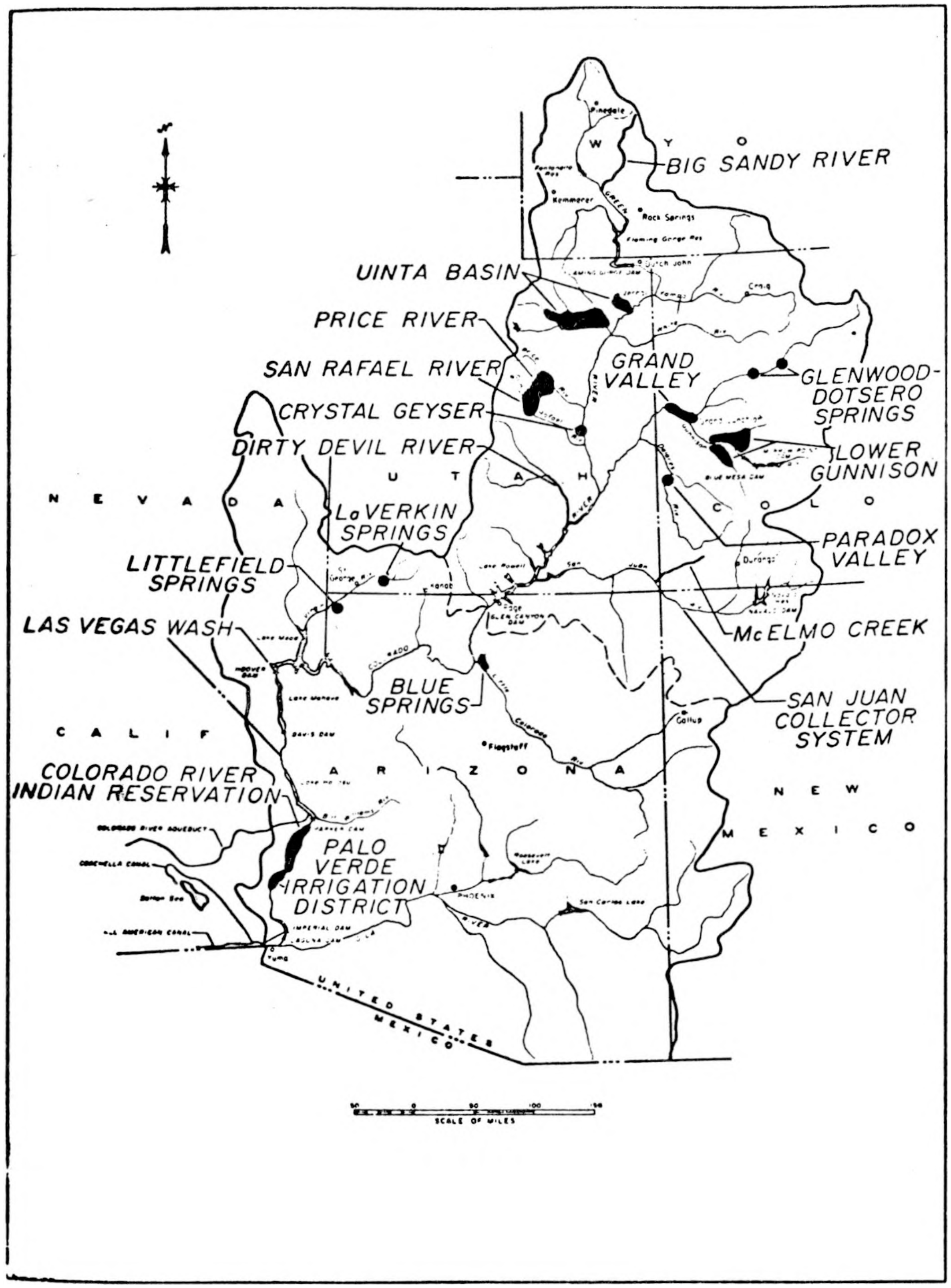

Fig. 6. Bureau of Reclamation Salinity Control Projects. Source: Ref. 38.

evaporation losses are estimated roughly at 5,000-30,000 acre-ft from each river. Obviously, interception of a stream for use in industrial energy processes such as cooling, perhaps in conjunction with a brine concentrator, could accomplish some of the objectives of a desalting plant or evaporation pond. The water loss, however, would have to be charged to someone's water budget, and to now the state and the Bureau of Reclamation have not worked out accounting procedures.[27]

Of the three rivers, the Dirty Devil is probably the least likely candidate for industrial application owing to the scenic wildness of its course, whereas the Price River may have the greatest potential for possible cooperation between industry and the Bureau of Reclamation.

Groundwater in South-Central Utah. The likelihood of obtaining enough groundwater for industrial purposes in central or southern Utah is not great. This is due less to the question of availability--indeed, the Navajo Sandstone formation is known to contain great quantities of water--than to institutional constraints. These constraints arise from uncertainty about how groundwater withdrawals will affect the surface hydrology of the Colorado system tributaries (and, therefore, enter into the accounting budget), and state water planners' inclination to observe the effect of IPP's groundwater development program.

The Intermountain Power Project will use at least 20,000 acre-ft of water developed from the Navajo Sandstone near Caineville, Utah. This use is equal to, perhaps slightly more than, the system's natural recharge. There is no question but that the IPP consortium would vigorously oppose any proposal for an additional generating station based on use of groundwater in that area. It is equally certain that Utah water authorities would not approve applications for ground water appropriation in this part of Utah until the results of the IPP test drilling and development program are more definitive.

Probably some of the 20,000 acre-ft that IPP hopes to develop from ground sources is lost through springs or vegetation before it can enter the surface system.

It is also virtually certain that withdrawing this amount of groundwater will affect the surface system, however infinitesimally. Officers of the Central Utah Water Conservancy District, while not opposing the project, have expressed concern over the degree of possible hydrologic linkage between groundwater and the surface water systems. They have reminded industrial developers that their own agricultural rights to the river system are senior and that in periods of low flow the industrial projects may face instances in which there is simply insufficient water for more junior rights.[39,40]

For the time being, therefore, there is a pervasive reluctance on the part of Utah water administrators to move hastily in approving applications for groundwater.

Summary

This survey of the the most likely sources of available water in Utah has dealt mainly with central Utah rather than the southern part of the state. The delay and other difficulties that affected the Kaiparowits project do not auger well for thermal electric projects in south-central Utah. One also senses that Utah Power and Light's Escalante Project in Garfield County, northeast of the Kaiparowits site, will probably encounter the same difficulties that beset Kaiparowits. The Intermountain Power Project, still farther north, is comparatively better off.

Carbon and Emery Counties, on the other hand, seem to have advantages not found elsewhere in the state for the siting of steam electric plants. This report has discussed the availability of water in that region which could be committed to industrial use. That availability stems from the apparent propensity of the agricultural districts and farmers to lease or to sell outright existing agricultural water rights. Also, Utah water authorities show a strong predisposition to work in harmony with potential industrial appropriators to make water available from the Green River, if their plans meet the state criteria discussed earlier. Furthermore, the favorable experiences of Utah Power and Light and the IPP consortium in working with and ensuring the interests of the farmers and agricultural districts in Utah should not be lost on other potential industrial developers.

The possibilities of groundwater development and of working with the state and the Bureau of Reclamation on the latter's Colorado River Salinity Control Program, particularly on the Price and San Rafael Rivers, suggest alternate, though far less certain, avenues through which water might be secured for a steam-electric plant.

To date, the availability of water resources has not posed an obstacle to energy development in Utah and, for the foreseeable future at least, potential energy projects in the state should not be frustrated because of lack of water, given the commitment of Utahns generally to industrial development.

III. WATER TRANSFERS

General

Other sections of this study have dealt with legal analysis of interstate and interbasin water transfers, and possible transfers of federally reserved agricultural water rights (for Indian reservations) for industrial purposes. Here we only touch on the problem as perceived by the upper basin states, for if interbasin transfers of water for energy development are to be considered seriously, there must be a perceived need for such transfers in those regions where energy development is to occur. The status of a contemporary proposal for water transfer between California and Nevada which highlights the dimensions of the interstate water transfer question is also discussed.

While to many in the upper Colorado River Basin the suggestion that California water ought to be used to produce California power in energy-exporting states such as Utah and New Mexico is a seductive proposition, to others, most importantly upper basin water administrators, that is not the major problem. Their problem, simply, is how best to put to beneficial use the water that is already allocated to the respective upper basin states but which is either unconsumed or uncommitted.

As mentioned, about 600,000 acre-ft of Utah's allotment flows downstream and is used in California. New Mexico, another upper basin state, faces a similar situation. Thus, to suggest that California should relinquish some of its water for energy production in Utah or New Mexico is, in the virtually unanimous opinion of upper basin water administrators, an irrelevancy at best.

One of the more serious attempts to bring the California water transfer question to public attention was made recently in Utah. A bill in the state legislature sponsored by a representative from Salt Lake would have required that as a precondition to the state's granting energy project construction permits, the applicant would have to show that water for the project would come from California's Colorado river allocation and would not be charged against Utah's water budget. The bill was opposed by state water administrators on the basis that it did not address the state's real water problems and that in the long term such a move would probably be contrary to Utah's best interests. For, allied to the present irrelevancy of the water transfer question, as far as the upper basin states are concerned, is the unanimous belief that interbasin water transfers between two states could not be accomplished without reopening the 1922 and 1948 Colorado River Basin Compacts. In addition to ensuring a protracted period of negotiations over years, perhaps decades, it is not at all clear that the best interests of the upper basin states would be served by such a process.

Thus, while interbasin water transfers between California and upper basin states may eventually be seen as providing very real regional social or economic gains, that time is clearly not now and certainly not within the time reference of this study.

The PSIAC Water Transfer Study

The Pacific Southwest Interagency Committee (PSIAC) is studying a possible interstate water transfer between California and Nevada. Certain aspects of the study suggest some of the possible dimensions of the interstate transfer problem. Although the PSIAC task force's final conclusions and recommendations are not yet available, certain parts of the problem are evident.

Nevada water officials have sought to determine the feasibility of augmenting southern Nevada's municipal and industrial water supply by 50,000 acre-ft/yr. Nevada, it is proposed, could become part of an interstate consortium that would jointly finance water development projects in California such as coastal desalting plants or geothermal sources.* Additional water would thus be made available for use in California. In return for its financial participation in the California water development project, Nevada would receive 50,000 acre-ft of water from California's entitlement to the Colorado River, diverted, of course, in Nevada. The California agencies whose rights would be involved in the transfer are the Metropolitan Water District and the Coachella and Imperial Irrigation Districts. Although the motivation for transfer might be different, it seems clear that possible interstate transfers of water for energy would raise questions essentially the same as those the PSIAC is studying.

An early task in the PSIAC study was to seek from the respective State Attorneys General preliminary legal opinions on the possibility of Colorado River water exchange for purchase by Nevada of desalted or geothermal water in California.

The California Attorney General tentatively concluded that such transfer would violate a basic promise of the Supreme Court Decree in *Arizona* v. *Cali-*

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*Possible projects are the Bolsa Island and Diablo Canyon Projects, Yuma Desalting Project, Imperial Geothermal Project, and the Imperial Agricultural Drain Water Conversion Project.

fornia, that Colorado River water apportioned to the three lower basin states is for use only in the state to which it is apportioned.[41] Article 1(K) of the decree notes:

> Consumptive use of water diverted in one state for consumptive use in another state shall be treated as if diverted in the state for whose benefit it is consumed.[41]

The California Attorney General's office believes this to mean that even if a California agency diverted water and then transported it for use in Nevada, that amount would be charged against Nevada's 300,000 acre-ft apportionment, not against California's 4.4 million.

Other articles of the decree similarly emphasize the apportionment schedule "for use in" the respective states, and, for our purposes, the phrase "for use in" appears to be the operative factor. Article II(B)(4) of the decree seems to summarize this point

> Any mainstream water conumptively used within a state shall be charged to its apportionment, regardless of the purpose for which it was released.[41]

The suggestion is, then, that the Arizona v. California decree would restrict an interstate transfer of mainstream water. To modify the Supreme Court's decree, furthermore, the California Attorney General suggests that the interested parties might first have to seek to amend the Boulder Canyon Project Act of 1928, because the Court's decree purports only to determine an apportionment of water rights already made by Congress in that Act. Thus, modification of the decree may have to be preceded by an amendment to the Boulder Canyon Act.

The Nevada Attorney General's survey of potential legal issues pertaining to possible interstate transfers of Colorado River water also acknowledges the difficulty in the decree articles mentioned above. From the Nevada analysis, however, Article III(D) may pose the most serious obstacle to interstate transfers:

> [Nevada, California and other states are prohibited] from consuming or purporting to authorize the consumptive use of water from the mainstream in excess of the quantities permitted under Article II of this decree.[42]

To quote from the Nevada Attorney General's letter,

> Because Article III of the decree does not provide for any exceptions to this mandate, it appears that Nevada would be barred from diverting more than 300,000 acre-feet and that California would be barred from authorizing Nevada to divert a portion of California's allotment if Nevada has already used its permitted quantity under the decree.... it is questionable whether even a tripartite contract between the

affected parties [California, Nevada, and the Secretary of the Interior] can be utilized to overcome the pertinent prohibition that exists.[42]

These are, of course, only preliminary opinions and surveys of potential legal issues that would be resolved ultimately by Congress and the courts.

If the long history of adjudication and negotiations involving the division of Colorado River waters is a guide, however, one can't be sanguine about rapid resolution of the interstate transfer question. In the broader perspective, however, there are less complicated options than transfer or exchange for obtaining industrial water in Utah and Nevada.

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42. Letter from Nevada Attorney General's Office to Donald L. Paff, Division of Colorado River Resources, March 15, 1976.