WATER RESOURCES APPRAISAL
FOR HYDROELECTRIC LICENSING

KINGS RIVER BASIN

CALIFORNIA

FEDERAL POWER COMMISSION

BUREAU OF POWER

1974

APPRAISAL REPORT

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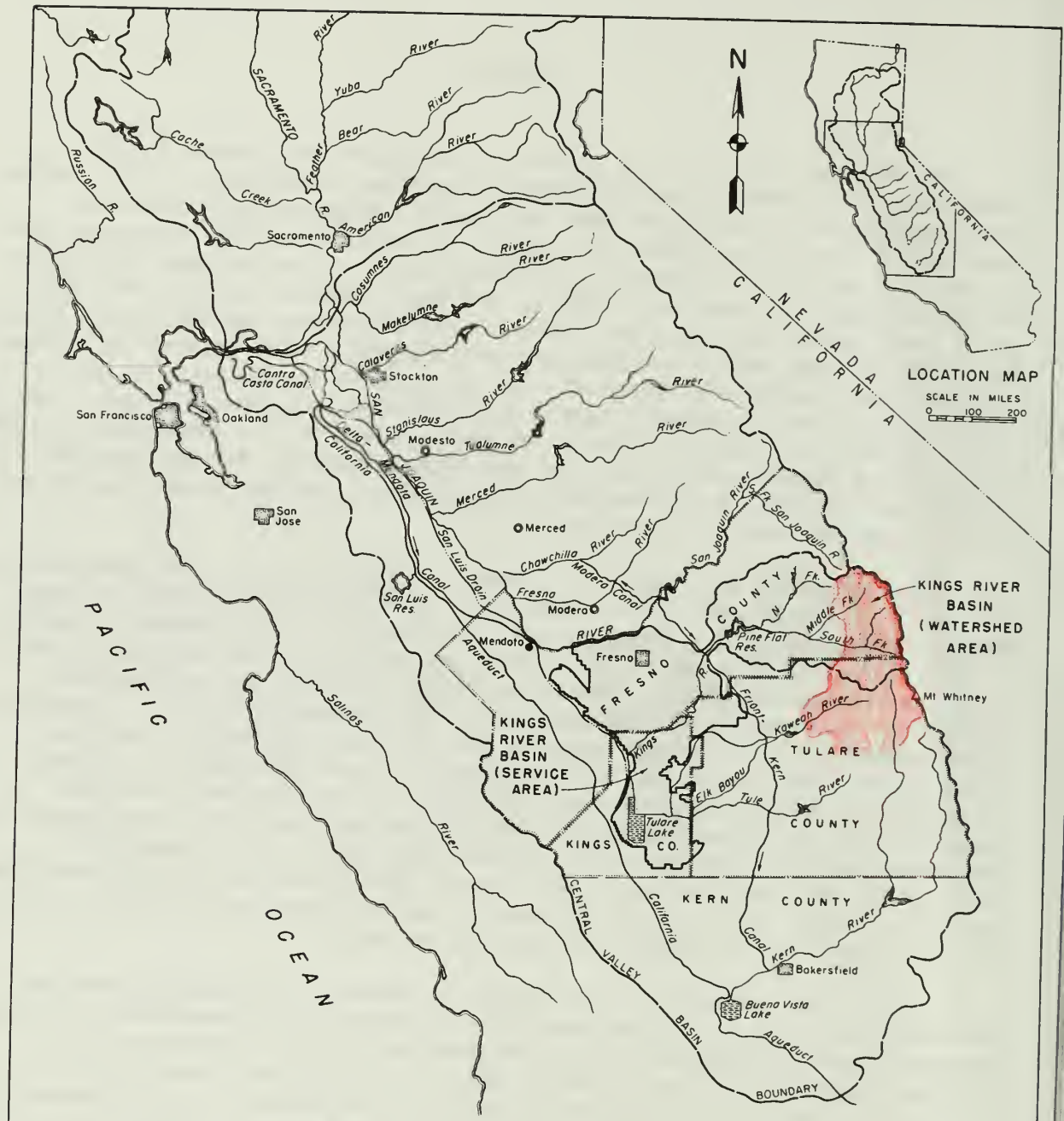
PREFACE

The Federal Power Act, as amended, authorizes the Federal Power Commission to undertake investigations of the water resources of any region to be developed; to cooperate with the executive departments and other agencies of Federal and State governments in water resources planning; and to issue licenses to non-Federal interests for the construction, operation, and maintenance of dams, powerhouses, and appurtenances for hydroelectric power development and other purposes. The Act reserves to the United States the right to take over a non-publicly owned project upon expiration of the license after paying the licensee's net investment in the project, not to exceed fair value of property taken, plus severance damages, if any. Projects to be licensed or relicensed must, in the judgment of the Commission, be best adapted to a comprehensive plan for improving waterways for the benefit of interstate commerce, for water power development, and for other beneficial public uses, including recreation.

This report on the Kings River Basin, California, has been prepared by the staff of the Federal Power Commission as a part of a program of Water Resources Appraisals for Hydroelectric Licensing. It is intended primarily to provide information which the Commission and its staff may use or build upon, as appropriate, when considering matters related to hydroelectric licensing, relicensing, or recommendation for Federal takeover. Licensing considerations are currently underway for several projects in the Kings River Basin. The report has been prepared to correlate and, when possible, to supplement available information and thus enable the staff and the Commission to act expeditiously on matters pertaining to the development of the hydroelectric power potential of the Kings River Basin within the limitations of other desirable water uses. The report is a staff study which was not prepared for adoption or approval by the Commission, and in no way does it commit or prejudge later Commission action.

Much of the material in the report is based on reconnaissance-type information, but more precise data have been used where available. The basic material used in preparing the report has largely been abstracted from previous reports of Federal, State, and local entities. Many agencies and individuals have participated in discussions pertaining to the information in the report and have provided useful background data or suggestions. The plans presented, however, do not necessarily carry the endorsement of any agency or group.



GENERAL MAP

KINGS RIVER BASIN

Approximate area of SEQUOIA.

F P C - Water Resources Appraisal for Hydroelectric Licensing

Figure 1

SUMMARY

The Kings River Basin, a part of the Great Central Valley Basin, comprises about 3,700 square miles of central California. It is located in the counties of Fresno, Kings, and Tulare. The Kings River, formed by the confluence of its South, Middle and North Forks, drains part of the western slope of the Sierra Nevada and flows into the valley where most of the water is diverted for irrigation. For the purpose of this report, the basin comprises a watershed area of about 1,700 square miles extending above the valley floor at Piedra, just below Pine Flat Dam, and a service area of about 2,000 square miles, encompassing the irrigated areas which receive water from the Kings River.

The basin's watershed area ranges in elevation from 14,242 feet above sea level to about 500 feet at Piedra. The basin's service area located on San Joaquin Valley floor slopes southwestward to a minimum elevation of about 190 feet at Tulare Lake. The Kings River Basin has a wide variation in climate. The valley area has a typical continental climate with hot and dry summers and moderate winters. The upper basin mountain areas have warm summers and cold winters, typical of a mountainous climate. There is considerable variation in annual precipitation in the basin, ranging from an average of 6 to 13 inches in the valley up to nearly 45 inches in the mountain areas. The average annual flow of the Kings River is about 1,650,000 acre-feet per year.

With most of the basin located in the counties of Fresno and Kings, data for the two counties are useful indicators of the economic conditions of the basin. Between the period 1960 to 1970, Fresno and Kings Counties had increases in total employment of 12.2 and 13.3 percent, respectively. Fresno County, with a 1970 population of about 413,000 is 75 percent urbanized while Kings County, with a 1970 population of about 64,600, is only 56 percent urbanized. The city of Fresno, the basin's largest center of population, has about 166,000 inhabitants.

While agriculture and the related food processing industry are still the major elements of the economy of the two-county area, the agricultural industry is declining in relative importance. The retail and wholesale trade has shown an increase in relative importance. Recreation use of the Kings River Basin contributes somewhat to the economy of the area. A large part of the Sierra National Forest and a small portion of the Sequoia National Forest lie within the basin. Virtually all of Kings Canyon National Park is situated in the upper part of the basin.

While most of the Kings River Basin is served with electric power by Pacific Gas and Electric Company, Hanford in Kings County is served by Southern California Edison Company. The total installed generating capability in the basin is 307,300 kilowatts in four existing hydroelectric

plants owned by Pacific Gas and Electric Company. The total average annual generation is 1,288.4 million kilowatt-hours. Southern California Edison Company owns four 230-kilovolt transmission lines which traverse Fresno and Tulare Counties.

The water and related land resources of the Kings River Basin have been developed for flood control, hydroelectric power generation, and irrigation water supply. The basin has three major reservoirs, Pine Flat, Wishon, and Courtright. The Corps of Engineers' Pine Flat Reservoir, located above Piedra on the Kings River, together with channel improvements on the Kings River and its distributaries provide flood control for the agricultural lands of the basin. Pine Flat Reservoir, with a capacity of 1,000,000 acre-feet, is operated for irrigation as well as for flood control. Pacific Gas and Electric Company's Wishon and Courtright Reservoirs, with a total capacity of 251,900 acre-feet, provides upstream power storage for the benefit of downstream hydroelectric plants.

The Kings River and its tributaries supply a large part of the basin's water needs, with irrigation being by far the basin's greatest water user. All the water in the Kings River, except flood water, is used. The other major source of water supply to the Kings River service area is by pumping from its ground water basins. Such pumping has been increasing over the years resulting in overdraft conditions in most areas. The area's water needs are also met in part from importations via facilities of the Federal Central Valley Project and the California State Water Project.

Except for local problems the quality of the surface and ground waters in the basin is adequate for most beneficial uses.

There are four hydroelectric generating plants in the Kings River Basin, all of which are located in the basin's watershed area. Two of the plants, Balch Nos. 1 and 2, are parts of the Balch project and the other two plants, Haas and Kings River, are included in the Kings River project. These two projects are owned and operated by Pacific Gas and Electric Company.

The Kings River project is licensed by the Federal Power Commission as Project No. 1988 with a license expiration data of March 31, 1985. The principal features of the project include Courtright and Wishon storage reservoirs, Haas and Kings River power plants, and several miles of power tunnel. The Kings River and Haas power plants operate under gross heads of 798 feet and 2,444 feet, respectively. The project has a total installed capacity of 179,100 kilowatts and generates an average of about 675 million kilowatt-hours annually.

The Balch project is licensed by the Federal Power Commission as Project No. 175. The project, the original license for which expired on July 27, 1972, is being considered by the Commission for relicensing or recommendation for Federal takeover. The project is presently operating under an annual license. The Balch project consists of a diversion dam, a tunnel and surge chamber, two penstocks, two adjacent power plants, an afterbay, and transmission lines. The pond created by the diversion dam is called Black Rock Reservoir. Two powerhouses, Balch No. 1 and No. 2, abut each other. Balch No. 1 has an installed capacity of 31,000 kilowatts and a gross head of 2,379 feet. Balch No. 2 has an installed capacity of

97,200 kilowatts and a gross head of 2,389 feet. The total average annual generation of the two plants is about 614 million kilowatt-hours. The operations of the Balch power plants are completely integrated with the other two plants in the basin, Haas and Kings River, utilizing the two upstream storage reservoirs, Courtright and Wishon, for regulating streamflows for power production.

The Balch project is satisfactorily maintained, in good condition, and capable of being operated efficiently for a number of years in the future. The continued operation of the project appears to be economically justified. The project, with its two small reservoirs, has limited opportunity for recreation. A small campground is being planned for development by Pacific Gas and Electric Company near Black Rock Reservoir.

The Balch project has been in existence for over 50 years, consequently its impact on the environment is well established. The alternative to the continued operation of the Balch project would require generation of equivalent power from some other source, probably thermal, which would consume fuel and could pollute air and water.

Estimates of future power requirements indicate that, during the 10-year period through 1980, the peak load of Power Supply Area 46, comprising most of central and northern California and northwestern Nevada, will more than double.

It is estimated that flood problems in the basin will increase in the future due to population and economic growth of the area as well as increase in the use of flood plains. It is estimated that an additional 451,000 acre-feet of flood control storage capacity will be required by the year 2020.

Agricultural development is expected to continue into the future requiring additional water supply for irrigation. Presently, much of the irrigation demand is met from ground water pumping, creating an overdraft of approximately 400,000 acre-feet annually. A combination of imported water and conservation of Kings River water is needed to meet the basin's needs.

Recreational use of basin lands is expected to increase. With such unique and limited resources as its Sequoia groves and its high country, any future development in and around these areas will require stringent controls to preserve these resources.

Investigations have been made for the future development and utilization of the water and related land resources of the basin. These studies have been made by Federal, State, and local agencies as well as by electric utilities. The principal purposes of the developments studied would be to provide hydroelectric power, water conservation for irrigation, and flood control. Other purposes include fish and wildlife management and recreation.

Potential projects discussed in this report are four conventional hydroelectric projects, two streamflow diversion projects to increase power flows at existing hydroelectric projects, a flood control and irrigation reservoir, and three pumped storage hydroelectric power projects.

The potential conventional projects include the possible installation of power facilities at the existing Pine Flat Reservoir, and reservoir and power developments at the Rodgers Crossing, Junction, and Dinkey Creek sites. None appears to be economically justified at this time, as an individual development with private financing. With Federal financing, however, Dinkey Creek appears to be justified and Junction appears to be marginal. A project consisting of two or more of these developments, with coordinated operation, would appear to be economically more attractive.

The Kings River Conservation District has filed an application with the Federal Power Commission for a preliminary permit (Project No. 2741) to investigate the development of hydroelectric power at the existing Pine Flat Reservoir, along with the development of several other reservoir and hydroelectric power sites in the basin.

The potential Deer Creek and Rancheria diversion projects, to supply additional streamflow to existing hydroelectric projects in the basin for increasing the power production at the existing plants, do not appear to be economically justified at this time.

Reconnaissance investigations of the Mill Creek flood control and irrigation project and of the two potential pumped storage hydroelectric power projects, Chinquapin Lakes and Dinkey Creek, indicate that they apparently would be attractive for development and that they merit further consideration.

Pacific Gas and Electric Company's proposed Helms pumped storage project, with an installed capacity of 1,050,000 kilowatts, appears to be economically justified. Pacific Gas and Electric Company's application for license to construct the Helms project (Project No. 2735) is pending before the Federal Power Commission.

None of the potential developments, except the Deer Creek and Rancheria diversion projects, would have any appreciable effects on the existing projects in the basin. The Deer Creek diversion would provide an additional water supply for power generation at the four existing power plants in the basin, including the Balch plants. The Rancheria diversion would supply additional water for power generation at the existing Haas power plant.

The national forests, the mountainous terrain characterizing most of the watershed area, and the numerous relatively unpolluted streams provide excellent potential for increasing the development and use of the recreational resources.

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CHAPTER I

DESCRIPTION OF THE BASIN

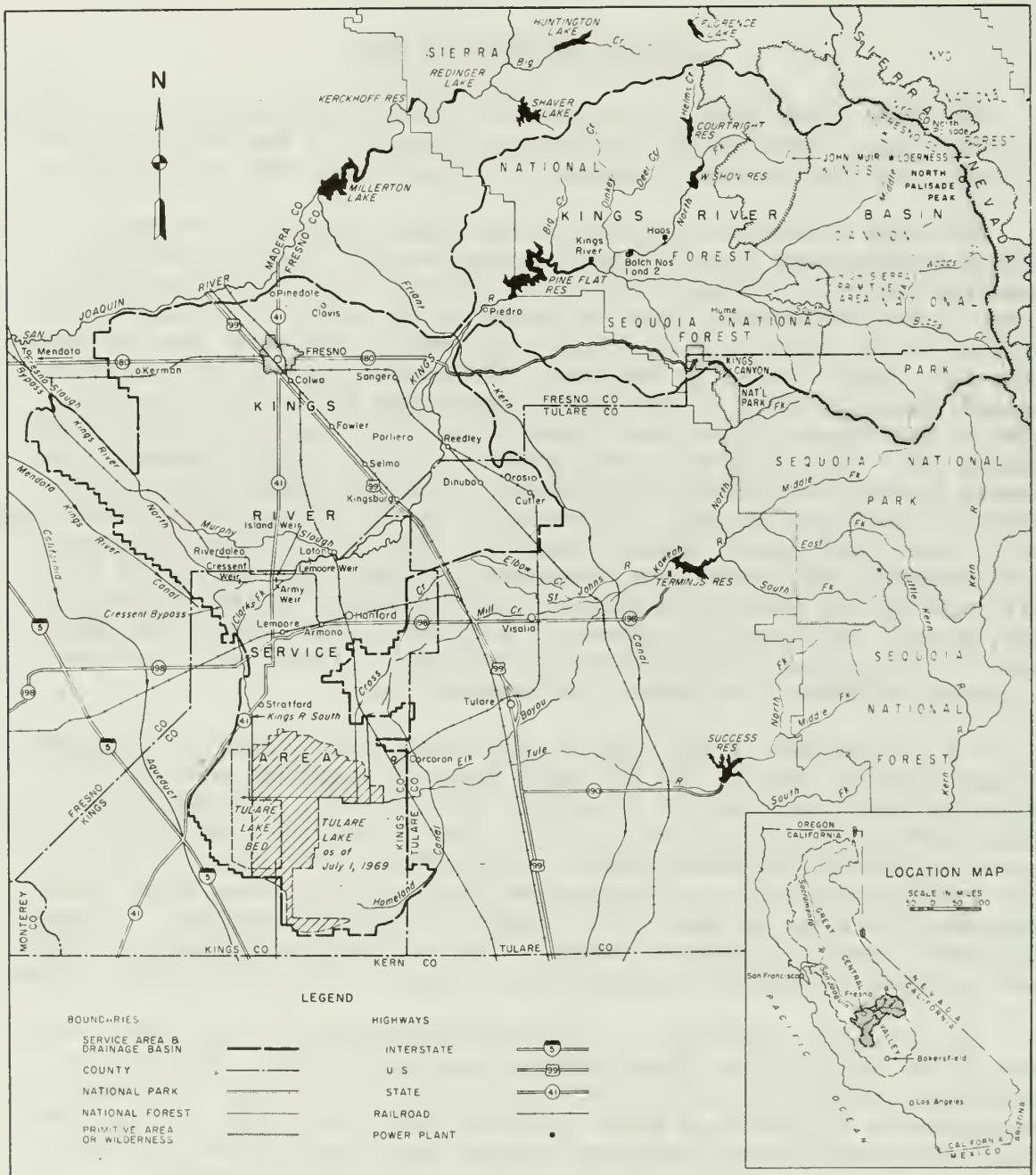
Location and Drainage Area

The Kings River Basin is located in central California in the counties of Fresno, Kings, and Tulare. The general location of the basin is shown on figure 1 and the general features of the basin are shown on figure 2.

The Kings River Basin, a part of the Great Central Valley Basin, includes mountain and foothill lands on the western slope of the Sierra Nevada and valley floor lands in the San Joaquin Valley. The basin is bounded by the San Joaquin River watershed on the north, the Kaweah River watershed on the south, the Sierra Nevada crest on the east, and the trough of the San Joaquin Valley on the west. The headwaters of the Kings River originate near the crest of the Sierra Nevada and flow down the western slopes to the valley floor, where most of the flows are diverted for consumptive use. Excess flows, during periods of high runoff, escape northwesterly through the Fresno Slough Bypass to the San Joaquin River which outlets in San Francisco Bay. Infrequently during periods of extremely high runoff, when flows exceed channel capacity, some excess water flows south to the normally dry Tulare Lake depression. Tulare Lake was, until the early part of this century, a shallow lake maintained by inflow from the Kings, Kaweah, Tule, and Kern Rivers. Now, due to the large-scale usage of water for irrigation, very little flow from these rivers reach the lake bed except at times of extremely high streamflow.

For the purpose of this report, the Kings River Basin is considered as containing two parts: (1) the upper basin or watershed area and (2) the valley floor lands or the irrigation service area. The upper basin extends above the valley floor at Piedra just below Pine Flat Dam and covers an area of about 1,700 square miles. The service area covers an area of about 2,000 square miles and encompasses the irrigated areas which receive substantial portions of their water supply from the Kings River. Figure 1 and figure 2 outline these two areas. Some municipal and industrial water users are also located within the service area, including the city of Fresno.

The principal tributaries of the watershed area are the three main forks of the Kings River, South, Middle, and North Forks. Several distributaries, natural and artificial, braid the valley floor. The main distributaries of the Kings River are the Kings River North and the Fresno Slough Bypass which flow northwest into the San Joaquin River, and the Kings River South which flows due south to the Tulare Lake area.



KINGS RIVER BASIN AND SERVICE AREA

LOCATION AND GENERAL FEATURES

FPC - Water Resources Appraisal for Hydroelectric Licensing

Figure 2

Physiography and Geology

The watershed area, located in the Sierra Nevada, ranges in elevation from 14,242 feet above sea level at North Palisade Peak along the eastern boundary to about 500 feet at Piedra near the eastern edge of the valley floor. Several glaciers, numerous lakes, and many peaks above elevation 13,000 feet are found in the high mountains in the eastern part of the basin. Below elevation 2,000 feet, the topography is characterized by rolling foothills which merge into the alluvial fan of the San Joaquin Valley floor. The valley floor is relatively flat with a slight slope to the west. Within much of the high mountainous region, the soil is thin with frequent rock outcrops and the vegetation is sparse. Forests cover a wide belt of the intermediate zone. Brush and grasses cover the slopes of the lower foothills. Along the Kings River, south of the city of Fresno, eroded material from the upper basin has built a broad low ridge across the trough of the San Joaquin Valley. As a result, that part of the valley south of the ridge is normally a closed basin; it has no direct outlet to the ocean except for occasional flood flows which escape northward via the Fresno Slough to the San Joaquin River. The low point of this closed basin is the Tulare Lake depression at an elevation of 190 feet, located south of the ridge and within the Kings River service area. Most of the lake bottom has been reclaimed for farming.

The high peaks of the Sierra Nevada are characterized by long easy westward slopes and steep escarpments to the east. The Sierra Nevada is a tilted fault block that has broken loose and lifted sharply on the east, and dips gently toward the west to the alluvial fill of the San Joaquin Valley. The mountainous region of the upper basin consists primarily of granite formations with some metamorphic rock and a few small areas of lava. The high country, showing marked effects of glaciation, is exceptionally steep and rough with large areas of bare granite domes and ridges exposed over large areas. The central and western portions are sedimentary in character. Streams have cut deep canyons into the otherwise gentle Sierran western slopes. The valley is a broad structural trough filled with an accumulation of sediments eroded from the surrounding highlands by rivers and streams.

Climate and Hydrology

Within the Kings River Basin there are wide variations in climate. At the lower elevations, summers are hot and dry while the winters are marked by moderate temperatures and relatively light precipitation. The mountains, on the other hand, are cold during the winter and the precipitation is heavy. Summer temperatures in the mountains are warm but considerably cooler than on the valley floor. Summer precipitation is quite light and showery.

The basin is subject to winter storms that originate with Pacific Ocean low pressure systems and move inland, causing rain to fall in the valley and snow to accumulate in the higher elevations. The snow usually

remains at a considerable depth until spring, when the snowmelt produces heavy runoff in the basin.

Average annual precipitation is in the range of 6 to 13 inches on the valley floor, while some of the mountain areas below the 9,000 feet elevation average up to nearly 45 inches annually. The average precipitation in the Kings River Basin above Piedra is about 35.5 inches. At elevations above 9,000 feet, precipitation decreases. There is considerable variation in the total annual precipitation from year to year.

Tables 1 and 2 show average monthly and annual temperatures and average monthly and annual precipitation, respectively, for representative climatological stations. Figure 3 shows the locations of these stations and the lines of equal annual precipitation.

Table 1

Average Monthly and Annual Temperatures
at Representative Climatological Stations

Kings River Basin

	Fresno	Dinkey Meadow	Courtright
Elevation in feet (m.s.l.)	331	5,550	8,200
	Degrees Fahrenheit		
January	45.5	31.7	20.6
February	49.8	35.0	22.8
March	54.0	38.5	28.2
April	60.8	42.8	33.0
May	67.5	50.5	43.8
June	73.9	58.7	49.2
July	80.6	65.0	55.3
August	78.4	62.4	52.8
September	73.9	56.2	46.2
October	64.3	49.6	39.3
November	53.2	41.6	29.9
December	46.4	33.2	22.2
Annual	62.4	47.1	36.9

On the valley floor, the growing season averages 215 to 230 days, with a slightly shorter season in the foothills. It is less than a month's duration in the higher elevations.

Table 2

Average Annual and Monthly Precipitation
at Representative Climatological Stations

Kings River Basin

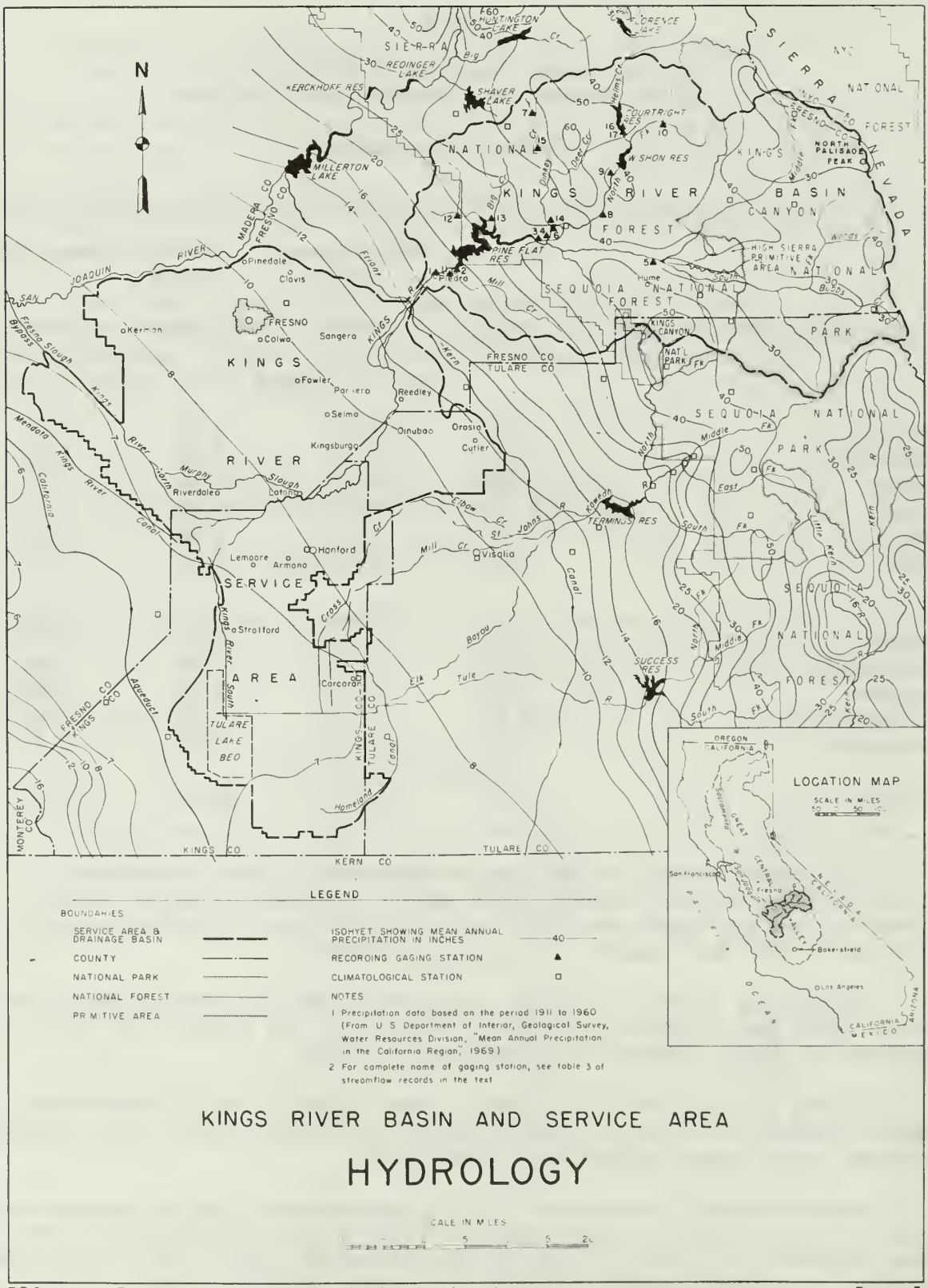
	Fresno	Balch Power House	Dinkey Meadow	Courtright
Elevation in feet (m.s.l.)	331	1,750	5,550	8,200
		Inches		
January	2.03	4.96	5.89	3.56
February	2.19	5.46	6.06	6.29
March	1.96	4.30	4.04	4.27
April	1.13	2.94	4.05	3.48
May	0.30	1.11	1.46	0.92
June	0.07	0.25	0.64	1.09
July	-	0.01	0.10	0.50
August	0.01	0.03	0.10	0.22
September	0.10	0.28	0.42	0.89
October	0.43	1.15	1.67	2.88
November	0.95	2.74	4.28	5.38
December	1.97	4.92	6.78	6.71
Total	11.14	28.15	35.49	36.19

The natural runoff in the Kings River Basin follows a seasonal distribution with the largest volume coming from melting snows, usually occurring between March and June, but with peak flows occurring usually between October and January due to winter rainfall.

Streamflow records have been published by the U.S. Geological Survey since 1919, and at present there are 17 gages in the basin. The flow records at these stations are summarized in table 3.

Figure 4 illustrates the average annual streamflows of Kings River Basin streams as they flow from the upper elevations, including the routing through reservoirs, tunnels, and power plants.

Approximately 52 percent of average annual precipitation appears as runoff from the basin as measured at the Piedra gage on the Kings River. The remaining 48 percent of average precipitation returns to the atmosphere through evapotranspiration or goes into ground water storage.



FPC - Water Resources Appraisal for Hydroelectric Licensing

Figure 3

Table 3

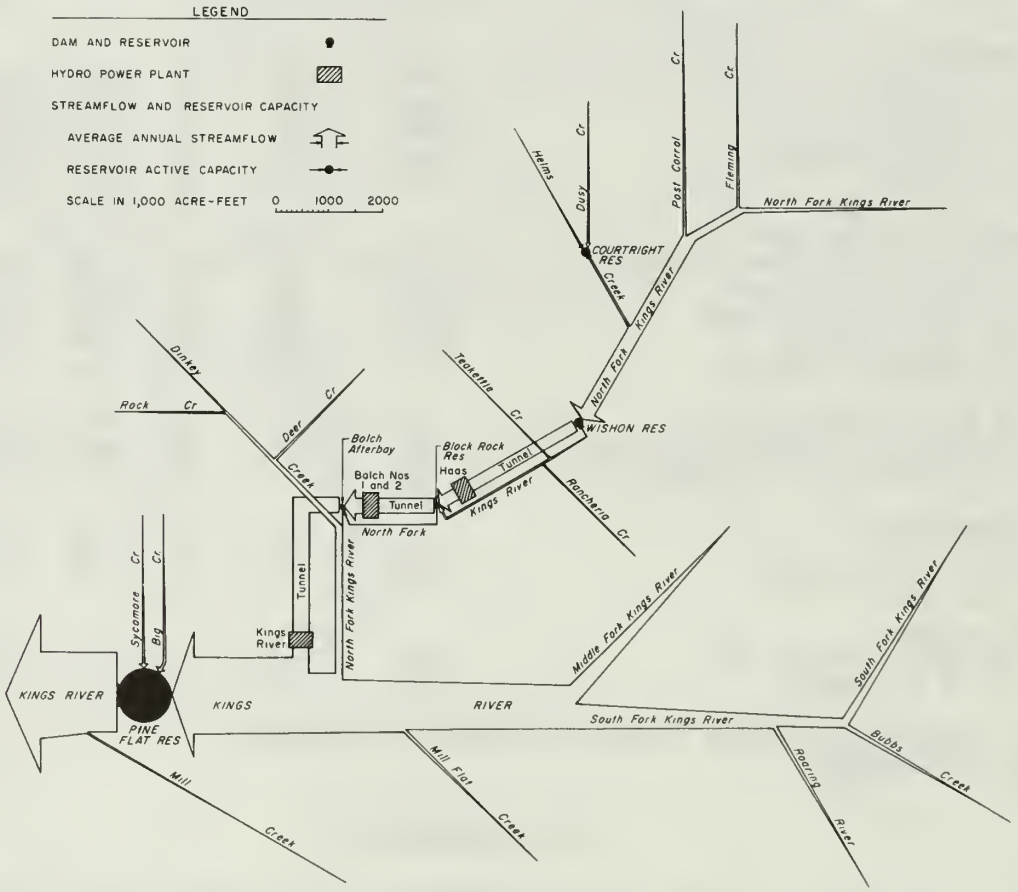
Streamflow Records
Kings River Basin
(Records through Water Year 1971)

Name and number of gaging station 1/	Elevation (ft)	Drainage Area (sq mi)	No. of Years	Discharge (cfs) Avg.	Max.	Min. Daily
Kings River:						
1 at Piedra	500	1,694	55	2,286	80,000	67
2 below Pine Flat Dam	557	1,545	18	2,239	17,100	1.1
3 below North Fork	942	1,342	20	2,176	85,200	97
4 above North Fork	1,002	952	41	1,435	59,100	70
5 near Hume	2,147	836	15	1,056	11,700	63
North Fork Kings River:						
6 below Dinkey Creek	1,035	387	11	2/	27,400	14
7 above Dinkey Creek	1,240	250	11	387	14,000	0.3
8 below Rancheria Creek	4,153	225	24	416	21,000	5.0
9 near Cliff Camp	6,144	181	50	362	4,880	0.8
10 below Meadow Brook	8,145	37.7	29	71.3	2,040	0.3
11 Mill Creek near Piedra	550	127	14	42.4	11,000	0.0
12 Sycamore Creek above Pine Flat Res.	1,142	56.1	18	22.4	16,800	0.0
13 Big Creek above Pine Flat Res.	962	70	18	51.7	16,400	0.0
Dinkey Creek:						
14 at mouth	1,310	136	17	181	4,320	0.0
15 at Dinkey Meadow	5,440	51	14	88	2,660	0.2
Helms Creek:						
16 below Courtright Dam	7,840	39.7	13	76.9	1,340	0.0
17 at Sand Meadow	8,030	35	11	49	1,140	0.1

1/ Gaging station number as shown on Hydrology Map (figure 3).
2/ Not available.

Water Quality

Except for local problems, the quality of surface and ground waters n the Kings River Basin is adequate for most beneficial uses. The Tulare ake area is the recipient of surface drainage from the basin except for an ccasional overflow of the Kings River into the San Joaquin River. The inimum, maximum, and average flows of the Kings River and its tributaries s recorded by the U.S. Geological Survey are shown in table 3.



WATERSHED AREA OF THE KINGS RIVER BASIN

AVERAGE ANNUAL STREAMFLOW CHART

F P C – Woter Resources Approisol for Hydroelectric Licensing

Figure 4

Surface Water

The chemical quality of the Kings River is characterized by nearly equivalent calcium, magnesium, and sodium cations with bicarbonate as the predominant anion. The surface water is highly suitable for irrigation and meets U.S. Public Health suggested chemical standards for drinking water. It is soft, with a maximum recorded hardness of 28 milligrams per liter. Table 4 shows the concentration ranges for chemical, physical, and bacteriological water quality constituents of the Kings River Basin surface water.

Table 4

Surface Water Quality
Kings River 1/

	Maximum	Minimum
Temperature, °F	74	37
Dissolved oxygen, mg/l	18.0	7.1
pH	7.7	6.4
Total dissolved solids, mg/l	52	12
Electro-conductivity, microhms/cm	71.7	16.8
NO_3, mg/l	2.1	0
Boron, mg/l	0.15	0
Sodium, percent	39	.19
Total hardness, mg/l	5	0
Turbidity, mg/l	45	0
Coliform, MPN/ml 2/	7000	0.045

Source: California Region Framework Study Committee
1/ From data compiled from existing information sources in 1965 on the Kings River below North Fork.
2/ MPN/ml, most probable number per milliliter.

Ground Water

The quality of ground water in that area of California classified as the Tulare Basin Subregion, which includes the Kings River Basin, varies considerably as to depth. The area is generally divided into two major water bearing zones. The upper zone, which extends to a depth of 200 to 300 feet below the surface, yields a calcium-magnesium sulfate water with a total dissolved solids content of about 3,000 milligrams per liter and a sodium percentage of 35. The lower zone yields sodium sulfate water with a total dissolved solids of about 800 milligrams per liter and a sodium content ranging from 70 to 90 percent. This lower zone furnishes about 80 percent of the ground water supply of the area.

CHAPTER II

PRIOR REPORTS AND CURRENT INVESTIGATIONS

Prior Reports

Much of the information used in this report was obtained from a number of available reports having a direct and important bearing on matters pertaining to the water and related land resources of the Kings River Basin. The more significant reports are described below.

A report to the Federal Power Commission, "Water Powers of California", by Frank E. Bonner, U.S. Forest Service, dated 1928, presents a summary of California's power resources. In the Kings River section an ultimate development is described, only a portion of which has since been built.

A report to the Federal Power Commission, "The Storage Resources of the South and Middle Forks of the Kings River, California", was prepared in 1930 by Ralph R. Randell of the U.S. Forest Service. That report gives physical and hydrological data concerning the principal reservoir sites of the South Fork Basin and includes a comprehensive plan of development.

The Bureau of Reclamation prepared a report, dated January 1940, "Kings River Project, California", Report No. 29A. The Bureau recommended a storage project (Pine Flat) on the Kings River for supplemental irrigation, flood control, and power development.

House Document No. 630, 76th Congress, 3rd Session, dated January 29, 1940, entitled, "Kings River and Tulare Lake, California", is a report by the Corps of Engineers on the Kings River Basin in conjunction with the Pine Flat Reservoir project. That project was authorized by the 1944 Flood Control Act and constructed by the Corps of Engineers in 1954.

House Document No. 537, 81st Congress, 2nd Session, entitled "North Fork Kings River Development", is a report by the Department of the Interior, published March 31, 1950, on the initial stage of the North Fork Kings River Development. It recommended construction of Wishon Dam and power plant, Haas power development, acquisition and initial enlargement of the existing Balch power development, and the installation of power facilities at Pine Flat Dam. The proposed developments above Pine Flat Reservoir have since been built by the Pacific Gas and Electric Company.

"The California Water Plan", Bulletin No. 3, is a report published May 1957 by the Department of Water Resources, State of California. It presents a comprehensive master plan for the development of the water resources of the State, including possible future water developments in the Kings River Basin.

A report by the Bureau of Reclamation, entitled "Kings River Projects, California", dated June 1963, presents information on the development and use of the flows of the Kings River below Pine Flat Dam. Flood control and the effect of operation of Pine Flat Dam on diversions from the Kings River are covered.

. Bulletin 119-11, "Feasibility of Serving the Tulare Lake Basin Water Storage District from the State Water Project", Department of Water Resources, State of California, dated May 1965, is a report on the history, economy, service areas, existing water supply, and potential water demand of the district.

A report, entitled "Progress Report of Engineering Committee on Kings River Water Utilization Projects Upstream from Pine Flat Reservoir", by S. M. Barnes, Henry Karrer, Wm. H. McGlasson, J. F. Sorensen, and Robert E. Leake, Jr., was prepared for the Kings River Water Association on November 16, 1965. It is a feasibility study for the construction of multipurpose water storage facilities at three sites: Junction, Rodgers Crossing, and Mill Creek. The committee recommended further studies on the Rodgers Crossing project.

A report by the Bureau of Reclamation, entitled "East Side Division, Initial Phase, Central Valley Project, California", was published in December 1965 and revised in June 1966. That report is a feasibility study of water supply development on the east side of the San Joaquin Valley and sets forth a plan for direct importation of water from surplus streams to the north.

"Progress Report of Engineering Committee on Potential Rodgers Crossing Project" by S. M. Barnes, Henry Karrer, Wm. H. McGlasson, J. F. Sorenson and Robert E. Leake, Jr., dated July, 1968, is a report to the Kings River Water Association on the feasibility of developing additional upstream storage on Kings River. The committee recommended no additional consideration of the project unless there is a substantial increase in benefits and/or lower project costs.

A Bureau of Reclamation report, entitled "East Side Division, Initial Phase, Central Valley Project, California", was published in September 1968. That report is a re-evaluation of a report on the feasibility of water supply development on the east side of the San Joaquin Valley, previously published in December 1965 and revised in 1966. A revision of cost estimates and a delay in initial project service from 1974 to 1979 is proposed.

Bulletin No. 119-28, "Feasibility of Serving Kings County from the State Water Project", by the Department of Water Resources, State of California, dated August 1968, is a study of the feasibility of delivering a quantity of water from the State water project each year to maintain ponds for recreation parks to be developed mainly on the Kings River. The project was determined to be feasible and a contract was signed August 31, 1967.

A comprehensive framework study for the development and management of water and related land resources of the California Region was prepared by the California Region Framework Study Committee under guidance of the Pacific Southwest Inter-Agency Committee. The Committee was composed of representatives of the Departments of Agriculture, Army, Commerce, Health, Education and Welfare, and Interior; the Federal Power Commission; and the States of Oregon and California. This field level study was initiated in fiscal year 1967 and was completed at the end of calendar year 1972.

Current Studies

The Corps of Engineers is currently evaluating further channel modifications along the Kings River and its distributaries below Lemoore Weir. The Corps plans to make a feasibility study of providing additional storage on the Kings River as part of a comprehensive investigation of the water resources in the San Joaquin Valley. This investigation is scheduled for completion in 1975.

Fresno County has an application pending before the Corps of Engineers, Sacramento District, for a Flood Plain Information Study on the Lower Kings River. Conduct of the study will depend on availability of funds.

Pacific Gas and Electric Company has filed a license application with the Federal Power Commission to construct and operate the Helms pumped storage project, to be located on the North Fork Kings River.

The Kings River Conservation District has filed an application for a preliminary permit with the Federal Power Commission to investigate development of hydroelectric power at Pine Flat on the Kings River and development of reservoir storage and hydroelectric power at the Rogers Crossing site on the North Fork Kings River, the Dinkey Creek site on Dinkey Creek, and the Mill Creek site on Mill Creek.

The staff of the Federal Power Commission, in preparing this report, has reviewed available reports of various Federal, State, and local agencies, and the Pacific Gas and Electric Company on the development of the Kings River Basin's water resources and has contacted those entities for further information. Such information used herein has been updated and supplemented as necessary. This report presents a general overall assessment of the basin's present water resource development, needs, and potential for further development.

CHAPTER III

THE ECONOMY OF THE BASIN

General

Spanish explorers first probed the Kings River Basin in the early 1800's seeking inland sites for missions. Soon afterwards, early settlers moved from the confines of the narrow coastal frontier to new land east of the California coastal range.

As settlement of the San Joaquin Valley expanded, agricultural development grew at a matching pace and dominated the economic life in the first half of the 19th century. Mineral extraction, a preoccupation of many early adventurers, reached a peak with the gold rush of the mid-1800's. Following the gold mining era, cattle raising became dominant and lasted until a disastrous drought in 1864. The coming of the railroad in 1870 gave impetus to general farming. Grain production became the major farming effort and led the agricultural sector for most of this early period. Irrigated farming expanded over the years and today dominates the rural areas of the Kings River Basin. More recently industrialization, urbanization, and the growth of the services sector of the basin's economy have caused a downward shift in the relative importance of the agricultural sector.

Since economic data are organized and readily available by county, the statistical information for Fresno and Kings Counties, which coincide quite closely with the basin itself, will be the quantitative basis for discussions in this chapter.

As shown in figure 1, the Kings River Basin (watershed and service area) includes most of Fresno County, about two-thirds of Kings County, and only a small portion of Tulare County.

An Overview of the Economy

Fresno County as shown in table 5 has about four percent of the land and about two percent of the population of California. With a population of about 413,000 inhabitants in 1970, Fresno County is more populous than the neighboring State of Nevada. Kings County, on the other hand, is considerably smaller in size and population than Fresno County. Kings County has only 0.9 percent of California's land area and a mere 0.3 percent of the State's population.

Fresno County has four times the size, six times the population, and almost eight times the number of jobs as Kings County. For these reasons, a separate presentation of data for the two counties permits a closer look at the nonurban characteristics of the river basin. Unlike the statistics

Table 5

Selected Demographic Data
California, Fresno and Kings Counties, 1970

	California	Fresno	Kings	Fresno as % of Cal.	Kings as % of Cal.
Land, square miles	156,361	5,966	1,396	3.8	0.9
Population	19,953,134	413,053	64,610	2.1	0.3
Population density 1/	127.6	69.2	46.3		
Urban population	18,136,045	309,871	36,194	1.7	0.2
Percent urban	90.9%	75.0%	56.0%		
Population Change, percent 1960-1970					
Urban	33.6%	25.8%	73.9%		
Rural	-15.3%	-13.8%	-2.5%		
Total	27.0%	12.9%	29.3%		

Source: 1970 Census of Population, California
1/ Persons per square mile.

for Fresno County, the Kings County data are much less influenced by a large urban area (i.e., city of Fresno). For example, the inhabitants of Fresno County, as shown in table 5, are 75 percent urbanized while the comparable figure for Kings County is only 56 percent.

The change in the total number of jobs in a particular county is a rough indicator of economic vitality while the change in composition of the work force reflects specific sectoral forces. Table 6 summarizes these two types of changes for the two counties. For the period 1960 to 1970, the increase in total employment in Fresno County (12.2 percent) matched its gain in population (12.9 percent); however, in Kings County, while its employment went up to 13.3 percent, its population leaped about 30 percent between 1960 and 1970. In Fresno County, the sectors, as shown in table 6, showing rapid growth were health and education with other services also posting significant increases. On the other hand, agriculture and mining had substantial losses. Almost 5,000 agricultural jobs were wiped out over the decade. A similar pattern, but on a much smaller scale, occurred in Kings County. Industrialization showed larger percentage gains in Kings County but this partly resulted from the smaller base year figure.

Changes in the relative importance of particular sectors reveal that agricultural jobs continued their long-run decline. As also shown in

Table 6

Industry of Employed Persons
Fresno and Kings Counties, 1970 and 1960

	Fresno				
	1960		1970		% Change
	No.	% of Total	No.	% of Total	1960 to 1970
Agriculture, forestry and fisheries	21,878	17.7	16,893	12.2	-22.8
Mining	846	0.7	534	0.4	-36.9
Construction	8,415	6.8	7,120	5.1	-15.4
Manufacturing	15,040	12.2	15,914	11.5	5.8
Transportation	4,843	3.9	5,089	3.7	5.1
Communications, Utilities, etc.	4,035	3.3	4,772	3.4	18.3
Wholesale and retail trade	27,341	22.1	33,849	24.4	23.8
Insurance, real estate and finance	4,865	3.9	7,270	5.2	49.4
Services, except health & education	11,757	9.5	13,431	9.7	14.2
Health	2,536	2.1	7,708	5.6	203.9
Education	7,613	6.2	13,667	9.9	79.5
Welfare and religion	1,509	1.2	2,234	1.6	48.0
Legal, engineering, and professional	3,470	2.8	3,449	2.5	-0.6
Public administration--government	4,850	3.9	6,799	4.9	40.2
Industry not reported	4,614	3.7	--	-	-
Total	123,612	100.0	138,729	100.1	12.2

	Kings				
	1960		1970		% Change
	No.	% of Total	No.	% of Total	1960 to 1970
Agriculture, forestry and fisheries	4,890	30.9	3,881	21.6	-20.6
Mining	192	1.2	159	0.9	-17.2
Construction	1,048	6.6	608	3.4	-42.0
Manufacturing	1,240	7.8	1,780	9.9	43.5
Transportation	463	2.9	430	2.4	-7.1
Communications, Utilities, etc.	462	2.9	535	3.0	15.8
Wholesale and retail trade	2,848	18.0	3,579	19.9	25.7
Insurance, real estate and finance	354	2.2	548	3.1	54.8
Services, except health & education	1,411	8.9	1,334	7.4	-5.5
Health	343	2.2	1,020	5.7	197.4
Education	946	6.0	1,944	10.8	105.5
Welfare and religion	122	0.8	332	1.9	172.1
Legal, engineering, and professional	392	2.5	347	1.9	-11.5
Public administration--government	643	4.1	1,443	8.0	124.4
Industry not reported	485	3.1	--	-	--
Total	15,839	100.1	17,940	99.9	13.3

Source: 1970 Census of Population, California, General, Social and Economic Characteristics, Table 123; 1960 Census, Table 85.

table 6, manufacturing in Fresno County showed a slight drop in relative importance while in Kings County it showed a slight increase in relative importance. Retail and wholesale trade played a major and growing role in providing jobs and income in both counties. In the two counties, agriculture lost about 6,000 jobs which may reflect the continuing mechanization of farming and gains in productivity. On the other hand, the use of migrant farm labor may account for part of the decline in jobs as reported in census data.

Table 7 summarizes three major economic changes that occurred in recent years in the two counties relative to the State and the Nation. In terms of growth in personal income, both counties trailed behind the State and National rate of increase over the period 1959 to 1970. In terms of population, however, Kings County posted sizeable increases while in Fresno County the percent increase was modest, and equal to the National average which was half that for the State of California. These divergent changes in income and population produced a relatively large increase in per capita income in Fresno County but a small gain in Kings County. Further, in absolute terms, both counties, particularly Kings County, were considerably below the State per capita income in 1970. Fresno County, incidentally, now has a higher per capita income than Kings County, a change that occurred about 1960.

Data on the source of personal income and earnings as compiled by the U.S. Department of Commerce show that in both counties the share of personal income attributable to proprietors' income, particularly from farms, has declined over the period 1960 to 1970, while property income and transfer payments have become relatively more important.

In 1970, the share of income derived from agricultural activities as reported by the U.S. Department of Commerce was relatively great in the two counties as compared to other counties in the State. In Fresno County, almost 13 percent of all personal income was classed as farm earnings while in Kings County the figure was more than 25 percent. These compare with State and National averages of about two percent.

Population and Income

Population growth for Fresno and Kings Counties and for the State of California during the decade 1960 - 1970 is shown in table 5. The growth in the number of inhabitants in Kings County (29.3 percent) actually outstripped that of California (27.0 percent) while Fresno County (12.9 percent) grew much more modestly over the decade between the two census surveys. The city of Fresno with about 166,000 inhabitants had the largest population of any city in the basin. The next largest community was Clovis which had a population of about 14,400.

Data from the 1970 U.S. Census of Population for California on general social and economic characteristics show three general characteristics for Fresno and Kings Counties: (1) most of the residents worked in their home county; (2) general or "average" economic opportunity was not as great as

Table 7

Income, Population, and Per Capita Income
Fresno and Kings Counties, 1959 and 1970
(adjusted for residency)

	1959	1970	Change 1959 to 1970
1. Personal Income ($ millions)			
Fresno County	782	1,626	107.9%
Kings County	118	221	87.3%
California	41,111	89,597	117.9%
United States	382,840	798,949	108.7%
2. Population (thousands, as of July 1)			
Fresno County	360	414	15.0%
Kings County	49	65	78.4%
California	15,467	19,994	29.3%
United States	177,124	203,793	15.1%
3. Per Capita Income ($)			
Fresno County	2,170	3,931	81.2%
Kings County	2,390	3,415	42.9%
California	2,658	4,481	68.6%
United States	2,161	3,920	81.4%

Source: U.S. Department of Commerce.

elsewhere in California; and (3) the proportion of white collar and manufacturing jobs was less in the two counties than for the State as a whole. The median income statistics show that family income in Fresno County was 80.3 percent of the State average while in Kings County, the families earned only 68.6 percent of the average for California. While the data do not reveal the structure of income distribution, they do indicate that poverty was a part of life in both counties, particularly in Kings County. In both counties, the proportion of families with incomes above $15,000 per year was well below the State average. This is surprising for Fresno County because it is the leading agricultural county in the Nation. Kings County is, however, a comparatively poor county. For example, it ranked third lowest in median income in 1970 out of 58 counties in California and was tied with

one other county for the greatest percentage of families below the "poverty line."

Agriculture

Fresno is probably the most important agricultural county in California and the United States. As shown in table 8, its 1969 sales of all farm products was just under $380 million, which ranked Fresno County first in this category among the 3,000 plus counties of the Nation. For the 81 different agricultural tabulations compiled in the 1969 Census of Agriculture, Fresno County headed the list in 18 categories of farm activity. Nationally, the county topped the list in both 1964 and 1969 for "value of farm products sold" and "irrigated farm land." Kings County, in 1969, on the other hand, ranked 38th and 9th nationally for the same two categories. Kings County, incidentally, dropped from 19th in 1964 to 38th in 1969 in the listing for the value of farm products sold.

As shown in table 6, Fresno County employed almost 17,000 persons in agriculture, forestry, or fisheries during 1970. This amounted to 12.2 percent of all employment and exceeded slightly the number of jobs in manufacturing (11.5 percent) but trailed behind trade and services (34.1 percent). Employment in the food processing industry provided another 4,520 jobs while the lumber and furniture subsector had 1,374 workers. Food and lumber incidentally are both "manufacturing" subsectors. Over the past decade, however, the number of workers employed in agriculture has dropped by more than 20 percent.

In Kings County, the relative importance of agriculture is greater than in Fresno County. As shown in table 6, agriculture along with forestry and fisheries provided 21.6 percent of all jobs in Kings County during 1970 but this was down from 30.9 percent in 1960, a loss of over 30 percent. Food processing in the county also registered a decline over the decade.

The 1969 Census of Agriculture shows that Fresno County with just 3.8 percent of the total land area of California had 13.0 percent of the "harvested cropland" acreage and 14.4 percent of the "irrigated farm land." Kings County, which occupies 0.9 percent of the California land mass, had 4.2 percent of the "harvested cropland" and 4.8 percent of the "irrigated farm land." Between the two counties, there were almost 1.4 million acres of irrigated farm land.

Table 8 shows that in 1969 the "average" farm in Fresno was valued at approximately $172,000, or almost $590 per acre, while its average size was just under 300 acres. By California standards, the farms in Fresno County were smaller in size and in total value but were more valuable on a per acre basis. In Kings County, the average farms were larger than those in Fresno County and the State, and the value per farm was higher but value per acre was a little below the State average and considerably less than in Fresno County.

Table 8

Agricultural Data

California, Fresno, and Kings, 1964 and 1969

	California		
	1964	1969	% Change 1964 to 1969
All farms, number	80,852	77,875	-3.7
Land in farms acres	37,010,500	35,722,348	-3.5
Average size acres	457.8	458.7	
Percent total land in farms	36.9	35.7	
Value of land and bldgs. $000	N.A.	16,956,000	
Avg./farm $	214,655	217,730	
Avg./acre $	468.40	474.65	
Market value of Products sold			
Total $000	3,499,350	3,903,560	11.6
Average $	43,281	50,125	15.8

	Fresno			
	1964	1969	% Change 1964 to 1969	As Percent of Cal. '69
All farms, number	7,294	7,539	3.4	9.7
Land in farms acres	2,201,150	2,208,070	0.3	6.2
Average size acres	301.8	292.8		63.8
Percent total land in farms	57.6	57.8		
Value of land and bldgs. $000	N.A.	1,294,000		7.6
Avg./farm $	172,865	171,622		78.8
Avg./acre $	572.18	585.96		123.5
Market value of Products sold				
Total $000	350,225	379,186	8.3	9.7
Average $	48,016	50,296	4.7	100.3

	Kings			
	1964	1969	% Change 1964 to 1969	As Percent of Cal. '69
All farms, number	1,251	1,109	-11.4	1.4
Land in farms acres	876,775	713,275	-18.6	2.0
Average size acres	700.9	643.1		140.2
Percent total land in farms	98.2	79.8		
Value of land and bldgs. $000	N.A.	277,000		1.6
Avg./farm $	249,285	249,681		114.7
Avg./acre $	353.87	388.20		81.8
Market value of Products sold				
Total $000	105,155	76,866	-26.9	2.0
Average $	84,058	69,310	-17.5	138.3

Source: 1969 Census of Agriculture.
N.A.: Not available.

Between the 1964 census and the 1969 survey, the number and acreage of farms in Fresno County grew slightly but declined markedly in Kings County. The amount of harvested cropland was relatively stable in Fresno County but fell in Kings County, which was also the statewide experience. Pasturage was reduced considerably in both counties while land under irrigation also declined.

In Fresno County, a high proportion of farm land was in irrigated cropland with relatively little acreage devoted to pastures and other uses, while a similar pattern on a smaller scale was followed in Kings County.

As reported in the 1969 Census of Agriculture, market value of agricultural products sold in 1969 by all farms in Fresno County totaled almost $380 million. This was a modest 8.3 percent increase from the value of sales in 1964. In Kings County, sales amounted to just under $77 million in 1969 and just over $105 million in 1964. Kings County thus suffered a 26.9 percent decline over the five years between the two surveys. The decline in 1969 was probably due to the 1969 flood which caused estimated agricultural losses of about $20 million in the Tulare Lake area.

Manufacturing

Data from the 1960 Census of Population (see table 6) show that there were almost 22,000 jobs in agriculture and 15,000 jobs in manufacturing in Fresno County. Ten years later, agriculture provided only 17,000 jobs while the number of employees in manufacturing had increased to 16,000. Included in this latter figure, however, were 4,500 jobs in the "food and kindred products", a subsector of manufacturing. These changes indicate that, although agriculture declined in relative importance, the farm sector of the Kings River Basin remained a major factor in the local economy. Further, by complementing manufacturing, the agricultural sector provided the means for economic diversity in Fresno County.

The "value added" by manufacturing is another indicator of relative economic importance. For example, table 9 shows that in 1969 the value added by manufacturing in Fresno County amounted to just under $308 million while farm sales in 1969 (see table 8) were just under $380 million. These two values do suggest that manufacturing was relatively quite important to the economy of the county. On the other hand, the amount of valued added by manufacturing in Fresno County was only a small part of the value added by manufacturing statewide. For example, in 1969, only 1.1 percent of the value added by manufacturing in California occurred in Fresno County. By comparison, in 1969, agricultural sales in Fresno County represented a tenth of all farm sales in the State.

Manufacturing in Kings County amounted to less than 0.1 percent of the State total and, therefore, was not reported in detail.

Table 9

General Manufacturing Statistics
California and Fresno County, 1958 and 1969

	California		
	1958	1969	Percent Change 1958 to 1969
Number of employees (000)	1,181.8	1,631.8	38.1
Payroll ($ million)	6,601.1	14,151.1	114.4
Value added by mfg. ($ million)	12,048.0	27,016.9	124.2

	Fresno			
	1958	1969	Percent Change 1958 to 1969	1969 As % of California
Number of employees (000)	12.4	17.2	38.7	1.0
Payroll ($ million)	54.8	113.0	106.2	0.8
Value added by mfg. ($ million)	131.1	307.4	134.5	1.1

Source: 1969 Annual Survey of Manufactures; 1958 Census of Manufactures.

Table 9 shows that in Fresno County between 1958 and 1969, the "long run" rate of increase in jobs, payroll, and value added closely paralleled statewide changes. The 38 percent increase in manufacturing jobs was well ahead of the increase in total county employment (12.2 percent, 1960 to 1970) and the gain in county population (12.9 percent, 1960 to 1970). The increases in payroll and value added, however, were obviously exaggerated by inflation.

Industry data for Fresno County as reported in the 1967 Census of Manufactures for 1963 and 1967 show that the food subsector was the dominant manufacturing activity as measured by the number of jobs and, particularly in value added. This subsector, however, was not growing in absolute terms and was actually slipping in terms of relative importance. The major components of food processing were canning, preserving, frozen foods, and beverage industries. On the other hand, fabrication of metal products including farm implements, lumber and wood products, and the meat component of the food subsector all posted sizeable gains over the four-year period.

Mining

In 1970, the mining industry (see table 6) in the two counties provided employment for about 700 people or less than one percent of the total labor

force. Gold mining, which had been an important factor in the early development of the basin has accounted for only a minute fraction of mineral production in more recent years. On the other hand, the extraction of oil and natural gas has contributed roughly 80 percent of the total value of mineral production while natural gas liquids, sand and gravel, asbestos, stone, clays, mercury, and silver have been of lesser importance. In 1968, the mineral production in the two counties accounted for about four percent in value of the total mineral output of California.

Forestry

Parts of the Sierra and Sequoia National Forests as well as other wooded areas are located within the Kings River watershed area, most of which is in Fresno County. Table 10 gives the area of forested land in the two-county area. In 1967, over 84 million board feet of timber were produced in Fresno County. Presently the two counties contain more than 10 billion board feet of saw timber.

Table 10

Forest Land

	Fresno County	Kings County
	(1,000 Acres)	
Total land area	3,817	893
Total forest land	1,467	15
Commercial	466	-
Non-commercial	1,001	15
Non-forest land	2,350	878

Source: 1969 California Statistical Abstract.

National Parks

Virtually all of Kings Canyon National Park is situated in the upper part of the Kings River drainage. The park, a major tourist attraction, consists of spectacular granite mountains, deep canyons, and magnificent forests. Two things, especially, distinguish this park - its forest of gigantic trees and its extensive lofty mountains. Here the giant Sequoias, largest of all trees, reach their greatest size and are found in large numbers. Here the peaks of the vast Sierra Nevada rise to high altitudes, with North Palisade Peak rising to 14,242 feet, the highest summit in the park.

Recreation

Recreational use of the Kings River Basin contributes somewhat to the economy of the area. In 1969, the Kings Canyon National Park alone catered to nearly a million visitors. For this same period, the U.S. Forest Service reports 500,000 recreation use-days spent on lands in the basin under its administration. In the Sierra National Forest the relatively new Wishon and Courtright Reservoirs in the North Fork Kings River drainage contribute significantly to the public recreation potential. The 1969 estimated use of the two reservoirs was 38,000 visitor days. Use of Black Rock Reservoir, the forebay to the Balch power plant, was estimated at 3,000 visitor days. The Corps of Engineers in 1969 recorded nearly 40,000 visitors to its facilities around Pine Flat Reservoir. Another quarter of a million people visited the Fresno County Park below the dam. The use of the North Fork Kings River portion of the John Muir Wilderness was reported at 24,900 visitor days during 1970.

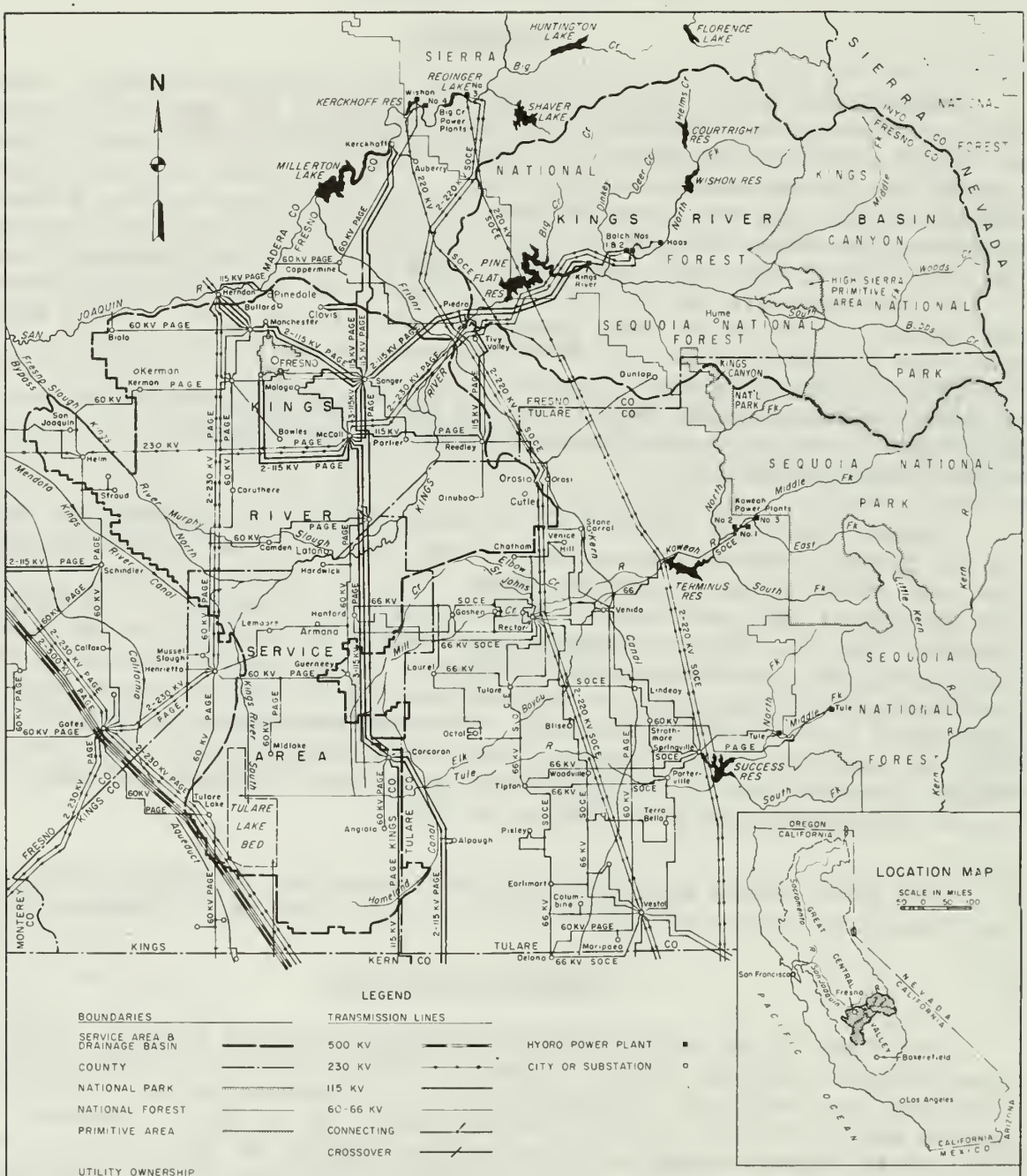
Another important resource of the basin for public enjoyment and benefit is the fishery resource represented in the over 150 miles of fishable streams and over 11,000 acres of natural lakes. The U.S. Bureau of Sport Fisheries and Wildlife's 1965 publication, National Survey of Hunting and Fishing, reported that the average fisherman spent about $89 annually on transportation, accommodations, subsistence, and equipment. It was also estimated by the California State Department of Fish and Game that 39,000 fisherman days were spent in the watershed in 1969. The California State Department of Fish and Game and the U.S. Forest Service also estimate that there are 10,000 resident deer in the North Fork Kings River drainage, and about 8,100 hunter days were spent deer hunting in 1969.

The above totals suggest that annual recreation use of the basin may add from seven to ten million dollars to the economy of the general area.

Electric Facilities

The Kings River Basin is served by Pacific Gas and Electric Company and Southern California Edison Company. Pacific Gas and Electric Company services practically all of the basin from its interconnected transmission system and is the only utility producing power in the basin. Southern California Edison Company supplies power to Hanford in Kings County, its only customer in the basin, and the Company's four 230-kilovolt transmission lines traverse the area from north to south. The two utilities are interconnected at points outside the basin. Power supply and transmission facilities in the area are shown in figure 5.

The total installed generating capacity in the Kings River Basin is 307,300 kilowatts, all of which is in four existing hydroelectric plants owned by Pacific Gas and Electric Company. The four plants, Balch No. 1, Balch No. 2, Haas, and Kings River, are further described in chapters IV and V.



KINGS RIVER BASIN AND SERVICE AREA

PRINCIPAL ELECTRIC FACILITIES

FPC - Water Resources Appraisal for Hydroelectric Licensing — Figure 5

Power from the four basin plants is generated at 13,800 volts (13,200 volts at Balch No. 1), stepped up, and delivered to the company's interconnected system via 115- and 230- kilovolt transmission lines. The basin's projects provide power for the local area and, because they are linked with Pacific Gas and Electric Company's interconnected system, surplus generation flows into the Company's grid to be utilized elsewhere.

Pacific Gas and Electric Company is a participant in the Western Systems Coordinating Council, a voluntary council open to all bulk power suppliers in the 13 western States. The purpose of this council is to promote the reliable operation in interconnected bulk power systems in the western region. It is one of nine electric reliability councils in the 48 contiguous States.

Transportation

Main line freight and passenger railway service in the basin is provided by the Santa Fe and Southern Pacific railroads.

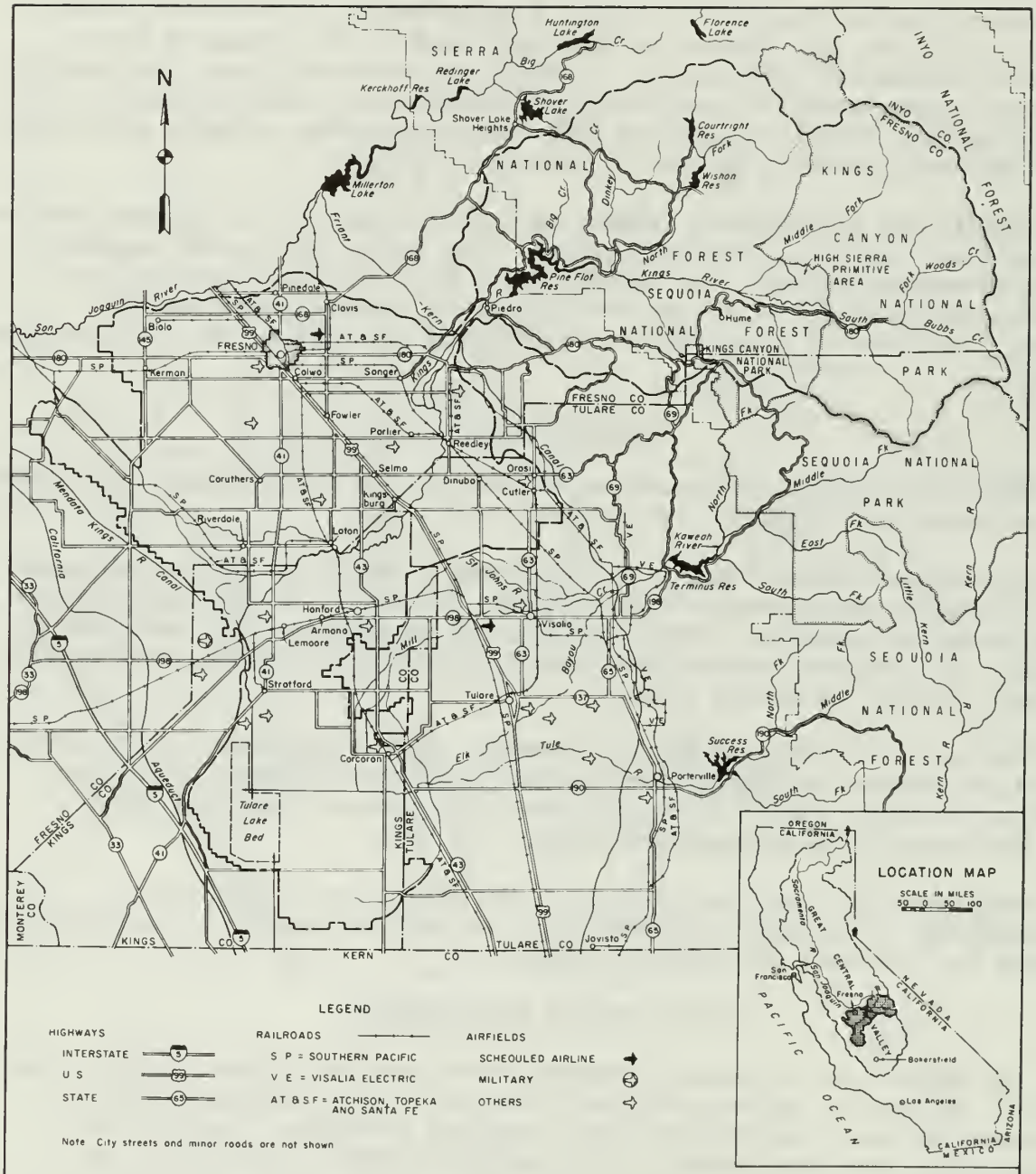
Interstate Highway 5 and U.S. Highway 99 traverse the basin from north to south, and a good system of county roads interconnects all the populated areas of the two counties. State Highway 198 is the principal east-west highway. It connects Hanford, the county seat of Kings County, with Sequoia National Park in the Sierra Nevada.

The basin is served by Hughes Air West, Pacific Southwest, Swift Aire, United, and Valley airlines, which provide scheduled flights from Fresno municipal airport. Swift Aire and United also provide scheduled flights from the nearby Visalia municipal airport.

More than 180 truck carriers serve the basin area. Bus lines, Greyhound and Continental, provide local and national service. Transportation systems for the basin are shown in figure 6.

Water Service Organizations

The history of irrigation diversions from the Kings River began in the 1860's. Because of the variable nature of the flow of the Kings River, controversies over insufficient water supplies developed. Early in this century there were many lawsuits filed and after much negotiating, the Administrative Agreement and Water Right Indenture was entered into on May 3, 1927. Nineteen irrigation districts and canal companies formed the present Kings River Water Association. The membership was expanded on June 1, 1949, to include all of the organizations then using water from the Kings River. With the construction of the Pine Flat Dam in 1954, the agreement was amended to provide for new operation under storage conditions. At the present time, there are 28 members of the Kings River Water Association under contract with the Bureau of Reclamation for irrigation water.



KINGS RIVER BASIN AND SERVICE AREA

TRANSPORTATION SYSTEMS

FPC – Water Resources Appraisal for Hydroelectric Licensing

Figure 6

Water Availability

All the water in the Kings River, except flood waters which escapes to the San Joaquin River or is impounded in the Tulare Lake depression, is used for irrigation in the Kings River service area. The Kings River supply is inadequate to meet the demand. Other sources of supply for irrigation and to a much lesser extent for municipal and industrial uses are: pumping from the ground water basins; import from the Friant-Kern Canal, Mendota Pool, and the California State Water Project; and inflow from the Kaweah, Tule, and Kern Rivers. At the present time, there are large overdrafts of ground water over a large part of the area. The imported water sources are fully utilized. The cities, towns, and residential areas obtain most of their water from pumping from underground aquifers. A more detailed discussion of these sources is presented in chapter IV.

CHAPTER IV

EXISTING WATER AND RELATED LAND RESOURCES DEVELOPMENT

General

The water and related land resources of the Kings River Basin have been developed for flood control, hydroelectric power generation, and irrigation water supply. Wells provide most of the water for urban use. Fish and wildlife abound throughout the region. The reservoirs, lakes, streams, national park, and national forests provide excellent opportunities for public water and land based recreational activities. Table 11 lists the major reservoirs in the basin.

Table 11

Major Reservoirs
Kings River Basin

Reservoir	Stream	Drainage Area (sq mi)	Full Pool Elev. (feet)	Surface Area (acres)	Storage Capacity (ac-ft)
Pine Flat	Kings R.	1,542	952	5,970	1,013,400
Wishon	North Fk. Kings R.	177	6,550	1,000	128,600
Courtright	Helms Cr.	40	8,188	1,620	123,300

Flood Control

The Corps of Engineers' Pine Flat Reservoir project, together with channel improvements on the Kings River and its distributaries on the valley floor, provides considerable flood control for about 80,000 acres of agricultural land in the Kings River service area; and, in conjunction with similar projects on the Kaweah, Tule, and Kern Rivers, it reduces flood damages on about 260,000 acres of crop land in the Tulare Lake area. Minor reduction of flood damage is also affected along the San Joaquin River immediately downstream from Mendota. The Pine Flat Reservoir also provides irrigation storage, recreational opportunities, and reregulation of upstream power plant releases. The dam, located on the Kings River about three miles east of the town of Piedra, was completed by the Corps of Engineers in 1954. A downstream view of the dam is shown on figure 7. The dam is a concrete gravity structure 429 feet high and 1,820 feet long at the crest. Three

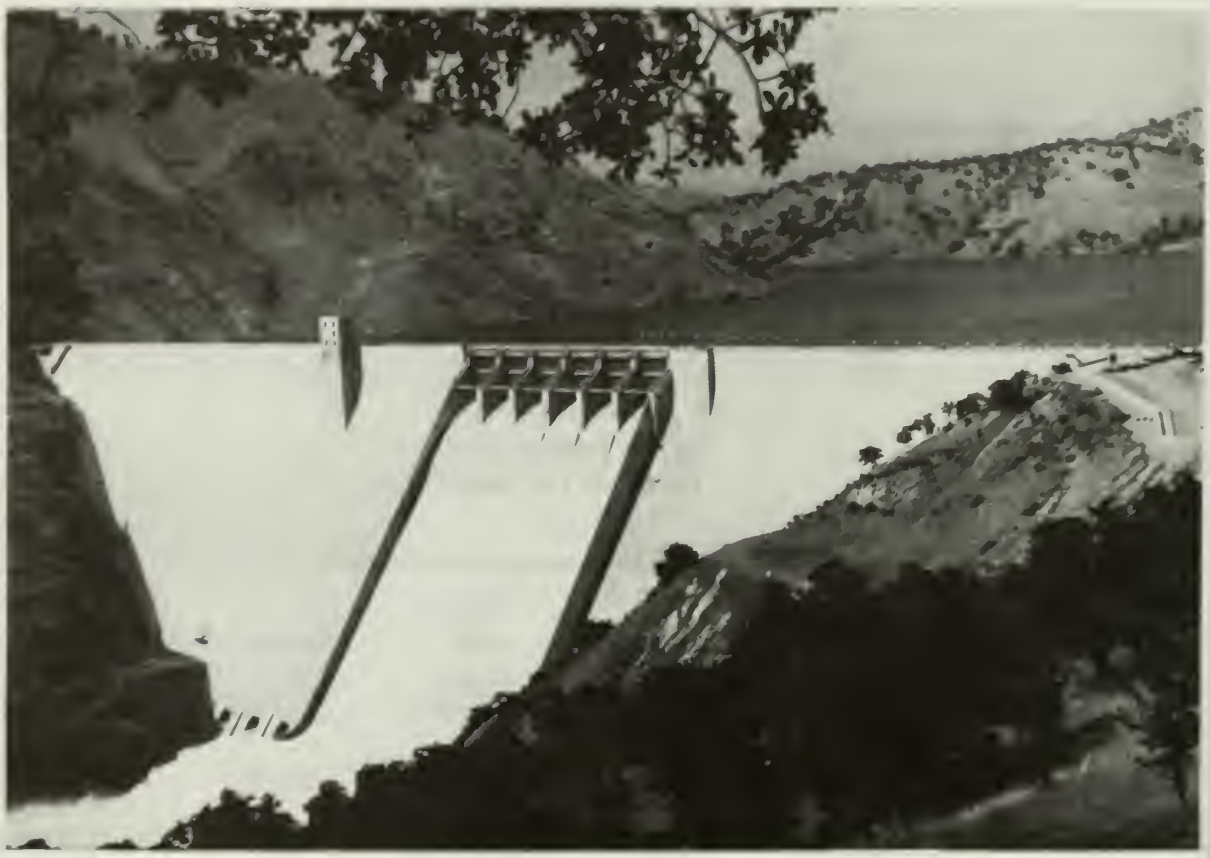


Figure 7. Pine Flat Dam and Reservoir.

13.5-foot diameter penstocks were installed in the dam for the possible future addition of power facilities. The reservoir has a gross storage capacity of 1,013,400 acre-feet at a pool elevation of 952 feet.

During the heavy winter rainfall months, Pine Flat Reservoir is operated for flood control purposes, and as the flood season ends, the reservoir is filled principally from snowmelt. The water is subsequently released for irrigation. Reservoir data are summarized in table 11. The dam and reservoir are shown on the basin map and river profiles, figures 8 and 9.

In addition to the reservoir, the Corps of Engineers has provided flood control features on the Kings River below Laton, California. These consist of three diversion structures: the South Fork Diversion Structure (Army Weir) at the head of Clarks Fork (which leads to Kings River South), the Island Weir on the Kings River just downstream of its confluence with Clarks Fork, and the Crescent Bypass Weir at the head of Kings River North. During flood periods these structures divert flood waters, not desired by the Kings River South and Tulare Lake, to the San Joaquin River through the Kings River North. Figure 2 shows the location of these features.

Some degree of flood control is also provided by the operation of Pacific Gas and Electric Company's Courtright and Wishon Reservoirs located in the North Fork Kings River drainage area. These reservoirs are described later in the hydroelectric power section of this chapter.

In the Tulare Lake area, there are numerous dikes and levees to contain any accumulated water in the depression and to provide flood control for the reclaimed agricultural land of the former lake bottom.

Water Supply

Water is supplied to the Kings River service area for irrigation, municipal, and industrial purposes. Irrigation is by far the greatest water user, accounting for about 95 percent of the total water demand of the basin's service area. The Kings River and its tributaries supply a large part of the basin's water needs. The Kaweah, Tule, and Kern Rivers, and their minor tributaries are also sources of supply from streamflow. Since the streams are not able to meet the total demands of the basin, the area is water deficient. The shortages are being met largely by pumping from the underground basins. Such pumping has been increasing over the years and, with the lowering of the ground water table over most of the area, overdraft conditions are common. The area's water needs are also supplied in part from importations via facilities of the Federal Central Valley Project and the California State Water Project. Table 12 summarizes the supply sources and average annual deliveries to the Kings River service area. As shown in the table, the Kings River and the ground water basin are the area's principal sources of supply. The quantities of water available from these two sources fluctuate considerably from year to year due to the annual variations in precipitation and runoff affecting the surface water flows.

The Kings River flows are regulated by the Corps of Engineers' Pine Flat Reservoir located in the Kings River foothills. The impoundment was constructed primarily for flood control and irrigation water supply. A description of the Pine Flat Dam and Reservoir is given in the preceeding section on flood control. The Bureau of Reclamation's Central Valley Project serves the Kings River service area by its Friant-Kern and the Delta-Mendota Divisions. The Friant-Kern Canal extends south from Millerton Lake on the San Joaquin River to the Bakersfield area and releases water to the Kings River area as well as to other areas along its course. The Delta-Mendota Canal conveys water from the Sacramento-San Joaquin Delta to the Mendota Pool on the San Joaquin River from which, via the Mendota-Kings River Canal, water is delivered to the Kings River area. The California State Water Project serves the Kings River area via the California Aqueduct which conveys water from the Sacramento-San Joaquin Delta to the San Luis Reservoir and thence south via the South San Joaquin Division of the California Aqueduct. The above facilities are shown on figures 1 and 2.

There are 28 organizations of water users in the service area. An extensive system of canals and laterals distributes water to about one

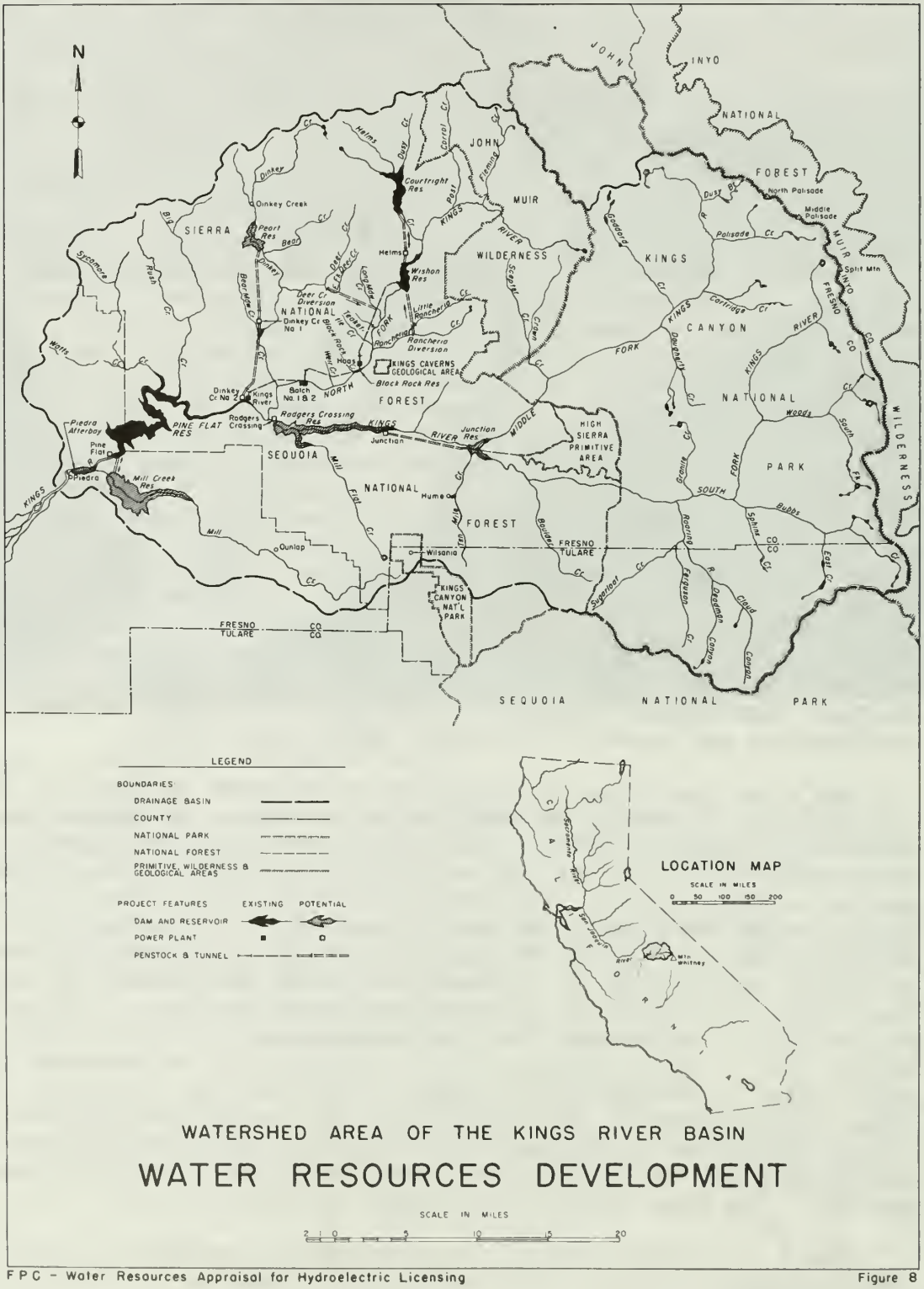


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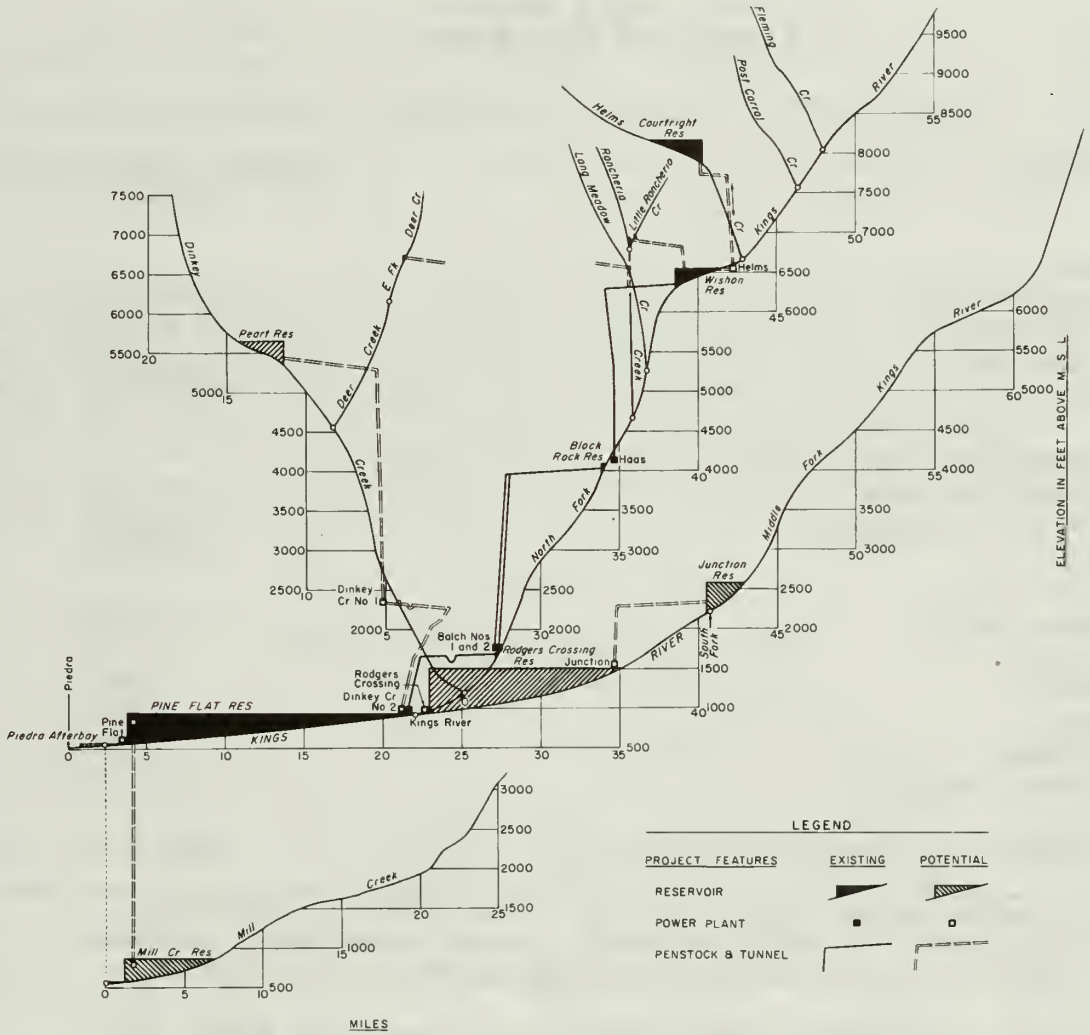
Figure 8



WATERSHED AREA OF THE KINGS RIVER BASIN

PROFILES

F P C - Water Resources Appraisal for Hydroelectric Licensing — Figure 9

Table 12

Water Supply Summary
Kings River Service Area

Supply Source	Average Annual Amount (acre-ft)
Kings River	
Gravity Diversion	1,513,600
Riparian Pumping	16,500
River Seepage	50,100
Total	1,580,200
Central Valley Project	
Friant-Kern Division	141,400
Delta-Mendota Division	79,000
Total	220,400
State Water Facility	113,000
Kaweah River	14,900
Tule River	18,900
Kern River	6,000
Minor Streams	17,700
Ground Water Pumping	1,500,000
Total to the Kings River Service Area	3,471,100

Sources: Surface water supply reported by the State of California, Department of Water Resources. Ground water supply estimated by the Kings River Water Association Watermaster.

million acres of irrigated land. Most of the urban areas derive their municipal and industrial water from ground water; however, some water is taken from the Friant-Kern Canal when such water is available.

Hydroelectric Power

There are four hydroelectric generating plants in the Kings River Basin, all of which are located in the basin's watershed area. Two of the plants, Balch Nos. 1 and 2, are a part of the Balch project and the other two plants, Haas and Kings River, are included in the Kings River project. These two projects, owned by Pacific Gas and Electric Company, have a total installed capacity of 307,300 kilowatts.

Streamflow regulation primarily in the interest of power production at the above four plants, is accomplished by the operation of the two upstream

reservoirs, Courtright and Wishon. These two reservoirs are part of the Kings River project. They provide a total usable storage capacity of 251,900 acre-feet.

The Balch project, which includes the Balch Nos. 1 and 2 power plants, is licensed by the Federal Power Commission as Project No. 175. The original license for Project No. 175 expired on July 27, 1972, and the project is currently operating under an annual license. The Kings River project, which includes the Haas and Kings River power plants, is licensed by the Federal Power Commission as Project No. 1988, with a license expiration date of March 31, 1985.

The Balch and Kings River projects develop a large part of the power potential of the North Fork Kings River. Following the flow of water downstream, the projects start with the Courtright Reservoir at the 8,188-foot elevation and extend to the Kings River power plant at the 914-foot elevation. The developments extend over a 22-mile route and comprise four dams, 14.9 miles of tunnels, and four power plants. The developments are shown on the basin map and river profiles, figures 8 and 9. Summary data on the four power plants are given in table 13.

Table 13

Existing Hydroelectric Power Plants
Kings River Basin

Plant Name	River	FPC Proj. No.	Drainage Area (sq mi)	Gross Head (ft)	Installed Capacity (kW)	Average Annual Generation (million kWh)	Year Installed
Kings River	Kings	1988	246	798	44,100	157.3	1962
Balch No. 1	N.Fk. Kings	175	232	2,379	31,000		1927
Balch No. 2	N.Fk. Kings	175	232	2,389	97,200	613.6 1/	1958
Haas	N.Fk. Kings	1988	177	2,444	135,000	517.5	1958
Total					307,300	1,288.4	

1/ Total for Balch No. 1 and No. 2.

The Balch project, which is being considered for relicensing or recommendation for Federal takeover, is described in detail in chapter V. A brief description of the Kings River project is given in the following paragraphs.

The principal features of the Kings River Project No. 1988 include Courtright and Wishon storage reservoirs, Haas and Kings River power plants, and several miles of power tunnel. The Courtright Reservoir on Helms Creek,

a tributary of the North Fork Kings River, was created by a 290-foot high rockfill dam. Wishon Reservoir on the North Fork Kings River, several miles below the Helms Creek-North Fork confluence, was created by a 250-foot high rockfill dam. Usable storage capacity in Courtright and Wishon Reservoirs is 123,300 acre-feet and 128,600 acre-feet, respectively. Data for these reservoirs are summarized in table 11. Downstream views of the dams are shown on figures 10 and 11.

Figure 10. Courtright Dam.

Water from Wishon Reservoir is conveyed by tunnel and penstock to the Haas power plant, a distance of about 7.5 miles. The Haas power plant, located on the North Fork of the Kings River, is an underground structure and has an installed capacity of 135,000 kilowatts. Views of the Haas powerhouse are shown on figures 12 and 13. Immediately below Haas, water is diverted at the small Black Rock Reservoir and conveyed by tunnel and penstocks to Balch No. 1 and No. 2 power plants. From there, water is discharged into Balch afterbay. The diversion dam, Black Rock Reservoir, conduit, power plants, and afterbay are included in the Balch Project No. 175. The Kings River Project No. 1988 continues from the Balch afterbay via a 3.4-mile long power conduit, most of which is tunnel, to the Kings River power plant. The 44,100-kilowatt Kings River power plant is located on the Kings River about two miles below the Kings River - North Fork Kings River confluence. A view of the Kings River powerhouse is shown on figure 14.

Figure 11. Wishon Dam.

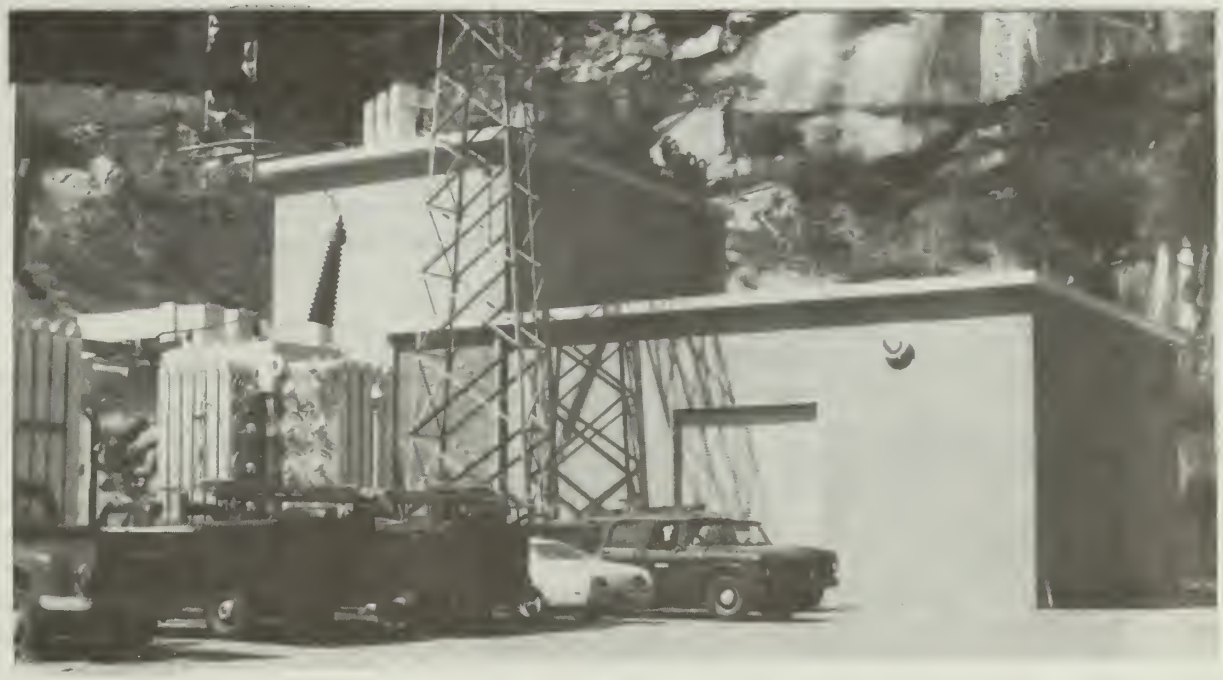


Figure 12. Surface access to Haas power plant.

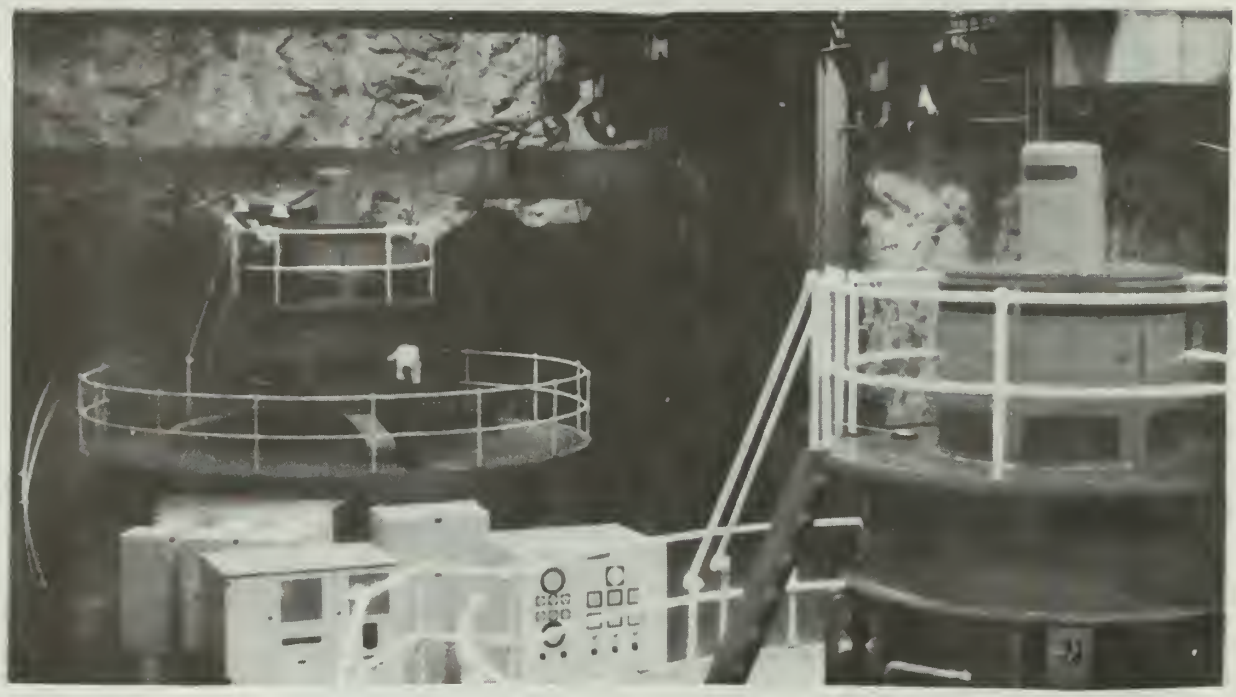


Figure 13. Underground generator room, Haas power plant.

Figure 14. Kings River power plant.

Recreation

The Kings River watershed upstream from Piedra includes some of the most spectacular scenery found anywhere in the Sierra Nevada. The Kings Canyon National Park covers the eastern part of the watershed while the Sierra and Sequoia National Forests cover much of the remaining watershed. The John Muir Wilderness is in the upper North Fork drainage and the High Sierra Primitive Area is west of the Kings Canyon National Park boundary between the Middle and South Forks. Figure 2 shows the locations of these areas. The watershed's high country is mantled with exposed granite rock and pock-marked with small glacier-carved lakes abounding with trout. Outstanding examples of hanging valleys, scoured river canyons, and other lesser remnants of glacier activity are found in the upper mountain areas. Dense forests cover the mountain slopes below the high rugged terrain. In this forested area, many groves of the giant Sequoias, largest of all trees, are found.

Only a few roads lead into Kings Canyon National Park and most of the area is inaccessible by vehicle. The National Park Service has provided roads, trails, and campground. Park concessionaires have provided a lodge, numerous cabins, a store, restaurant, service station, riding stable, and pack-saddle station. Throughout the national forests, the Forest Service has provided numerous campgrounds and picnic areas and many miles of trails. Concessionaires operate several stores and pack stations within the national forests. The YWCA has constructed a campground in Sierra National Forest.

At Pine Flat Reservoir, the Corps of Engineers has provided two campgrounds and four boat launching ramps. Concessionaires have constructed two marinas. Fresno County has constructed a park below Pine Flat Dam, which includes a 54-unit campground and a 40-unit picnic area. At Courtright Reservoir, the Forest Service maintains a 10-unit campground. A concessionaire operates a small marina at Wishon Reservoir.

Fish and Wildlife

The Kings River and its tributary streams afford excellent sport fishing. The upper basin has long been known for its excellent fishing, and the Middle Fork is known today as one of the best high quality trout streams in California. Species of brown, rainbow, golden, and eastern brook trout inhabit the streams and reservoirs above Pine Flat. At the lower elevations below the North Fork, there are rough fish present which tend to limit the trout population. Some warm water game fish are found in the lower reaches of the river. Fishing is popular in Pine Flat, Wishon, and Courtright Reservoirs. The modest fishery at Black Rock Reservoir attracts some fishermen.

The basin is rich in wildlife resources, and a wide variety of species is known to inhabit the area. Deer are by far the most important and are heavily hunted during the hunting season each year. Mountain quail are abundant in much of the basin. Other wildlife species present in the basin

include bald eagle, mountain lion, Sierra grouse, pileated woodpecker, pica, and goshawk. In the agricultural areas of the valley floor, the wildlife consists mainly of pheasants, jack rabbits, and song birds.

Sewage Treatment

The existing sewage treatment facilities within the basin consist mostly of municipal facilities serving the population centers. It is estimated that about 70 percent of the population in the basin is served by such facilities. Most waste water is discharged on land following secondary treatment. The larger municipal treatment facilities are listed in table 14.

Table 14

Municipal Treatment Facilities
Kings River Basin

Municipal System	Population Served	Flow MGD	Treatment	Effluent Discharge
Fresno metropolitan area	200,000	26.0	A,B,C	I, II
Hanford	15,000	1.5	A,B	I, II
Reedley	9,000	1.8	A,B	I
Dinuba	8,225	2.0	A,B	I
Lemoore	7,000	1.0	C	I, II
Corcoran	3,550	0.7	A	I, II
Selma, Fowler, and Kingsburg Irr. Dist.	15,000	3.7	A,B,D	I, II

Treatment: A- primary, B- secondary, C- areation lagoon, D- activated charcoal.
Effluent Discharge: I- evaporation - percolation pond, II- agricultural irrigation.
Source: Survey of communities and State of California, 1974.

In addition, nine smaller communities have treatment facilities serving a total population of 21,500. Individual homes not served by any municipal facility usually have septic tanks.

CHAPTER V

BALCH PROJECT

The Balch project, owned and operated by Pacific Gas and Electric Company, is located on the North Fork Kings River. The development is licensed by the Federal Power Commission as Project No. 175. The project, for which the original license expired on July 27, 1972, is being considered by the Commission for relicensing or recommendation for Federal takeover. The project is presently operating under an annual license. The principal facilities of the project are a forebay, a tunnel and penstocks, two power plants, and an afterbay.

History

On November 20, 1917, an application for a preliminary power permit was filed with the U.S. Forest Service by the San Joaquin Light and Power Company. On November 18, 1920, the U.S. Forest Service referred the application to the newly-formed Federal Power Commission. On December 6, 1920, San Joaquin Light and Power Company applied to the Federal Power Commission for a license for a power project to be located on the North Fork, West Fork, and main stem of the Kings River. The project was designated as FPC Project No. 175 and involved the construction of 11 dams, 7 powerhouses, 9 water conduits, and 3 transmission lines.

The license was issued on July 28, 1922, for a term of 50 years. The construction of the project was divided into five parts with the Balch No. 1 development to be constructed first. The initial development at Balch was restricted to 31,000 kilowatts, with an ultimate total of 92,000 kilowatts to be installed when downstream storage became a reality. With the completion of the Balch No. 1 development, project operation for power began on March 1, 1927.

On April 11, 1924, San Joaquin Light and Power Company submitted an application for amendment to the license for Project 175 to include the facilities in Project No. 102 with the Project 175 license. The amendment was authorized by the FPC on January 28, 1926. On March 28, 1934, San Joaquin applied to the FPC for abandonment of parts of the project, retaining only the Balch, Wishon, and Haas developments. The request was approved on July 19, 1935. On June 8, 1937, the Wishon and the Haas developments were also eliminated from Project 175, leaving the Balch development as the entire project.

The San Joaquin Light and Power Company was merged with the Pacific Gas and Electric Company on December 31, 1938. The FPC license for Project No. 175 was transferred to Pacific Gas and Electric Company effective November 22, 1939.

On January 19, 1948, the licensee filed an application with the Federal Power Commission to make additions and enlargments to the Balch project. These additions and enlargements, approved by the Commission Order issued on April 28, 1955, consisted of raising the existing diversion dam 44 feet, raising the spillcrest of the existing afterbay dam 6 feet, installing two 67,000 horsepower turbines and two - 54,000 kilovolt-ampere generators in a new powerhouse structure, modifying the surge chamber, installing an additional penstock, and installing an additional 115-kilovolt transmission circuit. Periodically other improvements have also been made for enhancing fish and wildlife and maintaining the dependability and overall efficiency of the project

An application for a new license for the project was filed with the Federal Power Commission on June 29, 1970, by Pacific Gas and Electric Company. Since expiration of the original license on July 27, 1972, the project has been operating under annual licenses issued to Pacific Gas and Electric Company under Section 15 of the Federal Power Act.

Description

The Balch project consists primarily of a diversion dam, a tunnel and surge chamber, two penstocks, two adjacent power plants, an afterbay, and transmission lines. Project data are summarized in table 15.

The Balch diversion dam is on the North Fork Kings River, several miles below the confluence of the North Fork Kings River and Rancheria Creek. Figure 15 shows a view of the Balch diversion dam. The pond created by the diversion dam, called Black Rock Reservoir, is used as the forebay for the Balch power plants as well as an afterbay for the upstream Haas power plant. The drainage area upstream of the dam is 233 square miles. The reservoir storage capacity at the normal full pool elevation of 4,097.0 feet is 1,260 acre-feet, of which 970 acre-feet are usable for power purposes. The dam is a concrete arch 135 feet high above the foundation at its maximum section. Most of the crest length of about 400 feet serves as an uncontrolled overflow spillway. The spillway crest is at elevation 4,098.0 feet. A 60-inch diameter and two 30-inch diameter sluices extend through the dam. The sluices are controlled by hydraulically operated gates. A 12-inch diameter pipe also extends through the dam for fish water releases.

An intake to the power tunnel is located approximately 150 feet from the end of the dam on the right bank. The intake is a reinforced concrete tower with trashracks and controlled by two steel gates, each 6.83 feet by 7.25 feet. From the intake tower, a pressure tunnel extends about 3.7 miles downstream on the right side of the river to the head of the penstocks. The tunnel, unlined except for short sections at each portal, is 12.0 feet wide by 12.5 feet high. Flows from Black Rock Creek and Weir Creek (see locations on figure 8) are diverted into the tunnel about 0.4 mile and about 2.0 miles, respectively, downstream from the intake. The flows are conveyed to the tunnel through 10-inch steel pipes. An unlined vertical shaft rises above the tunnel near the downstream portal and serves as a surge chamber.

Table 15

Balch Project Data

Black Rock Reservoir (Balch diversion)	
Drainage area, sq mi	233
Normal full pool water surface elevation, ft (msl)	4,097.0
Maximum drawdown, ft	40
Usable power storage capacity, ac-ft	970
Area at normal full pool, ac	35
Crest length of dam, ft	376
Maximum height of dam, ft	135
Balch Afterbay	
Normal full pool water surface elevation, ft (msl)	1,703.0
Maximum drawdown, ft	23
Usable power storage capacity, ac-ft	135
Area at normal full pool, ac	7
Crest length of dam, ft	238
Maximum height of dam, ft	179
Power Plant	
Generating unit 1	
Installed capacity, kW	31,000
Dependable capacity, kW	34,000
Gross power head, ft	2,379
Generating units 2 and 3	
Installed capacity, each unit, kW	48,600
Dependable capacity, each unit, kW	52,500
Gross power head, ft	2,389
Total installed capacity, kW	128,200
Total dependable capacity, kW	139,000
Average year generation, million kWh	613.6 1/

1/ Based on water year 1935, as indicated by the licensee on FPC Form 12.

Two steel penstocks extend from the tunnel to the powerhouses. An automatic butterfly valve is provided at the upstream end of each penstock. Penstock No. 1, a steel pipe with a diameter of 60 inches tapering to 48 inches, extends 0.87 mile to a wye near the No. 1 powerhouse. At the wye, the penstock branches into two 34-inch steel pipes leading to each impulse turbine wheel of unit 1. Penstock No. 2, a steel pipe with a diameter of 96 inches tapering to 68 inches, extends 0.92 mile to a wye near the No. 2 powerhouse. At the wye, the penstock branches into two steel pipes, one leading to unit 2 and the other to unit 3. Each branch tapers from a diameter of 46 to 36 inches.

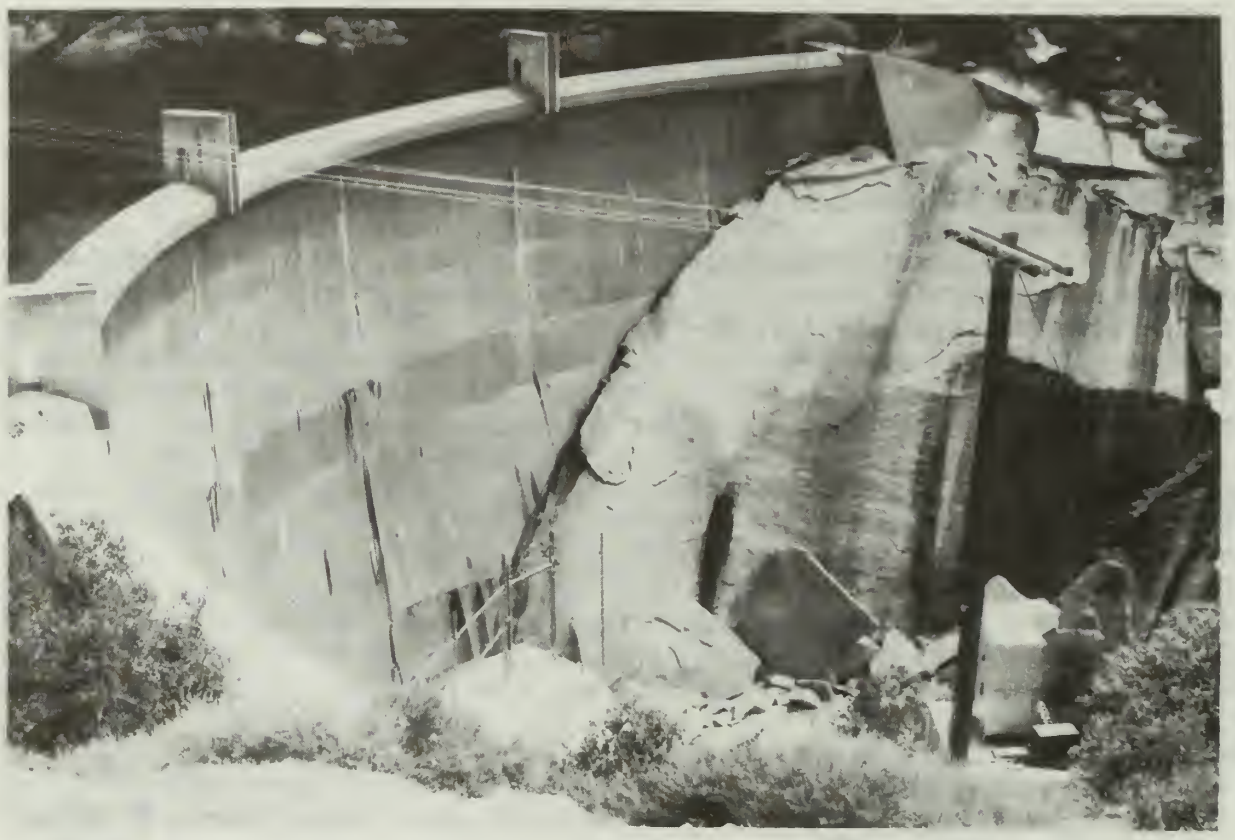


Figure 15. Balch diversion dam at Black Rock Reservoir.

Balch No. 1 and No. 2 powerhouses abut each other and are located on the North Fork Kings River about two miles upstream of the North Fork-Dinkey Creek confluence. The original No. 1 powerhouse is a steel framed and reinforced concrete building (see figure 16) while the latter built No. 2 powerhouse is a reinforced concrete outdoor-type structure (see figure 17). Powerhouse No. 1 contains one generating unit consisting of an Allis Chalmers double overhung, horizontal shaft, impulse turbine directly connected to a generator. The turbine is rated at 40,000 horsepower and operates at a speed of 360 revolutions per minute. The generator is rated at 31,000 kilowatts (33,000 kilovolt-amperes). Power is generated at 13,200 volts. Figure 18 shows a view of the Balch generator in powerhouse No. 1. Powerhouse No. 2 contains two units each having a Pelton vertical impulse turbine directly connected to a generator. Each turbine is rated at 67,000 horsepower and operates at a speed of 400 revolutions per minute. Each generator is rated at 48,600 kilowatts (54,000 kilovolt-amperes) and power is generated at 13,800 volts. Generating units 2 and 3 are installed 10 feet lower in elevation than unit 1 to gain additional head. A tailwater depression system is provided to lower the tailwater at units 2 and 3 to an acceptable operating level during periods of high river flows.

Figure 16. Balch No. 1 power plant.

Plant No. 1, equipped for semi-automatic operation, is operated by remote control from the Fresno Dispatch Center. Plant No. 2, equipped for full automatic operation, is remotely controlled from San Francisco and the Fresno Dispatch Center.

Substation and switching facilities for Plants No. 1 and No. 2 are located in an area immediately south of the plants. The outdoor transformer bank for Plant No. 1 steps up plant output from 13,200 volts to 115,000 volts. The bank consists of four 11,000-kilovolt-ampere, single phase, 60-cycle transformers, with one transformer serving as a spare. One 115,000-volt circuit breaker connects to the outgoing transmission line. The 12,000-volt station service is supplied by power from plant No. 1 via a 3,000-kilovolt-ampere transformer bank. Plant No. 2 has an outdoor transformer bank with a total capacity of 108,000 kilovolt-amperes which steps up the plant output from 13,800 volts to 230,000 volts. The bank consists of two 54,000-kilovolt-ampere, three phase, 60-cycle transformers. Three 230,000-volt circuit breakers are provided for connection to the licensee's transmission system.

Figure 17. Balch No. 2 power plant.

Figure 18. Balch No. 1 power plant interior.

A single circuit 115-kilovolt transmission line, known as the Balch-Sanger line, extends generally southwest for about 33 miles from Plant No. 1 to the licensee's Sanger substation via the Piedra Junction substation. A second 115-kilovolt line is installed on the double-circuit Balch-Sanger towers between the Kings River power plant and the Sanger substation, via the Piedra Junction substation, a distance of about 27 miles. Two short 230-kilovolt transmission line taps connect Plant No. 2 with the licensee's Haas transmission line which passes through the Balch switchyard. A 12-kilovolt distribution line connects Balch Camp (located near the confluence of the North Fork Kings River and Dinkey Creek) with the Balch Diversion Dam and Wishon Dam. The line within Project No. 175 is about 6.2 miles long and terminates near the Black Rock Diversion Reservoir. The line that continues to Wishon Dam is licensed as part of FPC Project No. 1988.

The Balch afterbay dam is constructed across the North Fork Kings River about one-quarter mile downstream from the Balch power plants. Figure 19 shows a view of the Balch afterbay dam. The penstocks in the background

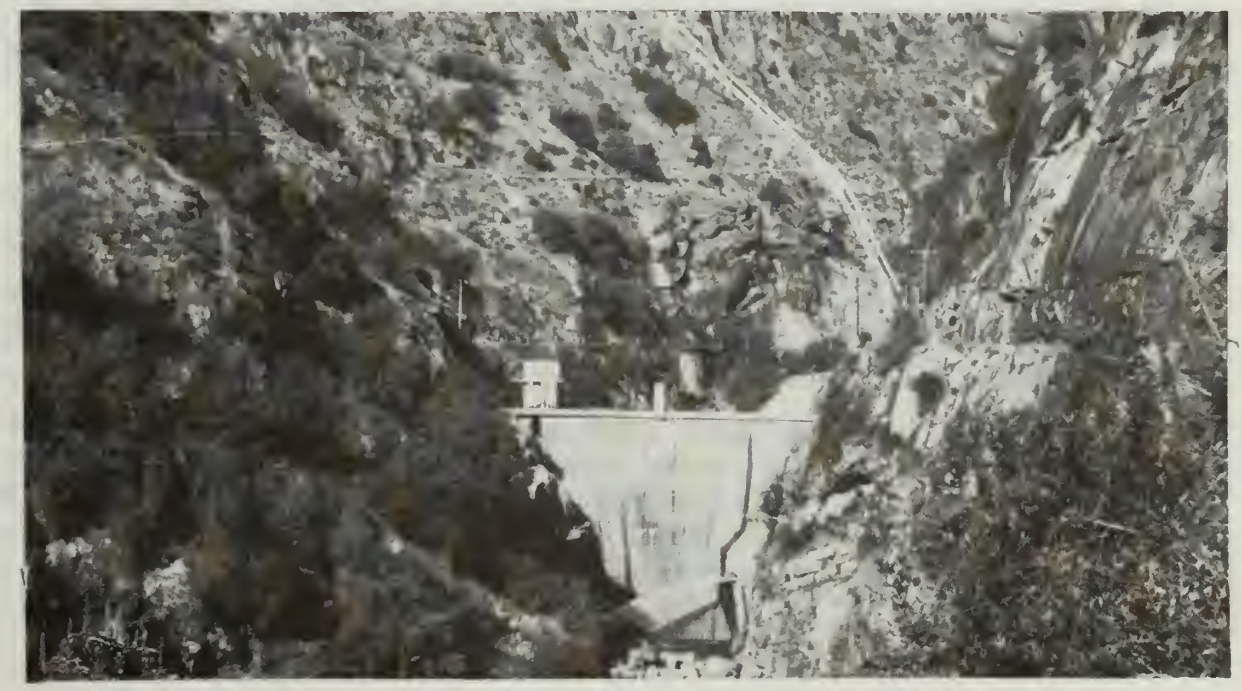


Figure 19. Balch afterbay.

supply the Balch power plants. The reservoir storage capacity at normal full pool elevation of 1,703.0 feet is 318 acre-feet. The dam is a concrete arch 179 feet high above the foundation at its maximum section and has a crest length of 238 feet. Most of the crest length serves as an uncontrolled overflow spillway. The spillway crest is at elevation 1,704.0 feet. The

dam is provided with 60-inch and 30-inch diameter hydraulically operated sluice gates and two 22-inch needle valve outlets. A power tunnel intake on the right bank upstream of the dam, not a part of the Balch project, diverts water from the afterbay into a tunnel leading to the downstream Kings River power plant.

Operation of the Project

The Balch project facilities are satisfactorily maintained and are in good working condition. The structures appear to be sound and stable. Some minor seepage is apparent in the concrete vertical joints and in the abutments of the diversion and afterbay dams.

At times of high runoff, large quantities of sediment are washed into the project reservoirs, especially into Black Rock. The Resources Agency of California reports that these deposits interfere with the operation of the reservoirs and cause turbidity and siltation downstream, thus adversely affecting water quality and the sport fishery downstream. Removal of the sediments by sluicing downstream through the dam outlets has not proved satisfactory. The Agency states that the deposits should be removed by dredging and disposed of at suitable spoil sites and that measures should be implemented to prevent the recurrence of the excessive erosion.

Very little recreation use is made of the two small project reservoirs, the 35-acre Black Rock Reservoir and the 7-acre afterbay, and of the stream in-between because of the widely fluctuating reservoir water levels, the steep and rugged terrain, the difficult access, and the larger water bodies in more attractive areas nearby. The project waters contain a modest native trout population.

The operations of the Balch power plants are completely integrated with the other two plants on the river, Haas and Kings River, utilizing the two upstream storage reservoirs, Courtright and Wishon, for regulation of stream-flow for power production.

The Balch forebay and afterbay are used for reregulation of daily inflow to and discharge from the Balch plants.

CHAPTER VI

ECONOMIC AND HUMAN NEEDS FOR FURTHER DEVELOPMENT OF WATER AND RELATED LAND RESOURCES

General

The Kings River Basin is in the heart of California's great agricultural region. Agriculture and its related industries are important sectors of the economy of the area. The agricultural development of the past has made Fresno County first nationally in farm products sales, and the importance of agriculture can be expected to continue into the future. This will require adequate water supply for irrigation, a mainstay in the Kings River Service Area.

Substantial growth of business and industry is expected in the future which will continue to diversify the economy of the area. The area is in the center of the State and excellent transportation facilities will support this expansion. Industrial and commercial growth is expected to provide employment for the projected increases in population.

Along with the agricultural, industrial, and commercial growth, there will be growth in population and accompanying urban development of former agricultural lands.

Electric Power Needs

The Kings River Basin is in the area designated by the Federal Power Commission as Power Supply Area (PSA) 46, encompassing most of central and northern California and the northwest sector of Nevada. It is appropriate to relate basin needs and project power output to PSA 46, because the Pacific Gas and Electric Company not only supplies virtually all power requirements of the basin, but it also supplies over 85 percent of the requirements of PSA 46.

Of some 22 electric utilities in PSA 46, the principal power systems are the Pacific Gas and Electric Company, the Sacramento Municipal Utility District, and the Central Valley Project of the U.S. Bureau of Reclamation. Historical and estimated future power requirements of PSA 46 are as shown in table 16.

The Western Systems Coordinating Council, in its report to the Commission, dated April 1, 1974, indicated that in the 10-year period through 1983, the peak load demand of the entire area comprising all or parts of the 13 western States is expected to more than double.

Table 16

Past and Estimated Future Power Requirements
FPC Power Supply Area 46

	Energy for Load (million kWh)	Maximum Demand (1000 kW)	Annual Load Factor (%)
1960	30,099	5,525	62.2
1970	58,600	10,500	64.6
1980	136,000	24,100	64.4
1990	291,000	51,600	64.4

Source: Data from Part III of the 1970 National Power Survey. 1960 and 1970 actual; 1980 and 1990 estimated.

Flood Control

Flood control features such as Pine Flat Reservoir, completed in 1954, and downstream channel improvements and control works on the Kings River and its distributaries, completed in 1969, provide a high degree of flood protection. However, flood problems still exist in some areas of the basin. Damages to agriculture and urban properties due to flooding, as well as streambank erosion and land loss due to sloughing, still occur. It is estimated that flood problems in the basin will increase in the future due to population and economic growth of the area as well as increased use of the flood plains.

To satisfy future flood control needs, the California Region Framework Study Committee indicates that a comprehensive flood control program is needed. This program would require a well-coordinated system of forecasting as well as procedures for coordinating releases from major reservoirs during flood flows. In addition, it is estimated by the California Region Framework Study Committee that an additional 451,000 acre-feet of flood control storage capacity will be required by the year 2020 to control a drainage area of approximately 1,700 square miles. Studies also indicate that an additional 30 river miles of levees and 60 miles of channel work will be desirable in the basin by the 1980's. Nonstructural measures such as land treatment for soil and water conservation will also be required.

Further studies should consider the above measures along with alternative measures including regulation of flood plain use to prevent their development in such a way that excessive damage will occur when floods strike, and to require that any structures that are built on the flood plain shall be designed so that they suffer little damage in time of flood.

Irrigation and Water Supply Requirements

There are approximately one million acres in the Kings River service area under intensive irrigation. These farmlands are located in Fresno, Kings, and Tulare Counties. The area has experienced an expansion in irrigated acreage in the past with a slight decline in 1969 due probably to the 1969 flood. Very little expansion in irrigated farming is expected in the future. Table 17 gives a summary of the historical and projected water demands of the Kings River Basin service area. Presently, much of the irrigation water is obtained from ground water pumping which, along with domestic, municipal and industrial water, creates an overdraft of approximately 400,000 acre-feet annually. Without additional water supply, this depletion could reach over 900,000 acre-feet annually by 1990. A combination of imported water and conservation of Kings River water is needed to meet the demands and halt the decline of ground water levels.

Table 17

Summary of Water Demands
Kings River Basin Service Area
(in 1,000 acre-feet)

Applied Water Demand	1960	1967	1990	2020
Urban	159.5	162.7	233.4	338.3
Agriculture	3,372.4	3,634.8	3,969.6	3,987.7
Total Applied	3,531.9	3,797.5	4,173.0	4,326.0

Source: International Engineering Co., Inc., adapted from California, Division of Water Resources.

Water users within the Kings River service area have contracted for imported water from the California State Water Project. The proposed East Side Division of the Central Valley Project is designed also to supply additional water in the future.

Recreation Needs

Recreational facilities have been provided in the area by the National Park Service and the U.S. Forest Service to meet the demand. Generally, the facilities have consisted of campgrounds, picnic areas, overlooks, and trails. One of the area's most outstanding features is the Kings Canyon National Park, operated and maintained by the National Park Service.

Any future development within the park should be made only after a full understanding is reached of its impact on the fragile ecology of the area. The Sequoia groves, a very unique and limited resource, and the park's high country are the main attractions of the area. In order to maintain the groves and to preserve its high country in a near natural setting, the development of future recreation facilities should occur outside the park. Logically, one would look to the basin's two national forests, Sierra on the west and Sequoia on the south, for areas near the park that could be develope into campgrounds and other public accommodations for visitors to the park. National forest lands appear to be able to absorb this additional development without undue degradation.

Some of the more heavily used Forest Service campgrounds, especially those popular with family groups, should be further improved rather than back country sites. Controlled camp site locations, dust suppression on interior roads, cooking grills that accept charcoal, showers, and possibly laundry facilities are needed. There is an increasing demand for such conveniences.

So long as there is a continuing increase in population, income, and leisure time, more people will look to mountains, forests, lakes, and waterways for relaxation and enjoyment. In order to meet this demand in an orderly fashion, recreation planners should recognize the trends, know the accommodation limits of these resources, and develop accordingly.

Fish and Wildlife Needs

In order to improve the stream fishery below each of the dams within the Kings River Basin, the California Department of Fish and Game would like to have increased uniform water releases from the reservoirs. They feel that existing water releases do not provide sufficient suitable fish habitat and that fluctuating flows, especially large sudden discharges, wash fish downstream and reductions in flow destroy sedentary aquatic life and strand fish. The Department of Fish and Game also stresses that management of reservoir fisheries is difficult because of priorities given to hydroelectric power and flood control operations. Since the reservoirs are subject to wide fluctuations, no beneficial littoral zone can be established, and this effectively limits natural regeneration. They feel that a stable reservoir water surface, at least through the spring months, would do much to increase reservoir fish production.

Water Quality Control Needs

Flows in the Kings River Basin are derived primarily from runoff from fall and winter rains and snows that occur primarily in the mountains. A shallow soil mantle in the mountains results in a poorly sustained base flow in the late summer. The mineral content in the Kings River Basin is

low and the quality of the water is excellent. The water is highly suitable for irrigation and meets drinking water standards. It is soft with a maximum recorded hardness of about 28 milligrams per liter.

Major surface water quality problems have not generally been experienced in the area. The Kings River and its tributaries originate in the Sierra Nevada in relatively isolated areas, not subjected to major man-made waste loads. Return irrigation water forms a major portion of the flow in the lower reaches of the river. Even this water is subjected to withdrawal, resulting in an accumulation of salt loads which are carried to the Tulare Lake area.

Quality of ground water near the Tulare Lake bed has indicated a rise in salt concentration over the years. Major waste loads do not reach streams since most discharges are applied on land; nevertheless, salt loads of waste origin are accumulated within this inland basin. Due to the import of agricultural water, the salt from agricultural consumptive use is a major factor. A potential problem exists and will require drains or other corrective measures in the future.

Most effluent in the Kings River Basin is discharged to land following secondary or other treatment at sewage treatment facilities.

CHAPTER VII

PLANS FOR FUTURE DEVELOPMENT

General

The Federal Power Commission license for Pacific Gas and Electric Company's Balch Project No. 175 expired July 27, 1972, and the project is now operating under an annual license. The Commission, under the Federal Power Act, must decide whether to issue a new license to the original licensee or to a new licensee or to recommend takeover by the Federal Government. Also, permit and license applications are pending before the Commission involving new developments in the basin for power and other purposes. This report has been prepared to provide information to the Commission and its staff that will aid in making decisions relating to these matters. Development plans of several agencies were reviewed and additional studies were made by the Commission staff for future development and utilization of the Kings River Basin water resources.

The potential water resource projects considered are those that could provide the opportunity for future development of the basin's resources and help to meet the increasing needs of the basin. The principal purposes of the projects considered would be flood control, irrigation, hydroelectric power production, fish and wildlife conservation, recreation, and water quality control.

The report does not formulate a plan for basin development or a program for implementing such a plan. The studies are of a reconnaissance level and denote type, complexity, and a general economic evaluation of the individual projects considered. Further detailed studies would be required to determine optimum project or basin plans.

Developments Considered

Many sites in the Kings River Basin have been investigated for the possible development of hydroelectric power as well as for other purposes since the 1890's. Recent studies of sites have been made by Pacific Gas and Electric Company and by local agencies such as the Kings River Water Association, the Fresno Irrigation District, and the Kings River Conservation District. Although most of the potential projects would benefit hydroelectric power, some would also provide benefits from flood control, irrigation, recreation, and fish and wildlife enhancement.

Possible future developments in the basin described herein include (1) four conventional hydroelectric power projects, (2) two water diversion projects having no new power facilities but capable of increasing the energy

production at existing hydroelectric projects, (3) an irrigation and flood control project, and (4) three potential pumped storage power projects. Table 18 lists these various projects classified under the above categories.

Table 18

Possible Future Development
Kings River Basin

Project Name	River	Installed Capacity (kW)	New Reservoir Capacity (acre-feet)
Conventional Hydroelectric Power Projects			
Pine Flat 1/	Kings	150,000	7,000 2/
Rodgers Crossing 1/	Kings	100,500	601,000
Junction	Kings	110,000	114,600
Dinkey Creek 1/	Dinkey Cr.	100,000	54,600
Diversions to Existing Hydroelectric Projects			
Deer Creek Diversion	Deer Cr.	-	-
Rancheria Diversion	Rancheria Cr.	-	-
Irrigation and Flood Control Project			
Mill Creek 1/	Mill Cr.	-	410,000
Pumped Storage Hydroelectric Power Projects			
Helms 3/	N. Fk. Kings	1,050,000	-
Chinquapin Lakes	Bear Cr.	3,000,000	26,000 4/
Dinkey Creek	Bear Cr.	2,000,000	22,000 4/

1/ *Development of site is considered in application for preliminary permit (Project No. 2741).*
2/ *At Piedra afterbay.*
3/ *Application for license pending (Project No. 2735).*
4/ *Storage in upper reservoir.*

Basis for Project Evaluation

In evaluating projects, the staff derived investment costs based on estimates contained in available reports. These cost estimates were

reviewed, modified, and updated as necessary. Where suitable cost data were not available, the staff prepared its own estimates.

The annual costs used in the benefit-cost analyses include fixed charges, operation and maintenance expenses, and administration and general expenses. In assuming Federal financing, the fixed charges included interest and amortization using an interest rate of 5-5/8 percent, interim replacements, and insurance (in lieu of). For private financing, fixed charges included the cost of money at 8-3/4 percent, depreciation, interim replacements, insurance, and taxes.

The annual value of power for the hydroelectric plants used in the benefit determinations was estimated on the basis of the annual costs of producing equivalent power from an alternative thermal-electric generating plant. For the Helms pumped storage project, the alternative was assumed to be a fossil-fueled combined cycle plant; and for the remaining potential projects, the alternative was assumed to be a baseload nuclear-fueled steam-electric plant. Annual costs were based on the assumption of 80 percent private financing and 20 percent non-Federal public financing of the alternative plant. With allowances made for the costs of associated thermal and hydro plant transmission facilities, the estimated at hydro-site value of power for Helms was $30.00 per kilowatt-year for dependable capacity and 17.0 mills per kilowatt-hour for energy. For the other hydro plants, the at hydro-site value of power, including an energy adjustment, was estimated to be $56.00 per kilowatt-year for dependable capacity and 1.8 mills per kilowatt-hour for generation. The cost of energy for pumping was estimated to be 5.66 mills per kilowatt-hour.

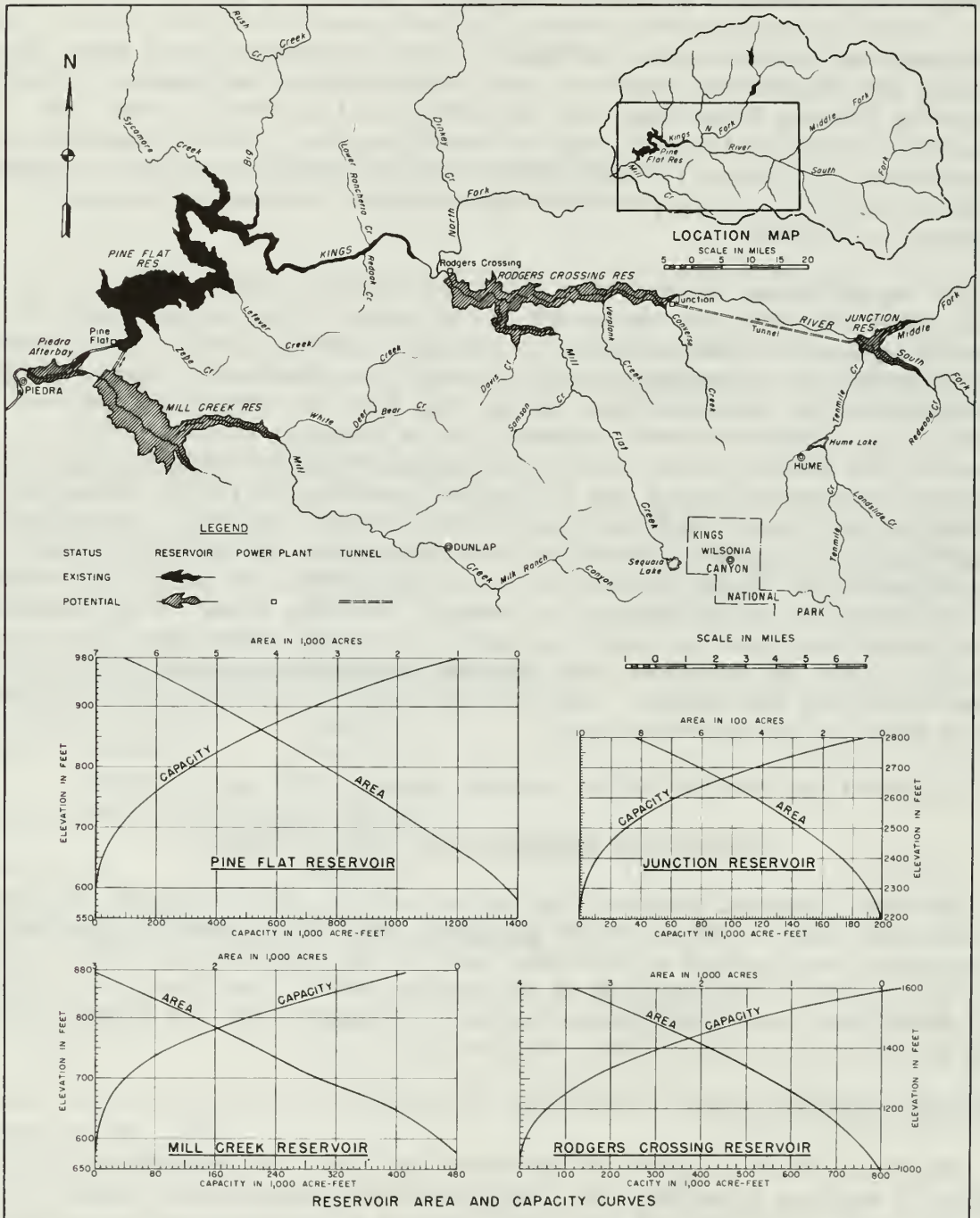
All costs and benefit values reflect January 1974 price levels.

Conventional Hydroelectric Power Projects

The four potential conventional hydroelectric power projects studied are described below. Three of the projects, Pine Flat, Rodgers Crossing, and Junction, are located on the main stem of the Kings River, while Dinkey Creek is located in the North Fork Kings River Area. The locations of the Kings River main stem projects are shown on figure 20 and the North Fork Kings River projects are shown on figure 21.

Pine Flat Power Project

The development of power at the existing Pine Flat Reservoir has been studied by various organizations. The power development would consist generally of the addition of two main features to be operated in conjunction with the existing Pine Flat Reservoir. These two features are (1) a power plant to be constructed at the existing Pine Flat dam, and (2) the Piedra afterbay to be constructed on the Kings River downstream from the existing Pine Flat Reservoir. The proposed facilities are shown on figure 20.

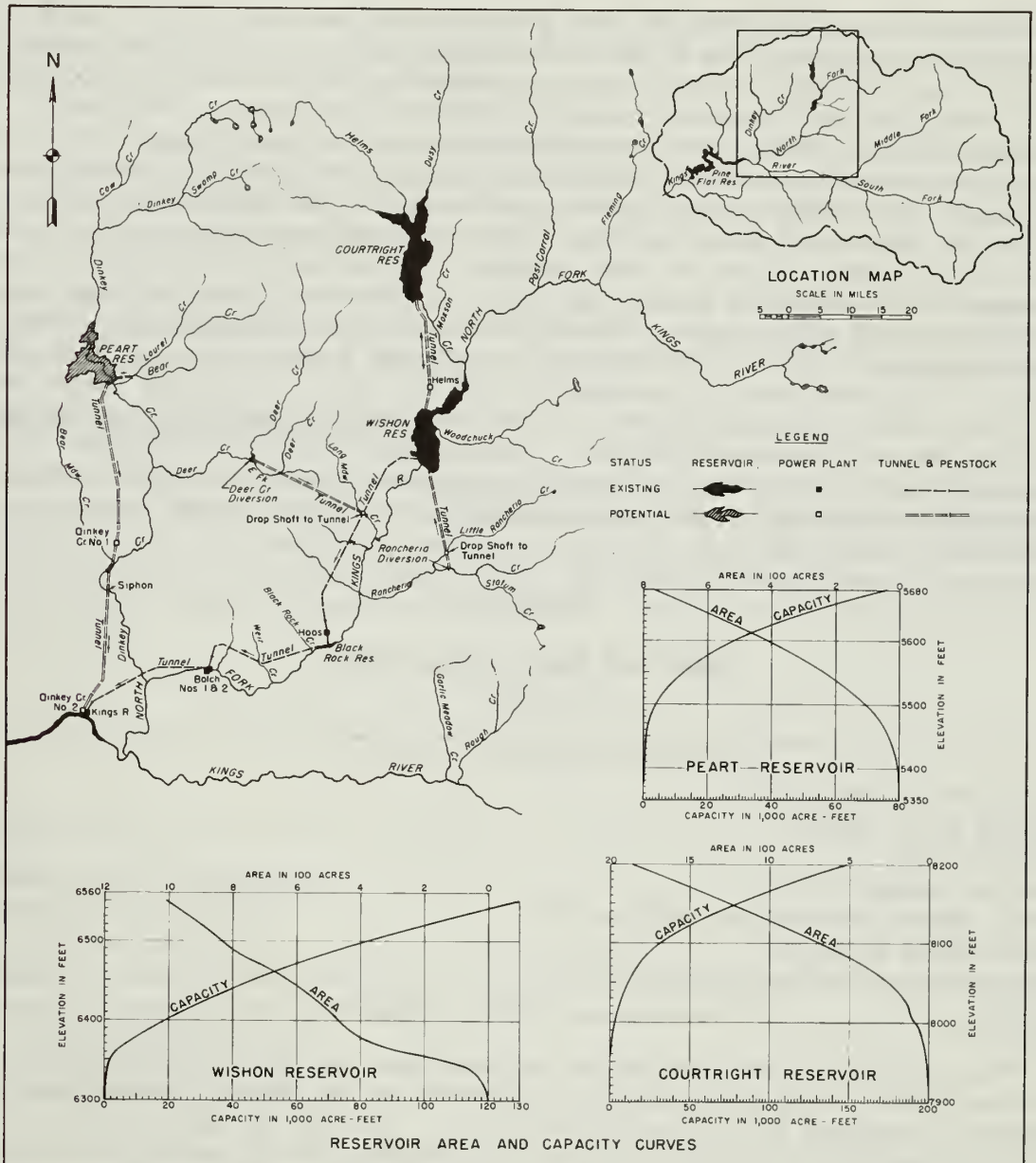


RESERVOIR AREA AND CAPACITY CURVES

FUTURE DEVELOPMENT PLAN

KINGS RIVER EXCLUDING NORTH FORK

F P C – Water Resources Appraisal for Hydroelectric Licensing — Figure 20



RESERVOIR AREA AND CAPACITY CURVES

FUTURE DEVELOPMENT PLAN

NORTH FORK KINGS RIVER

SCALE IN MILES

1 0 1 2 3 4 5 6 7

F P C – Water Resources Appraisal for Hydroelectric Licensing

Figure 21

Fresno Irrigation District, has proposed the installation of three 50,000-kilowatt units, or a total installed capacity of 150,000 kilowatts, capable of an estimated average annual generation of 300 million kilowatt-hours. The plant would operate under a maximum gross head of 386 feet. The dam, completed in 1954 by the Corps of Engineers, has provisions for a future power plant installation. The provisions consist of three 13.5-foot diameter steel penstocks through the concrete gravity dam. The afterbay at Piedra would allow peaking of the Pine Flat power plant by reregulating the releases to meet downstream irrigation requirements. The afterbay dam would be located approximately three miles downstream from the existing Pine Flat Dam, below the confluence of Mill Creek. It would be a rockfill dam with a minimum height of about 55 feet. The afterbay would have a gross storage capacity of about 7,000 acre-feet. The operation of the power facilities would be coordinated with the requirements of functions now served by the existing Pine Flat Dam and Reservoir project. Because the reservoir would be essentially emptied at times to supply irrigation needs, the power project alone could not provide dependable generating capacity. Power data are summarized in table 19.

Table 19

Pine Flat Power Project Data

River mile, Kings River	4
Drainage area, sq mi	1,542
Mean flow, cfs	2,360
Installed capacity, kW	150,000
Average annual generation, million kWh	300
Maximum gross head, ft	386
Piedra afterbay storage capacity, ac-ft	7,000

The addition of the facilities as described above would require an investment of $41,200,000, based on estimates by the Fresno Irrigation District as updated by the Commission staff. Studies by the Commission staff indicate that the power project's estimated annual costs with either Federal or private financing would substantially exceed the value of power produced. Therefore, the project does not appear to be economically favorable.

The Kings River Conservation District is presently conducting studies of a basin-wide project that would develop power at Pine Flat, along with the development of reservoir storage and conventional power at the upstream Rodgers Crossing, Mill Creek, and Dinkey Creek sites. The District has filed an application with the Federal Power Commission for a preliminary permit. The basin-wide project is designated by the Commission as Project

No. 2741. Plans previously considered for the development of the Rodgers Crossing, Mill Creek, and Dinkey Creek sites as individual projects are discussed in the following sections.

Preliminary studies show that, while no firm power would be available from Pine Flat during several months of most years when considered alone, a coordinated operation of Pine Flat combined with an upstream storage and power project such as Rodgers Crossing could provide dependable capacity.

The Pine Flat power project would not affect the operation of the existing power developments in the Kings River Basin, since the latter projects are upstream and utilize the flows of the North Fork Kings River.

Rodgers Crossing Development

The Rodgers Crossing development has been studied by the Kings River Water Association primarily for power production. The potential development consists of a dam, reservoir, and power plant. The dam site is located on the main stem of the Kings River about one-half mile upstream from the mouth of the North Fork, as shown in figure 20. Project data are summarized in table 20.

Table 20

Rodgers Crossing Project Data

River mile, Kings River	25
Drainage area, sq mi	956
Mean flow, cfs	1,400
Reservoir area at full pool, ac	2,815
Reservoir capacity at full pool, ac-ft	601,000
Installed Capacity, kW	100,500
Average annual generation, million kWh	349
Maximum gross head, ft	520

The project reservoir would have a capacity of about 601,000 acre-feet and extend upstream from the dam for over seven miles. The dam, an impervious earth-core rockfill structure, would be 570 feet high and have a crest length of about 2,150 feet. The reservoir at a maximum water surface elevation of 1,522 feet would cover an area of almost 3,000 acres. A power plant, with an installed capacity of 100,500 kilowatts and an estimated average annual generation of 349 million kilowatt-hours, would be located just downstream of the dam.

Economic studies of the project were made by the Commission staff based on private and Federal financing. Investment costs of $135,600,000 for the project as originally estimated by the Kings River Water Association and updated by the staff were used in the evaluation. With either Federal or private financing the estimated annual costs would be substantially in excess of the annual value of power from the project, resulting in an uneconomical project.

While the main project purpose would be for power production, some incidental benefits would accrue from flood control, water supply, irrigation fish and wildlife enhancement, and recreation. Such incidental benefits were considered to be relatively small.

Engineering reports prepared for the Kings River Water Association have indicated that the Rodgers Crossing project would not be economically justified. However, further studies of a basin-wide hydroelectric development, which would include the Rodgers Crossing project along with power development at Pine Flat and the development of reservoir storage and power at the Mill Creek and Dinkey Creek sites, are presently being made by the Kings River Conservation District.

The Rodgers Crossing project would not affect the operation of the existing power developments in the Kings River Basin, since the latter projects utilize flows of the North Fork Kings River.

Junction Project

The potential Junction project, primarily for power production, was considered by the Kings River Conservation District and somewhat modified by the Federal Power Commission staff. The modified project would consist of a dam on the Kings River just downstream from the confluence of the Middle and South Forks, a six-mile diversion tunnel, and a power plant. The general layout of the project is shown in figure 20.

The dam would be a rockfill structure with a concrete face. The dam would have a height of about 520 feet above streambed and have a crest length of about 1,410 feet. At full pool, the reservoir would have a storage capacity of 114,000 acre-feet and cover an area of about 600 acres. The six-mile tunnel would convey water from the reservoir to a power plant located at the upper end of the potential Rodgers Crossing Reservoir. The project's 110,000-kilowatt power plant would operate under a gross head of 1,190 feet and would have an estimated average annual generation of about 500 million kilowatt-hours. Project data are summarized in table 21.

The Junction project would require an investment of about $118,900,000, as estimated by the Commission staff. Benefits from the project would accrue primarily from power production. Some additional benefits for irrigation and recreation might be provided; however, such benefits would be relatively small and would probably not be enough to significantly alter the project economics.

Table 21

Junction Project Data

River mile, Kings River	41
Drainage area, sq mi	836
Mean flow, cfs	1,180
Reservoir area at full pool, ac	600
Reservoir capacity at full pool, ac-ft	114,000
Length of conduit, ft	31,680
Installed capacity, kW	110,000
Average annual generation, million kWh	500
Maximum gross head, ft	1,190

Economic studies of the project were made by the Commission staff based on private and Federal financing. With private financing, the estimated project costs would be substantially in excess of the value of project power, resulting in an uneconomical project. With Federal financing, the estimated project costs would be slightly greater than the power benefits, indicating marginal economic justification of the project.

Being located on the main stem of the Kings River, the Junction project would not affect the operation of the existing power projects in the Kings River Basin, since the latter projects utilize flows of North Fork Kings River.

Dinkey Creek Development

The Dinkey Creek development, studied by Pacific Gas and Electric Company, would consist of the following features: (1) a dam and reservoir on Dinkey Creek, just upstream from the mouth of Bear Creek, (2) two power tunnels, (3) two power plants, (4) a power plant tailrace tunnel and afterbay, and (5) a small diversion dam and tunnel on Bear Creek.

The Dinkey Creek dam, planned as a rockfill structure, would be approximately 310 feet high and would form the Peart Reservoir which would have capacity of about 55,000 acre-feet. The water surface of the reservoir would cover approximately 636 acres at an elevation of 5,650 feet. A small diversion dam on Bear Creek would divert that stream through a 3,200-foot tunnel into Peart Reservoir or through power plant No. 1.

The Dinkey Creek No. 1 power plant, to be connected by a six-mile power tunnel and penstock with Peart Reservoir, would be an underground plant similar to the existing Haas project. Discharges from the Dinkey Creek No. 1 power plant would be through a 3,800-foot long tailrace tunnel into a small afterbay on Dinkey Creek. The plant would have an installed capacity of 70,000 kilowatts and would operate under a maximum gross head of 3,320 feet.

From the afterbay on Dinkey Creek, water would flow through a four-mile power tunnel and penstock to the Dinkey Creek No. 2 power plant. The site of this power plant is located on the Kings River near the existing Kings River power plant. The No. 2 plant would develop a gross head of 1,410 feet and would have an installed capacity of 30,000 kilowatts. Plant No. 1 and plant No. 2 would have an estimated average annual generation of 265 million kilowatt-hours and 112 million kilowatt-hours, respectively. The pertinent project data are given on table 22.

Table 22

Dinkey Creek Project Data

River mile, Dinkey Creek		13
Drainage area, sq mi		67
Mean flow, cfs		135
Peart Reservoir area at full pool, ac		636
Peart Reservoir capacity at full pool, ac-ft		54,660
	Power Plant No. 1	Power Plant No. 2
Length of conduit, ft	24,375	22,090
Installed capacity, kW	70,000	30,000
Average annual generation, million kWh	265	112
Maximum gross head, ft	3,300	1,400

The Dinkey Creek project would require an investment of $63,900,000, as originally estimated by Pacific Gas and Electric Company and updated by the Commission staff. Studies by the Commission staff indicate that, based on the value of power produced, the project appears to be economically favorable under Federal financing and uneconomical under private financing.

Further consideration is being given to the development of Dinkey Creek by the Kings River Conservation District in its basin-wide project study.

The potential Dinkey Creek project, being located on Dinkey Creek, a tributary of the North Fork Kings River, downstream from the existing power projects would not directly affect the operation of the existing power projects.

Diversions to Existing Hydroelectric Projects

There are two potential projects, Deer Creek and Rancheria Creek, that would divert additional water to existing hydroelectric projects. While not

developing any new power capacity, they would be capable of increasing the energy output of existing projects. These two projects have been studied by Pacific Gas and Electric Company and are located in the North Fork Kings River area, as shown in figure 21.

Deer Creek Diversion Project

The Deer Creek Diversion project would provide an additional source of water supply which could be used beneficially at the Haas, Balch Nos. 1 and 2, and Kings River power plants. This potential project would divert flows from Deer Creek, a main tributary of Dinkey Creek, and from Long Meadow Creek, a tributary of the North Fork Kings River, into the Haas project tunnel. The diversion would consist of two diversion dams and approximately 3-1/2 miles of tunnel. A 290-foot shaft would connect to the Haas tunnel at Long Meadow Creek.

The diversion of flows from an additional 18.9 square miles of drainage area at Deer Creek and 6.6 square miles at Long Meadow Creek would provide an average annual yield of 21,300 acre-feet. It has been estimated by Pacific Gas and Electric Company that this new yield would increase the energy output of the existing plants by a total of about 98 million kilowatt-hours per year.

The Deer Creek project would reduce the power flows to the potential Dinkey Creek project by diverting flows from about 19 of the 67 square miles of drainage area that would otherwise be available to the latter project.

The Deer Creek Diversion project would require an investment of $4,600,000 as originally estimated by Pacific Gas and Electric Company and updated by the Commission staff. Studies by the Commission staff indicate that the project would not be economically favorable using private financing.

Rancheria Diversion Project

The Rancheria Diversion project would provide a new source of water supply to the existing Haas hydroelectric project. The diversion project would consist of two small diversions, one on Rancheria Creek and the other on Little Rancheria Creek. The flows would diverted to the existing Wishon Reservoir through a 2-1/2 mile Rancheria tunnel. The diversion from Little Rancheria Creek would be through a 65-foot shaft which would connect to the Rancheria tunnel.

This project would divert the runoff from about 20.2 square miles of additional drainage area to Wishon Reservoir. The additional average annual water yield would be about 19,800 acre-feet. It is estimated that this new yield would increase the annual generation of the existing Haas plant by about 41 million kilowatt-hours.

The Rancheria Diversion project would require an investment of about $3,300,000 as originally estimated by Pacific Gas and Electric Company and updated by the Commission staff. Studies by the Commission staff indicate that the project would not be economically favorable under private financing.

Mill Creek Project

A reconnaissance appraisal of a project on Mill Creek has been prepared for the Kings River Water Association. The project for flood control, irrigation, and recreation would consist of the Mill Creek Dam and Reservoir and a tunnel connecting the proposed reservoir with the existing Pine Flat Reservoir. The location of the project is shown on figure 20.

The dam site would be on Mill Creek about one mile south of the existing Pine Flat Dam and one mile upstream from the Mill Creek confluence with the Kings River. The proposed dam would be rockfill, 325 feet high, with a crest length of approximately 3,500 feet. A reservoir with 410,000 acre-feet capacity would cover approximately 3,000 acres and extend six miles up Mill Creek. The reconnaissance estimate, as updated by the Commission staff, indicates that the cost of the project would be about $82,000,000.

The proposed project would be operated first, to regulate the flows of Mill Creek and, secondly, as an adjunct to the existing Pine Flat Reservoir. A tunnel, 4,500 feet in length, would connect the two reservoirs at elevation 800 feet. This tunnel would be capable of passing 3,000 cubic feet per second from Pine Flat to Mill Creek when the storage of Pine Flat Reservoir equals or exceeds about 600,000 acre-feet. The Mill Creek Reservoir would conserve much of the flow that would otherwise be spilled at Pine Flat. The project data are summarized in table 23.

Table 23

Mill Creek Project Data

River mile, Mill Creek	1
Drainage area, sq mi	120
Mean flow, Mill Creek, cfs	31
Reservoir area at full pool, ac	3,000
Reservoir capacity at full pool, ac-ft	410,000
Length of tunnel, ft	4,500

The Kings River Water Association's reconnaissance study indicated that the value of the annual benefits from flood control, irrigation, and recreation would be slightly greater than the annual project costs (assuming private financing). Thus, the project should merit further consideration.

Further consideration is being given to the development of Mill Creek by the Kings River Conservation District in its basin-wide project study that would delete the tunnel connection to Pine Flat Reservoir and would add a hydroelectric power plant at the Mill Creek project.

Pumped Storage Potential

Several plans have been considered for the development of pumped storage capacity in the Kings River Basin. One such plan, is Pacific Gas and Electric Company's proposed Helms pumped storage project. Two other sites have been considered by the Commission staff for possible pumped storage development.

Helms Pumped Storage Project

A license application has been filed by Pacific Gas and Electric Company to construct and operate the Helms pumped storage project. The Federal Power Commission has designated Helms as Project No. 2735. The project would be a combination pumped storage and conventional hydroelectric project for the development and utilization of the water resources of Helms Creek and the North Fork Kings River above Wishon Dam. The project would have a nameplate rating of 1,050 megawatts with a maximum expected capability, estimated to be available within normal overload ratings, of approximately 1,125 megawatts. The project would develop about 1,600 feet of head between existing Courtright Lake, located on Helms Creek, and existing Lake Wishon, located on the North Fork Kings River. The location of the project is shown on figure 21.

The project facilities would consist of the following: an intake structure in Courtright Lake; an underground conduit 16,862 feet long connecting Courtright Lake and the powerhouse; the project powerhouse located near Wishon Lake to be entirely underground; two tunnels, each about 4,000 feet long to serve as the tailrace and the access to the powerhouses; and two surge chambers, one within the conduit and the other connected to the tailrace tunnel just downstream of the powerhouse.

The underground powerhouse would have three reversible units, with a total installed capacity of 1,050 megawatts. It is estimated by Pacific Gas and Electric Company that by 1995 the project would operate on an annual plant factor of about 20 percent. Such operation would require about 2,600 million kilowatt-hours of energy for pumping and would generate 1,938 million kilowatt hours of electricity. The plant would operate under a normal static head of 1,600 feet. Table 24 lists the pertinent project data.

The Helms pumped storage project would require an investment of about $204,200,000, as estimated by Pacific Gas and Electric Company and updated by the Commission staff. Utilizing this cost, studies by the staff indicate that the annual value of the power produced would exceed the annual project costs assuming private financing.

Table 24

Helms Pumped Storage Project Data

Powerhouse river mile, North Fork Kings River	20
Drainage area, sq mi	-
Mean flow, cfs	-
Length of conduit, ft	16,862
Installed nameplate capacity, kW	1,050,000
Normal static head, ft	1,600
Average annual generation, million kWh	1,938
Average annual power for pumping, million kWh	2,600

Other Pumped Storage Potentials

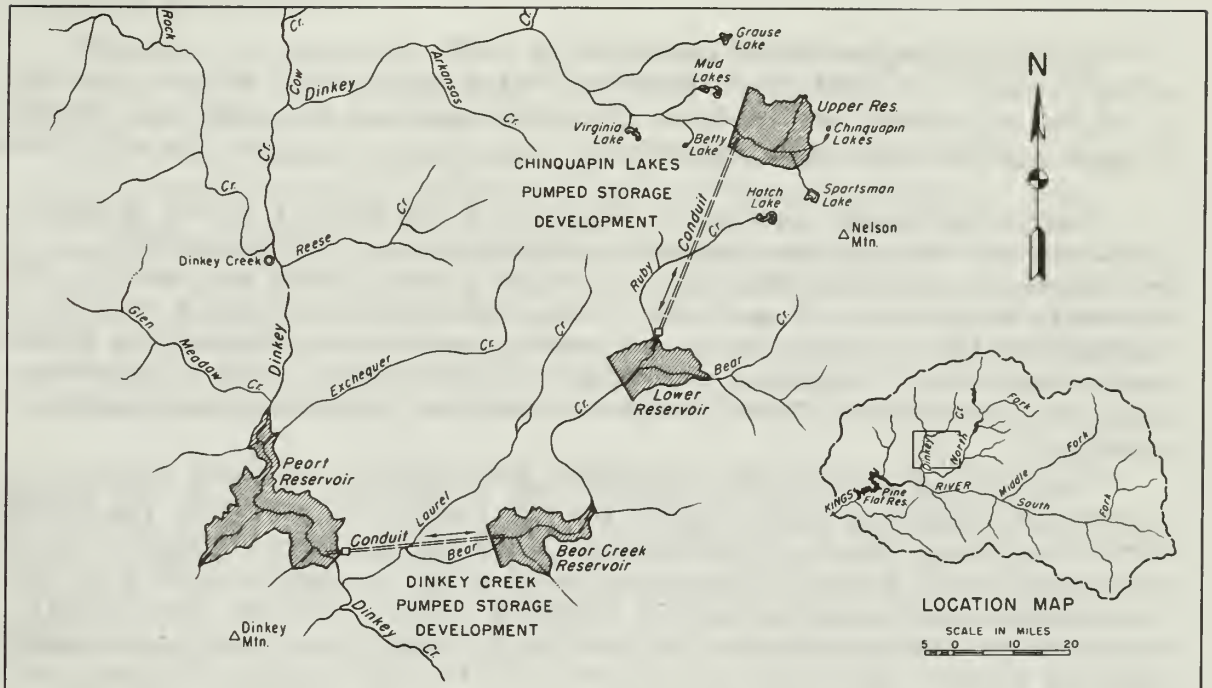
From staff reconnaissance studies based solely on U.S. Geological Survey topographic maps, pumped storage projects appear attractive in the Chinquapin Lakes area and in the Dinkey Creek areas of the basin. Figure 22 shows the location of these two potential pumped storage projects.

The Chinquapin Lakes pumped storage development would consist of an upper reservoir on a minor tributary of Dinkey Creek. A 2.5-mile conduit would connect the upper reservoir to a lower reservoir at Bear Meadow on Bear Creek about four miles east of the Peart Reservoir site. The upper and lower reservoirs, each with a storage capacity of up to 26,000 acre-feet, would develop about 1,555 feet of head for a pumped storage installation of up to 3,000 megawatts. The investment costs of a 1,000 and a 3,000 megawatt installation are estimated to be about $193 and $154 per kilowatt, respectively.

The potential Dinkey Creek pumped storage development would consist of an upper reservoir on Bear Creek, connected by a 1.7-mile conduit to a power plant at a lower reservoir at the Peart Reservoir site. The upper and lower reservoirs, each with a storage of up to 22,000 acre-feet, would develop about 1,115 feet of head for a pumped storage plant of up to 2,000 megawatts. The investment costs of a 1,000 and 2,000 megawatt installation are estimated to be about $191 and $170 per kilowatt, respectively.

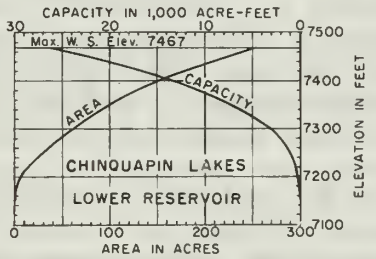
Future Operation of Balch Project

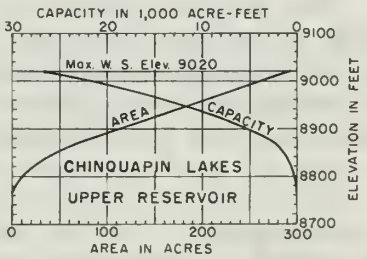
An application was filed with the Federal Power Commission by Pacific Gas and Electric Company for a new license to operate and maintain Project No. 175. The original license expired on July 27, 1972, and the project is presently operating under an annual license.

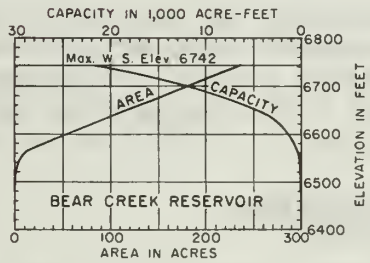


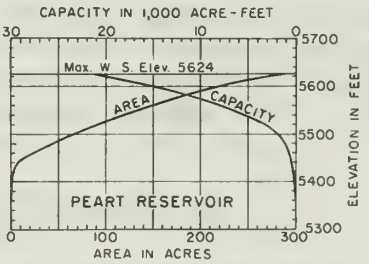
LEGEND

POTENTIAL RESERVOIR — POTENTIAL CONDUIT — POTENTIAL POWERHOUSE □









KINGS RIVER BASIN

POTENTIAL PUMPED STORAGE PROJECTS

SCALE IN MILES

1 0 1 2 3

FPC - Water Resources Appraisal for Hydroelectric Licensing — Figure 22

The Balch project began operating in 1927, with its first 31,000-kilowatt unit. In 1958, its second and third units, each with a capacity of 48,600 kilowatts, were added. The structures and equipment are presently in good condition and well maintained. The project is operating efficiently.

Due to the rugged terrain in the area of the project making access difficult and the existence of more attractive areas nearby, minimal recreation is currently associated with the project lands and waters. The two small reservoirs and sections of the North Fork Kings River provide limited fishing. Pacific Gas and Electric Company contemplates the development of an 8-unit campground near Black Rock Reservoir. Two other sites along the north shore of the reservoir also have recreation development potential.

Pacific Gas and Electric Company has investigated several undeveloped sources of additional water supply for the project on the upper reaches of North Fork Kings River and tributaries above the Haas power plant. The relatively small amount of new water which could be made available by such development and the costs incurred from the construction of long tunnels would not warrant modification of the Balch plant to increase its capability. Existing project developments have realized the full potential power head of this stretch of North Fork Kings River.

The project should be capable of continuing to produce power for a number of years. Economic analysis indicates that continued operation of the project would be favorable; that is, the annual project costs comprising the estimated fixed charges on the project's net value and estimated operating costs would be less than the annual value of project power.

The project's net value of $15,390,000, as used in the above analysis, is considered to be the estimated project cost minus the estimated project depreciation at the time of expiration of the original license. Under procedures prescribed in Order No. 387, issued by the Commission on August 4, 1969, for the determination of the net investment component of a takeover price, the net value as computed above would be subject to a maximum potential further deduction of the balance accumulated in the project Section 10(d) (Federal Power Act) amortization reserve account.

Environmental Considerations

Almost 80 percent of the Kings River Basin is within the boundaries of the Sierra and Sequoia National Forests and the Kings Canyon National Park. Within these areas are located the High Sierra Primitive area and the John Muir Wilderness area. These areas, noted for their wide variety of outdoor recreation facilities, are increasing rapidly in popularity due to their close proximity to large population centers. It is important that these areas do not deteriorate because of over-use. Thus, in considering the development of any potential water resources project or in the continued operation of an existing project, the effects, both beneficial and adverse, on scenic values, recreational opportunities, fish and wildlife resources, and water quality should be taken into account.

Potential New Projects

As shown in figure 8, all of the potential new developments in the basin are within the Sierra and the Sequoia National Forests but outside of the Kings Canyon National Park and wilderness and primitive areas.

All of the potential projects would involve either dams and reservoirs or stream diversions which would alter fish and wildlife habitats. Construction of reservoirs would put an end to the stream fisheries at the impoundment sites, while diversions from one stream to another and from one subbasin to another would change the flow characteristics of the streams involved. However, by proper management, lake fisheries could be developed in the reservoirs as well as below the reservoirs through control of flood flows and low flow augmentation. The potential reservoirs could provide an improved setting for water oriented recreational opportunities.

A bill which has recently been signed into law (State of California), amends the State of California's Public Resources Code by providing a moratorium on any construction on specified portions of the Kings River until January 1, 1979. The intent of the law is to provide time for additional water resources studies of the area and not to designate any portion of the Kings River as a component of the California Wild and Scenic Rivers System. The potential Rodgers Crossing and the Junction projects are in the above designated area.

Continued Operation of Balch Project

The various facilities of the Balch project have been in existence for over 50 years. Consequently, their impact on the environment is well established. The operation of the Balch project is completely integrated with the other two plants on the river, Haas and Kings River. Their combined peaking capability makes an important contribution toward meeting the peak power demands of the licensee's system.

The project, with its two small reservoirs and the section of North Fork Kings River between them, provides limited fishing for naturally produced brown and rainbow trout. Regulated minimum water releases are made below each of the two dams of the project in the interest of the fishery resources, wildlife, and other aquatic life of the stream. These minimum releases are as follows:

	June 1 through November 30	Dec. 1 through May 31	Dry Years
Black Rock Reservoir	5 cfs	2.5 cfs	2.5 cfs
Balch Afterbay Dam	25 cfs	12.5 cfs	12.5 cfs

Pacific Gas and Electric Company proposes to develop an eight-unit campground near Black Rock Reservoir which will serve as a recreational focal point for the forebay and nearby downstream fishing areas.

Alternative to the continued operation of the Balch project would be generation of equivalent power from some other source, probably thermal, which would consume fuel and could pollute air and water.

Conclusions

A major part of the comprehensive development of the water and related land resources of the Kings River Basin has been accomplished through Pacific Gas and Electric Company's two hydroelectric projects, the Balch and Kings River Projects; the Corps of Engineers' Pine Flat Reservoir; and land management of the basin's national forests and parks by the U.S. Forest Service and the National Park Service.

Potentials for further development of the basin exist on the main stem and on the North Fork Kings River, as well as on Mill and Dinkey Creeks. Development would be primarily for hydroelectric power production. Other project purposes would include flood control, irrigation, fish and wildlife enhancement, and recreation.

Pacific Gas and Electric Company's proposed Helms pumped storage appears to be economically favorable for development.

Consideration has been given to the possible development of conventional hydroelectric power at the existing Pine Flat Reservoir and reservoir storage and conventional hydroelectric power development at the Rodgers Crossing, Junction, and Dinkey Creek sites. None appear to be economically justified as individual developments with private financing. With Federal financing, Dinkey Creek appears to be the only project economically justified. However, Junction appears to have marginal economic justification with Federal financing. A combination project consisting of several of these developments with coordinated operation would appear to be economically more attractive. The Kings River Conservation District is currently studying a multiple-development project such as this and has applied to the Commission for a preliminary permit covering such investigations.

Schemes to divert additional streamflow to existing hydroelectric projects for increased power generation do not appear to be economically justified.

Reconnaissance investigations of a flood control and irrigation project at the Mill Creek site and two pumped storage projects, Chinquapin Lakes and Dinkey Creek, indicate that they appear to be attractive for development and that they, therefore, merit further consideration.

The Balch project, for which an application for a new license is pending, is in good condition and capable of being operated efficiently for a number of years in the future. The continued operation of the project appears to be economically justified.

None of the potential developments in the basin, except the Deer Creek and Rancheria diversion projects, would have any appreciable effect on the existing projects in the basin. The Deer Creek diversion would provide an additional water supply for power generation at all of the existing power plants in the basin. The Rancheria diversion would supply additional water for power generation at the existing Haas plant.