STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

GOODWIN J. KNIGHT, Governor
FRANK B. DURKEE, Director of Public Works
A. D. EDMONSTON, State Engineer

PROGRAM

FOR

FINANCING AND CONSTRUCTING THE FEATHER RIVER PROJECT

AS THE

INITIAL UNIT OF THE CALIFORNIA WATER PLAN

FEBRUARY 1955

Artist's Conception of Oroville Reservoir, Dam and Power Plant

Goodwin J. Knight
Governor

Water Project Authority of the State of California

PUBLIC WORKS BUILDING
1120 N STREET
SACRAMENTO, CALIFORNIA

CHAS. G. JOHNSON, State Treasurer
ROBERT C. KIRKWOOD, State Controller
FRANK B. DURKEE, Director of Public Works, Chairman
JOHN M. PEIRCE, Director of Finance
EDMUND G. BROWN, Attorney General

A. D. EDMONSTON, State Engineer, Executive Officer

ADDRESS ALL COMMUNICATIONS TO EXECUTIVE OFFICER
P. O. BOX 1079, SACRAMENTO 5, CALIF.

February 18, 1955

Honorable Joseph A. Beek
Secretary of the Senate
State Capitol

Dear Mr. Beek:

There is transmitted herewith for consideration of the State Legislature a report entitled "Program for Financing and Constructing the Feather River Project as the Initial Unit of The California Water Plan," dated February 1955.

This is a report of the investigations, surveys, and studies conducted with funds appropriated by the Legislatures of 1952, 1953, and 1954, and which were authorized by Chapter 1441, Statutes of 1951.

This report was presented to the Water Project Authority at its meeting held on February 16, 1955, and the Authority concurred in the transmittal of the report to the Legislature.

Very truly yours,

/s/ Frank B. Durkee

FRANK B. DURKEE
Director of Public Works and
Chairman, Water Project Authority

Same letter to
Honorable Arthur A. Ohnimus
Clerk of the Assembly
State Capitol

GOODWIN J. KNIGHT
GOVERNOR OF CALIFORNIA

A. D. EDMONSTON, State Engineer
CHIEF OF DIVISION

FRANK B. DURKEE
DIRECTOR

STATE OF CALIFORNIA
Department of Public Works
SACRAMENTO

ADDRESS REPLY TO
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5
PUBLIC WORKS BUILDING
1120 N STREET

February 14, 1955

Mr. Frank B. Durkee
Director of Public Works, and
Chairman, Water Project Authority
Public Works Building
Sacramento, California

Dear Mr. Durkee:

There is submitted herewith a report entitled, "Program for Financing and Constructing the Feather River Project as the Initial Unit of The California Water Plan." This is a report of the investigations, surveys, and studies conducted with funds appropriated by the Legislatures of 1952, 1953, and 1954, and which were authorized by Chapter 1441, Statutes of 1951.

Your attention is particularly directed to the Conclusions and Recommendations on pages 189, 190 and 191 of the report.

In connection with Recommendation No. 1, it is more particularly recommended that $16,000,000 be appropriated by the Legislature to be expended in connection with the first step in the program, segregated as follows:

(a) Acquisition of rights of way for Oroville Reservoir and related facilities, Feather River Aqueduct from Sacramento-San Joaquin Delta to Pastoria Creek in Kern County, including San Luis Reservoir $12,000,000

(b) Surveys and exploration of Oroville Dam and afterbays, and Feather River Aqueduct including San Luis Dam site and related activities . $1,500,000

(c) Construction plans and specifications for Oroville Dam, afterbay dams, San Luis Dam, Oroville Power Plant, Feather River Aqueduct, including pumping plants and highway, railroad and other relocations $2,300,000

(d) Negotiation of water right and other agreements $200,000

It is further recommended that this report be transmitted to the Governor and the Legislature.

Very truly yours,

A. D. Edmonston
State Engineer

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ORGANIZATION

WATER PROJECT AUTHORITY OF THE STATE OF CALIFORNIA

FRANK B. DURKEE, Director of Public Works, Chairman

EDMUND G. BROWN
Attorney General

CHARLES G. JOHNSON
State Treasurer

JOHN M. PEIRCE
Director of Finance

ROBERT C. KIRKWOOD
State Controller

A. D. EDMONSTON, State Engineer
Executive Officer

ISABEL C. NESSLER
Acting Secretary

STATE DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

FRANK B. DURKEE — Director of Public Works
A. D. EDMONSTON — State Engineer
T. B. WADDELL — Assistant State Engineer

This report has been prepared under the direct supervision of the State Engineer

by

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Principal Hydraulic Engineer

Assisted by

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Operative studies of the Feather River Project were made by

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Assisted by

ARTHUR J. WALTERS — Assistant Hydraulic Engi
JAMES C. MORRIS — Assistant Hydraulic Engi

Geologic studies, exploration work and materials testing were performed under the direction of

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WALTER G. SCHULZ — Principal Hydraulic Engi
WALTER A. BROWN — Principal Engineer, Design Construction of D

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ROBERT K. MILLER — Assistant Physical Testing Engineer
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Water Quality

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Water Rights

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Assisted by

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Maps and plates for the report were prepared by

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ISABEL C. NESSLER — Coordinator of Reports

CONSULTANTS

Pumping Plant Design

ALADAR HOLLANDER — Consulting Mechanical Engineer

Evaluation of Right of Way and Hydraulic Design

B. A. ETCHEVERRY * — Consulting Civil Engineer

Dam Design and Tunnels

RAYMOND A. HILL — Consulting Civil Engineer

Tunnels

OLE SINGSTAD — Consulting Civil Engineer
CARL R. RANKIN — *Consulting Civil Engineer*

Pumping Plant—Electrical Features

S. E. GAMBLE — Consulting Electrical Engineer

Geology for Dams and Tunnels

DR. GEORGE D. LOUDERBACK — Consulting Geologist

Evaluation of Mining Properties

E. C. GALBRAITH — Consulting Mining Engineer

Evaluation of Big Bend Power Plant

A. O. OLSON — Consulting Civil Engineer

Unit Prices and Cost Estimates

JOHN C. GIST — Engineer and Contractor

Financing

RENE ROTHSCHILD — Investment Advisor, Department of Finance

Regulation and Conveyance of Project Water in Southern California

W. P. ROWE — Consulting Civil Engineer

* Deceased.

ORGANIZATIONS GIVING CONTRACTUAL OR VOLUNTARY ASSISTANCE

Agencies of the State of California

DIVISION OF BEACHES AND PARKS, DEPARTMENT OF NATURAL RESOURCES
DEPARTMENT OF FISH AND GAME
DEPARTMENT OF FINANCE
DIVISION OF HIGHWAYS, DEPARTMENT OF PUBLIC WORKS
COUNTY OF BUTTE

Federal Agencies

U. S. BUREAU OF RECLAMATION, REGION II
U. S. DEPARTMENT OF AGRICULTURE—FOREST SERVICE
U. S. GEOLOGICAL SURVEY

Private Agencies

ALLIS-CHALMERS MANUFACTURING COMPANY
AMERICAN PIPE AND CONSTRUCTION COMPANY
BYRON-JACKSON COMPANY
THE COMMERCIAL SHEARING AND STAMPING COMPANY
CONSOLIDATED WESTERN STEEL DIVISION, UNITED STATES STEEL COMPANY
FEATHER RIVER RAILWAY COMPANY
GENERAL ELECTRIC COMPANY
JUDSON PACIFIC-MURPHY CORPORATION
S. MORGAN SMITH COMPANY
NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
PACIFIC GAS AND ELECTRIC COMPANY
PACIFIC TELEPHONE AND TELEGRAPH COMPANY
UNITED CONCRETE PIPE CORPORATION
WESTERN PACIFIC RAILROAD
WORTHINGTON CORPORATION

CHAPTER I

INTRODUCTION

The State Water Resources Board, the Department of Public Works, acting through the agency of the State Engineer, and the California Central Valleys Flood Control Association entered into an agreement on February 1, 1951, for the preparation of a report on the Feather River Project. That report, entitled "Report on Feasibility of Feather River Project and Sacramento-San Joaquin Delta Diversion Projects Proposed as Features of The California Water Plan," was published by the State Water Resources Board in May, 1951. At a special meeting on June 5, 1951, the State Water Resources Board passed a resolution in which it adopted and approved the aforementioned report and recommended to the Legislature that it be adopted as a part of The California Water Plan.

STATUTORY AUTHORIZATION OF THE PROJECT

Construction of the Feather River Project by the State of California, acting through the Water Project Authority, was authorized by the Legislature in 1951 by Chapter 1441, Statutes of 1951. The effect of this legislation was to make applicable to the Feather River Project all relevant provisions of the Water Code relating to the Central Valley Project, including provisions for issuance and sale of revenue bonds, but eliminating restrictions on the total amount of such bonds. The act authorized and directed the Department of Public Works to conduct the necessary investigations, surveys and studies and preparation of plans and specifications for the construction of the works authorized by the act and to submit the same to the Water Project Authority for its approval. No funds were appropriated for such work by the Legislature of 1951.

The Legislature of 1952, however, appropriated $800,000 for conducting the necessary studies, investigations and surveys and preparation of plans and specifications for the project. Subsequently the 1953 Legislature appropriated $750,000 and the 1954 Legislature $677,056, or a total of $2,227,056 for the work.

FEATURES OF THE PROJECT INCLUDED IN REPORT OF MAY, 1951

The Feather River Project as originally contemplated and set forth in the publication of the State Water Resources Board "Report on Feasibility of the Feather River Project and Sacramento-San Joaquin Delta Diversion Projects Proposed as Features of The California Water Plan," May, 1951, comprised the following features: (a) A dam on the Feather River 1.7 miles below the junction of the North and Middle Forks of the stream and 5.5 miles above the City of Oroville in Butte County; (b) a power plant at the dam; (c) an afterbay dam and power plant 4.5 miles below the main dam and one mile above the City of Oroville; (d) the Delta Cross Channel; (e) an electric power transmission system from Oroville Power Plant to load center near Tracy; (f) a conduit to transport water from the Sacramento-San Joaquin Delta to the San Joaquin Valley and Southern California, and (g) a conduit to transport water from the Sacramento-San Joaquin Delta to Santa Clara and Alameda Counties.

REVISION OF PROJECT FEATURES AND INCLUSION OF OTHER FEATURES

Further study of the project showed the advisability of adding afterbay capacity in excess of that provided by the original afterbay to enable operation of the Oroville Power Plant for power peaking purposes. No further storage capacity could be obtained at the original afterbay site as added capacity caused a rise in tailwater of Oroville Power Plant with a consequent loss of head. The necessary additional capacity was found at an afterbay site which is located on the Feather River 5 miles below the City of Oroville. Further studies of the economic feasibility of the Oroville Afterbay Power Plant indicated that there was no advantage in constructing such a plant.

In the 1951 report on the Feather River Project, there were included electric transmission facilities to the vicinity of Bethany in Contra Costa County and a Terminal Substation at that point. It has been known that the annual cost of electric transmission facilities to load center would be directly reflected in the rate that might be offered for the power generated at the Oroville Power Plant. Studies indicate that there is a definite financial advantage in a rate submitted by the Pacific Gas and Electric Company for the power based on power plant bus bar delivery, over that for power delivered at the load center near Tracy. In view of the decrease in the project annual charges, the financial advantage obtainable and the effect of reducing the bonded indebtedness by the cost

of these facilities, the transmission system has not been included as a project feature in this report.

It was found that it was advantageous to the project from operational and economic viewpoints to add to it the following features along the Feather River Project Aqueduct, not included in the original report: the San Luis Forebay, San Luis Reservoir, Buena Vista Forebay and Quail Lake Afterbay. Other possible plans which will be discussed later in the report include power drops from the main conduit located in Southern California that would, if adopted, add one or two power plants with afterbay and forebay at each unit. The Feather River Project, delineated on a map of the State is included as Plate 1, with the route shown in more detail on Plate 3.

There have been several material changes from the preliminary design for the spillway for the Oroville Dam, for the Oroville Power Plant, and for the pumping plants. This will be covered in the detailed description of the several features in the following chapter.

POSSIBLE ROUTES AND MODIFICATIONS OF FEATHER RIVER PROJECT AQUEDUCT

In an effort to reduce the total pumping lift set forth in the original plan, two possible routes to deliver water south of the Tehachapi Mountains have been studied. One of these routes has been designated the "Coastal Line"; the other the "Long Tunnel Line." Both of these routes are shown on Plate 1 of this report and in more detail on Plate 4. Descriptions and estimates of cost of these routes are included in Chapter II of this report. It should be pointed out that these possible routes are not alternatives as they would not furnish service comparable to that obtainable from the original route which is referred to in this report as the "High Line Route." Descriptions of the several routes are also included in Chapter II of this report. In connection with the High Line Route, which terminates at Barrett Reservoir in San Diego County, two possible modifications have been considered herein. One of these modifications is a termination of the High Line Route at the outlet of the tunnel between the Mojave River and Devil Canyon near San Bernardino. A forebay would be constructed on the West Fork of Mojave River at the tunnel inlet, and the power plant would be located near Devil Canyon. From the power plant, a conduit including a long siphon would extend to a terminal afterbay reservoir located near the outskirts of San Bernardino. The other modification is a termination of the High Line Route at Quail Lake Afterbay and a series of tunnels to two power drops, the lowest power plant discharging into a regulating reservoir on Castaic Creek just below its confluence with Elizabeth Lake Canyon.

ORGANIZATION OF REPORT

The subject matter of this report is presented in seven chapters, as follows: Chapter I, Introduction; Chapter II, Feather River Project; Chapter III, Step-Construction Program for the Project; Chapter IV, Methods of Financing; Chapter V, Financial Analyses; Chapter VI, Upstream Development; and Chapter VII, Conclusions and Recommendations.

Additional data are presented in appendixes to the report, as follows: A. Status of Water Rights; B. Status of Application to Federal Power Commission for License for Feather River Project; C. Summary Geologic Report on Oroville Dam Site; D. Estimated Cost of the 1870 Tunnel through the Tehachapi Mountains; E-1. Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation; E-2. Water Uses In and Diversion From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project; E-3. Operation of San Luis Reservoir and Feather River Project Aqueduct; F. Budget Required Acquisition of Rights of Way for First Step of Construction of Feather River Project and Budget Required for Developing Plans and Specifications for First-Step Construction Program to Advertising for Bids; G. Communications from Pacific Gas and Electric Company re Power Costs and Rates; H. Questions Propounded by Attorney Robert Taylor Adams Pursuant to his Request Made at the Water Project Authority Meeting on August 31, 1954, Together with Answers thereto as Prepared by the Division of Water Resources; I. Opinions of Attorney General with Reference to Assignment of State Filings and Protection of Counties and Watersheds of Origin; and J. Ultimate Exportable Water from the Sacramento Basin under The California Water Plan.

CHAPTER II

FEATHER RIVER PROJECT

The plan for the Feather River Project as discussed herein has been developed during a two-year study of the project. This chapter includes (a) a description of the features of the project, (b) the proposed operation of the project features, (c) the accomplishments of coordinated operation of those features in the delivery of a water supply, generation of electric energy and flood control protection, (d) the estimated capital cost of the works, (e) a discussion of quality of water to be furnished by the project, (f) a regulation and conveyance system for water delivered to Southern California, (g) a description and cost estimate of a Feather River-Sacramento River Canal requested by the Legislature, (h) legal considerations and (j) a discussion of future availability of water in the Sacramento-San Joaquin Delta. There is also presented a description of other possible routes to the area south of the Tehachapi Mountains, and a discussion of two possible modifications of the route as presented in the 1951 report.

The Feather River Project is the first unit of The California Water Plan. Its proposed purposes are for flood control and irrigation in the Sacramento Valley, electric power generation and furnishing Feather River water for firming surplus waters existing in the Sacramento-San Joaquin Delta, in most years, to provide a water supply to areas of water deficiency on the west side of the San Joaquin Valley in Fresno, Kings and Kern Counties, to South San Francisco Bay area in Alameda, Santa Clara, and San Benito Counties, and to Southern California.

DESCRIPTIONS OF PROJECT FEATURES

There are presented in this section descriptions of the project features including the Oroville Reservoir, Dam and Power Plant, and the Feather River Project Aqueduct, including a branch which would convey water to Alameda, Santa Clara and San Benito Counties. There are also presented two modifications of the Feather River Project Aqueduct, one with the aqueduct terminating near San Bernardino and the other near Castaic, and two other possible routes to bring water to the South Coastal Area of Southern California, one by way of the so-called Coastal Line and the other by the Long Tunnel Line.

Oroville Reservoir, Dam and Power Plant

The drainage area tributary to the Oroville Dam site includes 3,610 square miles or about 17 percent of the watershed area of the Sacramento River basin above the valley floor. Power and irrigation storage and diversion above the Oroville Dam site have a large influence on the runoff that reaches that point. The total upstream storage capacity in 13 reservoirs amounts to 864,000 acre-feet, of which Lake Almanor has about 650,000 acre-feet. The average seasonal natural runoff of the Feather River at Oroville is about 4,500,000 acre-feet.

The Oroville Reservoir would be created by a dam which would be located immediately upstream from the State Highway Sign Route No. 24 (Alternate U. S. 40) bridge crossing of the Feather River about 5½ miles upstream from Oroville, Butte County. The reservoir would have a gross capacity of about 3,500,000 acre-feet at water surface elevation 900 feet, United States Geological Survey datum, and would inundate an area of about 15,500 acres. The shore line at 900 feet elevation would be about 167 miles long. The purchase of the Big Bend Power Plant of the Pacific Gas and Electric Company which would be inundated by the reservoir and the relocations of 20.5 miles of State Highway Sign Route No. 24, 27.1 miles of the Western Pacific Railroad, 6.0 miles of the Feather River Railway, county roads, fire protection roads, power transmission, telegraph and telephone lines, and the Palermo Canal of the Oroville-Wyandotte Irrigation District would be required.

The Oroville Reservoir would be operated coordinately with the Shasta and Folsom Reservoirs of the Central Valley Project. It would be operated for (a) flood control, (b) to provide an irrigation supply for the Feather River service area, and (c) to make available releases to supplement surplus waters in the Sacramento-San Joaquin Delta to provide a firm supply for water exportation to areas of deficiency. It would also be operated for generation of power to supply the greatest financial return consistent with the water needs of the project. In order to accomplish this the reservoir would be so operated that the power plant would furnish a large dependable electric generating capacity for daily and weekly power peaking requirements of the Northern California power market.

It should be pointed out that under full project operation the need for power for pumping at the project pumping plants would be five times the amount generated at the Oroville Power Plant. It is necessary, therefore, to realize the fullest capability of the Oroville Power Plant, which under the proposed operation would yield a very high quality of power. This power, if sold at its true value, would provide a substantial credit against the power bill for pumping which would be based on use of lower cost power which it is contemplated could be supplied by existing equipment of the power-generating agencies in the region at the time it would be required. The operation of the Oroville Reservoir for the period 1921 through 1951 is delineated on Plate 7.

The Oroville Dam, including the spillway section, would have a total length of 6,780 feet. The concrete gravity-type dam section would be located across the channel of the Feather River and would be 730 feet high above stream bed elevation. It would have a base thickness at stream bed of about 680 feet and would be 4,930 feet long. The spillway and flood control outlet structure would be located in a saddle on the right abutment and would be 720 feet in length. It would be joined to the main concrete dam section by 850 feet of earth-fill dam, and there would be 280 feet of earth-fill dam to the right of the spillway structure. Two auxiliary earth-fill dams with a total length of 1,800 feet and a maximum height of 35 feet above natural ground will be required at low points in the periphery of the reservoir.

The volume of concrete in the gravity concrete section has been estimated to be about 14,000,000 cubic yards and the excavation to be about 4,000,000 cubic yards. The estimated concrete yardage required for the gravity concrete section of Oroville Dam would be about 3,500,000 cubic yards more than the amount used for the Grand Coulee Dam and more than twice that placed in the Shasta Dam. The maximum height of the dam above foundation bedrock would be about 20 feet greater than that of Hoover Dam and 140 feet greater than that of Shasta Dam.

The Oroville Power Plant would be located across the stream channel section at the downstream toe of the dam and would have an installed capacity of 440,000 kilowatts. As has been stated the power plant would be operated to produce the greatest dependable electric generating capacity consistent with releases for supplying project water needs. The Oroville Dam and Power Plant are shown on Plate 5.

The dam for Oroville Afterbay No. 1 would be located on the Feather River about one-half mile upstream from Oroville. The afterbay would have a capacity of 5,000 acre-feet and would provide reregulation for part of the fluctuation in flow that would occur due to the peaking operation of the Oroville Power Plant.

The dam for Oroville Afterbay No. 2 would be located on the Feather River about five miles downstream from Oroville. The afterbay would have a net capacity of 18,000 acre-feet and would provide the remainder of the reregulation required to convert the power releases from the Oroville Power Plant to a continuous flow.

Feather River Project Aqueduct

The Delta Cross Channel would convey water flowing down the Sacramento River to the westerly channels of the San Joaquin Delta, from which channels the water would flow to the intake channel to the project pumps.

The inlet of the Delta Cross Chanel would be located near Isleton from which point a channel would be excavated from the Sacramento River to Georgiana Slough, which in turn would be enlarged to its confluence with the Mokelumne River. The water would then be conveyed through the channel of the Mokelumne River to the San Joaquin River. The Old River Channel of the San Joaquin River, and a tributary, would be dredged to provide ample capacity for conveying the water through it to the project intake headworks located at a point about three miles southeast of Byron.

An unlined intake channel would convey the water from the headworks on the tributary of the Old River Channel to Pumping Plant No. I located about 11 miles northwest of Tracy. The water would be lifted at that point to the Feather River Project Aqueduct from approximately sea level to elevation 230 feet. From the discharge pipes of Pumping Plant No. I the conduit, a concrete lined canal, would parallel the Delta-Mendota Canal of the Central Valley Project to San Luis Creek. On San Luis Creek, immediately upstream from the crossing of that creek by the Delta-Mendota Canal of the Central Valley Project, there would be constructed the San Luis Forebay. The project conduit would deliver water directly by gravity into the forebay. The forebay would extend up San Luis Creek to two pumping plants located at the base of the San Luis Dam. Pumping Plant No. II-A would contain units that would pump from the forebay either into the San Luis Reservoir or directly into the project canal at elevation 402 feet. Pumping Plant No. II-B would have units pumping directly from the forebay into the reservoir only. The pumping plants numbered II-A and II-B would be of such capacity that the pumps could be operated on off-peak electric energy. However, operation in certain years would utilize a combination of on-peak and off-peak electric energy. Off-peak electric energy is that which would be available at night and on Saturday and Sunday when there is no demand for electric power for the customary commercial uses. The capacity of the pumps that would be required to utilize the off-peak electric energy would be about twice the capacity needed for continuous pumping. The forebay provided would store sufficient water so that the pumping plants could be operated during the off-peak power periods. The San Luis Reservoir would act as the afterbay providing a continuous flow in the project canal conveying the water to the south. The San Luis Reservoir would also provide storage that would reregulate pumped water so that a variable monthly demand for irrigation use in Fresno County could be satisfied, as well as an irrigation demand in Kings and Kern Counties, in which there would be a two-month no-irrigation demand period, and a ten-month uniform irrigation demand.

The San Luis Dam and Reservoir would be located on San Luis Creek with the dam about 12 miles west of the City of Los Banos. For a reservoir capacity of 2,100,000 acre-feet, the dam of the earth-fill type would be 18,700 feet long and 310 feet high above stream bed level and would require about 68,000,000 cubic yards of earth fill. The construction of the reservoir would necessitate the replacement of 10.7 miles of State Highway Sign Route 152, over the Pacheco Pass, with about 12 miles of new road.

The project conduit would follow on grade contour along the west side of the San Joaquin Valley from the end of the discharge line of Pumping Plant No. II-A, passing west of Huron, Kettleman City, and Tupman to the Buena Vista Hills, a distance of about 264 miles from the point of diversion, at which point it would discharge into the Buena Vista Forebay. Pumping Plant No. III located on this forebay would lift water from it to elevation 500 feet. From the discharge pipes of Pumping Plant No. III the canal would extend southerly, passing about five miles east of Taft and thence easterly to a point north of the Wheeler Ridge to Pumping Plant No. IV. That plant would lift the water to elevation 800 feet. The canal would then extend easterly along the north slopes of Wheeler Ridge for about one and one-half miles to a point where Pumping Plant No. V would be located in a saddle of Wheeler Ridge. The latter pumping plant would lift the water to elevation 1,500 feet, the discharge pipes following a saddle in Wheeler Ridge to the south side of the ridge. From that point the canal would follow on grade contour south and east, crossing U. S. Highway No. 99 near Grapevine and continuing easterly about five miles to Pastoria Creek, where Pumping Plant No. VI would be located.

Provision would be made at strategic points for adequate wasteways to existing channels or sumps along the entire length of the aqueduct from the Delta to Pastoria Creek.

The pumping plant located at Pastoria Creek would lift the water to elevation 3,357 feet to the inlet portal of two consecutive tunnels, totaling 10½ miles in length. The tunnels would convey the water through the Tehachapi Mountains to the Quail Lake Afterbay. The reach of the conduit between Buena Vista Forebay and Quail Lake Afterbay, and Pumping Plants Nos. III, IV, V and VI, would be constructed to a sufficient capacity so that the pumping plants could be operated entirely on off-peak electric energy. It has been ascertained that the existing power agencies with facilities in the area, the Pacific Gas and Electric Company, and the Southern California Edison Company could probably make available sufficient off-peak electric energy for project needs at the time water was delivered to Southern California with their then available facilities. The capacity of the conduit, and the pumping plants, for the aforementioned reach, would be about twice that required for water delivery on a continuous basis. The increased annual charges on the capital cost for the works under discussion required by utilization of off-peak electric energy would be considerably more than offset by the reduction in the cost of power for pumping. Typical transverse sections of Pumping Plants Nos. I, V and VI are shown on Plate 6.

The Quail Lake Afterbay would reregulate the water to provide a continuous flow to the south. The conduit would extend along the south side of the Antelope Valley on the desert side of the mountains, passing about 270 feet above the Fairmont Reservoir on the Los Angeles Aqueduct. It would pass 470 feet in elevation above the Palmdale Reservoir, cross the Soledad Pass at Vincent and Little Rock Creek below the Little Rock-Palmdale Dam. The course would then be easterly across the Mojave Desert to the portal of a three-mile tunnel, located near Cedar Springs, from the Mojave River into Devil Canyon, a tributary of the Santa Ana River, and a source of water supply for the City of San Bernardino.

The conduit would continue through a series of tunnels following the south slope of the mountains north and east of San Bernardino and Redlands, then southerly to a siphon across the San Gorgonio Pass between Beaumont and Banning. The route would then bear southerly along the mountains east of the San Jacinto Valley, passing above Lake Henshaw on the San Luis Rey River, to a spillway into Horsethief Canyon, a tributary of Pine Valley Creek that runs into the reservoir created by Barrett Dam in San Diego County. The total length of the conduit would be about 585 miles from the point of diversion in the

Sacramento-San Joaquin Delta to its terminus at Horsethief Canyon. The plan and profile of the Feather River Project Aqueduct is shown on Plate 3 of this report.

The Alameda-Santa Clara-San Benito Branch of the Feather River Project Aqueduct would begin at a pumping plant located on the main diversion canal about two miles south of Pumping Plant No. I and would lift water from that canal from elevation 230 feet to elevation 705 feet. The discharge pipes from the pumping plant would convey the water to a short reach of canal leading to the portal of a tunnel 7,500 feet in length through Brushy Peak. From the western portal of that tunnel a concrete lined canal would convey the water around the east and south sides of the Livermore Valley in Alameda County to a tunnel 3,400 feet long located about four miles south of Livermore. A reinforced concrete pipe would continue westerly to a 1,300-foot tunnel at Mission Pass. The pipe conduit would continue southerly passing to the east of Mission San Jose and Warm Springs to the proposed Airpoint regulating reservoir on the Arroyo De Los Coches, two miles east of Milpitas in Santa Clara County. The reservoir would have a capacity of 23,000 acre-feet and would be utilized to regulate the portion of continuous flows not directly usable from the pipeline.

From the reservoir a pipe conduit would continue in a southeasterly direction crossing Alum Rock Park to another regulating reservoir at Evergreen on Silver Creek, with a capacity of 32,500 acre-feet, located about six miles southeast of San Jose.

A conduit, principally canal section, would extend southeasterly following the base of the hills above the Santa Clara Valley to a terminus on Pacheco Creek north of Hollister at an elevation of about 360 feet, for service to the Upper Santa Clara Valley and San Benito County.

Two pressure pipe laterals from the main conduit have been studied, the cost of which has not been included in the cost of the Feather River Project. One of these laterals would start at a turnout on the main conduit about one mile northwest of the Evergreen Dam at elevation 450 feet. It would traverse the Santa Clara Valley, passing about seven miles south of San Jose, and continue westerly to the vicinity of Saratoga and thence along the base of the foothills in a northwesterly direction, passing near Monte Vista and Los Altos to a terminus at Felt Reservoir at a maximum water surface elevation of 380 feet. The total length of conduit would be approximately 30 miles.

The other pressure pipe lateral would start at a point about 1½ miles south of the outlet portal of the tunnel through Brushy Peak and would run westerly, passing approximately 2½ miles north of Livermore, to the portal of a short tunnel about 3½ miles south of Danville, through which it would discharge into a possible reservoir in Crow Canyon with a storage capacity of 16,000 acre-feet at water surface elevation 620 feet. The total length of this lateral would be 22 miles.

The plan and profiles of the Alameda-Santa Clara-San Benito Branch of the aqueduct and the two laterals are delineated on sheet 2 of Plate 3.

Modifications of Feather River Project Aqueduct

The general plan of the High Line Route contemplates a pumping plant at Pastoria Creek about 2[illegible] miles south of Bakersfield, where about 5,000 second-feet of water would be lifted to elevation 3,357 feet to the portal of two consecutive tunnels totaling 10[illegible] miles in length. The outlet portal of these tunnels is at Quail Lake Afterbay where water could be released to the Antelope Valley, to the main conduit to the south, and into Piru Creek, a tributary of the Santa Clara River, and then into Ventura County. The continuation of the conduit to San Diego County is located at an elevation that permits serving the larger part of the area in the Mojave Desert and the South Coastal Plain without relifting. The conduit is so located that water could be released into most of the storage reservoirs serving San Diego County. Maps showing the possible connections to the service areas in Southern California, utilizing existing systems where possible, are included in this report as Plates 11A and 11B.

There are two modifications of this route which have been considered. One of these would be to continue the main conduit through the Antelope Valley area to the Mojave River. The Cedar Springs Forebay would be constructed on the west fork of the Mojave River, near the inlet portal of the three-mile tunnel to Devil Canyon. From the tunnel outlet the conduit would extend to a power drop of about 1,600 feet. The power plant would have an ultimate installed capacity of 440,000 kilowatts.

From the outlets of the power plant a conduit, including a siphon, would extend to a terminal afterbay reservoir located near San Bernardino. Water could be delivered by gravity on a continuous flow basis to Lake Mathews and Morris Reservoir. In order to deliver water at the approximate elevation of 1,500 feet at the west portal of the San Jacinto Tunnel of the Colorado River Aqueduct, it would be necessary to relift a portion of the water from the outlet of the afterbay only, as a conduit from the tailrace of the power plant could deliver a part of the water by gravity when the power plant was operating. It is proposed to only operate the plant during the peak hours of the commercial power demand in the region and develop the maximum dependable power capacity possible in order to realize the greatest power revenue obtainable to assist in paying the pumping power bill incurred at the pumping lifts in the north. A sketch of this modification of the High Line Route is shown on Plate 13.

The other modification of the High Line Route is to terminate the main conduit at Quail Lake. Water could be delivered to a local agency in the Antelope Valley at this point and also released into Piru Creek for Ventura County. All the remaining available water to Southern California could be put through a series of tunnels, and through a power drop of about 700 feet to Liebre Gulch Power Plant and then through another series of tunnels to a power plant with a head of 1,100 feet located on a storage reservoir on Castaic Creek. The ultimate installed capacity of both power plants would be 516,000 kilowatts. A forebay would be constructed near Quail Lake, and the Castaic Creek Reservoir would serve as an afterbay, making the power plant's operation principally for meeting peaking demands for power. An earth-fill dam about 200 feet high above stream bed level, on Castaic Creek below its confluence with Elizabeth Lake Canyon, would provide a storage capacity of about 100,000 acre-feet. A layout of the power development from the Quail Lake Forebay to Castaic Creek Reservoir is also delineated on Plate 13.

It is to be noted that the two possible routes described subsequently as the Coastal Line and the Long Tunnel Line could also terminate in the reservoir on Castaic Creek.

Other Possible Routes to Deliver Water South of Tehachapi Mountains

There are under study other possible routes to deliver water to Southern California; two of these are discussed in this report as the Coastal Line and the Long Tunnel Line. These routes cannot be considered as being alternate routes, as they do not accomplish the same water delivery to the same areas as in the plan for the High Line Route.

Coastal Line. The route called the Coastal Line would begin at mile 340 on the main aqueduct in the San Joaquin Valley about 10 miles south of Kettleman City at a point near Devils Den. Four successive lifts through four pumping plants located in the first 17 miles of the aqueduct would lift the water from elevation 370 feet in the main canal to elevation 1,250 feet at the portal of a 4½ mile tunnel through Polonio Pass. From the outlet portal the conduit would be in canal following the Cholame-Paso Robles State Highway, then through San Luis Obispo County to a siphon crossing the Salinas River about three miles east of Santa Margarita. The conduit would then pass through the Santa Lucia Range in a series of tunnels, passing about seven miles to the east of San Luis Obispo. It would then be another series of tunnels running southeasterly to a siphon across the Cuyama River about six miles southeast of Santa Maria. The conduit would extend southeasterly in a series of tunnels and some canal into Santa Barbara County to a siphon crossing the Santa Ynez River a short distance below the Cachuma Dam. The conduit would follow up the Santa Ynez drainage basin to a 3.7 mile tunnel through the Santa Ynez Mountains about three miles east of the San Marcos Pass Road, thence easterly along the mountains north of Santa Barbara and Carpenteria into Ventura County. The aqueduct, composed of a series of tunnels, canal and siphons, would continue to a crossing of the Ventura River just above the northern portion of the Ojai Valley. From that point the conduit would extend easterly and south across Ojai Valley to the portal of a tunnel 4.2 miles long through Sulphur Mountain. The route would then extend easterly along the north side of the Santa Clara River Basin crossing Sespe Creek in a 1.3-mile-long siphon, then easterly, passing to the north of Fillmore and Piru, to a crossing of the Santa Clara River three miles west of Castaic Junction. At this point on the south side of the Santa Clara River flood plain there would be located a pumping plant which would lift the water from elevation 862 feet to elevation 1,310 feet. A series of tunnels and canals would extend easterly, crossing U. S. Highway No. 99 and U. S. Highway No. 6 between Saugus and Newhall, to a pumping plant at Soledad Canyon about 3.6 miles east of Saugus, where pumps would lift the water from elevation 1,288 feet to elevation 1,755 feet. From this point the conduit, including tunnel and canal, would extend to a point in Mint Canyon, intersecting the Long Tunnel Line subsequently described.

The length of the conduit from its beginning in the San Joaquin Valley near Devils Den to the intersection with the Long Tunnel Line would be 302 miles and would include 205 miles of canal, 70 miles of tunnel, 24 miles of siphon and 3 miles of discharge pipe at the pumping plants. The distance to the portal of the San Jacinto Tunnel on the Colorado River Aqueduct of the Metropolitan Water District from the point of intersection mentioned is an additional 117 miles. The route of the Coastal Line is delineated on Plate 4.

Long Tunnel Line. The route named Long Tunnel Line would begin with the pumping plant at Pastoria Creek, where the water would be lifted from approximately elevation 1,500 feet to elevation 1,870 feet through a series of short tunnels, and then to a 26.7-mile-long tunnel with its outlet portal in Elizabeth Lake Canyon. From the long tunnel outlet at Elizabeth Lake Canyon, the water would be conveyed through a series of tunnels southeasterly to La

Crescenta, then through another series of tunnels running easterly and passing to the north of Pasadena to a siphon across the San Gabriel River, near the Morris Reservoir. A series of short tunnels would then convey the water to the Los Angeles-San Bernardino county line near Uplands. The aqueduct would then be in canal and covered aqueduct extending easterly and passing to the north of Etiwanda and San Bernardino to Redlands. The aqueduct would then extend from Redlands to a point near Moreno in two consecutive tunnels 9.3 miles in aggregate length. From a point near Moreno the aqueduct, in canal section, would extend to Gilman Hot Springs and to the portal of the San Jacinto Tunnel on the Colorado River Aqueduct of the Metropolitan Water District of Southern California. The length of the aqueduct from Pastoria Creek to San Jacinto tunnel is about 157 miles, of which 38 miles would be canal, 95 miles tunnel, 5 miles siphon, and 19 miles covered conduit. The plan and profile is delineated on Plate 4.

The Long Tunnel Line, as previously mentioned, could also be terminated in the reservoir site located at Castaic Creek similarly to one of the modified High Line routes previously described.

ESTIMATED COST

Estimates have been made of the Feather River Project using the High Line Route for the Feather River Project Aqueduct from the Delta to Barrett Reservoir in San Diego County, of the project using two modifications of the High Line Route and of the project with an aqueduct constructed via the Coastal Line, and also via the Long Tunnel Line. The price base used was that of January, 1955.

In the estimates of cost which have been prepared, interest has been included on each feature for its construction period only. It has been assumed that all other interest after that time would be carried as a part of project debt service. The amount of interest during construction has been based on the same rate proposed for bond financing, which is on an average cost of money of 2½ percent. The interest during construction is computed on amounts set up for each year's expenditure in the step-construction program for each feature to its completion, or partial completion. In general, in making the estimates of cost, an amount of 15 percent for contingencies and 10 percent for engineering and administration has been added to the construction cost for each feature, except for certain special items where an additional or lesser percentage was justified.

Feather River Project Using the High Line Route From the Delta to Barrett Reservoir

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Barrett Reservoir using the High Line Route and the Alameda-Santa Clara-San Benito Branch of that aqueduct.

Oroville Reservoir, Dam and Power Plant. The estimated costs of the Oroville Reservoir lands and improvements are based on a field evaluation and a recheck by an eminent consulting engineer experienced in such matters.

The cost of the relocation of the Western Pacific Railroad has been estimated by the railroad company under a cooperative agreement with the Division of Water Resources. A completed paper location of the railroad has been transferred to a location on the ground by a survey party of the division. The cost of the relocation of the State Highway from Oroville via Wicks Corner to Jarbo Gap has been estimated by the State Division of Highways. Detailed topographic maps along the proposed relocation routes made under the Division of Water Resources' supervision have been furnished to both the railroad company and the Division of Highways. A survey party of the Division of Water Resources is engaged in field surveys of the relocations of such other facilities as the Feather River Railway and Butte County roads. An exploration program has been completed with the advice of a special consulting board, within the limited funds available, of the site of the Oroville Dam and Spillway. This program included forty-four diamond drill core holes with an aggregate depth of 5,369 feet and two exploration tunnels with drifts therefrom for a total length of about 2,300 feet. Exploration and laboratory tests were made of aggregates located near Oroville to determine the adequacy and quality. Appendix C gives a summary of the exploration work accomplished and the results obtained.

The Pacific Gas and Electric Company has submitted an evaluation of the loss to the company of the Big Bend Power Plant.

A detailed map of the Oroville Dam Site was completed on scale of 50 feet to the inch on which the proposed dam was projected for obtaining construction quantities. The design of the dam and the spillway gates has been accomplished with the advice of an eminent consulting engineer. A hydraulic model test of the design of the spillway for the dam is being made at the hydraulic laboratory of the University of California at Davis and is nearly completed. An evaluation has been made of the mining claims in the Oroville Reservoir under the direction of a mining engineer with long experience on such evaluations. A report has been completed by the United States Forest Service in cooperation with the California Division of Forestry under a cooperative agreement with the Division of Water Resources on the effect of Oroville Reservoir on national forest, public domain lands and lands protected by the California Division of Forestry. The Department of Fish and Game has prepared an estimate of a required fish protection program, and the cost of a fish hatchery has been included in the costs.

Estimates of the cost of the hydraulic and electrical equipment in the Oroville Power Plant have been secured from several large manufacturers of such equipment.

Feather River Project Aqueduct Using the High Line Route. The estimate of cost of the Feather River Project Aqueduct for the line from the Sacramento-San Joaquin Delta to Barrett Reservoir in San Diego County is based for the most part on quantities computed from maps showing detailed topography made by the photogrammetric method. One section about 170 miles long between the south line of Merced County and Buena Vista Hills east of Taft was located on the ground by a survey party, and the estimates were based on this survey. The designs of the pumps were made under the direction of a consulting mechanical engineer who is an eminent specialist in the design of such large pumps. A cooperative agreement with the Byron Jackson Company was made for the specifications and design of the pumps. Several of the large pump and motor manufacturers gave advice and furnished cost estimates on the equipment in the pumping plants. A drill rig owned by the division and operated by its personnel has been utilized to explore the materials which would be excavated for the aqueduct. This work has been done in conjunction with geologic mapping along the line of the aqueduct. Testing of the samples obtained from the drilling has been accomplished in the laboratory of the division.

Summary of Costs. A summary of the estimated costs of the project features is given in Table 1.

Feather River Project Using the High Line Route From the Delta to San Bernardino

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to San Bernardino, the Alameda-Santa Clara-San Benito Branch, and the Devil Canyon Power Development.

The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost estimate of the Feather River Project Aqueduct is the same as for the same section of the High Line Route from the Delta to the Cedar Springs Forebay on the West Fork of the Mojave River.

TABLE 1

Summary of Cost of Feather River Project Using High Line Route

Oroville Reservoir, Dams and Power Plant	
Main dam	$185,581,000
Power plant	27,926,000
Spillway	10,854,000
Afterbay Dam No. 1	2,938,000
Afterbay Dam No. 2	3,089,000
Permanent buildings and roads	772,000
Fish hatchery	440,000
Acquisition of lands and improvements	2,473,000
Acquisition of Big Bend Power Plant	27,000,000
Relocation of Western Pacific Railroad	30,608,000
Relocation of Feather River Railway	2,651,000
Relocation of State Highway Sign Route 24	5,030,000
Relocation of county roads	3,004,000
Joint Western Pacific Railroad and state highway bridge	6,682,000
Joint Feather River Railway and county road bridge	2,850,000
Relocation of power and telephone lines	1,348,000
Relocation of Forest Service facilities	293,000
Subtotal	$313,539,000
Contingencies	32,863,000
Engineering and administration	30,251,000
Interest during construction	42,008,000
Subtotal Oroville Reservoir, Dams and Power Plant	$418,661,000
Feather River Project Aqueduct	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	106,681,000
Pumping Plant No. III	12,412,000
Pumping Plant No. IV	17,326,000
Pumping Plant No. V	36,760,000
Pumping Plant No. VI	76,312,000
Buena Vista Forebay	1,452,000
Quail Lake Afterbay	400,000
Aqueduct—Wheeler Ridge to Cedar Springs	179,343,000
Aqueduct—Cedar Springs to Barrett Reservoir	190,894,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$891,197,000
Contingencies	$135,526,000
Engineering and administration	90,350,000
Interest during construction	57,174,000
Subtotal Feather River Project Aqueduct	$1,174,247,000
Total cost	$1,592,908,000

Devil Canyon Power Development. The development includes the Cedar Springs Forebay, tunnel, conduit and penstocks to the Devil Canyon Power Plant, the power plant and a conduit to the San Bernardino Afterbay and the afterbay. Layout of the Cedar Springs forebay, penstocks, power plant and afterbay was made on U. S. Geological Survey quadrangles at a scale of one inch equals 2,000 feet.

Summary of Costs. A summary of the estimated cost of the project features is given in Table 2.

TABLE 2

Summary of Cost of Feather River Project Using the High Line Route From the Delta to San Bernardino and the Devil Canyon Power Development

Oroville Reservoir, Dams and Power Plant Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct and Devil Canyon Power Development	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	106,681,000
Pumping Plant No. III	12,412,000
Pumping Plant No. IV	17,326,000
Pumping Plant No. V	36,760,000
Pumping Plant No. VI	76,312,000
Buena Vista Forebay	1,452,000
Quail Lake Afterbay	400,000
Aqueduct—Wheeler Ridge to Cedar Springs	179,343,000
Cedar Springs Forebay	3,782,000
Aqueduct—Cedar Springs to Devil Canyon	24,984,000
Devil Canyon Power Plant	66,185,000
San Bernardino Afterbay, Dam and reregulation System	21,275,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$816,529,000
Contingencies	124,244,000
Engineering and administration	82,964,000
Interest during construction	48,749,000
Subtotal Feather River Project Aqueduct and Devil Canyon Power Development	$1,072,486,000
Total cost	$1,491,147,000

Feather River Project Using the High Line Route From the Delta to Castaic Creek Reservoir

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Quail Lake Forebay, the Alameda-Santa Clara-San Benito Branch, and the Castaic Creek Power Development. The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost estimate of Feather River Project Aqueduct is the same as the same section of the High Line Route from the Delta to the Quail Lake Forebay.

Castaic Creek Power Development. This development includes the Quail Lake Forebay, tunnels and penstock to power plant at Liebre Gulch, Liebre Gulch Afterbay, tunnels and penstock to power plant at Castaic Creek Reservoir and the reservoir. The plan of development including layout of the Quail Lake Forebay, tunnels, Liebre Gulch Afterbay, penstocks and power plants was made on U. S. Geological Survey quadrangles at a scale of one inch equals 2,000 feet. A survey was made of the Castaic Creek dam site at a scale of one inch equals 200 feet.

Summary of Costs. A summary of the estimated cost of the project features is given in Table 3.

TABLE 3

Summary of Cost of Feather River Project Using the High Line Route From the Delta to Quail Lake Forebay and the Castaic Creek Power Development

Oroville Reservoir, Dams and Power Plant Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct and Castaic Creek Power Development	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	106,681,000
Pumping Plant No. III	12,412,000
Pumping Plant No. IV	17,326,000
Pumping Plant No. V	36,760,000
Pumping Plant No. VI	76,312,000
Buena Vista Forebay	1,452,000
Aqueduct—Wheeler Ridge to Quail Lake	70,876,000
Quail Lake Forebay	3,626,000
Aqueduct—Quail Lake to Liebre Gulch	31,088,000
Liebre Gulch Power Plant	19,956,000
Liebre Gulch Afterbay	1,107,000
Aqueduct—Liebre Gulch to Castaic Creek	48,510,000
Castaic Power Plant	32,190,000
Castaic Creek Dam and Reservoir	12,171,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$740,084,000
Contingencies	119,344,000
Engineering and administration	74,008,000
Interest during construction	43,425,000
Subtotal Feather River Project Aqueduct and Castaic Creek Power Development	$976,861,000
Total cost	$1,395,522,000

Feather River Project Using the High Line Route From the Delta to Devils Den and Extensions to Wheeler Ridge and Via the Coastal Line to Castaic Creek Reservoir

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Devils Den, the Alameda-Santa Clara-San Benito Branch, an extension from Devils Den to Wheeler Ridge and the Coastal Line to Castaic Creek Reservoir. The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost of the Feather River Project Aqueduct from the Delta to Devils Den is the same as for the same section of the High Line Route.

Coastal Line to Castaic Reservoir. The cost estimate of the aqueduct via the Coastal Line previously described herein is preliminary and based on layouts on U. S. Geological Survey quadrangles at a scale of one inch equals 5,280 feet and one inch equals 2,000 feet. The design capacity of the aqueduct was assumed to be 1,700 second-feet and the amount of water delivered to the coastal plain of Southern California would be 1,224,000 acre-feet of water annually. Field reconnaissance of the route has been made by engineers and geologists of the Division of Water Resources staff.

Extension From Devils Den to Wheeler Ridge. The route of the extension of the branch of the aqueduct from Devils Den to Wheeler Ridge is the same as used for the High Line Route. The capacity of the aqueduct from Devils Den to Wheeler Ridge would be reduced to 2,300 second-feet to deliver 936,000 acre-feet annually to Kern County.

Summary of Costs. A summary of the estimated cost of the project features is given in Table 4.

Feather River Project Using the High Line Route From the Delta to Devils Den and Extensions to Wheeler Ridge and Via the Coastal Line to San Jacinto Tunnel Portal of Colorado River Aqueduct

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Devils Den, the Alameda-Santa Clara-San Benito Branch, an extension from Devils Den to Wheeler Ridge and the Coastal Line to the westerly portal of the San Jacinto Tunnel of the Colorado River Aqueduct. The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost of the Feather River Project Aqueduct from the Delta to Devils Den is the same as for the same section of the High Line Route. The summary of the costs is given in Table 5.

Coastal Line to San Jacinto Tunnel Portal of Colorado River Aqueduct. The cost estimate of the aqueduct via the Coastal Line and Mint Canyon to San Jacinto Tunnel portal of Colorado River Aqueduct, previously described herein, is preliminary and based on layouts on U. S. Geological Survey quadrangles at a scale of one inch equals 5,280 feet and one inch equals 2,000 feet. The design capacity of the aqueduct was assumed to be 1,700 second-feet and the amount of water delivered to the coastal plain of Southern California would be 1,224,000 acre-feet annually. Field reconnaissance of the route has been made by engineers and geologists of the Division of Water Resources staff.

Extension From Devils Den to Wheeler Ridge. The route of the extension of the branch of the aqueduct from Devils Den to Wheeler Ridge is the same as used for the High Line Route. The capacity of the aqueduct from Devils Den to Wheeler Ridge would be reduced to 2,300 second-feet to deliver 936,000 acre-feet of water annually to Kern County.

Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to Castaic Creek Reservoir

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Pastoria Creek, the Alameda-Santa Clara-San Benito Branch and the Long Tunnel Line

TABLE 4

Summary of Cost of Feather River Project Using the High Line Route From the Delta to Devils Den and Extensions to Wheeler Ridge and Via the Coastal Line to Castaic Creek Reservoir

Oroville Reservoir, Dams and Power Plant Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	103,588,000
Pumping Plant No. III	6,580,000
Coastal Line Aqueduct—Devils Den to Castaic Creek	375,362,000
Coastal Line Pumping Plants	73,627,000
Castaic Creek Dam and Reservoir	12,171,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$840,945,000
Contingencies	149,331,000
Engineering and administration	84,080,000
Interest during construction	56,971,000
Subtotal Feather River Project Aqueduct	$1,131,327,000
Total cost	$1,549,988,000

TABLE 5

Summary of Cost of Feather River Project Using the High Line Route From the Delta to Devils Den and Extensions to Wheeler Ridge and Via the Coastal Line to San Jacinto Tunnel Portal of the Colorado River Aqueduct

Oroville Reservoir, Dams and Power Plant	
Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	103,588,000
Pumping Plant No. III	6,580,000
Coastal Line Aqueduct—Devils Den to San Jacinto	585,556,000
Coastal Line Pumping Plants	88,908,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$1,054,249,000
Contingencies	191,861,000
Engineering and administration	105,425,000
Interest during construction	67,371,000
Subtotal Feather River Project Aqueduct	$1,418,906,000
Total cost	$1,837,567,000

to Castaic Creek Reservoir. The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost of the Feather River Project Aqueduct from the Delta to Wheeler Ridge is the same as for the same section of the High Line Route.

Long Tunnel Line to Castaic Creek Reservoir. The cost estimate of the aqueduct via the Long Tunnel Line to Castaic Creek Reservoir previously described herein is based on layouts using U. S. Geological Survey quadrangles at a scale of one inch equals 2,000 feet for that portion of the line southward from Pastoria Creek. The most critical section of the Long Tunnel Line is the 26.7-mile tunnel through the Tehachapi Mountains. It is considered that this tunnel would be exceedingly difficult and costly to construct. Since the region is highly active seismically, the completed tunnel would be subject to damage from earthquake. Appendix D contains a description of the 26.7 mile tunnel, a brief account of the geologic investigation conducted in this region and a preliminary estimate of the cost of this tunnel.

Summary of Costs. A summary of the estimated cost of the project features is given in Table 6.

TABLE 6

Summary of Cost of Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to Castaic Creek Reservoir

Oroville Reservoir, Dams and Power Plant	
Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. I	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	106,681,000
Pumping Plant No. III	12,412,000
Pumping Plant No. IV	13,530,000
Pumping Plant No. V	31,626,000
Pumping Plant No. VI	14,550,000
Buena Vista Forebay	1,452,000
Aqueduct—Wheeler Ridge to Pastoria Creek	10,720,000
Aqueduct—Pastoria Creek to Castaic Creek Reservoir	248,929,000
Castaic Creek Reservoir	12,171,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch	3,122,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Subtotal	$721,688,000
Contingencies	105,366,000
Engineering and administration	72,169,000
Interest during construction	63,957,000
Subtotal Feather River Project Aqueduct	$963,180,000
Total cost	$1,381,841,000

Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to San Jacinto Tunnel Portal of the Colorado River Aqueduct

This estimate includes the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Pastoria Creek, the Alameda-Santa Clara-San Benito Branch and the Long Tunnel Line to the westerly portal of the San Jacinto Tunnel of the Colorado River Aqueduct. The cost estimate of the Oroville Reservoir, Dam and Power Plant and the two afterbay dams is the same as set forth under Feather River Project Using the High Line Route from the Delta to Barrett Reservoir. The cost of the Feather River Project Aqueduct from the Delta to Wheeler Ridge is the same as for the same section of the High Line Route.

Long Tunnel Line to San Jacinto Tunnel Portal of Colorado River Aqueduct. The cost of the aqueduct previously given for the Long Tunnel Line to Castaic Creek Reservoir is the same for this plan from Wheeler Ridge to Elizabeth Lake Canyon. A cost estimate has also been made from this point south to the west portal of the San Jacinto Tunnel of the Colorado River Aqueduct of the Metropolitan Water District of Southern California.

Summary of Costs. A summary of the estimated cost of the project features is given in Table 7.

TABLE 7

Summary of the Cost of Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to the San Jacinto Tunnel Portal of the Colorado River Aqueduct

Oroville Reservoir, Dams and Power Plant	
Subtotal Oroville Reservoir, Dams and Power Plant from Table 1	$418,661,000
Feather River Project Aqueduct	
Delta Cross Channel	$8,320,000
Fish protective works	2,400,000
Pumping Plant No. 1	30,223,000
Aqueduct—Intake to San Luis Creek	52,507,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir	76,130,000
Pumping Plant No. II-A	30,486,000
Pumping Plant No. II-B	24,742,000
Aqueduct—San Luis Creek to Wheeler Ridge	106,681,000
Pumping Plant No. III	12,412,000
Pumping Plant No. IV	13,530,000
Pumping Plant No. V	31,626,000
Pumping Plant No. VI	14,550,000
Buena Vista Forebay	1,452,000
Aqueduct—Wheeler Ridge to Pastoria Creek	10,720,000
Aqueduct—Pastoria Creek to Elizabeth Lake Canyon	248,929,000
Aqueduct—Elizabeth Lake Canyon to San Jacinto Tunnel Portal	250,783,000
Subtotal	$916,710,000
Contingencies	148,415,000
Engineering and administration	91,671,000
Interest during construction	62,795,000
Subtotal Feather River Project Aqueduct	$1,219,591,000
Total cost	$1,638,252,000

OPERATION OF THE PROJECT

In accordance with the step-construction program subsequently described in Chapter III, several operation studies have been made of the features included in the initial step and also with the complete construction to deliver the full supplemental water supplies available from the project. In order to avoid the presentation of the great detail involved in these operation studies, only one of these studies is discussed in this report. That study is the one in which the Oroville Reservoir and Power Plant are operated to produce the maximum dependable power generating capability and then, with reregulation of water releases for power together with surplus waters available in the Sacramento-San Joaquin Delta, and with storage in San Luis Reservoir, make available supplemental water supplies for the upper western area of the San Joaquin Valley, the Alameda, Santa Clara and San Benito counties area and Southern California. This operation study has been made on a monthly basis for the runoff period 1921-1951.

Investigations by this office have indicated that from economic and engineering standpoints it would be most advisable to operate Oroville Reservoir and Power Plant in such a manner as to obtain the maximum dependable power generating capacity in order to secure the maximum possible power revenues obtainable without impairing the ultimate objective, that of making available the greatest possible yield of water for export to areas of deficient supply. It is believed that this type of operation could be continued for a major portion of the project repayment period, requiring modification only upon major development of the use of water from the Feather River within the drainage area above Oroville Dam. There follows a description of the assumptions and criteria used for this operation study of Oroville Reservoir and Power Plant with operation primarily for the generation of maximum power output.

Water Supply

The natural runoff from the drainage area of the Feather River above Oroville dam site is subject to impairment by power storage and diversion and by diversions for irrigation use. Power and irrigation storage reservoirs which influence Feather River runoff are listed as follows:

Reservoir	*Branch of stream on which located*	*Storage capacity acre-feet*
Lake Almanor	North Fork	649,800
Mountain Meadows	North Fork	24,000
Butt Valley	North Fork	50,000
Buck's Storage	North Fork	103,000
Buck's Diversion	North Fork	6,000
Three Lakes	North Fork	500
Grizzly Forebay	North Fork	1,100
Rock Creek	North Fork	4,700
Cresta	North Fork	4,400
Round Valley	West Branch	1,300
Philbrook	West Branch	4,900
Lake Wilenor	West Branch	8,600
Lost Creek	South Fork	5,500
Total		863,800

Water is diverted from the West Branch of the Feather River through the Hendricks Canal for power generation at De Sabla and Centerville power plants located on Butte Creek and through Miocene and Wilenor Canals for power generation at Lime Saddle and Coal Canyon power plants and for irrigation in the Table Mountain and Thermalito Irrigation Districts, and domestic use in Oroville. Water is diverted from the South Fork of Feather River through the Forbestown and Palermo Canals for irrigation and domestic use in the Oroville-Wyandotte Irrigation District and some area contiguous to that district's service area. Average annual diversions through the foregoing canals during the past five seasons have been as follows:

Canal	Diversion, acre-feet
Hendricks	38,000
Miocene and Wilenor	38,000
Forbestown	15,000
Palermo	14,000
Total	105,000

All of the water involved in the foregoing diversions is used in such a manner that it does not return to Feather River upstream from Oroville Dam.

Diversions are presently being made for consumptive irrigation requirements of the mountain valleys in the Feather River watershed, including: Clover, Squaw, Genessee and Indian Valleys on Indian Creek; American Valley on Spanish Creek; Sierra and Grizzly Valleys on the Middle Fork of Feather River, and in the valley above Lake Almanor on the North Fork of Feather River. The net depletion of flow of the Feather River by the foregoing diversions as used in the study for this report is 100,000 acre-feet per year.

Based upon the experience of watermasters of this office familiar with irrigation operations on the upper Feather River, it is concluded that further increase in use of water for irrigation purposes in the areas just described would require construction of storage facilities since very nearly complete use is made of the summer low flows of the streams involved. An investigation by this office, having as one of its purposes the determination of possible water and power storage projects for the Feather River above Oroville dam site, indicates that the cost of irrigation water from the storage projects being considered, even under the most favorable financing, would be relatively high when considered in the light of the crops which could be grown in the upper Feather River valleys. For the foregoing reason it is believed that development of irrigation use in the upper Feather River watershed may be slow. Attention is also called to the fact that additional water supplies for irrigation obtained from future storage projects would come primarily from flood flows of the Feather River so that the effect of such storage and diversion upon the water yields of Oroville Reservoir would be, to a great extent, minimized.

The Richvale Irrigation District has made applications for a Federal Power Commission license and water right permits for a power and irrigation water development on the Middle Fork of Feather River. Storage works involved in such a development, if constructed, would tend to increase the power yield of Oroville Reservoir, and would increase the irrigation yield from that reservoir more than the additional requirements of the Richvale Irrigation District which is located wholly within the Feather River Service area.

The Oroville-Wyandotte Irrigation District has received a Federal Power Commission license to construct and operate a power and irrigation project on the South Fork of Feather River, including works to divert to the Feather River drainage area a portion of the flows at Slate Creek, a tributary of the North Yuba River. Water right applications by the district for the foregoing project conflict with similar applications by the County of Yuba and the Yuba County Water District for a water and power project utilizing essentially the same flows and dam sites but with an additional diversion of a portion of the flows of Canyon Creek, another tributary of the North Yuba River. No decision on the granting of a water right permit to either agency has as yet been made by the State Engineer. Analyses of various plans proposed for the foregoing development have been made and reported upon in a publication by the office of the State Engineer entitled "Analysis of Plans For Development And Utilization Of Water Resources Of The South Fork Of Feather River," dated December, 1954.

It is believed that diversion of Feather River water to Yuba County will develop slowly at least during the repayment period of any development which may be constructed to implement such diversions. Studies by this office also show that deliveries of irrigation water to the Oroville-Wyandotte area in the amount of the ultimate requirements of the area would not reduce the yield of Oroville Reservoir, because of the increased control of South Fork of Feather River flows resulting from construction of power and irrigation storage and importation of water from the Yuba River watershed.

The Pacific Gas and Electric Company has under construction the Poe power project and has received Federal Power Commission approval of their applications for licenses for the Belden, Caribou No. 2 and Butt Valley power developments, all of which are located on the North Fork of Feather River. These projects in themselves do not materially influence the monthly distribution of the flows of the stream. However, it is understood that some time in the future the company will take the steps necessary for utilizing the maximum storage capacity of Lake Almanor. At present the company limits storage in the reservoir to 649,800 acre-feet, whereas it is possible to store 1,300,000 acre-feet. Should full storage capacity be utilized to regulate flows of the North Fork of Feather River, a considerable increase in yield at Oroville Reservoir would result.

After consideration of the factors discussed in the foregoing paragraphs it was concluded that the flow of the Feather River into Oroville Reservoir during a major portion of the repayment period thereof assumed in this report would be essentially equal to

that which would have entered the reservoir during the historical period 1921-1951 if existing power and irrigation developments had been in operation for the same period. Therefore in the operation study of Oroville Reservoir for flood control, power and water, the present impaired flow of the Feather River at Oroville was used as the inflow to the reservoir. The present impaired flow was calculated by correcting the natural flow of the Feather River at Oroville for the following items:

(a) Storage and release at the reservoirs of Pacific Gas and Electric Company located on the North Fork as estimated by that company for the period 1921-1946 and extended through 1951 by this office. These reservoirs include Lake Almanor, Mountain Meadows, Buck's Storage and Diversion, Butt Valley, Three Lakes, Grizzly Forebay, Rock Creek and Cresta. The company has supplied this office with the historical operation of the foregoing reservoirs, designated "Operation A," and two estimates of their possible operation designated "Operations B and C." The estimate designated "Operation B" was made on the assumption of maximum drawdown of cyclic storage in the foregoing reservoirs. The estimate designated "Operation C" was based upon the assumption that limited use of cyclic storage would be made by holding a relatively large amount of water in storage through the dry cycle which occurred in the period 1928-1934. The calculation of present impaired flow was based upon the foregoing "Operation B."

(b) Diversions of the Hendricks, Miocene and Wilenor canals equal to the average of the five years of operation from 1949 through 1953.

(c) Storage and release at Round Valley, Philbrook and Wilenor reservoirs on the West Branch and Lost Creek Reservoir on the South Fork, as reflected by the five years of operation from 1949 through 1953.

(d) Net depletion of stream flow by irrigation diversions as estimated by this office for present conditions of development and set forth in the following tabulation:

Month	Net depletion acre-feet
January	0
February	0
March	0
April	4,000
May	17,600
June	27,300
July	26,700
August	19,300
September	9,100
October	4,000
November	0
December	0
Total	100,000

The natural flow and the present impaired flow of the Feather River at Oroville Dam Site as computed by this office are set forth in Table 8.

TABLE 8

FEATHER RIVER PROJECT

Annual Flows of Feather River at Oroville Dam Site

(Quantities in 1,000 acre-feet)

Calendar year	Natural flow	Present impaired flow	Calendar year	Natural flow	Present impaired flow
1921	5,136	4,823	1936	4,257	3,655
1922	5,231	4,910	1937	4,491	3,801
1923	2,782	2,478	1938	7,345	7,140
1924	1,434	1,787	1939	1,770	1,659
1925	3,107	2,555	1940	6,319	5,823
1926	3,603	3,072	1941	6,629	6,156
1927	5,392	4,904	1942	6,302	6,102
1928	3,896	3,593	1943	5,200	4,950
1929	2,600	2,447	1944	3,068	2,872
1930	3,218	2,750	1945	4,346	3,852
1931	1,655	1,868	1946	3,472	3,269
1932	3,136	2,656	1947	2,438	2,265
1933	2,135	1,991	1948	3,871	3,446
1934	2,060	2,103	1949	2,519	2,322
1935	4,153	3,522	1950	5,706	5,232
			1951	4,632	4,378
			31-year mean	3,932	3,625

Further discussion of future impairment of Feather River flows and its effect upon Feather River Project operation is included in the later portion of this chapter.

Operction of Oroville Reservoir

The areas and capacities of Oroville Reservoir were obtained from topographic maps made by the Fairchild Company, by photogrammetric methods, for the U. S. Bureau of Reclamation in 1946. The foregoing maps were prepared on a scale of one inch equals 400 feet, with contour interval of 10 feet. The areas and capacities for the reservoir are shown in Table 9.

Net evaporation losses from the reservoir surface were computed from the following monthly factors:

Month	Net Evaporation in feet
January	0
February	0
March	0
April	0.32
May	0.44
June	0.52
July	0.62
August	0.58
September	0.45
October	0.34
November	0.23
December	0
Total	3.50

The control of floods was assumed to be a primary function of Oroville Reservoir. The operation study was based upon maintaining a maximum storage reservation in the reservoir of 500,000 acre-feet from November 15th to April 1st of each year. Operation during flood periods was based upon limiting reservoir releases to actual inflow to the reservoir, but not more than 50,000 second-feet, as long as flood control reserve storage of more than 400,000 acre-feet was available. Releases would then be increased to the actual inflow, but not more than 100,000 second-feet,

TABLE 9

Areas and Capacities of Oroville Reservoir

United States Geological Survey Datum

Water surface elevation in reservoir in feet	Area of water surface in acres	Capacity of reservoir in acre-feet	Water surface elevation in reservoir in feet	Area of water surface in acres	Capacity of reservoir in acre-feet
200	0	0	560	3,927	470,000
220	26	200	580	4,340	552,700
240	67	1,100	600	4,738	643,300
260	115	3,100	620	5,250	743,200
280	200	6,300	640	5,785	853,400
300	300	11,300	660	6,355	975,100
320	445	18,700	680	6,970	1,108,300
340	605	29,200	700	7,618	1,254,100
360	799	43,300	720	8,260	1,412,600
380	995	61,200	740	8,950	1,584,600
400	1,189	83,100	760	9,675	1,770,700
420	1,450	109,500	780	10,450	1,972,000
440	1,705	141,000	800	11,220	2,188,600
460	2,000	178,500	820	12,050	2,421,200
480	2,327	221,700	840	12,900	2,670,800
500	2,685	271,800	860	13,780	2,937,700
520	3,085	329,400	880	14,600	3,221,600
540	*3,500*	*395,300*	*900*	*15,450*	*3,522,800*

when less than 400,000 acre-feet of flood control reserve storage was available. With decreasing inflow, the maximum release, if more than 50,000 second-feet, was continued until a flood control reserve storage space of 400,000 acre-feet was reached. The releases were then reduced to 50,000 second-feet until a flood control storage of 500,000 acre-feet was reached. With decreasing inflow when the maximum release was less than 50,000 second-feet, the release being made was continued until a flood control storage of 500,000 acre-feet was reached. Flood control operation studies for the period 1904-1951 showed that at no time would a release of more than 100,000 second-feet have been necessary. That flow would have occurred eight times during the years of record. A flow of 50,000 to 100,000 second-feet would have occurred six times in the years of record. At all other times the outflow would have been 50,000 second-feet or less.

The portion of the Sacramento Valley floor which has been designated as the Feather River Water Service Area is shown on Plate 2 of this report. This division has made estimates of the present and ultimate consumptive water requirements of this service area. During the irrigation season of 1952, gross diversions from the Feather River between Oroville and the Nicolaus gaging station amounted to about 730,000 acre-feet. In the operation study described in this section it was assumed that the foregoing irrigation diversion to the service area would be supplied, distributed by months as follows:

Month	*Acre-feet*
January	0
February	0
March	7,300
April	73,000
May	109,500
June	138,700
July	146,000
August	146,000
September	73,000
October	36,500
November	0
December	0
Total	730,000

It is estimated by this office that the ultimate water requirements of the area designated as the Feather River Service Area will be 721,000 acre-feet of net consumption of applied water, including allowance for municipal and domestic uses, as well as irrigation of an estimated 272,000 acres of irrigable land. It is estimated that the ultimate gross diversion requirement for the foregoing uses will be 970,000 acre-feet per year.

Judging by the rapid increase in diversions from the Feather River in recent years, it is anticipated that diversion of the foregoing ultimate gross amount of 970,000 acre-feet may develop quite rapidly. It is believed that such an increase in the gross diversions from the Feather River will have a very minor effect upon the operation and realization of maximum dependable electric generating capacity of Oroville Reservoir and Power Plant. Examination of the reservoir operation shown on Plate 7 indicates that, with the exception of the months of May and June, releases from Oroville Reservoir would always be able to accommodate considerably larger service area demands. It is believed that an adjustment of the minimum power requirement assumed in the study could be made to accommodate increased irrigation requirements in May and June with no detrimental effect upon the value of power output.

It is estimated that the present consumptive use of water diverted from the Feather River is about 400,000 acre-feet, as compared to the 730,000 acre-feet diverted during the season of 1952. The area irrigated with the foregoing amount of water, along with reuse of return flow and ground water pumping, consists of approximately 146,000 acres. The amounts of water assumed in this report to be available for diversion from the Sacramento-San Joaquin Delta are based upon a contribution from the Feather River of all reservoir release and spill in excess of the 730,000 acre-foot service area demand, plus a return flow of 340,000 acre-feet per year. It was assumed that during the final year of the critical runoff period 1928-1934, no return flow from Feather River diversions reached the Sacramento-San Joaquin Delta. The development of additional water-consuming agriculture in the area is expected to continue over a considerable period of time and in this report it is assumed that the ultimate condition will be reached in about 50 years from the beginning of construction of Oroville Dam. It is recognized that a national emergency could accelerate such development to a very great degree. Discussion of the effect of such water use development upon future project operations is included later in this chapter.

The over-all efficiency of the Oroville Power Plant was assumed to be 83 percent for gross power generating heads varying from 703 feet down to the design head of 558 feet, and was assumed to vary from 83 percent to 78 percent for heads ranging from design head down to the minimum head of 352 feet.

Power plant generating equipment was assumed to have a generating capacity of 440,000 kilowatts for gross power generating heads, ranging from the maximum of 703 feet down to the design head of 558 feet, and was assumed to have a generating capacity varying with the three halves power of the head from 440,000 kilowatts at the design head to 220,000 kilowatts at the minimum head of 352 feet.

The dependable electric power and energy output capability of Oroville Power Plant was based upon operation of the reservoir through the period of lowest runoff from 1928 through 1934. Officials of Pacific Gas and Electric Company have suggested certain maximum and minimum energy output characteristics to be used in determining the magnitude of the marketable commercial power output of the project. The foregoing characteristics are shown in Table 10.

Minimum reservoir operating stages were established which would permit maximum use of water through the power plants and at the same time give assurance that no failure of irrigation supply or power output would occur in any year or period of years as dry as those experienced in the period studied. These stages were used in operating Oroville Reservoir through the period 1921-1951 in order to determine average annual energy output.

In this operation study no special releases were made for preservation of fish life. Preliminary discussions have been held with representatives of the California Department of Fish and Game and the U. S. Fish and Wildlife Service for the purpose of determining the flows which it would be desirable to maintain in the channel of the Feather River to preserve fish life. No final estimates of the required flows were available during the preparation of the operation studies for this report. However, after consultation with representatives of the foregoing agencies, examination of the study showed that, with the operation herein described, flows in the Feather River between Sutter-Butte Dam and the mouth of the Yuba River would always be adequate during the October-November-December fall-run salmon spawning season, as well as during the winter and spring incubation and hatching season. A minor problem is anticipated during the months of May and June when power release requirements would be relatively low and service area irrigation requirements would require diversion of a major portion of such power releases at the Sutter-Butte Dam. The fish and wildlife interests have recommended to the Federal Power Commission that a minimum flow of 400 second-feet be provided in the Feather River. It is believed that minor adjustments

TABLE 10

Suggested Schedules for Power Generation of Feather River Project Kilowatt Hours per Kilowatt of Useful Capacity [a]

Month	Minimum monthly requirement	Usable on firm basis	Estimated maximum usable		
			Except months A and B	Months A	Months B
	(1)	(2)	(3)	(4)	(5)
January	160	310	650	500	400
February	140	260	600	450	350
March	140	260	650	450	350
April	140	260	650	450	350
May	140	260	650	450	350
June	*200*	*350*	*650*	*500*	
July	470	600	700		
August	550	600	700		
September	460	600	700		
October	290	600	700		
November	170	500	650	500	
December	120	400	650	500	

Wet Periods in Period 1921 to 1951, Incl., When Estimated Maximum Usable Power Is Less Than Column (3)

Months A
1921-January, February and May
1922-April and May
1926-December
1927-January, May and December
1928-January and February
1936-January and April
1937-November and December
1938-June
1940-January, May and December
1942-January, April and May
1943-January, February and April
1950-December*
1951-February, March*

Months B
1921-March and April
1927-February, March and April
1928-March and April
1936-February and March
1938-January to May, incl.
1940-February, March and April
1941-February to May, incl.
1942-February
1943-March
1951-January*

NOTE: [a] Applicable to dependable capacity plus additional capacity available for not less than six months. Factors should be applied to each plant separately.
* Added by Division of Water Resources.

of minimum power requirements for the months of May and June can be made so that releases sufficiently in excess of service area irrigation requirements can be utilized for power purposes. The operation study of Oroville Reservoir for flood control, water supplies and power generation for the period 1921-1951 is set forth by years in Table 11, and by months in Table E-1 in Appendix E, and on Plate 7.

The Sacramento-San Joaquin Delta

The Sacramento-San Joaquin Delta, at sea-level elevation, is a common point of diversion for both the Feather River Project and the Central Valley Project. Therefore a very close coordination of operations of the two projects will be required to accomplish their respective purposes without waste of water. A detailed study of water operations in the delta has been made by this office for conditions reflecting operation of Central Valley Project features now constructed or under construction in coordination with authorized Feather River Project features in addition to the foregoing features. There follows a description of the assumptions and criteria used in the studies.

(1) The total inflow to the Sacramento-San Joaquin Delta was assumed to be composed of four items:

(a) All stream flow from the Sacramento-San Joaquin drainage basin, excluding the flows of the Feather River at Oroville Dam Site, the Sacramento

TABLE 11

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation

1921-1951 (Annual Summary)

Year	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of year 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather river service area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921	4,823	2,493	50	730	4,043	4,773	2,236.5
1922	4,910	2,493	50	730	4,130	4,860	2,239.2
1923	2,478	2,493	51	730	1,718	2,448	1,368.5
1924	1,787	2,472	42	730	1,737	2,467	1,271.1
1925	2,555	1,750	45	730	1,599	2,329	1,225.7
1926	3,072	1,931	49	730	1,731	2,461	1,341.3
1927	4,904	2,493	52	730	4,122	4,852	2,117.2
1928	3,593	2,493	51	730	2,812	3,542	1,682.0
1929	2,447	2,493	45	730	1,672	2,402	1,277.7
1930	2,750	2,493	50	730	1,970	2,700	1,505.0
1931	1,868	2,493	43	730	1,615	2,345	1,225.0
1932	2,656	1,973	49	730	1,508	2,238	1,226.7
1933	1,991	2,342	45	730	1,581	2,311	1,224.9
1934	2,103	1,977	41	730	1,706	2,436	1,223.3
1935	3,522	1,603	50	730	1,877	2,607	1,443.0
1936	3,655	2,468	51	730	2,905	3,635	1,785.3
1937	3,801	2,437	52	730	2,457	3,187	1,757.3
1938	7,140	2,990	51	730	6,866	7,596	2,187.6
1939	1,659	2,492	44	730	1,656	2,386	1,247.8
1940	5,823	1,721	50	730	4,036	4,766	2,036.3
1941	6,156	1,728	51	730	5,430	6,160	2,484.6
1942	6,102	2,673	52	730	5,500	6,230	2,684.8
1943	4,950	2,493	51	730	4,169	4,899	2,210.6
1944	2,872	2,493	50	730	2,091	2,821	1,575.8
1945	3,852	2,494	50	730	2,811	3,541	1,972.7
1946	3,269	2,755	51	730	2,749	3,479	1,944.5
1947	2,265	2,495	47	730	1,803	2,533	1,374.7
1948	3,446	2,178	52	730	2,350	3,080	1,736.6
1949	2,322	2,493	50	730	1,605	2,335	1,310.5
1950	5,232	2,430	50	730	3,882	4,612	2,280.8
1951	4,378	3,000	51	730	3,988	4,718	2,141.7
31-year mean	3,625	2,609	50	730	2,843	3,573	1,720.6

River at Keswick Dam and the American River at Folsom Dam, as it would have occurred during the period studied (1921-1951) with all existing water storage developments and present (1950) irrigation consumptive uses. The computation of the foregoing stream flow was accomplished by deducting estimated irrigation consumptive uses on the Sacramento and San Joaquin valley floors from the flows of the tributary streams as measured at the foothill line and modified by upstream storage, diversion or consumptive use.

(b) Water released from Shasta and Folsom Reservoirs to maintain adequate navigation depths in the Sacramento River between Sacramento and Chico Landing, or to fulfill the stream flow requirements of the Central Valley Project in the Delta. In the coordinated operation study of these two reservoirs it was found that firm irrigation yields in addition to Central Valley Project requirements in the delta could be obtained in the amounts of 450,000 acre-feet per year from Shasta Reservoir and 800,000 acre-feet per year from Folsom Reservoir. It was assumed that the full 450,000 acre-feet would be used in the Sacramento Valley Canals Area and it was estimated that the Folsom Service Area would require about 500,000 acre-feet per year, leaving 300,000 acre-feet per year distributed on an irrigation use basis to flow into the Delta for export to water users along the Delta-Mendota Canal.

(c) Water released from Shasta and Folsom Reservoirs specifically for power generation or wasted from these reservoirs through the flood control outlets or over the spillways.

(d) All water released or wasted from Oroville Reservoir less a gross diversion requirement of 710,000 acre-feet per year for the Feather River Service Area and plus estimated return flows from the foregoing diversions.

(2) The total water uses and diversions in the Sacramento-San Joaquin Delta for all purposes except the Feather River Project were assumed as follows:

(a) Consumptive irrigation uses on the crop lands and evaporation losses from flooded lands and channels all within the delta.

(b) Water requirements of the area served by the Contra Costa Conduit as estimated for the year 1990.

(c) Consumptive irrigation uses in the Delta Uplands served by pumping diversions from the delta channels.

(d) Water diverted through the Delta-Mendota Canal to fulfill the terms of the Exchange Agreement, dated July 27, 1939, between the United States and four contracting canal companies serving lands along the San Joaquin River below Mendota Dam. In addition the United States has executed, or proposes to execute, contracts for sale of an additional 414,000 acre-feet of water to water user groups located along the Delta-Mendota Canal. The amounts assumed for the foregoing items were obtained from the U. S. Bureau of Reclamation, which agency has revised the original estimated requirements for the exchange agreement to some extent. As a result of this revision it was found that in several months of the period studied water supplies in the Delta fell short of amounts required for Central Valley Project purposes. It is believed that slight modifications of power operations at Shasta and Folsom could eliminate these shortages. No Feather River Project diversions were assumed to be made during the months when the foregoing shortages occurred.

(e) Flow into Suisun Bay estimated to be necessary for prevention of the encroachment of saline waters into the Delta. For the study herein described, a flow of 4,500 second-feet was assumed to be necessary.

(3) The amounts of water to be diverted from the Sacramento-San Joaquin Delta for Feather River Project purposes were assumed as follows:

(a) A continuous pumping diversion of 350 second-feet into a conduit leading to the South San Francisco Bay Area for use in Alameda, Santa Clara and San Benito Counties. It was found that, with the operation of Oroville Reservoir as described in the foregoing pages there would be one or two months during extremely dry years when there would be no flow available in the Delta for diversion through Feather River Project facilities. It is the nature of the proposed works that deliveries in Livermore Valley must be made without benefit of storage. However, as discussed previously in this report, it is anticipated that increase of reservoir releases will be necessary during the months of May and June to preserve fish habitat. These latter releases are expected to adequately supply the shortages in supply for the Alameda-Santa Clara-San Benito area.

(b) Diversions up to a maximum of 11,200 second-feet through the Feather River Project Aqueduct for storage in San Luis Reservoir or direct diversion to the San Joaquin Valley or Southern California. A loss of 1 percent of the amounts diverted was assumed in transferring water from the Delta to San Luis Forebay. There are shown in Table 12 by years and in Table E-2 of Appendix E and on Plate 9, by months, the water uses in and diversions from the Sacramento-San Joaquin Delta with coordinated operation of the Feather River Project and Central Valley Project.

Operation of San Luis Reservoir and Feather River Project Aqueduct

The major portions of the water deliveries from Feather River Project facilities are accomplished by diversion of flows from the Delta on a "when available" basis and, by use of storage in San Luis Reservoir, regulating the foregoing flows to a monthly distribution satisfactory to the needs of the San Joaquin Valley and Southern California water users. The assumptions and criteria used in making the operation study of San Luis Reservoir consisted of the following:

(1) It was assumed that the natural runoff of San Luis Creek would not be stored in San Luis Reservoir but would be released through the dam into its natural channel in order not to disturb vested rights

TABLE 12

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project 1921-1951 (Annual Summary)

Quantities in thousands of acre-feet

Year	Water supplies			Water utilization					
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta	Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the Delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1921	21,937	4,043	25,980	6,123	253	3,697	10,073	15,907	
1922	22,074	4,130	26,204	6,133	253	3,794	10,180	16,024	
1923	12,585	1,718	14,303	6,069	253	3,544	9,866	4,437	
1924	7,492	1,737	9,229	5,788	232	3,202	9,222	7	
1925	14,608	1,599	16,207	6,113	253	4,577	10,943	5,264	
1926	14,311	1,731	16,042	6,046	245	3,666	9,957	6,085	
1927	24,729	4,122	28,851	6,145	253	3,970	10,368	18,483	
1928	16,280	2,812	19,092	6,065	254	3,896	10,215	8,877	
1929	8,069	1,672	9,741	6,045	250	2,915	9,210	531	
1930	10,266	1,970	12,236	6,029	253	3,704	9,986	2,250	
1931	7,877	1,615	9,492	5,803	235	2,783	8,821	671	
1932	11,915	1,508	13,423	6,138	254	4,569	10,961	2,462	
1933	8,794	1,581	10,375	6,072	253	3,886	10,211	164	
1934	8,450	1,706	10,156	5,845	198	3,407	9,450	706	
1935	15,135	1,877	17,012	6,053	253	4,205	10,511	6,501	
1936	18,805	2,905	21,710	6,141	254	3,740	10,135	11,575	
1937	20,937	2,457	23,394	6,069	253	4,136	10,458	12,936	
1938	34,681	6,866	41,547	6,096	253	3,794	10,143	31,404	
1939	7,864	1,656	9,520	6,044	230	2,926	9,200	320	
1940	27,204	4,036	31,240	6,110	254	4,663	11,027	20,213	
1941	33,873	5,430	39,303	6,071	253	3,794	10,118	29,185	
1942	27,837	5,500	33,337	6,134	253	3,794	10,181	23,156	
1943	22,320	4,169	26,489	6,124	253	3,785	10,162	16,327	
1944	11,227	2,091	13,318	6,120	254	3,809	10,183	3,135	
1945	20,161	2,811	22,972	6,162	253	3,794	10,209	12,763	
1946	14,244	2,749	16,993	6.117	253	3,794	10,164	6,829	
1947	8,976	1,803	10,779	6,052	232	3,144	9,428	1,351	
1948	14,676	2,350	17,024	6,087	254	4,403	10,744	6,280	
1949	11,511	1,605	13,113	6,078	253	3,443	9,774	3,342	
1950	24,066	3,882	27,948	6,097	253	4,187	10,537	17,411	
1951	20,602	3,988	24,590	6,108	253	3,794	10,155	14,435	
31-year mean	16,887	2,843	19,730	6,067	248	3,768	10,084	9,646	

stream flow. The inflow to San Luis Reservoir was assumed to be that portion of the flows arriving at San Luis Forebay by way of the Feather River Project Aqueduct which could not be put to immediate use along the remaining portion of the aqueduct in the San Joaquin Valley or Southern California.

(2) Areas and capacities of San Luis Reservoir were obtained from a curve prepared by the U. S. Bureau of Reclamation based upon an aerial survey map designated 484-207-22 having a contour interval of 10 feet and a scale of one inch equals 200 feet for the portion of the reservoir lying below elevation 450 feet. For the portion of the reservoir lying above 450 the foregoing curve was based upon the U. S. Geological Survey quadrangle entitled "Pacheco Pass" on a scale of 1:62,500 and having a contour interval of 50 feet, prepared in the year 1920. A tabulation of areas and capacities of San Luis Reservoir is presented in Table 13.

TABLE 13

FEATHER RIVER PROJECT

Areas and Capacities of San Luis Reservoir

United States Geological Survey Datum

Water surface elevation in reservoir in feet	Area of water surface in acres	Capacity of reservoir in acre-feet	Water surface elevation in reservoir in feet	Area of water surface in acres	Capacity of reservoir in acre-feet
250	0	0	410	8,700	622,700
260	50	300	420	9,150	712,000
270	100	1,000	430	9,540	805,400
280	290	2,900	440	9,900	902,600
290	560	7,000	450	10,250	1,003,400
300	1,070	15,000	460	10,570	1,107,500
310	2,100	30,800	470	10,880	1,214,600
320	3,040	56,400	480	11,160	1,324,800
330	4,000	91,800	490	11,430	1,437,800
340	4,800	135,800	500	11,700	1,553,400
350	5,550	187,600	510	12,000	1,672,000
360	6,220	246,600	520	12,290	1,793,400
370	6,800	311,700	530	12,560	1,917,600
380	7,300	382,200	540	12,840	2,044,600
390	7,800	457,700	550	13,120	2,174,500
400	8,250	537,800			

(3) Evaporation losses from San Luis Reservoir were estimated from a computation of similar losses for Tulare Lake made by S. T. Harding and reported in Bulletin No. 54 of the Division of Water Resources. The foregoing computation was based upon fluctuation of the water surface of Tulare Lake corrected for precipitation at Hanford. The evaporation factors used in the operation study consisted of the computed average evaporation for Tulare Lake less precipitation at Hanford for the year 1929 and are listed in the following tabulation.

Month	*Net evaporation in feet*
January	0.05
February	0.08
March	0.13
April	0.23
May	0.50
June	0.68
July	0.80
August	0.60
September	0.60
October	0.30
November	0.20
December	0.07
Total	4.24

(4) Water supplies routed through the Feather River Project Aqueduct south of San Luis Creek consisted of the following:

Month	*Fresno and Kings Counties acre-feet*	*Kern County acre-feet*	*Southern California acre-feet*
January	40,400	84,900	156,800
February	50,500	84,900	141,700
March	60,600	84,900	156,800
April	50,500	84,900	159,900
May	40,400	84,900	156,800
June	121,200	84,800	151,900
July	181,800	84,800	156,800
August	181,900	84,800	156,800
September	131,300	84,800	151,900
October	80,800	84,800	156,800
November	40,400	0	151,900
December	30,300	0	156,800
Totals	1,010,100	848,500	1,846,900

It was assumed that transportation losses of 1 percent of gross diversion would occur in the supplies to Fresno, Kings and Kern Counties with resultant annual deliveries of 1,000,000 acre-feet to Fresno and Kings Counties and 840,000 acre-feet to Kern County.

Losses of 2 percent of gross diversion were assumed for the Southern California supply resulting in an annual delivery of 1,828,000 acre-feet. In making the operation studies it was assumed that deficiencies in supply would be allowable in the Fresno, Kings and Kern Counties supplies and also in a 500,000 acre-foot portion of the Southern California supply. It was assumed that a maximum deficiency of 35 percent of full supply in any one month would be allowed and that the total deficiency in supply for the 31-year period studied would not exceed 35 percent of one year's supply. The operation study of the San Luis Reservoir and Feather River Project Aqueduct for the period 1921-1951 is set forth by years in Table 14, and by months in Table E-3 in Appendix E and on Plate 8.

Accomplishments of Project Operation

The operation study just described is based upon assumptions and criteria which it is believed will pre-

vail with full absorption of water deliveries and throughout a major portion of the repayment period of the project. The accomplishments of the project obtained from the foregoing operation studies are summarized as follows:

Oroville Reservoir and Power Plant. The accomplishments of the Feather River Project locally in the general Feather River area would consist of the following:

(a) The control of all flood flows of the Feather River at Oroville gaging station, for the period 1903-1954, to a maximum flow of 100,000 second-feet. It was found that a release of 100,000 second-feet would have been necessary eight times during the foregoing period and that a release of between 50,000 second-feet and 100,000 second-feet would have been necessary six times during the same period. The foregoing controlled flows compare with historical peak flows of the Feather River at Oroville gaging station which reached a peak flow of 230,000 second-feet and exceeded 100,000 second-feet 13 times during the period studied and exceeded 50,000 second-feet 43 times during the same period.

(b) Provision of a firm irrigation supply of 730,000 acre-feet per year for use in the Feather River Service area with an increase of such supply to 970,000 acre-feet as required, with a consequent decrease in power revenues. The foregoing irrigation supplies compare with the presently available dry year irrigation supply from the Feather River estimated to be about 450,000 acre-feet per year.

(c) The production of marketable hydroelectric power and energy amounting to 410,000 kilowatts of dependable capacity and 1,720,600,000 kilowatt-hours of energy measured at generation, based upon the average of 31 years of operation study. The foregoing amounts of power and energy would have characteristics conforming to the Northern California commercial power load in order that a maximum revenue therefrom would be available to reduce charges for pumping at Feather River Project facilities in the San Joaquin Valley and Southern California.

(d) Provision of more uniform sustained releases of colder-than-natural water down the channel of the Feather River during the late summer and fall months reducing the natural hazards to the spawning of fall-run salmon in the stream channel gravels. The foregoing improved stream flows are expected to more than offset the detrimental effect upon salmon runs resulting from obstruction of the channel by Oroville Dam, and closing off relatively minor spawning areas above the dam.

TABLE 14

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct
1921-1951 (Annual Summary)

(Quantities in thousands of acre-feet)

Year	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of year	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921	3,661	1,609	51	1,010	849	1,847	3,706
1922	3,756	1,513	51	1,010	849	1,847	3,706
1923	3,509	1,513	51	1,010	849	1,847	3,706
1924	3,170	1,265	36	1,010	849	1,852	3,711
1925	4,531	688	50	1,010	849	1,847	3,706
1926	3,630	1,463	48	1,010	849	1,847	3,706
1927	3,031	1,339	51	1,010	849	1,847	3,706
1928	3,858	1,513	51	1,010	849	1,852	3,711
1929	2,886	1,609	43	1,010	849	1,847	3,706
1930	3,668	746	47	1,010	849	1,847	3,706
1931	2,754	661	29	706	611	1,726	3,043
1932	4,523	343	48	1,010	849	1,852	3,711
1933	3,848	1,107	47	1,010	849	1,847	3,706
1934	3,373	1,202	43	1,010	849	1,847	3,706
1935	4,164	826	51	1,010	849	1,847	3,706
1936	3,703	1,233	50	1,010	849	1,852	3,711
1937	4,095	1,175	51	1,010	849	1,847	3,706
1938	3,757	1,513	51	1,010	849	1,847	3,706
1939	2,897	1,513	46	1,010	849	1,847	3,706
1940	4,617	658	51	1,010	849	1,852	3,711
1941	3,757	1,513	51	1,010	849	1,847	3,706
1942	3,757	1,513	51	1,010	849	1,847	3,706
1943	3,748	1,513	51	1,010	849	1,847	3,706
1944	3,770	1,504	50	1,010	849	1,852	3,711
1945	3,757	1,513	51	1,010	849	1,847	3,706
1946	3,757	1,513	51	1,010	849	1,847	3,706
1947	3,113	1,513	46	1,010	849	1,847	3,706
1948	4,359	874	50	1,610	849	1,852	3,711
1949	2,409	1,472	50	1,010	849	1,847	3,706
1950	4,145	1,125	51	1,010	849	1,847	3,706
1951	3,756	1,513	50	1,010	849	1,847	3,706
31 year mean	3,731		48	1,000	841	1,844	3,686

Sacramento-San Joaquin Delta. It is not intended that the Feather River Project will produce any major accomplishments in the Delta other than incidentally providing additional fresh water flows during summer months to aid in diluting increasingly saline San Joaquin Valley irrigation return waters.

San Luis Reservoir and Feather River Project Aqueduct. The water supplies which could be delivered at the different areas of export are summarized as follows:

(a) An annual supply of irrigation, municipal and industrial water of about 240,000 acre-feet on a continuous draft basis measured at its point of diversion from the Feather River Project Aqueduct, to be delivered to water deficient areas in Alameda, Santa Clara and San Benito Counties.

(b) An annual irrigation supply of 1,000,000 acre-feet, measured at points of delivery along the Feather River Project Aqueduct, for use on crop lands of western Fresno County, based on an irrigation demand schedule.

(c) An annual irrigation supply of 840,000 acre-feet, measured at points of delivery along the Feather River Project Aqueduct for use on crop lands of western Kings and Kern Counties, based upon a continuous delivery during the months from January through October.

(d) An annual supply of municipal, industrial and irrigation water of 1,800,000 acre-feet, or a continuous flow of 2,500 second-feet, measured at points of delivery along the Feather River Project Aqueduct, for use in the cities and on crop lands located in southern California.

It was found that, in producing the foregoing accomplishments for the 31-year period 1921-1951, the average annual amount of water diverted from the Delta which would be required specifically from the Feather River would be approximately 950,000 acre-feet per year and the maximum amount of such flow required in any one year would be approximately 1,700,000 acre-feet. It will be noted that the 31-year mean annual natural and present impaired flows of the Feather River at Oroville gaging station are approximately 3,900,000 acre-feet and 3,600,000 acre-feet, respectively. It is therefore concluded that, should all of the water required by the Feather River Service Area and in the Feather River watershed be eventually used in those areas, deliveries of water from the Feather River Project as previously described would not be jeopardized.

WATER QUALITY

In any discussion of water quality it should be borne in mind that quality requirements are, or ought to be, related to intended beneficial uses of water. In situations where the aim is to achieve maximum utilization of rivers for several purposes, as in the Feather River Project, effort has to be made to reconcile higher uses of water with requirements for waste disposal. The only alternative to this course would be to segregate either water or wastes in a separate aqueduct or waste way.

Proposed beneficial uses of Feather River water are for domestic, irrigation and industrial supplies, navigation, salinity control, production of electric power and other uses. The term "other uses" includes the preservation of fish and wildlife and recreation in accordance with provisions of the State Water Code (Sections 12581, 12582).

Accordingly, it is the purpose of this section to review criteria of water quality for the higher beneficial uses, so as to afford a basis for comparison and judgment; secondly, to set forth special considerations affecting quality of water for export; thirdly, to present data on present quality of waters involved in the Feather River Project, the Feather River itself, the Sacramento River downstream from its confluence with the Feather River, and the Sacramento-San Joaquin Delta; and finally, to make such general predictions as present data warrant relative to water quality which will prevail under conditions created by the Feather River Project and other future water resources developments of The California Water Plan.

The higher beneficial uses of the water in this case are construed to include domestic supply, irrigation and preservation of fish and wildlife. Water of a quality satisfying these uses would be generally suitable for navigation, hydroelectric power generation

and salinity control; and although certain industries require water of higher quality in some respects than drinking water, they ordinarily accept the necessity for conditioning or treating the supply to meet their special standards.

Quality for Domestic Water Supply

The leading criteria of water quality for domestic supply are undoubtedly those recommended by the United States Public Health Service. Although originally intended to apply only to common carriers in interstate commerce, they have been adopted voluntarily as a legal standard for municipal and domestic use by a large number of public agencies, as well as by the American Water Works Association. The standards of the latter organization, which incorporate the drinking water criteria of the Public Health Service, were accepted by the California Legislature in 1949 as official for public water supplies in the State.

The drinking water standards are of three kinds: bacteriological, physical and chemical.

The bacteriological standard is complex in its expression, but in essence limits the number of coliform organisms to an equivalent of not more than one per hundred milliliters. Allowance is made for occasional higher concentrations caused by random distribution of bacteria.

The physical standards require water to be relatively clear and colorless, and free from objectionable odor or taste.

The chemical standards set limits for phenolic and inorganic substances. The limits are of two types: mandatory for certain substances of proven toxicity (or other damage to health) in minute amounts; permissive for other substances not seriously harmful in the concentrations ordinarily encountered but which impair economic value of water, or make it physiologically irritating or unpleasant to taste and smell. Specific values are as follows:

	Parts per Million
Mandatory	
Lead	0.1
Fluoride	1.5
Arsenic	0.05
Selenium	0.05
Chromium, hexavalent	0.05
Permissive	
Copper	3.0
Iron and manganese together	0.3
Magnesium	125
Zinc	15
Chloride	250
Sulfate	250
Phenolic compounds	0.001
Total dissolved solids (preferred)	500
(limit allowed)	1000

Hardness of water is not covered by the Public Health Service standards, since it is a consideration of economics rather than health. It is nevertheless an important characteristic, affecting water quality both for domestic and industrial use. Undesirable effects of hardness include excessive consumption of soap, owing to inhibition of lathering, and the formation of soft or hard scale in water pipes, hot water tanks and boiler tubes. Hard water is objectionable to many industries, including laundering, beverage and food processing, textile manufacturing, photography, etc. Although no official limits have been promulgated, the United States Geological Survey has suggested the following classification for degrees of hardness:

Class 1	0- 55	Soft
Class 2	56-100	Slightly hard
Class 3	101-200	Moderately hard
Class 4	201-500	Very hard

The Public Health Service standards apply to finished water, i.e., water as it is delivered to the consumer for domestic uses. It should be observed that, under modern conditions, few if any public health and water works authorities expect a raw water supply to be maintained in such a high degree of purity as to require no treatment. Even reservoir waters on isolated and patrolled watersheds normally receive at least disinfective treatment before delivery to their users. The waters of lakes and streams accessible to the public, and utilized for disposal of wastes are considered to need treatment invariably. The degree of such treatment varies with the physical, chemical, and bacteriological quality of the raw water supply.

Quality for Irrigation Water Supply

Criteria used by the Division of Water Resources for quality of irrigation waters are those recommended by Lloyd D. Doneen, Professor of Irrigation, University of California at Davis. Doctor Doneen's recommendations are based upon earlier research done at the laboratories of the University of California, and the Rubidoux and Regional Salinity Laboratories of the United States Department of Agriculture.

Four parameters are employed to indicate the suitability of water for irrigation: (1) electrical conductivity, which is closely related to content of dissolved minerals; (2) chloride content; (3) percentage of sodium; (4) boron content.

For convenience three quality classes are recognized. Class I, "excellent to good" is safe for practically all crops under any conditions. Class II, "good to injurious" water is of marginal or doubtful suitability for certain sensitive crops, including both citrus and deciduous orchard fruits, several truck garden vegetables and most clover grasses. Class III, "injurious to unsatisfactory" waters are believed probably harmful to all except salt-tolerant products such as date palms, cotton, beets, and some hardy forage grasses. Quality limits are shown in the following table:

Qualitative Classification of Irrigation Waters
(After Doneen)

	Class I excellent to good	*Class II good to injurious*	*Class III injurious to unsatisfactory*
Conductance micromhos at 25° C.	Under 1,000	1,000 to 3,000	Over 3,000
Boron, ppm	Under 0.5	0.5 to 2.0	Over 2.0
Sodium percentage	Under 60	60 to 75	Over 75
Chlorides, ppm	Under 178	178 to 355	Over 355

Recent research by Dr. Doneen has revealed certain inadequacies of the total salts concept as an indicator of quality of irrigation water, and therefore he has suggested revised standards which take into account additional factors: the relative insolubility of certain calcium and magnesium salts, and the drainage characteristics of the soils to which irrigation water is applied. Specifically, Dr. Doneen recommends omitting calcium and magnesium carbonates and calcium sulfate from consideration in calculating total salts, and then classifying irrigation waters according to their "effective salinity" rather than total salinity, with appropriate modifications for soil conditions, as shown in the following table:

Tentative Classification for Effective Salinity of Irrigation Water

Soil conditions	*Terms used*	*Class I*	*Class II*	*Class III*
Little or no leaching of the soil can be expected.	milliequivalents of ions	3	3–5	5
	ppm.	165	165–275	275
	lbs. per acre-foot	450	450–750	750
Some leaching but restricted. Deep percolation or drainage slow.	m.e. of ions	5	5–10	10
	ppm.	275	275–550	550
	lbs. per acre-foot	750	750–1500	1500
Open soils. Deep percolation of water easily accomplished.	m.e. of ions	7	7–15	15
	ppm.	385	385–825	825
	lbs. per acre-foot	1050	1050–2250	2250

Quality for Preservation and Protection of Fish and Wildlife

Game fish of the upper Sacramento Valley, including salmon and steelhead, have a rather narrowly adjusted ecology, and are sensitive to environmental changes. According to the California Department of Fish and Game, their perpetuation requires a high degree of water quality in the streams, including absolute prohibition of the discharge of any toxic substances in hurtful concentrations. The specific limits of quality recently advocated by the department for the protection of these fish in the upper Sacramento in a communication to Central Valley Regional Water Pollution Control Board, dated August 23, 1954, are given as follows:

1. Dissolved oxygen content: never less than six parts per million, and preferably 85 percent, or more, of the saturation value. (The latter varies with temperature and salinity. For fresh water at 68° F., saturation value is 9.2 parts per million.)
2. Hydrogen-ion concentration (pH): a nearly neutral water is required, with pH in the range of 6.5 to 8.5.
3. Discharges of wastes high in suspended solids must be avoided since the latter tend to settle out, blanketing spawning gravels and smothering the lesser organisms which serve as fish food.
4. Discharge of wastes containing more than 15 parts per million of oily matter (especially petroleum products) is harmful and should be eliminated.

Water conforming to the foregoing standards would be safe not only for fish but also for migrating waterfowl.

Water temperatures are a very important factor in the survival of salmonoid fishes. Optimum temperatures for the king salmon species lie below 60° F.; stream temperatures over 70° are avoided when possible, while prolonged exposure to temperatures above 80° is generally lethal.

Quality for Recreational Uses

Recreational uses includes swimming, boating, angling and other water sports, picnicking and camping, and seasonal hunting of wild fowl. No absolute standards of safety for natural fresh-water bathing places have been adopted by the California Department of Public Health. That agency, in common with many other health authorities, believes that quantitative standards are of no proven value in this application, and may even be detrimental if enforced indiscriminately and without exercise of seasoned judgment. The safety of waters for recreational uses is generally evaluated by means of a sanitary survey, taking into account such factors as the proximity of sewage discharges, the presence of floating or suspended matter of sewage origin, the existence of sludge banks, discoloration of the water, etc. No bacterial standard of safety has been adopted although the bacterial density is certainly taken into account conjunctively with other factors in appraising fitness of bathing waters.

Special Consideration Affecting Quality of Water for Export

In any proposal for the large-scale export of water, such as the Feather River Project, certain qualitative influences are at work which do not exist, or exist only in a reduced degree, in purely local diversion and use of water. This section will briefly describe the nature and effects of such influences, but will not attempt to evaluate them closely, since that is a matter for much more extended study than the conditions of

the present work permit. The special considerations referred to may be described as degradation in transit, recycling, and salt balance.

Degradation in Transit. The Feather River Project will utilize existing channels of the lower Feather and Sacramento Rivers and of the Sacramento-San Joaquin Delta for conveying the water from the Oroville Reservoir to the pumping stations on Old River in the San Joaquin Delta. Consequently, this water will be subject to such quality impairment en route as would normally be expected in traversing a populous and rather highly developed valley, in the form of discharges of sewage, industrial wastes and drainage from irrigated lands. Notwithstanding probable future increases in population and development, it is believed that pollution from municipal and trade wastes can be kept within bounds so that usefulness of the water will not be significantly impaired. Some deterioration in mineral quality is even now apparent as a result of seasonal drainage from irrigated lands, as is shown on Plate 15, but this effect is not at present serious, nor is it expected to become so in the foreseeable future. Present water quality is so high that it affords a very large reserve of permissible waste loading, insofar as purely local use of water is concerned.

A second obvious source of impairment of quality of water in transit is in concentration of dissolved mineral solids due to evaporation from open canals and reservoir surfaces. This effect can be calculated with some precision and compensated by providing a corresponding excess of water.

The most serious threat to quality of Feather River waters in transit will probably lie in admixture with other waters of poor quality in the Sacramento-San Joaquin Delta. Plate 15 depicting results of sampling at Orwood Bridge on Old River, and Italian Slough, show what type of water must be expected along this portion of the route of the Feather River Project Aqueduct. The United States Bureau of Reclamation, in its operation of the Central Valley Project, has already experienced difficulty at times in meeting the standard of water quality required by the Exchange Agreement with the four canal companies being supplied Sacramento-San Joaquin Delta water by the Delta-Mendota Canal, which standard is the quality of water of Sacramento River near Hood. However, the quality of this water is still satisfactory for irrigation and domestic use. While the source of degradants in Delta water has never been fully explained, it is probable that they originate in part from degraded irrigation return water entering from the San Joaquin River and the Delta itself and in part from rising connate waters. Insofar as quality is concerned, the Delta is a critical area in the operation of projects for export of water from the Sacramento Valley. Improvement is expected, however, under conditions of eventual development of water resources under The California Water Plan.

Recycling. The second important consideration in the long-distance export of water is preservation of a quality high enough to be suitable for use and reuse at its destination. The cost of long-distance transfer is so high that effort should be exerted to gain the utmost possible value by repeated cycles of use to the economical and physical limits.

Such recycling may be brought about in various ways. One method is by reclamation of used water, i.e., sewage or industrial wastes, a field which is being actively investigated by the Division of Water Resources and other agencies. Reuse may also come about through the simple recapture in streams or ground water bodies of discharged sewage, industrial waste, or land drainage waters.

Such used waters, when recaptured are poorer in quality than virgin water. The degradation of surface streams, owing to use and reuse for irrigation, is a well documented phenomenon. Municipal water supplies are similarly affected in a cycle of use. In a recent report to the State Water Pollution Control Board, the University of California at Los Angeles reported the following increments in mineral content of the water supply of 15 California cities, as observed in the sewage of those communities:

	Normal range	*Maximum*
Total dissolved solids, ppm.	100-300	1200
Conductance, micromhos at 25 degree C.	300-600	2400
Sodium, ppm.	40- 70	290
Chlorides, ppm.	20- 50	550
Boron, ppm.	0.1- 0.4	3.8
Phosphate, ppm.	20- 40	50
Percent sodium	5- 15	42

Salt Balance. When water is used to recharge ground water basins, as contemplated under the California Water Plan, not all of it is available for extraction and consumptive use. A certain amount is needed to maintain a stable, or at least usable, mineral quality in the stored water and that amount is lost to the particular basin in the form of outflow. Other conditions remaining stable, the proportion which must be so wasted, varies according to the quality of water used for recharge. The poorer the quality, the more water must be released as outflow. Alternately, if the outflow is not permitted to increase, the salinity of the ground water may rise above acceptable limits. For stable conditions of water quality, the amount of salts removed in a given time must equal the amount entering a basin in the same time.

Satisfaction of the ultimate water-using potential of the Southern California area is predicated on the full utilization of the storage capacity of its underground basins for regulation and reuse not only of local water supplies, but also of imported water supplies. Destruction of the utility of these basins would necessitate importation of additional amounts of water at relatively high cost from water surplus areas in the north, and would require costly construction of additional surface regulation.

Further, in portions of the Southern California area, particularly in San Diego County, a prevalence of heavy-textured soils underlain in part by hardpan at shallow depth poses problems in utilization of water containing high concentrations of dissolved salts for irrigation. Use of such water in these areas would soon destroy soil fertility, without application of sufficient water to flush the accumulation of undesirable salts. This would substantially increase operational costs, and would create drainage problems.

The foregoing discussion indicates that there may be very decided economic advantages in preserving high quality in waters which are to be used for charging ground water basins. It is a problem which ought to be completely explored and analyzed in any proposal for importation of water on a large scale, such as the Feather River Project.

Quality of Water Supply

The best record available to this office on quality of waters of the Feather and Sacramento Rivers and Sacramento-San Joaquin Delta is that maintained under the state-wide cooperative stream sampling program. This study was begun in April, 1951, in collaboration with several agencies of federal, state and local governments, and has been carried on since that date by monthly sampling and reports.

The Feather River in its reaches above Oroville is typical of Sierra water: clear, soft and colorless, slightly alkaline, well aerated and suitable for all common beneficial uses. Pollution of the upper basin has been minor and localized, originating mainly in log ponds and sawmill debris, in drainage from mines, mostly abandoned, and in discharges of domestic sewage. Table 15 following shows results of detailed analysis at the sampling station above Oroville in the years 1953 and 1954.

In proceeding southward from Oroville it will be noted from graphs presented on Plate 15 that the mineral quality remains high at sampling stations at Nicolaus on the lower Feather, and at Sacramento and Walnut Grove on the Sacramento River. Some small impairment is apparent by comparison with the exceedingly high level of quality of the upper Feather River water, but the water remains eminently suitable for domestic and municipal supply, irrigation and general industrial use. Such degradation as now occurs is probably due in part to irrigation return water and in part to the discharge of municipal and industrial wastes, especially at Sacramento. Water temperatures are also higher than in the upper Feather Basin owing to warmer ambient temperatures on the valley floor.

Plate 15 shows present conditions of water at two points in the proposed traverse of the Delta, Orwood Bridge on the Old River, and Italian Slough near the site of the proposed Feather River Project Aqueduct intake. These graphs reveal the degradation of water quality which takes place in the Delta. As compared with the record for Walnut Grove, conductivities at Orwood and Italian Slough are about three times higher, hardness about double, and chloride multiplied seven or eight times. Quality variations appear to be irregular and not seasonal: peaks of low quality are found both in late summer and in the winter months. The poorer quality of water indicated for the winter of 1953-54 is perhaps partly due to the planned leachings of agricultural lands in the winter by flooding. It may also reflect cessation of draft on the Sacramento River, during the winter, at the Tracy Pumping Plant of the Delta-Mendota Canal at Tracy.

Future Water Quality

The final and most important subject of this discussion concerns water quality conditions which would prevail in futurity, following completion of the Feather River Project and other major features of The California Water Plan. Such predictions are subject to errors associated with any long-range forecast, but are believed as accurate as historical analogy and engineering judgment can make them at present.

Prediction will be confined to two critical areas: the reach of Feather River for some miles below Oroville dam site; and waters of the Sacramento-San Joaquin Delta, where pumping will begin for Feather River Project Aqueduct. The first-named area is critical with respect to survival of anadromous fish on a major tributary of the Sacramento; the second, with reference to quality of water for all beneficial uses along the route of Feather River Project Aqueduct and the Alameda-Santa Clara-San Benito Branch.

Feather River Below Oroville. Analyses of quality changes in the Feather River below Oroville Dam, following its completion, are based on comparison with historical effects of completion and operation of Shasta Reservoir.

Dr. James W. Moffett, in describing ecological changes affecting the king salmon, in an article in "California Fish and Game" for April, 1949, stated that certain problems controlling the survival of this species in the Central Valley were "more or less ameliorated by the limnological changes in Sacramento River wrought by the operation of Shasta Reservoir." The changes in water conditions favorable to the survival of salmon (and, presumably,

TABLE 15

Division of Water Resources

Report on Complete Analyses of Surface Waters

Periodic Stream Sampling Program

Station No.		19		19		19		19
Stream		Feather River		Feather River		Feather River		Feather River
Stream mile		71		71		71		71
At or near		Oroville		Oroville		Oroville		Oroville
Date collected		5/12/53		9/27/53		5/14/54		9/23/54
Time (P.S.T.)		1340		1400		0745		1430
Gage height		18.27		8.62		15.86		8.31
Discharge, cfs		9540		2590		7510		2590
Temp. °F.		55.4		68		57		66
pH		7.6		7.9		7.2		7.8
EC x 10^6 at 25° C.		70.7		102		68.6		106
Constituents in Cations—		ppm.	epm.	ppm.	epm.	ppm.	epm.	ppm.	epm.
Calcium	(Ca)	6.7	0.334	10	0.499	7.3	0.364	11	0.549
Magnesium	(Mg)	3.2	0.263	4.8	0.395	3.1	0.255	4.0	0.331
Sodium	(Na)	3.1	0.135	4.1	0.178	2.0	0.087	4.6	0.200
Potassium	(K)	0.6	0.015	1.1	0.028	0.7	0.018	1.1	0.028
Iron	(Fe)	0.0		0.03		0.00		0.04	
Aluminum	(Al)	0.02		0.01		0.00		0.00	
Manganese	(Mn)	0.00		0.00		0.01		0.00	
Zinc	(Zn)	0.00		0.00		0.00		0.01	
Copper	(Cu)	0.0		0.0		0.0		0.00	
Lead	(Pb)	0.00		0.00		0.00		0.00	
Tin	(Sn)								
Arsenic	(As)	0.00		0.00		0.00		0.00	
Total Cations			0.747		1.100		0.724		1.108
Anions—									
Carbonate	(CO_3)	0	0.000	0	0.000	0	0.000	0	0.000
Bicarbonate	(HCO_3)	41	0.672	61	1.000	38	0.623	62	1.016
Sulfate	(SO_4)	2.1	0.044	1.8	0.037	2.1	0.044	1.9	0.040
Chloride	(Cl)	0.5	0.014	2.0	0.056	1.2	0.034	1.4	0.039
Nitrate	(NO_3)	0.2	0.003	0.2	0.003	0.0	0.000	0.1	0.002
Fluoride	(F)	0.0	0.000	0.0	0.000	0.0	0.000	0.2	0.011
Hexavalent Chromium	(CrO_3)	0.00		0.00		0.00		0.00	
Total Anions			0.733		1.096		0.701		1.108
Constituents in		ppm.	% Reacting value	ppm.	% Reacting value	ppm.	% Reacting value	ppm.	% Reacting value
Boron	(B)	0.01		0.07		0.04		0.02	
Silica	(SiO_2)	14		9.0		16		13	
Sum of dissolved constituents		51		63		51		68	
Tons/acre-foot		0.07		0.09		0.07		0.09	
Per cent sodium			18		16		12		18
Total hardness as $CaCO_3$		30		45		31		44	
NC hardness		0		0		0		0	
Coliform, MPN/ml*		0.62, 23.0		0.23, 2.3		0.23, 0.62		0.23, 23.0	
Dissolved oxygen (DO)		12.2				10.6		9.5	
% saturation		115.2				101		101	
Turbidity		5		1		6		2	
Remarks: Color, odor, etc.		Fast flow		Fast flow		Fast flow		Clear	
Sampled by		DWR		DWR		DWR		DWR	
Laboratory†		USGS		USGS		USGS		USGS	

* Bacteriological examinations by State Department of Public Health.
† U.S.G.S., Quality of Water Branch, Sacramento—Analyses subject to revision.

certain other cold-water game fish) were, first, the creation of substantially lower downstream water temperatures in summer; second, a rise in downstream water temperatures in winter; and third, a reduction in turbidity for many miles below the dam. The most striking of these three effects, perhaps, is the reduction in water temperatures (13 degrees in June, 16.1 degrees in July, 14.5 degrees in August, 7.1 degrees in September) which led Dr. Moffett to conclude that "the thermal cycle in Sacramento River below Shasta Dam now resembles cycles in streams which are in the center of the range (i.e., the most favorable habitat) of this species."

Midsummer temperatures on the Feather River at Oroville now range into the low seventies, and at Nicolaus, 60 miles downstream, they reach 80 degrees or higher. The release from the deeper zones of Feather River water impounded by Oroville Dam can be expected to lower water temperatures downstream by as much as 15 degrees. This effect should persist for many miles below Oroville, and create a thermal environment favorable to survival of cold water game fish. This should compensate substantially for the loss of summer habitat now utilized by fish in the reaches of the Feather River and its tributaries above the dam site.

Sacramento-San Joaquin Delta. A second critical area for water quality is in the Sacramento-San Joaquin Delta. The problem of mineral quality of these waters, under conditions approaching maximum development, is being studied intensively in connection with the investigations of the feasibility of saltwater barriers in San Francisco Bay. Provisional findings indicate that the following range of quality characteristics is likely to prevail in the Delta under conditions of physical and economic development forecast for the year 2010, providing a saltwater barrier is constructed.

Total dissolved solids, ppm.	100 to 500
Chlorides, ppm.	10 to 100
Total hardness, ppm.	50 to 240

Thus total dissolved solids and chlorides are expected to fall at all times within an acceptable standard for drinking water and for irrigation water of the first class. Hardness will be excessive occasionally, and provision for intermittent softening will no doubt seem necessary to exacting domestic and industrial water consumers.

In making the above mentioned findings it is pointed out, first, that the calculations are based on an idealized situation of complete and uniform mixing of the incoming fresh waters throughout the Delta, a condition which does not exist now, and is unlikely to exist in the future except for certain channels where displacement of water is rapid and continuous; secondly, it is assumed that much larger quantities of fresh water will be available for dilution of salts following completion of major units of The California Water Plan, and the routing of their waters through the Delta for export to distant regions. A more detailed statement of the premises on which the quality forecast for 2010 is based is given as follows:

1. The meteorological conditions of the most severe drought period of record, 1927-1934, are superimposed on the cultural development predicted for the year 2010. Estimates of the latter predict a population increase of approximately 80 percent above the present, and an increase of about 75 percent in irrigated acreages in that portion of the Central Valley tributary to the Delta, or from 4,000,000 to about 7,000,000 acres.

2. It is assumed that the following major units of The California Water Plan will have been completed: Feather River Project, Trinity Diversion, Yuba Narrows Dam, New Don Pedro Dam, New Melones Dam, Monticello Dam, and Sacramento Valley canals.

3. Releases from Shasta Dam for control of salinity, or in lieu thereof, will be 3,300 second-feet. Volume of flow originating in the Delta itself, or around its border, is estimated at 500 second-feet continuously.

Summary

Present quality of Feather River water above Oroville dam site is excellent. It is suitable in its native state for any irrigation purpose and for virtually all industrial uses. It is acceptable for domestic supply after relatively cheap and simple treatment.

Some loss of quality occurs after the river emerges upon the valley floor, and further deterioriation of the water takes place progressively downstream after its confluence with the Sacramento, owing to discharge into the rivers of municipal and industrial wastes, and of drainage from irrigated lands. Damage resulting from sewage and industrial wastes, however, is coming increasingly under control, and need not become serious providing proper vigilance in pollution control continues to be exercised. At present there is no procedure or plan for reducing seasonal degradation of the river waters due to drainage from irrigated land. It is believed that waste loadings from this source, even under full development of the Central Valley will not destroy the value of the Feather and Sacramento Rivers for *local* use. The effect of further mineral waste loading on *export* value of these waters would be more serious, since it would diminish capacity for reuse in areas of import, and if used for replenishment of ground water basins would necessitate an increased outflow to maintain their salt balance.

Present exports of Sacramento River water, as in the Delta-Mendota Canal, are degraded at times by mixing with water of poorer quality in the Sacramento-San Joaquin Delta. This effect will continue, but with reduced force, under conditions of ultimate development of the Central Valley. Preliminary calculations show that under conditions of development predicted for the year 2010, recurrence of an extreme drought cycle similar to that of 1927-34 will cause a maximum content of total dissolved solids of about 500 ppm. Chlorides will rise to about 100 ppm., and

hardness to 240 ppm. In years of normal or excess rainfall, these respective values will range downward to 100 ppm., 10 ppm., and 50 ppm., respectively. Mineral quality will therefore be acceptable for the higher beneficial uses, except for occasional periods of excessive hardness.

Two advantageous water quality effects are foreseen in respect to fish life in the Feather River below Oroville Reservoir: improved water temperature conditions for indigenous game fish, and greater clarity. No quality changes detrimental to cold-water game fish are anticipated.

The quality considerations which control purely local use of water do not necessarily suffice to determine its fitness for export. Degradation in transit, economic necessity for repeated cycles of use, and the maintenance of salt balance in the distant ground water basins utilized for storage, must all be taken into account. From a strictly economic point of view, the optimum quality for export is that value where cost of its maintenance balances the loss incurred by further degradation.

Recommendations

1. The water quality considerations set forth here should be taken into account in the latter phases of The California Water Plan, which concern ultimate water requirements of the State, and development of engineering and financial plans to satisfy those needs. Quality requirements should be estimated for specific projects. Physical and economic feasibility, as well as proposed uses of water, should govern such standards of quality.

2. In the meantime, and until such standards are published and recognized formally, no further substantial deterioration should be permitted in waters of the Feather and Sacramento Rivers, and the Sacramento-San Joaquin Delta, insofar as such deterioration results from causes controllable by law.

REGULATION AND CONVEYANCE OF PROJECT WATER IN SOUTHERN CALIFORNIA

The rapid intensive development in the southern part of California has resulted in a complex pattern of facilities to serve both local and imported water. It was, therefore, considered desirable in the planning of the Feather River Project to give special study to the problem of delivering this new supply of 1,800,000 acre-feet per annum to potential service areas south of the Tehachapi Mountains. Investigation was made of possible storage facilities to regulate the uniform flow in the Feather River Project Aqueduct to meet fluctuating demands and of possible conveyance routes to the potential project service areas. A prime consideration was connecting to and utilizing existing water supply facilities in order to avoid unnecessary overlap and duplication of such works.

For illustrative purposes, a possible system for the regulation and conveyance of water from the Feather River Project Aqueduct, using the High Line Route, is presented herein. Assumed allocations of project water to various areas and entities have been made for the purpose of ascertaining the physical and engineering feasibility of the system. As such, these allocations are not to be construed as a recommendation for project water distribution.

Description of Southern California Area

The Southern California Area, as considered herein, embraces more than 36,000 square miles, including the entire coastal drainage area from the City of Santa Barbara southerly to the Mexican border, the Mojave Desert areas easterly to Indian Wells Valley, the Coyote Creek-Twentynine Palms area, Upper Coachella Valley, and Borrego Valley. As shown on Plates 11A and 11B, the Area includes portions of Santa Barbara, Riverside, San Bernardino, and San Diego Counties, and all or essentially all of Los Angeles, Ventura, and Orange Counties.

The Southern California area offers extreme contrasts in topography, climate, and development. About two-thirds of the area is mountainous with peaks ranging to above 11,000 feet in elevation. To the east of the mountains are the broad desert valleys and to the west is the coastal area with its alluvial valleys and coastal plains. Along the coast a mediterranean type climate with mild equable temperatures prevails. The coastal portion of the area is characterized by a rich and intensive irrigated agricultural development, by very large urban centers, and by an industrial development of national significance. This portion of the area contains more than half of the State's population, with most of it concentrated in the Los Angeles and San Diego metropolitan areas. The desert areas by comparison are sparsely inhabited and largely undeveloped.

Existing Water Supply Facilities

More than a thousand organizations are presently engaged in the development and distribution of water in the Southern California area, the largest of which are the Metropolitan Water District of Southern California and the Department of Water and Power of the City of Los Angeles, an original member city of the district.

The Colorado River Aqueduct of the Metropolitan Water District of Southern California, extending 242 miles from the Colorado River to its terminus at Lake Mathews, has a planned ultimate capacity of 1,212,000 acre-feet per annum. The district provides water service to member agencies in Orange County and in the coastal portions of Los Angeles, San Bernardino, Riverside, and San Diego Counties. The Colorado River supply to San Diego County is delivered through the San Diego Aqueduct to the San Diego County Water Authority.

The City of Los Angeles obtains most of its water from the Owens River and Mono Basin through the Los Angeles Aqueduct. The capacity of this aqueduct approximates 475 second-feet throughout most of its length. However, a section below Fairmont Reservoir, which includes two hydroelectric plants in San Franciscuito Canyon, can carry up to 1,000 second-feet. The Los Angeles Department of Water and Power reports the safe capacity of this system to be about 320,000 acre-feet per annum.

The present stage of development of the greater portion of the Southern California area largely has been made possible through exploitation of underground reservoirs. This has been accomplished both by individual effort and by numerous mutual water companies and public agencies, which have distribution facilities providing water service to areas varying from a few acres to many square miles in extent. Water agencies in the area have also been active in construction of spreading facilities to artificially replenish ground water supplies. Underground reservoirs of the area will continue to be a valuable natural resource, not only in providing regulation for local waters but also for needed regulation of imported water supplies.

Numerous surface reservoirs have been constructed to conserve mountain runoff, particularly in San Diego County. Prior to construction of the San Diego Aqueduct, the City of San Diego obtained its entire supply from such surface storage developments. Because of the erratic occurrence of the water supply in the Southern California area, facilities to divert and utilize uncontrolled surface runoff are of lesser magnitude.

Existing water supply facilities that have been considered for possible utilization in regulating and distributing project water are delineated and listed on Plates 11A and 11B.

Need for Project Water

The Southern California area at present contains more than 800,000 acres of irrigated land, over 80 percent of which is located in the coastal portion thereof. The coastal portion of the area also encompasses more than 97 percent of the 563,000 acres of present urban and suburban development. It is estimated that, with provisions for an adequate water supply, an area in excess of 5,000,000 acres is susceptible to water-using development. Over 2½ million acres of these lands are in the coastal portion of the area, with the remainder constituting desert lands. It is probable that the desert lands will experience a large agricultural expansion, with the greatest urban expansion occurring in the coastal segment. Lands included within the Metropolitan Water District of Southern California as of October, 1954, together with present and potential water-using lands in the area outside the district, are shown on Plates 11A and 11B.

As stated, the growth of the Southern California area has been supported in large measure by its ground water resources, and withdrawals from many of its ground water reservoirs now exceed safe yields. As a result, supplemental water is needed to eliminate these overdrafts and sustain present development. In the coastal portion of the area, present supplemental water requirements exceed 400,000 acre-feet per year, while over 150,000 acre-feet per year are required to eliminate ground water overdraft in the desert area, largely in Antelope Valley. It should be noted that there is a potential supply of Colorado River water now available to meet supplemental requirements in the service area of the Metropolitan Water District of Southern California, in the amount of about one million acre-feet per year over and above the supply of Colorado River water presently being put to use. This potential supply, however, is not available to all areas presently in need of supplemental water. Furthermore, the development of a large portion of the potential water-using lands in the Southern California area has been retarded because of a lack of adequate local water supplies or availability of an imported water supply.

It is estimated that with maximum feasible development of local water resources and utilizing the entire supply of Colorado River water available through facilities of the Metropolitan Water District of Southern California, over 8 million acre-feet per year of supplemental water will be required to satisfy the water-using potential of the Southern California Area. Of this amount, about 3 million acre-feet will be required in the coastal portion of the area and the remainder in the desert lands.

Thus, Feather River Project water is presently needed in those areas experiencing ground water overdraft, where Colorado River water is not available and where further conservation of local supplies is not feasible, and in areas where growth has been retarded by lack of adequate water supplies. With the ever-increasing growth in the Southern California area, this need for project water will become progressively greater throughout the area.

Regulation and Conveyance of Project Water

The numerous existing systems for the regulation, conveyance, and distribution of both local water sup-

plies and presently available imported supplies in the coastal portion of the Southern California area offer a multitude of possibilities for providing service of Feather River Project water. In the desert lands, water resources development largely has been by exploitation of ground water storage through individual effort and small water agencies and companies, and few distribution facilities of major size exist. There are many systems and combinations of systems that would be feasible for regulating and conveying project water in the area. As has been pointed out, for the full development of potential water-using lands in the area there will be needed a quantity of supplemental water far in excess of that which could be supplied by the Feather River Project. Thus, the actual system of works, which will be constructed, will depend in large measure on the relative growth and need for project water in various portions of the area, at the time such water is made available.

There are delineated on Plates 11A and 11B existing and potential reservoirs which could be utilized for the regulation of project water. The Feather River Project Aqueduct south of Quail Lake Afterbay is designed for uniform continuous flow. Since demands of the potential project service area vary throughout the year, with mean monthy requirements ranging from less than 1 percent to a maximum of 16 percent of the seasonal total, storage must be provided to regulate this uniform supply to the fluctuating demand. Regulatory storage requirements for irrigation use approximate 25 percent of the total seasonal demand, whereas urban requirements range from about 5 to 14 percent. Most of the existing conservation reservoirs in the Southern California area are below the grade of and accessible to the Feather River Project Aqueduct. These reservoirs were considered as possible delivery points for project water, and the feasibility of providing regulation therein either with the existing storage capacity or by enlargement of existing structures was studied. A list of existing and potential reservoirs so considered is presented in Table 16.

Also shown on Plates 11A and 11B are possible conveyance routes from the aqueduct to all present or potential water-using lands in the area, reasonably accessible to the aqueduct. Insofar as possible, connections have been made with existing distribution systems so that overlap and duplication of facilities would be avoided. In the absence of existing facilities conveyance units have been extended to strategically located points, from which it is considered that distribution facilities would be provided by local entities. Also delineated on Plates 11A and 11B are locations where substantial head differentials would exist along the considered routes thereby creating a potential for hydroelectric power development.

TABLE 16

Potential Regulatory Storage Sites

Name	Location	Storage capacity, in acre-feet	Height to maximum storage level	Water surface elevation, maximum storage level	Type of structure
Piru Creek sites:					
Santa Felicia (Under construction)	Piru Creek, five miles upstream from confluence with Santa Clara River	100,000	187	1,057	Earthfill
Blue Point	Piru Creek, ten miles upstream from confluence with Santa Clara River	50,000	215	1,280	Earthfill
Elizabeth Lake Canyon	Elizabeth Lake Canyon, two miles southwest of Hughes Lake	24,300	220	3,200	Earthfill
Morris (Constructed)	San Gabriel River, three miles north of Azusa	35,200	245	1,170	Concrete gravity
Mias	Mias Canyon, two miles north of Banning	8,000	145	2,960	Earthfill
Potrero	Potrero Creek, four miles north of San Jacinto	49,000	240	2,000	Rock fill
Hemet Butte	Four miles south of Hemet, between Hemet Butte and Polly Butte	27,800	240	2,000	Rock or earthfill
Wilson Valley	Coahuila Creek, four miles north of Aguanga	28,300	210	2,120	Rock or earthfill
San Felipe	San Felipe Creek, ten miles southwest of Borrego Valley	53,600	120	2,300	Earthfill
Pamo	Santa Ysabel Creek, one mile below confluence with Temescal Creek	251,100	260	1,120	Earthfill
El Capitan (Constructed)	San Diego River, eight miles east of Lakeside	116,900	197	750	Semi-hydraulic fill
San Vicente (Constructed)	San Vicente Creek, four miles north of Lakeside	90,200	199	650	Concrete gravity
Barrett (Constructed)	Cottonwood Creek, twenty-five miles east of San Diego	42,900	159	1,615	Concrete gravity
Loveland (Constructed)	Sweetwater River	27,700	195	1,355	Variable radius arch
Sweetwater (Constructed)	Sweetwater River	27,689	92	224	Curved gravity
Hodges (Constructed)	San Dieguito River	33,600	116	315	Multiple arch
Henshaw (Constructed)	San Luis Rey River	203,581	110	2,727	Semi-hydraulic fill
Sutherland (Constructed)	Santa Ysabel Creek	29,000	145	2,057	Multiple arch
Jawbone	Jawbone Canyon on Cottonwood Creek, one-quarter mile upstream from Los Angeles Aqueduct siphon	265,000	350	2,800	Earthfill
Liebre	State Highway 138, four miles east of Quail Lake	53,000	162	3,250	Earthfill
Antelope Buttes	Between Antelope Buttes and Fairmont Butte, two miles northeast of Fairmont	62,000	175	2,825	Earthfill
Lovejoy	Lovejoy Buttes, eight miles west of Los Angeles-San Bernardino County line	140,000	160	2,825	Earthfill
Gray Mountain	Three miles southwest of Mirage Lake, between Black Mountain and Gray Mountain	141,000	140	3,000	Earthfill
Forks of Mojave	Six miles southeast of Hesperia, across West Fork of Mojave River above confluence with Deep Creek	521,000	260	3,250	Concrete gravity
Barstow	Six miles southeast of Barstow	12,000	150	2,450	Earthfill
Surprise Spring	Seven miles northeast of Joshua Tree	27,000	100	2,700	Earthfill

For illustrative purposes, a possible system for the regulation and conveyance of project water in the Southern California Area is presented herein. This system comprises a portion of the works delineated on Plates 11A and 11B. It would provide 298,000 acre-feet of storage capacity in 10 reservoirs to regulate the supply from the Feather River Project Aqueduct of 1,800,000 acre-feet per annum.

In order to determine physical and engineering feasibility of the system, the supply of project water has been apportioned throughout the area giving consideration to potential supplemental water requirements, availability of Colorado River water, and of supplies from possible additional local water resource development. There is delineated on Plate 12 a flow diagram indicating the various conduit capacities, annual water deliveries to various entities and localities, and project regulatory storage requirements at the various considered reservoir sites.

This illustrative system would utilize Santa Felicia Reservoir, presently under construction on Piru Creek. Gravity service would be provided to areas of need in Ventura County and to the Malibu coastal strip in Los Angeles County. There is a possibility for substantial hydroelectric power development along the diversion from the aqueduct to Santa Felicia Reservoir.

Delivery to the water supply system of the City of Los Angeles would be effected through a connection to the Los Angeles Aqueduct using its excess capacity below Fairmont Reservoir. Such a connection would enable the generation of additional hydroelectric power along this portion of the Los Angeles Aqueduct.

Project water would be delivered to the distribution system of the Metropolitan Water District of Southern California at Morris Reservoir and at the westerly portal of the San Jacinto Tunnel. The conveyance unit to Morris Reservoir along the base of the San Bernardino and San Gabriel Mountains would provide gravity service to foothill lands and would intersect many existing local distribution facilities and spreading grounds in the Santa Ana and San Gabriel Valleys. Hydroelectric power could be developed between the Aqueduct and Morris Reservoir. Gravity service would also be provided to Eastern Municipal Water District and to presently undeveloped lands adjacent thereto.

San Diego County would receive project water by gravity connection to five existing reservoirs—Henshaw, Sutherland, El Capitan, Loveland, and Barrett—and to a reservoir which could be constructed at the Pamo site on Santa Ysabel Creek, a tributary of the San Dieguito River. With the exception of Lake Henshaw, incidental hydroelectric power could be developed in connection with each of the foregoing diversions.

As shown on Plate 12, project water for the Antelope Valley-Mojave Desert area would be delivered to regulatory storage at the Antelope Buttes, Lovejoy, and Forks of Mojave Reservoirs. Regulatory storage for the Banning-Beaumont area and the Upper Coachella Valley would be provided at Mias Reservoir. Borrego Valley would be supplied directly from the aqueduct.

By this system, about 600,000 acre-feet of water per annum, less losses, would be delivered for use in the desert lands, and 1,200,000 acre-feet per annum, less losses, would be supplied to the coastal portion of the area. The system illustrates one method of serving the Southern California area from the Feather River Project utilizing existing facilities to the maximum practicable extent. It would provide supplemental water to areas of present need and to areas with potential future requirements.

FEATHER RIVER-SACRAMENTO RIVER CANAL

By Item 262 of the State Operation's Budget for the Fiscal Year 1952-1953, there was appropriated to the Division of Water Resources, Department of Public Works, the sum of $800,000 "For necessary investigations, surveys, and studies, and preparation of plans and specifications for; (1) the construction of the works, referred to as the Feather River Project and Sacramento-San Joaquin Delta Diversion Projects, authorized by Article 9.5, Chapter 2, Part 3, Division 6, of the Water Code; and (2) a Feather River-Sacramento exchange canal north of the Marysville Buttes in connection with the consideration by the Water Project Authority of a modification pursuant to Chapter 1441, Statutes of 1951, of the Feather River Project to include such a canal. * * *" Subsequent appropriations for the Feather River Project investigation have repeated the above-quoted language. Responsive to that directive of the Legislature with reference to the item numbered (2), the cost of a canal from the Feather River to the Sacramento River has been estimated. The capacity of the canal has been taken as 750 second-feet. It has been estimated as an unlined canal diverting from the Feather

River about six miles below Oroville and immediately above the diversion dam for the Sutter-Butte Canal. The line was projected on U. S. Geological Survey quadrangles and reconnoitered on the ground. The canal would extend westerly a distance of about six miles to the Cherokee Canal and thence southwesterly along the Cherokee Canal a distance of about 10 miles to Butte Creek, at a point about four miles north of the Butte-Sutter County line and about five miles north of the Marysville Buttes. From this point the water would flow down Butte Creek to Butte Slough, then southwest along Butte Slough through the Butte Slough Outfall Gates to the Sacramento River, about three miles north of Meridian.

An allowance was made in the cost estimate for constructing a low diversion weir in Butte Slough just below its confluence with Butte Creek to permit the regulation of the existing outfall gates to provide the passage of 750 second-feet to the Sacramento River. The estimated cost of the canal is $1,250,000. The location of this canal is shown on Plate 14 of the report.

The Feather River-Sacramento River Canal could be utilized to transfer Oroville Reservoir releases to the Sacramento River to replace Shasta Reservoir navigation and salinity control releases, thereby making additional irrigation water available in the upper Sacramento River for diversion and use through the Sacramento Canals. Operation studies by this office indicate that the irrigation supply available for the Sacramento Canals service area from Shasta Reservoir after all other Central Valley Project requirements are satisfied will be 450,000 acre-feet per year. It is estimated that the ultimate water requirements of the Sacramento Canals service area will be 665,000 acre-feet per year making it necessary to obtain a supply of 215,000 acre-feet per year from some other source for this area. It is also estimated that the demand for this additional 215,000 acre-foot supply will not occur until about 20 years after completion of construction of those canals. The 750 second-foot capacity of the Feather River-Sacramento River Canal would be adequate to supply the foregoing 215,000 acre-foot supply by replacement of Shasta Reservoir releases as just described.

The Feather River-Sacramento River Canal could be operated to assist in maintaining navigation depths in the critical reach of the Sacramento River between Butte Slough outfall gates and Knights Landing. However, operating regulations for and authorization of facilities of the Central Valley Project are based upon the maintenance of satisfactory navigation conditions in the foregoing reach of the stream with the facilities presently existing or under construction. It is possible that routing Oroville Reservoir releases through the aforementioned critical reach of the Sacramento River will incidentally reduce the annual costs of dredging the river channel in that reach which will be necessary even under conditions of full operation of the Central Valley Project. The water deliveries from the Feather River Project described in this report are based upon the diversion from the Delta of a major portion of the water released from Shasta Reservoir for navigation purposes which would not be required for fulfilling the equipments of the Central Valley Project in the Delta. Therefore, any increase in yield from Shasta Reservoir resulting from routing of Feather River water through the proposed canal would result in a corresponding decrease in the yields from the Feather River Project.

It is believed that there may be other operational advantages resulting from the use of the Feather River-Sacramento River Canal for coordinated operation of Oroville Reservoir with the facilities of the Central Valley Project. However, there also is a possibility that the introduction of Feather River waters into the Sacramento River system at points other than where they would enter naturally might further complicate the already complex problems of water rights and utilization of water now facing the Sacramento River Water Users, the State of California, and the United States Bureau of Reclamation. It would therefore be advisable to make extensive investigations and studies of plans for such a canal before any final plan were decided upon.

LEGAL CONSIDERATIONS

Appendix A contains a statement of the status of water rights for the Feather River Project. It includes a brief description of the applications filed by the Department of Finance to appropriate water for the project, the statutes which authorize the filing of such applications and their assignment, action taken by the Water Project Authority to secure an assignment of the applications and the protests thereto that were presented on behalf of inhabitants of the counties in which Feather River water originates, which resulted in delay of action on the request for assignment until after the Division of Water Resources completes its pending studies of present and future water requirements in the Feather River watershed.

The protests to the proposed assignment of the Department of Finance applications to the Water Project Authority were based upon the misapprehension that such assignment would jeopardize rights of the counties of origin to receive water sufficient for their ultimate requirements, nothwithstanding positive statutory safeguards and assurances given by the State Engineer that he would recommend such assignment "*only* on condition that the rights thereunder of the Water Project Authority shall at all times be subject to the requirements of any county or area in

which the water sought to be appropriated originates, for such quantities of water as may be necessary for the full development of any such county or area," and that "when and if permits are issued to the Water Project Authority, it is contemplated that all necessary and appropriate terms and conditions will be included to subject the rights of the authority to the needs of the counties and areas of origin for water for their full development" (see letter to Mr. Louis Genasci, Appendix A).

The minutes of regular meeting of the Water Project Authority of the State of California for Tuesday, August 31, 1954, contained the following:

> "Robert Taylor Adams, Attorney at Law, from Reno, Nevada, representing clients in the northeastern counties requested permission to submit questions in written form concerning the assignment of Feather River Project filings."

Chairman of the authority, Frank B. Durkee, Director of Public Works, granted the request and stated that the staff of the executive officer would formulate replies to the questions and forward the same to Mr. Adams. Subsequently, a statement containing the questions and answers thereto was formulated by the Division of Water Resources and forwarded to Mr. Adams. Copies were distributed to interested parties. This statement is contained in Appendix H.

Thereafter the Attorney General was requested for an opinion concerning the proper construction and effect of the statutes which deal with state applications, their assignment and the watershed protection laws contained in Water Code Sections 11460 and 11463. None of these statutes have been judicially construed. His opinions numbered 53/298 and 54/159 are set forth in full as Appendix I. In the latter opinion he advised that the Department of Finance can make an assignment of an application "conditioned by a reservation of all water necessary for development of the counties of origin," as had been proposed by the State Engineer, without data on the water needs of the counties where the water originates, "since such a reservation would withhold from assignment whatever amount of water is from time to time determined to be needed in the counties of origin."

In his opinion number 53/298, the Attorney General concluded that Water Code Sections 10505, 11460 and 11463, properly construed and applied, are constitutional and that in the circumstances specified in the statute, Water Code Sections 10505 and 11460 would require that water which had been put to use in the operation of the Central Valley Project in areas outside the county of origin or the watershed of origin and areas immediately adjacent thereto, be withdrawn from such outside areas and made available for use in the specified areas of origin. He further advised: "Section 11460 has the effect of reserving to the entire body of inhabitants and the property owners in watersheds of origin a priority as against the Water Project Authority in establishing their own water rights in the usual manner as their needs increases from time to time up to the maximum of either their ultimate needs or the yield of the particular watershed." The Attorney General expressed the opinion that the priority thus reserved to inhabitants of watersheds of origin "may not in any way be defeated by any action or proceeding by the authority," and that the limitations upon any state or federal agency engaged in the construction or operation of the Central Valley Project set forth in Water Code Sections 11460 and 11463 are imposed by force of the statute regardless of their inclusion or omission from any permit granted and issued by the State Engineer.

With respect to the proper definition of a county of origin, the Attorney General's opinion states:

> "Section 10505 requires that 'the county in which the appropriated water originates' be protected from deprivation of any such water necessary for the development of the county. The common sense meaning of the word 'originates' in this context would seem to be 'falls in the form of precipitation.' The protection afforded by the section to each county relates only to the water which falls as precipitation within that county's boundaries. But the need to be considered is that of the entire county, regardless of whether the place of need is in a different watershed from the place where the water originates. That is, each county is to be regarded as a unit, and all water originating therein which is covered by Department of Finance applications is, to the extent that such water may be needed anywhere therein, subject to the protection of the statute. Hence, the place of use of the water is the sole standard by which the preference is established, and the extent of the preference is limited to the aggregate amount of water which falls in the form of precipitation upon the county in question."

Likewise, a "watershed or area wherein water originates" was determined to be the watershed which contributes the water, i.e., in which the water falls as precipitation, and "an area immediately adjacent thereto which can conveniently be supplied with water therefrom" was held to be an area adjoining the watershed which can be supplied with water therefrom without difficulty and by delivery "clearly feasible from both a financial and engineering point of

view.'' It was also stated: ''How much water is reasonably required to supply the beneficial needs of the watershed, the adjacent area and the inhabitants and property owners therein is a question of fact depending upon the circumstances in a particular case at any given time.''

Water Code Sections 10505, 11460 and 11463, and the foregoing comments of the Attorney General are directly applicable to the Feather River Project since that project is a part of the Central Valley Project (Stats. 1951, Chapter 1441) and is dependent for its water supply upon assignment of applications of the Department of Finance.

FUTURE AVAILABILITY OF WATER IN THE SACRAMENTO-SAN JOAQUIN DELTA FOR FEATHER RIVER PROJECT

The estimates of water available in the Sacramento-San Joaquin Delta, discussed earlier in this chapter, are based upon existing developments and use within the Central Valley Basin.

Studies have been completed in connection with the investigations for The California Water Plan, of the ultimate water requirements of the State, and plans for supplying these requirements are being studied. These studies show that adequate water supplies can be developed and regulated from California's water resources, including California's rights in and to the waters of the Colorado River, in available surface reservoir sites and ground water basins to meet the probable ultimate water requirements in the State.

The average annual ultimate surplus of water in the areas of excess, the North Coastal Region and the Sacramento River Basin, is estimated to be about 41,000,000 acre-feet. Of this amount it will be possible to salvage and put to use about 21,500,000 acre-feet of water annually for export to areas of deficiency. About 11,000,000 acre-feet of this water would come from the North Coastal Region and the remainder, 10,500,000 acre-feet, from the Sacramento River Basin. The entire amount would be available in the Sacramento-San Joaquin Delta.

The supporting data for the aforementioned figures are given in Appendix J.

CHAPTER III

STEP CONSTRUCTION PROGRAM FOR THE PROJECT

A step-construction program has been developed for the Feather River Project to fit the urgency of need for a water supply in the several water service areas. The need for flood control and firming of water supply in the Feather River Project Service Area is immediate. Under the method of financing proposed, there would be power revenues from the Oroville Power Plant to aid in payment of the power bill for pumping in the early years of the project. An immediate need is evident, therefore, for the Feather River features, namely Oroville Dam and Reservoir, Oroville Power Plant, Oroville Afterbays No. 1 and No. 2.

There are certain areas on the west side of the San Joaquin Valley that are in immediate need of water. One of these is the Westlands Water District, where directors state they are five years behind in their water program to alleviate present conditions. Another area that is in great need of water is an area to the north of Wheeler Ridge where ground water tables have been lowered about 150 feet in the last three years by pumping. These two areas would be among the first to get a water supply under the program proposed.

It has been estimated that the South San Francisco Bay Area would receive its first delivery in 1964 after completion of the second step of the proposed program.

Officials of the Metropolitan Water District of Southern California state that they will not need an additional water supply until present sources of supply are utilized, a period of about 20 years. This has been recognized in the timing for furnishing a supplemental supply to the area. Water could be used immediately in the Antelope Valley; however, it is not economically feasible to bring a supply to that area without the coincidence of furnishing a supply to all of Southern California.

In each case an absorption period has been allowed for a gradual absorption of each delivered supply.

Schedule of Absorption of Project Water for Exportation

A schedule of water deliveries for the Feather River Project has been developed in accordance with the estimated timing of the need for supplemental supplies and used for determining a step-construction program. In Table 17 there is set forth by years the proposed schedule of water deliveries for the areas of deficiency on the west side of the San Joaquin Valley, the Alameda, Santa Clara, San Benito Counties area and to Southern California.

CONSTRUCTION PROGRAM

Construction programs have been developed for the Feather River Project using the High Line Route for the Feather River Project Aqueduct from the Delta to Barrett Reservoir in San Diego County, for the project using two modifications of the High Line Route and for the project with an aqueduct constructed via the Coastal Line and also via the Long Tunnel Line. The construction programs have been

TABLE 17

FEATHER RIVER PROJECT

Schedule of Water Deliveries

(Acre-feet)

Year	Fresno and Kings Counties	Kern County	Alameda Santa Clara San Benito Counties	Southern California	Total
1959	450,000	150,000			600,000
1960	450,000	150,000			600,000
1961	450,000	150,000			600,000
1962	450,000	150,000			600,000
1963	450,000	150,000			600,000
1964	520,000	300,000	60,000		880,000
1965	590,000	325,000	72,000		987,000
1966	660,000	350,000	84,000		1,094,000
1967	730,000	375,000	96,000		1,201,000
1968	800,000	400,000	108,000		1,308,000
1969	840,000	488,000	120,000		1,448,000
1970	880,000	576,000	132,000		1,588,000
1971	920,000	664,000	144,000		1,728,000
1972	960,000	752,000	156,000		1,868,000
1973	1,000,000	840,000	168,000		2,008,000
1974	1,000,000	840,000	180,000		2,020,000
1975	1,000,000	840,000	192,000		2,032,000
1976	1,000,000	840,000	204,000	450,000	2,494,000
1977	1,000,000	840,000	216,000	540,000	2,596,000
1978	1,000,000	840,000	228,000	630,000	2,698,000
1979	1,000,000	840,000	240,000	720,000	2,800,000
1980	1,000,000	840,000	240,000	810,000	2,890,000
1981	1,000,000	840,000	240,000	900,000	2,980,000
1982	1,000,000	840,000	240,000	990,000	3,070,000
1983	1,000,000	840,000	240,000	1,080,000	3,160,000
1984	1,000,000	840,000	240,000	1,170,000	3,250,000
1985	1,000,000	840,000	240,000	1,260,000	3,340,000
1986	1,000,000	840,000	240,000	1,350,000	3,430,000
1987	1,000,000	840,000	240,000	1,440,000	3,520,000
1988	1,000,000	840,000	240,000	1,530,000	3,610,000
1989	1,000,000	840,000	240,000	1,620,000	3,700,000
1990	1,000,000	840,000	240,000	1,710,000	3,790,000
1991	1,000,000	840,000	240,000	1,800,000	3,880,000
1992-2036	1,000,000	840,000	240,000	1,800,000	3,880,000

developed to coincide with the schedule of water deliveries set forth in Table 17. Each program has been developed for six steps of construction. The beginning of construction has been assumed to be the year 1956, however, deferment of the starting date would be relative and would not affect the sequence of the steps of the construction.

Feather River Project Using the High Line Route From the Delta to Barrett Reservoir

The features of this construction program include the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Barrett Reservoir using the High Line Route and the Alameda-Santa Clara-San Benito Branch of that aqueduct. The program on the basis of six steps of construction is set forth in Table 18 and shown graphically on Plate 10.

Initial Step of Construction. The initial step of construction would be to construct the following features—Oroville Dam and Reservoir, Oroville Power Plant and Afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Wheeler Ridge, 1,000,000 acre-foot San Luis Reservoir, San Luis Forebay, Pumping Plant No. I to three-eighths capacity, Pumping Plant II-A to one-half capacity, and Pumping Plant No. III to one-eighth capacity.

A tabulation of the features of the project in this step and their estimated costs is as follows:

First Step of Construction

Oroville Dam, Reservoir, Power Plant and Afterbays	$313,539,000
Aqueduct—Intake to Wheeler Ridge	161,588,000
Pumping Plant No. I—⅜ capacity	14,606,000
Pumping Plant No. II-A—½ capacity	17,553,000
Pumping Plant No. III—⅛ capacity	4,282,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir—1,000,000 acre-feet capacity	37,751,000
Subtotal	$550,538,000
Contingencies	68,414,000
Engineering and administration	53,951,000
Interest during construction	56,327,000
Subtotal first step	$729,230,000

Possible Alternative to the Initial Step of Construction. An alternative to the construction of the portion of the Feather River Project Aqueduct from the intake channel to San Luis Creek would be the utilization of the excess capacity of the Tracy Pumping Plant and the Delta-Mendota Canal of the Central Valley Project. This alternative would be contingent on a mutually satisfactory agreement between the State and the United States with respect to operational and financial arrangements. Water could be pumped at the Tracy pumps from the Sacramento-San Joaquin Delta into the Delta-Mendota Canal, principally in the winter months. This pumping is contemplated to be on a continuous basis and would utilize both off-peak and on-peak electric energy which would be purchased. The water in the Delta-Mendota Canal would be checked at San Luis Creek where it could be lifted an average of about 30 feet to the San Luis Forebay by a pumping plant. Capacity of the Delta-Mendota Canal at this point is 4,200 second-feet. Pumping Plant No. II-A, would lift the water from the forebay into either the San Luis Reservoir or into the project canal at elevation 402 feet. The power utilized at the forebay pumping plant would be a combination of on-peak and off-peak electric energy. The power utilized for pumping at Pumping Plant No. II-A would be principally off-peak electric energy.

Accomplishments of First Step of Construction. The construction of the first step would make available a water supply to the west side of the San Joaquin Valley in an initial amount of 600,000 acre-feet in 1959. On completion of the Oroville Dam, Reservoir, Power Plant and Afterbays, the power plant would be operated primarily for power and the reservoir would provide flood control and incidentally would firm the present water supply available to the Feather River Service Area.

Second Step of Construction. The second step of construction would include the construction to three-fourths capacity of Pumping Plant No. I, and to full capacity of Pumping Plant No. II-A, Alameda-Santa Clara-San Benito Branch of the Aqueduct and one-half capacity of the Relift Pumping Plant located at Mile 2 on the main canal.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Second Step of Construction

Pumping Plant No. I to three-fourth capacity	$9,371,000
Pumping Plant No. II-A to full capacity	12,933,000
Aqueduct—Alameda-Santa Clara-San Benito Branch	28,141,000
Airpoint Dam and Reservoir	6,835,000
Evergreen Dam and Reservoir	5,492,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch—one-half capacity	1,726,000
Subtotal	$64,498,000
Contingencies	9,675,000
Engineering and administration	6,450,000
Interest during construction	3,187,000
Subtotal second step	$83,810,000

Accomplishments of the Second Step of Construction. This step would provide additional water supplies to the west side of the San Joaquin Valley up to the amount of 1,600,000 acre-feet and provide an initial supply of 120,000 acre-feet or one-half of the delivery to the Alameda, Santa Clara and San Benito Counties area.

TABLE 18

Tentative Construction Program for Feather River Project Using the High Line Route From the Delta to Barrett Reservoir

Step of construction program	Beginning of year (Jan. 1)	
1	1956	Begin project construction; Oroville Dam, Power Plant and Afterbays; 1,000,000 Ac. Ft. San Luis Reservoir, San Luis Forebay, Project Aqueduct—Intake channel to Wheeler Ridge, ⅛ capacity at Pumping Plant No. III and ⅜ capacity Pumping Plant No. I, ½ capacity Pumping Plant No. II-A.
	1957	
	1958	
	1959	Complete work begun in 1956, exclusive of Oroville Dam, Power Plant and Afterbays.
	1960	
2	1961	Begin construction ¾ capacity Pumping Plant No. I and to full capacity on Pumping Plant No. II-A, Alameda-Santa Clara-San Benito Branch of Aqueduct, ½ capacity of Alameda-Santa Clara-San Benito Relift Pumping Plant at Mile 2 on main canal, Airpoint and Evergreen Reservoirs.
	1962	
	1963	Complete Oroville Dam, Power Plant and Afterbays.
	1964	Complete 1961 construction program.
	1965	
	1966	
3	1967	Begin construction to increase San Luis Reservoir to 2,100,000 Ac. Ft., Delta Cross Channel, Pumping Plant No. I to full capacity and Pumping Plant No. II-B to ¼ capacity, Alameda-Santa Clara-San Benito Relift Pumping Plant to full capacity.
	1968	
	1969	
	1970	Complete 1967 construction program.
	1971	
4	1972	Begin construction to ½ capacity, Pumping Plants No. II-B, III, IV, V, VI, Buena Vista Forebay, Pumping Plant No. III, Quail Lake Afterbay, and Project Aqueduct-Wheeler Ridge to Barrett Reservoir.
	1973	
	1974	
	1975	
	1976	Complete 1973 construction program.
	1977	
	1978	
5	1979	Begin construction Pumping Plants Nos. II-B, III, IV, V, VI, to ¾ capacity.
	1980	
	1981	
	1982	Complete 1979 construction program.
	1983	
6	1984	Begin construction of Pumping Plants Nos. II-B, III, IV, V, VI to full capacity.
	1985	
	1986	
	1987	Complete 1984 construction program.

Third Step of Construction. The third step of construction would include the construction of the San Luis Reservoir to its full capacity of 2,100,000 acre-feet, Delta Cross Channel, Pumping Plants Nos. I to full capacity and II-B to one-fourth capacity and the Alameda-Santa Clara-San Benito Relift Pumping Plant to full capacity.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Third Step of Construction

San Luis Reservoir increased to 2,100,000 acre-feet capacity	$38,379,000
Delta Cross Channel	8,320,000
Pumping Plant No. I to full capacity	6,246,000
Pumping Plant No. II-B—one-fourth capacity	9,227,000
Relift Pumping Plant—Alameda-Santa Clara-San Benito Branch to full capacity	1,396,000
Subtotal	$63,568,000
Contingencies	9,634,000
Engineering and administration	6,413,000
Interest during construction	3,685,000
Subtotal third step	$83,300,000

Accomplishments of the Third Step of Construction. Completion of this step of construction would make available to the west side of the San Joaquin Valley a water supply of 1,840,000 acre-feet and provide for the full delivery amount for the Alameda, Santa Clara, and San Benito Counties area of 240,000 acre-feet.

Fourth Step of Construction. The fourth step of construction would include the main project conduit from Wheeler Ridge to Barrett Reservoir in San Diego County and the construction to one-half capacity of Pumping Plants Nos. II-B, III, IV, V, VI, and Buena Vista Forebay at Pumping Plant No. III, and the Quail Lake Afterbay.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fourth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to ½ capacity	$85,804,000
Quail Lake Afterbay	400,000
Aqueduct—Wheeler Ridge to Barret Reservoir	370,237,000
Buena Vista Forebay	1,452,000
Subtotal	$457,893,000
Contingencies	70,430,000
Engineering and administration	46,964,000
Interest during construction	32,799,000
Subtotal fourth step	$608,086,000

Accomplishments of the Fourth Step of Construction. Completion of this step would make available the initial delivery of water to Southern California in the year 1976, 20 years after the start of project construction. It has been assumed that the initial delivery would be one-fourth of that available from the project, or 450,000 acre-feet. The construction of the features in this step would provide capacity for delivery of one-half of the water supply to Southern California.

Fifth Step of Construction. The fifth step of construction would include the addition of one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V, and VI.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fifth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to ⅞ capacity	$36,293,000
Contingencies	5,444,000
Engineering and administration	3,629,000
Interest during construction	1,693,000
Subtotal fifth step	$47,059,000

Accomplishments of the Fifth Step of Construction. Completion of this step would make available capacity for the delivery of an additional one-fourth of the water supply for Southern California or a total of three-fourths of the full supply.

Sixth Step of Construction. The sixth step of construction would include the addition of the final one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V and VI.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Sixth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to full capacity	$31,946,000
Contingencies	4,792,000
Engineering and administration	3,194,000
Interest during construction	1,491,000
Subtotal sixth step	$41,423,000

Accomplishments of the Sixth Step of Construction. Completion of this final step of construction would make available capacity for delivery of the full water supply to Southern California in accordance with the 15-year absorption period assumed, of 1,800,000 acre-feet.

Summary of Cost by Steps of Construction. A tabulation summarizing the estimated cost of each step of construction follows:

Step of construction	*Estimated cost*
1	729,230,000
2	83,810,000
3	83,300,000
4	608,086,000
5	47,059,000
6	41,423,000
Total	$1,592,908,000

Feather River Project Using the High Line Route From the Delta to San Bernardino

The features of this construction program include the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to San Bernardino, the Alameda-Santa Clara-San Benito Branch and the Devil Canyon Power Development The first three steps of construction for this program are the same as to features, estimated costs and accomplishments as those set forth under Feather River Project using the High Line Route from the Delta to Barrett Reservoir. The Feather River Project Aqueduct is the same from the Delta to the Cedar Springs Forebay on the West Fork of the Mojave River. The Devil Canyon Power Development includes the Cedar Springs Forebay, tunnel, conduit and penstocks to the Devil Canyon Power Plant, the power plant, a conduit to the San Bernardino Afterbay and the afterbay.

Fourth Step of Construction. The fourth step of the construction would include the main project conduit from Wheeler Ridge to Cedar Springs Forebay and the construction to one-half capacity of the Pumping Plants Nos. II-B, III, IV, V, VI, Buena Vista Forebay, Quail Lake Afterbay, Cedar Springs Forebay, Aqueduct—Cedar Springs to Devil Canyon, construction to one-half capacity of the Devil Canyon Power Plant, conduit from the power plant to the San Bernardino Afterbay and the afterbay.

A tabulation of the features of the project in this step and their estimated cost is as follows:

Fourth Step of Construction

Pumping Plant Nos. II-B, III, IV, V and VI to one-half capacity	$85,804,000
Buena Vista Forebay Dam	1,452,000
Quail Lake Afterbay Dam	400,000
Aqueduct—Wheeler Ridge to Cedar Springs	179,343,000
Cedar Springs Forebay Dam	3,782,000
Aqueduct—Cedar Springs to Devil Canyon	24,984,000
Devil Canyon Power Plant to one-half capacity	42,475,000
Reregulation system	4,800,000
San Bernardino Afterbay Dam	12,485,000
Subtotal	$355,525,000
Contingencies	54,994,000
Engineering and administration	36,808,000
Interest during construction	23,087,000
Subtotal fourth step	$470,414,000

Accomplishments of the Fourth Step of Construction. Completion of this step would make available the initial delivery of water to Southern California in the year 1976, 20 years after the start of project construction. It has been assumed that the initial delivery would be one-fourth of that available from the project, or 450,000 acre-feet. The construction of the features in this step would provide delivery capacity up to one-half of the water supply for Southern California. It has also been assumed that the water supply to the south coastal plain of California and ultimately through the Devil Canyon Power Plant would be a total of 2,000 second-feet. The construction of the Devil Canyon Power Development would make available for sale a power output as the water is absorbed, up to one-half of the dependable generating capability and the energy output of the plant, respectively, 220,000 kilowatts and 873,600,000 kilowatt hours.

Fifth Step of Construction. The fifth step of construction would include the addition of one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V, VI, one-fourth of the power generating capacity of the Devil Canyon Power Plant and completion of the reregulating system.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fifth Step of Construction

Pumping Plants Nos. II-B, III, IV, V, and VI to three-fourths capacity	$36,293,000
Devil Canyon Power Plant to three-fourths capacity	11,600,000
Reregulating system	3,990,000
Subtotal	$51,883,000
Contingencies	7,782,000
Engineering and administration	5,188,000
Interest during construction	2,411,000
Subtotal fifth step	$67,264,000

Accomplishments of the Fifth Step of Construction. Completion of this step would make available capacity for the delivery of an additional one-fourth of the water supply for Southern California, or a total of three-fourths of the full supply. It would also make available an additional power output that could be realized with the additional water supply put through the power plant.

Sixth Step of Construction. The sixth step of construction would include the addition of the final one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V, VI, and the final one-fourth of the power generating capacity of the Devil Canyon Power Plant.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Sixth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to full capacity	$31,946,000
Devil Canyon Power Plant to full capacity	12,110,000
Subtotal	$44,056,000
Contingencies	$6,608,000
Engineering and administration	4,405,000
Interest during construction	2,060,000
Subtotal sixth step	$57,129,000

Accomplishments of the Sixth Step of Construction. Completion of the final step of construction would make available capacity for delivery of the full water supply to Southern California of 1,800,000 acre-feet. It would also make available a firm power supply with a dependable generating capability of 440,000 kilowatts and an electric energy output of 1,747,200,000 kilowatt hours.

Summary of Cost by Steps of Construction. A tabulation summarizing the estimated cost of each step of construction follows:

Step of construction	*Estimated cost*
1	$729,230,000
2	83,810,000
3	83,300,000
4	470,414,000
5	67,264,000
6	57,129,000
Total	$1,491,147,000

Feather River Project Using the High Line Route From the Delta to Castaic Creek Reservoir

The features of this construction program include the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Quail Lake Forebay, the Alameda-Santa Clara-San Benito Branch and the Castaic Creek Power Development. The first three steps of construction for this program are the same as to features, estimated costs and accomplishments as for those set forth under Feather River Project using the High Line Route from the Delta to Barrett Reservoir. The Feather River Project Aqueduct is the same from the Delta to Quail Lake Forebay. The Castaic Creek Power Development includes the Quail Lake Forebay, tunnels and penstock to the power plant at Liebre Gulch, Liebre Gulch Afterbay, tunnels and penstock to the power plant at Castaic Creek Reservoir and the reservoir.

Fourth Step of Construction. The fourth step of the construction would include the main project aqueduct from Wheeler Ridge to Quail Lake Forebay and the construction to one-half capacity of the Pumping Plants Nos. II-B, III, IV, V, VI, Buena Vista Forebay, Quail Lake Forebay, Aqueduct-Quail Lake Forebay to Liebre Gulch, construction to one-half the generating capacity of the Liebre Gulch Power Plant, Liebre Gulch Afterbay, Aqueduct-Liebre Gulch to Castaic Creek Reservoir and the construction to one-half of the generating capacity of the Castaic Power Plant and the Castaic Creek Reservoir.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fourth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to one-half capacity	$85,804,000
Aqueduct—Wheeler Ridge to Quail Lake	70,876,000
Buena Vista Forebay	1,452,000
Quail Lake Forebay	3,626,000
Aqueduct—Quail Lake to Liebre Gulch	29,073,000
Liebre Gulch Power Plant to one-half capacity	14,286,000
Liebre Gulch Afterbay	1,107,000
Aqueduct—Liebre Gulch to Castaic Creek	45,533,000
Castaic Power Plant to one-half capacity	23,015,000
Castaic Creek Dam and Reservoir	12,171,000
Subtotal	$286,943,000
Contingencies	51,264,000
Engineering and administration	28,637,000
Interest during construction	18,124,000
Subtotal fourth step	$384,968,000

Accomplishments of the Fourth Step of Construction. Completion of this step would make available the initial delivery of water to Southern California in the year 1976, 20 years after the start of project construction. It has been assumed that the initial delivery would be one-fourth of that available from the project, or 450,000 acre-feet. The construction of the features in this step would provide delivery capacity up to one-half of the water supply for Southern California. It has been assumed that the water supply to the south coastal plain of Southern California and ultimately through the Castaic Creek Power Development would be a total of 2,000 second-feet. The construction of the Castaic Creek Power Development would make available for sale a power output as the water is absorbed, up to one-half of the dependable generating capability of both the power plants and the electric energy output of the plants, respectively, 258,000 kilowatts and 1,006,200,000 kilowatt-hours.

Fifth Step of Construction. The fifth step of construction would include the addition of one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V, VI and one-fourth of the power generating capacity of the Liebre Gulch Power Plant and Castaic Power Plant and addition to aqueduct siphons.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fifth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to three-fourth capacity	$36,293,000
Aqueduct—Quail Lake to Liebre Gulch	1,008,000
Liebre Gulch Power Plant to three-fourth capacity	2,819,000
Aqueduct—Liebre Gulch to Castaic Creek	1,488,000
Castaic Power Plant to three-fourth capacity	4,541,000
Subtotal	$46,149,000
Contingencies	6,922,000
Engineering and administration	4,615,000
Interest during construction	2,154,000
Subtotal fifth step	$59,840,000

Accomplishments of the Fifth Step of Construction. Completion of this step would make available capacity for the delivery of an additional one-fourth of the water supply for Southern California or a total of three-fourths of the full supply. It would also make available an additional power output that could be realized with the additional water supply put through the power plants.

Sixth Step of Construction. The sixth step of construction would include the addition of the final one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V, VI, the final one-fourth of the power generating capacity of the Liebre Gulch Power Plant and the Castaic Power Plant, and completion of aqueduct siphons.

A tabulation of the features of the project in this step and their estimated costs, is as follows:

Sixth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to full capacity	$31,946,000
Aqueduct—Quail Lake to Liebre Gulch	1,007,000
Liebre Gulch Power Plant to full capacity	2,851,000
Aqueduct—Liebre Gulch to Castaic Creek	1,489,000
Castaic Power Plant to full capacity	4,634,000
Subtotal	$41,927,000
Contingencies	$6,298,000
Engineering and administration	4,193,000
Interest during construction	1,956,000
Subtotal sixth step	$54,374,000

Accomplishments of the Sixth Step of Construction. Completion of this step would make available capacity for the delivery of the full water supply to Southern California of 1,800,000 acre-feet. It would also make available a firm power supply with a dependable generating capability of 516,000 kilowatts and an electric energy output of 2,012,400,000 kilowatt-hours.

Summary of Cost by Steps of Construction. A tabulation summarizing the estimated cost of each step of construction follows:

Step of construction	*Estimated cost*
1	$729,230,000
2	83,810,000
3	83,300,000
4	384,968,000
5	59,840,000
6	54,374,000
Total	$1,395,522,000

Feather River Project Using the High Line Route From the Delta to Devils Den and Extensions to Wheeler Ridge and Via the Coastal Line to Castaic Creek Reservoir

The features of this construction program include the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Devils Den, an extension of the aqueduct to Wheeler Ridge, the Alameda-Santa Clara-San Benito Branch and the Coastal Line from Devils Den to Castaic Creek Reservoir and the reservoir.

Initial Step of Construction. The initial step of construction would include the same features as those set forth under Feather River Project using the High Line Route from the Delta to Barrett Reservoir. The Feather River Project Aqueduct would be the same from the Delta to Devils Den. The route of the extension of the aqueduct from Devils Den to Wheeler Ridge would be the same as for the Feather River Project Aqueduct, however, the capacity of the extension conduit would be reduced to 2,300 second-feet. The estimated cost would be the same as for that of the initial step using the High Line Route except for the cost of that portion of the aqueduct from Devils Den to Wheeler Ridge. The accomplishments of the step would be the same as for that with the High Line Route.

A tabulation of the features of the project in this step and their estimated costs is as follows:

First Step of Construction

Oroville Dam, Reservoir, Power Plant and Afterbays	$313,539,000
Aqueduct—Intake to Wheeler Ridge	156,095,000
Pumping Plant No. I—⅜ capacity	14,606,000
Pumping Plant No. II-A—½ capacity	17,553,000
Pumping Plant No. III—⅛ capacity	4,282,000
San Luis Forebay	1,219,000
San Luis Dam and Reservoir—1,000,000 acre-feet capacity	37,751,000
Subtotal	$545,045,000
Contingencies	68,187,000
Engineering and administration	53,951,000
Interest during construction	56,133,000
Subtotal first step	$723,316,000

Second and Third Steps of Construction. The second and third steps of construction for this program are the same as to features, estimated costs and accomplishments as those set forth under Feather River Project using the High Line Route from the Delta to Barrett Reservoir.

Fourth Step of Construction. The fourth step of construction would include the construction to one-half capacity of Pumping Plants Nos. II-B and III, Coastal Line from Devils Den to Castaic Creek, Coastal Line Pumping Plants to one-half capacity and Castaic Creek Dam and Reservoir.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fourth Step of Construction

Pumping Plants Nos. II-B and III to ½ capacity	$6,452,000
Coastal Line-Devils Den to Castaic Creek	375,362,000
Coastal Line Pumping Plants to ½ capacity	38,707,000
Castaic Creek Dam and Reservoir	12,171,000
Subtotal	$432,692,000
Contingencies	85,613,000
Engineering and administration	42,649,000
Interest during construction	33,648,000
Subtotal fourth step	$594,602,000

Accomplishments of the Fourth Step of Construction. Completion of this step would make available the initial delivery of water to the coastal plain of Southern California in the year 1976, 20 years after the start of project construction. It is assumed that the initial delivery would be one-fourth of that available from the project, or 306,000 acre-feet. The construction of the features in this step would provide delivery capacity up to one-half of the water supply for the coastal plain of Southern California. With the completion of the fourth step of construction an additional 144,000 acre-feet of water would be made available to Southern Kern County.

Fifth Step of Construction. The fifth step of construction would include the addition of one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B and III and one-fourth capacity of the Coastal Line Pumping Plants.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fifth Step of Construction

Pumping Plants Nos. II-B and III to ¾ capacity	$6,459,000
Coastal Line Pumping Plants to ¾ capacity	18,049,000
Subtotal	$24,508,000
Contingencies	4,222,000
Engineering and administration	2,451,000
Interest during construction	1,160,000
Subtotal fifth step	$32,341,000

Accomplishments of the Fifth Step of Construction. Completion of this step would make available capacity for the delivery of an additional one-fourth of the water supply for the coastal plain of Southern California or a total of three-fourths of the full supply. An additional 288,000 acre-feet would be made available to Southern Kern County with completion of this step.

Sixth Step of Construction. The sixth step of construction would include the addition of the final one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B and III and the final one-fourth capacity in the Coastal Line Pumping Plants.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Sixth Step of Construction

Pumping Plants Nos. II-B and III to full capacity	$6,391,000
Coastal Line Pumping Plants to full capacity	17,782,000
Subtotal	$24,173,000
Contingencies	4,863,000
Engineering and administration	2,417,000
Interest during construction	1,166,000
Subtotal sixth step	$32,619,000

Accomplishments of the Sixth Step of Construction. Completion of this step would make available capacity for the delivery of the full water supply to the coastal plain of Southern California of 1,224,000 acre-feet and a total of 926,000 acre-feet to Southern Kern County.

Summary of Cost by Steps of Construction. A tabulation summarizing the estimated cost of each step of construction follows:

Step of construction	*Estimated cost*
1	$723,316,000
2	83,810,000
3	83,300,000
4	594,602,000
5	32,341,000
6	32,619,000
Total	$1,549,988,000

Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to Castaic Creek Reservoir

The features of this construction program include the Oroville Reservoir, Dam and Power Plant, two afterbay dams, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Pastoria Creek, the Alameda-Santa Clara-San Benito Branch, the Long Tunnel Line to Castaic Creek Reservoir and the reservoir. The first three steps of construction for this program are the same as to features, estimated costs and accomplishments as for those set forth under Feather River Project Using the High Line Route From the Delta to Barrett Reservoir.

Fourth Step of Construction. The fourth step of the construction program would include the Feather River Project Aqueduct from Wheeler Ridge to Pastoria Creek, the Long Tunnel Line to Elizabeth Lake Canyon, a tributary of Castaic Creek, Buena Vista Forebay, construction to one-half capacity of the Pumping Plants Nos. II-B, III, IV, V and VI and the Castaic Creek Reservoir.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fourth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to one-half capacity	$44,357,000
Aqueduct—Wheeler Ridge to Castaic Creek Reservoir	259,649,000
Buena Vista Forebay	1,452,000
Castaic Creek Reservoir	12,171,000
Subtotal	$317,629,000
Contingencies	44,656,000
Engineering and administration	31,707,000
Interest during construction	40,889,000
Subtotal fourth step	$434,881,000

Accomplishments of the Fourth Step of Construction. Completion of this step would make available the initial delivery of water to the coastal plain of Southern California in the year 1976, 20 years after the start of project construction. It is assumed that the initial delivery would be one-fourth of that available from the project or 306,000 acre-feet. The construction of the features in this step would provide delivery capacity up to one-half of the water supply for the coastal plain of Southern California. Under this plan of development an additional 144,000 acre-feet of water would be made available to southern Kern County with the completion of the fourth step of construction.

Fifth Step of Construction. The fifth step of construction would include the addition of one-fourth of the pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V and VI.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Fifth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to three-fourths capacity	$20,692,000
Contingencies	3,104,000
Engineering and administration	2,069,000
Interest during construction	997,000
Subtotal fifth step	$26,862,000

Accomplishments of the Fifth Step of Construction. Completion of this step would make available capacity for the delivery of an additional one-fourth of the water supply for the coastal plain of Southern California or a total of three-fourths of the full supply. An additional 288,000 acre-feet would be made available to Southern Kern County at the completion of this step.

Sixth Step of Construction. The sixth step of construction would include the addition of the final one-fourth of pumping plant capacity in each of Pumping Plants Nos. II-B, III, IV, V and VI.

A tabulation of the features of the project in this step and their estimated costs is as follows:

Sixth Step of Construction

Pumping Plants Nos. II-B, III, IV, V and VI to full capacity	$18,302,000
Contingencies	2,746,000
Engineering and administration	1,830,000
Interest during construction	880,000
Subtotal sixth step	$23,758,000

Accomplishments of the Sixth Step of Construction. Completion of this step would make available capacity for the delivery of the full water supply to the coastal plain of Southern California of 1,224,000 acre-feet and a total of 926,000 acre-feet to Southern Kern County.

Summary of Cost by Steps of Construction. A tabulation summarizing the estimated cost of each step of construction follows:

Step of construction	*Estimated cost*
1	$729,230,000
2	83,810,000
3	83,300,000
4	434,881,000
5	26,862,000
6	23,758,000
Total	$1,381,841,000

CHAPTER IV
METHODS OF FINANCING

The 1951 State Legislature amended Division 6, Part 3 of the State Water Code pertaining to the Central Valley Project by the passage of an act which became Chapter 1441, Statutes of 1951. The law now authorizes the issuance of revenue bonds without limitation in amount, from time to time, for the purposes of providing funds to carry out any of the objects and purposes of that part of the Water Code, including the construction of the units composing the Feather River Project.

There is discussed in this chapter the possibility of financing the project by revenue bonds, and the desirability of financing it by other means, and a proposal therefor. Assistance has been secured from authorities who have knowledge of the problems that are to be solved in financing this project.

REVENUE BONDS

Revenue bonds are defined as bonds that are entirely self-liquidating, whose debt service is payable solely from project revenues and without any liability or obligation of the State. The revenues in the aggregate must be sufficient to cover all costs of debt service, operation and maintenance, replacements, and other expenses. Bonds of this type have been used increasingly by state and political subdivisions and they are exempt from federal and State of California income tax similar to general obligation bonds issued by the State.

It has previously been explained that the project would be constructed on a step-by-step basis as supplemental water is needed by the several areas of deficient supply. With respect to the sale of revenue bonds to be used in financing construction of a large project, it is customary to call for construction bids on the total work involved in the initial step of construction in order to ascertain if the amount of bonds proposed for sale would cover the cost of that step. In order to assure completion of any step of the project, all of the bonds covering the construction bids for that step would have to be sold in a single issue, such as a Series A for the first step, Series B for the second step, and so on. Advice received indicates that the amount of bonds required to be sold (about $675,000,000), the proceeds from which would be used to construct the first step of the project, may well be too large for the bond market to absorb at any one time without increasing the interest rates appreciably. With respect to the project, there is also the difficulty of forecasting water toll revenues during the earlier years of project operation. This adverse factor, combined with the fact that the project must be fully self-liquidating, would probably result in making the revenue bonds difficult to sell. It is also customary in making financial analyses of projects financed with revenue bonds to allow for charges for services that would provide a margin of safety from net revenues of at least 25 percent in excess of debt service charges, and usually a larger percentage is allowed. This added burden might raise the required charges for water beyond the point that they could be met by the water users since the revenue from the sale of generated power is a more or less fixed amount.

In general, it is found that the cost of borrowed money is one-half percent, or more, higher on revenue bonds than on general obligation bonds. There follows a tabulation on page 46 that shows, among other things, the net cost of money of a number of the largest issues sold in the United States in recent years by state agencies, followed by a second tabulation showing recent past and current net interest costs on selected general obligation bonds issued by the State of California.

In recognition of the foregoing and other factors inherent in financing the Feather River Project by revenue bonds, it is considered impracticable to finance it by that means.

GENERAL OBLIGATION BONDS

General obligation bonds of the State are bonds whose debt service is secured by the taxing power of the State. Because of this, they are on a higher plane of credit soundness than revenue bonds. Thus, they can be marketed at lower interest rates than revenue bonds, providing a decided advantage to the financing of the project that must be utilized in order to deliver water to the user at a price within his ability to pay.

Advisors state that amounts proposed for construction in each year could be sold prior to such construction and it would not be necessary to issue all of the bonds for each step of the construction program at one time.

There are two methods that are available in issuing general obligation bonds. One of these is by a constitutional amendment, in which case the amendment

Date of issue	Amount (000)	Issuer	Net interest cost (%)	Maturity range	Security
1/53	$62,000	California Toll Bridge Authority	3.88	1992	Revenue
5/54	100,000	State of Connecticut	2.857	1962-94	Revenue plus motor fuel tax
12/53	280,000	Indiana Toll Road Commission	3.56	1994	Revenue
8/54	160,000	Kansas Turnpike Authority	3.443	1994	Revenue
11/54	180,000	Maryland Bridge and Tunnel Authority	2.991	1960-94	Revenue
5/54	239,000	Massachusetts Turnpike Authority	3.356	1994	Revenue
12/53	99,800	Mackinac Bridge Authority	4.35	1994	Revenue
2/50	220,000	New Jersey Turnpike Authority	3.25	1985	Revenue
7/53	150,000	Garden Street Parkway—New Jersey	3.00	1960-88	Guaranteed
11/53	135,000	Garden Street Parkway—New Jersey	2.77	1960-88	Guaranteed
10/53	150,000	New Jersey Turnpike Authority	3.49	1988	Revenue
1/52	215,000	Triborough Bridge and Tunnel Authority	2.13	1957-69	Revenue
5/53	125,000	New York Thruway Authority	2.64	1958-84	Guaranteed
9/53	125,000	New York Thruway Authority	2.70	1958-84	Guaranteed
6/54	300,000	New York Thruway Authority	3.07	1964-94	Revenue
12/54	335,000	New York Power Authority	3.189	1965-95	Revenue
6/52	326,000	Ohio Turnpike Commission	3.36	1992	Revenue
4/54	233,000	Pennsylvania Turnpike Commission	3.20	1993	Revenue

State of California General Obligation Issues

Date of issue	Amount	Purpose	Net interest cost
June, 1949	$30,000,000	Veterans	1.92%
May, 1950	50,000,000	Public School Building Loan	1.74
September, 1950	50,000,000	Public School Building Loan	1.76
September, 1950	50,000,000	Veterans	1.66
April, 1951	50,000,000	Public School Building Loan	1.84
June, 1952	50,000,000	Public School Building Loan	1.87
February, 1953	100,000,000	Veterans	2.42
January, 1954	50,000,000	Veterans	1.93
April, 1954	50,000,000	State School Building Aid	2.20
January, 1955	60,000,000	Veterans	2.03

providing for the bonds would require a two-thirds vote of approval by the State Legislature and subsequent approval by the electorate by a majority vote. The other means is by a bond act which requires a majority vote of the State Legislature and the electorate.

The Feather River Project is of wide interest because it would afford supplemental water supplies to areas which include about 55 percent of the State's total assessed value. It is the initial unit of The California Water Plan and an opportunity should be afforded to the voters of the State to decide whether they desire to sponsor and adopt this plan, and assist financially in its materialization.

Justifiable reasons exist for the State Government assisting in the construction of this project by issuing general obligation bonds. In the construction of the project the many hundreds of millions of dollars spent in California for wages, for materials and some of the equipment would enhance the material welfare of Californians and concurrently increase tax collections to the State Government by many millions of dollars. After the project is completed, it would not be a depletable investment like that of a mine or oil well, *but would maintain and augment the production* of goods, and services, by providing a prime and essential ingredient—water. In some areas proposed to be served by the project, Project water would maintain investments which would otherwise be depleted as *the local reserve ground water supply* was exhausted. In other areas, expansion of agriculture and cities could occur. With respect to agriculture, the annual outpouring of about $250 worth of produce per irrigated acre, together with all of the many economic activities *stemming from and induced by* agriculture, would be tremendous. Cities can take in new territory and use the water for innumerable purposes. This project should be regarded as income-generating, as a stimulant to many industries.

PROPOSED METHOD OF FINANCING

The proposed method of financing set forth in this report is on the basis of issuance of general obligation bonds. Bonds would be issued and sold each year in the amount required to finance the programmed construction. The revenues from water and power would be applied to meet the debt service requirements on

the outstanding bonds, operation and maintenance, including power for pumping costs, a replacement reserve and general expense. The amount of the annual charges that could not be met from current revenues would be an obligation of the General Fund. Based on past experience, it would be necessary to issue general obligation bonds with a 40-year life in order to maintain the average cost of money at about 2½ percent. It would also be the duty of the project operating agency to charge water rates which are considered fair and within the ability of the user to pay. These rates must be high enough, however, to not create an undue burden on the General Fund.

The extent of the obligation of the General Fund, under the several proposed plans, is set forth in Chapter V, Financial Analyses.

The development of the water supply for each of several large metropolitan areas in California has been financed by a combination of ad valorem taxes, water charges and power revenues when available. Among the public agencies which have so financed their water supply are the Metropolitan Water District of Southern California with its Colorado River Aqueduct, the City and County of San Francisco with its Hetch Hetchy Project, and the East Bay Municipal Utility District with its Mokelumne River Project.

CHAPTER V

FINANCIAL ANALYSES

The five financial analyses presented herein are made on the basis of financing by general obligation bonds of the State. The bonds would be sold in the annual amounts as determined by the project step-construction requirements. Water revenues would be realized by sale of project water at main canalside from the Feather River Project Aqueduct to existing municipalities and public districts under long term agreements. When districts are not presently organized, new districts will have to be formed to contract for the proposed water deliveries. Electric power, generated at the power plants of the project would be sold at the plants to the existing power distributing agencies or public districts in the power load areas, however, a revaluation of this matter should be made at the time agreements are entered into for the disposal or utilization of the electric power involved in the operation of the project.

The analyses presented herein include the entire Feather River Project features with the Feather River Project Aqueduct extending from the Sacramento-San Joaquin Delta to San Diego County, two modifications thereof and two on other possible routes to deliver water south of the Tehachapi Mountains to Southern California. The numbers of these analyses and the features included in each as previously described in Chapter II, are as follows:

Financial Analysis No. 1 includes the Feather River Project using the High Line Route from the Delta to Barrett Reservoir. The features include Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Barrett Reservoir using the High Line Route and the Alameda-Santa Clara-San Benito Branch of that aqueduct.

Financial Analysis No. 2 includes the Feather River Project using the High Line Route from the Delta to San Bernardino. The features include Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to San Bernardino, the Alameda-Santa Clara-San Benito Branch and the Devil Canyon Power Development.

Financial Analysis No. 3 includes the Feather River Project using the High Line Route from the Delta to Castaic Creek Reservoir. The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Quail Lake Forebay, the Alameda-Santa Clara-San Benito Branch and the Castaic Creek Power Development.

Financial Analysis No. 4 includes the Feather River Project using the High Line Route from the Delta to Devils Den and an extension to Wheeler Ridge and via the Coastal Line to Castaic Creek Reservoir. The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Devils Den, an extension of the aqueduct to Wheeler Ridge, the Alameda-Santa Clara-San Benito Branch and the Coastal Line from Devils Den to Castaic Creek Reservoir and that reservoir.

Financial Analysis No. 5 includes the Feather River Project using the High Line Route from the Delta to Pastoria Creek and via the Long Tunnel Line to Castaic Creek Reservoir. The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Pastoria Creek, the Alameda-Santa Clara-San Benito Branch, the Long Tunnel Line to Castaic Creek Reservoir and that reservoir.

CAPITAL COSTS

The capital costs included in the financial analyses as presented are the total construction costs of all of the features of the project as envisioned for the particular analysis and set forth in Chapter II. No lump sum contributions toward the project cost by either the State or the Federal Government have been anticipated in any of the analyses presented herein. If any contributions can ultimately be realized, as for flood control, such funds could be used toward retirement of outstanding bonds, or returned to the State Treasury in repayment of the advances made from the General Fund.

ANNUAL COSTS

Annual costs used in the financial analyses include debt service, replacements, operations and maintenance, cost of power for pumping and general expense, each of which is discussed below.

Debt Service

Debt service includes interest and repayment of bonds. The cost of money used in making the analyses was taken at an average rate of 2½ percent per annum. Bond repayments were assumed to be deferred during an initial 10-year period on each issue and repayment made in a subsequent 30-year period making the bond life 40 years.

Replacements

A fund was established for replacement of items with an estimated life less than the payout period of the project. This replacement allowance was based on a 2½ percent sinking fund reserve. The following schedule was used to determine this allowance:

Item	*Estimated life in years*	*Percent replaceable*
Pumps and turbines	35	50
Motors and generators	35	50
Electrical equipment	35	75
Mechanical equipment	45	75
Valves	45	50
Discharge pipelines	45	50
Aqueduct	45	2

Operation and Maintenance

Operation and maintenance costs of project features are those costs directly attributable to their operation and include salaries, materials and supplies, and motor vehicle and equipment expense. Salaries were based on prevailing wages in state service and were determined for a staff deemed adequate to operate and maintain project features. Cost of materials and supplies was based on that experienced by the U. S. Bureau of Reclamation in the operation of similar units of the Central Valley Project. Motor vehicle and equipment expenses were based on standard mileage and rental rates.

Cost of Power for Pumping

An estimate of the unit cost of supplying electric power for pumping from its system has been submitted by a letter from the Pacific Gas and Electric Company, signed by its Chief Engineer and dated August 17, 1954. A copy of this letter is included in Appendix G of this report. The company's letter states that the estimated charges are based on present conditions as to construction costs, plant efficiencies, fuel prices, financing, taxes, wage levels and related costs. It is stated further that the figures submitted are not to be taken as a firm proposal but as the best estimates that could be made at the time. It is to be noted that the company has used as its basis for the charges for pumping the cost of steam-electric produced power using $1.85 per barrel as the cost of fuel oil. The same cost of fuel and approach has been used by the company in evaluating the generated energy it would purchase at the Oroville Power Plant. The company has estimated the cost of supplying both on-peak and off-peak power for pumping at the several locations of the pumping plants. The company's statement as to the unit cost for such power, is quoted as follows:

Company to supply electric service at pumping plant sites at suitable voltage for large pump installations.

State to construct pumping plants and receive power from Company's low tension bus. Pump prime movers assumed to be synchronous motors capable of operating at full load at 95% leading power factors.

Power to be supplied on either of the following bases at State option.

1. **On-peak Power.** Highest kw demand in 12-month period.

2. **Off-peak Power** up to a specified demand subject to increase on reasonable advance notice. Company would schedule operation of the pumping plant so as to pump an average weekly flow of water specified by the State within the limits of the specified maximum demand, the available pumps and motors (including spares), and the available forebay and afterbay storage capacity. Excess pumping facilities and forebay and afterbay storage capacity (or equivalent) should be provided in either of the following two combinations:

   a. Available pumping capacity of not less than twice the average pumping capacity required and not less than 3½ acre-feet of both forebay and afterbay effective storage capacity for each second foot of average weekly flow of water specified.

   b. Available pumping capacity of not less than 2½ times the average pumping capacity required and not less than 1½ acre-feet of both forebay and afterbay effective storage capacity for each second foot of average weekly flow of water specified.

3. State could provide for a pumping plant to be served in part with On-peak Power and in part with Off-peak Power and specify the maximum demand for each. Transfer from one class to the other could be made on reasonable advance notice.

4. Costs based on present conditions as to construction costs, plant efficiencies, fuel prices, financing, taxes, wage levels and related costs.

	Delivered to pumping plants numbered		
	1 and 2	*3, 4 and 5*	*6*
On-peak power			
Cost per kw. per month	$2.50	$2.80	$2.90
Off-peak power			
Cost per kw. per month	$0.125	$0.325	$0.35
Increment energy cost all plants			
Per kilowatt hour—mills		3.00	

In connection with provision of excess pumping facilities and afterbay and forebay storage capacity, combination "2a" of the foregoing statement has been utilized in making the cost estimates of the project. The installed pumping capacity where it is contemplated to utilize off-peak power is approximately twice the pumping capacity required for continuous pumping and 3½ acre-feet of both forebay and afterbay storage capacity has been provided for each second-foot of average weekly flow of water.

The amount of electrical energy required at each pumping plant during the development period and under complete development is shown in the following tabulation:

Electric Energy Requirements for Pumping
Energy in millions of kilowatt hours

Year	Pumping Plant I	Alameda-Santa Clara-San Benito relift	Pumping plants II-A & II-B	Pumping plant III	Pumping plants IV, V & VI	Total
1959	181.4		198.9	30.0		410.3
1960	181.4		198.9	30.0		410.3
1961	181.4		198.9	30.0		410.3
1962	181.4		198.9	30.0		410.3
1963	181.4		198.9	30.0		410.3
1964	277.7	35.3	285.9	30.0		628.9
1965	311.4	42.4	319.2	30.0		703.0
1966	345.2	49.2	352.4	30.0		777.0
1967	378.9	56.5	385.7	30.0		851.1
1968	412.6	63.6	419.0	30.0		925.2
1969	455.7	70.6	462.5	38.0		1026.8
1970	478.3	77.7	483.6	45.9		1085.5
1971	518.0	84.7	516.8	53.9		1173.4
1972	557.7	91.8	556.0	61.9		1267.4
1973	597.4	98.9	595.3	69.9		1361.5
1974	600.8	105.9	595.3	69.9		1371.9
1975	604.2	113.0	595.3	69.9		1382.4
1976	735.1	120.0	733.4	159.8	1612.3	3360.6
1977	764.0	127.1	761.0	177.8	1931.7	3761.6
1978	792.9	134.2	788.6	195.8	2254.3	4165.8
1979	821.8	141.2	816.2	213.7	2579.8	4572.7
1980	847.3	141.2	843.9	213.7	2899.4	4945.5
1981	872.8	141.2	871.5	249.7	3221.9	5357.1
1982	898.3	141.2	899.1	367.7	3544.5	5750.8
1983	923.8	141.2	957.4	285.6	3866.9	6174.9
1984	949.3	141.2	954.3	303.6	4189.5	6537.9
1985	974.8	141.2	988.1	321.6	4512.0	6937.7
1986	1000.3	141.2	1009.6	339.6	4834.6	7328.0
1987	1025.8	141.2	1037.2	357.6	5153.6	7715.4
1988	1051.3	141.2	1064.8	375.6	5476.1	8109.0
1989	1076.9	141.2	1092.4	393.5	5798.6	8502.6
1990	1102.4	141.2	1120.0	411.5	6121.2	8896.3
1991	1127.9	141.2	1130.3	429.5	6443.8	9272.7
1992	1127.9	141.2	1130.3	429.5	6443.8	9272.7
1993	1127.9	141.2	1130.3	429.5	6443.8	9272.7

General Expense

General expense is the cost of providing services not directly chargeable to the operation and maintenance of the project features. This item of expense is largely salaries and miscellaneous costs. These services, deemed necessary to adequately manage and operate the project include engineering, general administration, legal and finance.

PROJECT REVENUES

Gross revenues estimated herein include returns from the sale of generated electric power and a water charge per acre-foot to each general area of water delivery. The additional funds needed to meet annual costs in excess of current revenues would be an obligation of the General Fund.

Power Revenue

The power output of the Oroville Power Plant when operated as discussed in Chapter II of this report would consist of 410,000 kilowatts of dependable generating capability and an average annual energy output of 1,720,600,000 kilowatt-hours. The Pacific Gas and Electric Company by letter dated December 7, 1954, included herein in Appendix G has estimated the value of this power to the company from the unit cost of producing and delivering equivalent power from a modern company-owned steam-electric plant located in the Delta area. For this purpose the company estimated that the unit cost of the assumed steam-electric plant would be $125 per kilowatt and that related step-up facilities and transmission to the vicinity of Tesla in Alameda County would be $18 per kilowatt. On the basis of (a) the above unit capital costs; (b) an incremental net output of 684 kilowatt hours per barrel of oil, and oil priced at $1.85 per barrel; (c) financing and wage levels as of the middle of 1954; and (d) taxes on income 4 percent state and 47 percent federal, the company has estimated the unit values of power delivered at 230 kilovolts to company lines at Oroville Power Plant and also delivered from terminal facilities in the vicinity of Tracy with the project supplying the transmission system. The company's statement as to the unit value of the power is quoted as follows:

	Estimated unit values of power delivered at 230 kilovolts at Oroville Plant	*in vicinity of Tracy*
1. Dependable capacity (per kilowatt year)	$20.83	$24.42
2. Nondependable capacity (per kilowatt year)	4.20	4.50
3. Useable energy (per kilowatt hour)	2.73 mills	2.86 mills

The unit value for dependable capacity at Oroville is based on 400,000 dependable kilowatts being made available. It would differ from other amounts of dependable capacity because the company would construct transmission facilities to handle the maximum output of the Oroville plant. We estimate that the price at Oroville would change eight cents per kilowatt year for each 10,000 kilowatt change in dependable capacity.

Nondependable capacity, i.e., capacity in excess of dependable, must be known in advance to be available for continuous periods of at least six months duration.

The cost of transmission facilities to load center is directly reflected in the rate that has been submitted for generated power delivered to Tracy. Studies made indicate that there is a financial advantage in the above rates for power based on delivery at the high tension side of the Oroville Power Plant over that for the delivery at the load center near Tracy. The annual charges on a transmission system from the Oroville Power Plant to the vicinity of Tracy would be in excess of the difference between the revenue using the higher rate for the power delivered near Tracy and the revenue with delivery at the power plant. In view of the net gain to the revenues of the project by omitting the transmission system in the financial analyses presented herein and the reduction in the capital requirements of about $22,000,000, the transmission system has not been included in the project. However, a revaluation of this matter should be made at the time agreements are entered into for the disposal or utilization of the electric power generated by and purchased for the project.

The unit values for electric power delivered at the power plant bus, as set forth in the above tabulation, have also been used in evaluating the power that could be delivered in Southern California by means of the power drop between Quail Lake and Castaic Creek Reservoir, and that at Devil Canyon near San Bernardino. In each of these power drops adequate forebay and afterbay capacity has been provided so that the power plants could be operated for maximum dependable generating capability on a peaking basis.

Depletion of Oroville Power Plant Dependable Capability. Present studies indicate that a factor which would cause depletion of dependable capacity at Oroville Power Plant would be increase of irrigation or other water use in the watershed area above Oroville. Present depletion of stream flow for such purposes is estimated to be about 100,000 acre-feet per year and ultimate depletion of such flow is presently estimated to be about 375,000 acre-feet per year. Development of upstream water uses which would result in depletion would cause a reduction of dependable capability at Oroville Power Plant. It was assumed that this depletion of stream flow would cause a reduction in the dependable capability by 1,900 kilowatts per year. As a practical consideration, reduction of dependable capacity would probably occur at five year intervals or in increments of 9,500 kilowatts. Such a reduction in the dependable capability of the Oroville Power Plant has been used in each financial analysis.

It is anticipated that delivery of the full supplies of water of 3,880,000 acre-feet per year by the Feather River Project Aqueduct would not occur until 29 years after completion of the power plant in 1963. It is also estimated that prior to 1991 adjustments in reservoir operation could be made to maintain the 410,000 kilowatts of dependable capability.

Water Revenues

Water delivery rates have been assumed for the several financial analyses presented herein. They are based on an allocation of the distribution of multiple-purpose costs according to total water deliveries to each area, plus any single purpose costs chargeable to a specific area. The water prices used for each analysis are as follows:

Financial analysis	Feather River Project Aqueduct	*Dollars per acre-foot* San Joaquin Valley: Fresno, Kings, and Northern Kern Counties	San Joaquin Valley: Southern Kern County	Alameda, Santa Clara, and San Benito Counties	Southern California
1	Delta to Barrett Reservoir	$8.00	$9.00	$22.50	$45.00
2	Delta to San Bernardino	7.00	8.00	20.00	35.00
3	Delta to Castaic	7.00	8.00	17.50	25.00
4	Coastal Line to Castaic	8.00	9.00	20.00	45.00
5	Long Tunnel Line to Castaic	8.00	9.00	20.00	35.00

The total water revenues obtainable from the application of the above rates to the water delivery amounts as scheduled are shown in the respective financial analysis.

FINANCIAL ANALYSES

The financing of the project for these analyses is on the basis of issuance and sale of general obligation bonds over a programmed step construction period timed to a water delivery schedule, both of which have been discussed previously in Chapter III. The revenues from water and power have been applied to meet the annual costs which have previously been described. The amount of the annual costs that could not be met from current revenues from water and power would be an obligation of the General Fund of the State.

The revenue from the power generated by the Oroville Power Plant is set forth in each analysis, based on a study by water years for the period 1921 through 1951. The water year 1921 has been assumed the same as the year 1963 in the payout period. The average annual electric energy output for the 30-year period mentioned has been used in each analysis for the years following that period, together with a depletion of the dependable generating capacity aforementioned. In the computations for the analyses it was assumed that the Big Bend Power Plant of the Pacific Gas and Electric Company would be purchased in the first year of construction and that it would be operated by the project agency to yield an interim power revenue for the following three and one-half years. The net revenue from that operation has been utilized for payment of construction costs in the year following its receipt. This is the reason that the cumulative bond issue shown in each financial analysis does not agree with the total estimated cost given for the plan covered by that analysis.

A description of the features included in each financial analysis and their estimated cost are given in Chapter II of this report. The construction program, cost of each step of construction and the accomplishments of each step, for each analysis given in the subsequent section of this chapter, are set forth in Chapter III.

Financial Analysis No. 1—Feather River Project Using the High Line Route From Delta to Barrett Reservoir

This analysis includes the Oroville Reservoir Dam, Power Plant and afterbays, Feather River Project Aqueduct from Sacramento-San Joaquin Delta to Barrett Reservoir using the High Line Route and the Alameda-Santa Clara-San Benito Branch of that aqueduct. The estimated capital cost of the plan set forth in this financial analysis is $1,592,908,000, which includes the construction cost, contingencies, engineering and administration and interest during construction.

The water rates that were used in estimating the water revenues shown in the analysis are as follows:

Area	*Revenue in dollars per acre-foot*
Fresno, Kings and northern Kern Counties	$8.00
Southern Kern County	9.00
Alameda, Santa Clara, San Benito Counties	22.50
Southern California south of Tehachapi Mountains	45.00

The revenues are given for each year in the analysis itself, based on the schedule of anticipated water deliveries.

The financial analysis for this plan, from the beginning of construction to final payout, is set forth in Table 19 and the annual costs and revenues are shown graphically on Plate 18.

It will be noted from the financial analysis, that the amounts required from the General Fund in the first 42 years of the project financing, under the assumptions made, vary from zero to $22,899,000.

It may be noted that in the 42d year after the beginning of construction, and subsequently thereafter, there would be a sizeable surplus net revenue, or an excess of water and power revenues over annual costs, also, that no contribution is required from the General Fund beyond that point to final payout. This surplus revenue has not been utilized in the analysis. It could be applied to redemption of outstanding bonds and a shorter payout period realized, a reduction in the price of water could be made, or returned to the State Treasury in repayment of the advances made from the General Fund.

The total estimated obligation of the General Fund of the State as computed in this analysis is $496,988,000 for the period 1959 through 1996, which is about 8 per cent of the entire income required to meet the annual costs in the period of payout. The average annual obligation for the 38-year period would be about $13,100,000, and the maximum computed amount $22,899,000. The total power revenue, water revenue and obligation of the General Fund for the entire period covered by the financial analysis, from the beginning of construction to final payout, is set forth in Table 24.

The relation of the cumulative bond issue for this financial analysis to the total amount of bonds outstanding at five year intervals and in the year where each is a maximum is given in the following tabulation:

Number of years after Jan. 1, 1956	*Calendar year*	*Cumulative bond issue*	*Total bonds outstanding*
1	1956	$148,866,000	$148,866,000
5	1960	613,426,000	613,426,000
10	1965	805,271,000	805,271,000
15	1970	888,571,000	853,306,000
20	1975	1,496,657,000	*1,369,341,000*
25	1980	1,515,545,000	1,271,596,000
30	1985	1,560,333,000	1,160,918,000
31	1986	1,585,139,000	1,141,649,000
35	1990		953,972,000
40	1995		686,846,000
45	2000		453,615,000
50	2005		298,497,000
55	2010		149,194,000
60	2015		29,572,000
65	2020		11,402,000
70	2025		1,156,000
71	2026		0

Financial Analysis No. 2—Feather River Project Using the High Line Route From the Delta to San Bernardino

This analysis includes the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to San Bernardino, the Alameda-Santa Clara-San Benito Branch and the Devil Canyon Power Development as previously described in Chapter II. The estimated capital cost of the plan set forth in this financial analysis is $1,491,147,000 which includes the construction cost, contingencies, engineering and administration and interest during construction.

The water rates that were used in estimating the water revenue shown in the analysis are as follows:

Area	*Revenue in dollars per acre-foot*
Fresno, Kings and northern Kern Counties	7.00
Southern Kern County	8.00
Alameda, Santa Clara, San Benito Counties	20.00
Southern California south of Tehachapi Mountains	35.00

The revenues are given for each year in the analysis itself, based on the schedule of anticipated water deliveries.

It will be noted from the financial analysis that the amounts required from the General Fund in the first 42 years of the project financing, under the assumptions made, vary from zero to $22,480,000.

The financial analysis for this plan, from the beginning of construction to final payout, is set forth in Table 20 and the annual costs and revenues are shown graphically on Plate 18.

It may also be noted that in the 43d year after the beginning of construction, and subsequently thereafter, there would be a sizeable surplus net revenue, or an excess of water and power revenues over annual costs, also, that no contribution is required from the General Fund beyond that point to final payout. This surplus revenue has not been utilized in the analysis. It could be applied to redemption of outstanding bonds and a shorter payout period realized, a reduction in the price of water could be made, or returned to the State Treasury in repayment of the advances made from the General Fund.

The total estimated obligation of the General Fund of the State as computed in this analysis is $531,625,000 for the period 1959 to 1997, inclusive, which is about 9 percent of the entire income required to meet the annual costs in the period of payout. The average annual obligation for the 39-year period would be about $13,700,000, and the maximum computed amount $22,480,000. The total power revenue, water revenue and obligation of the General Fund for the entire period covered by the financial analysis from the beginning of construction to final payout is set forth in Table 24.

The relation of the cumulative bond issue for this financial analysis to the total amount of bonds outstanding at five year intervals and in the year where each is a maximum is given in the following tabulation.

Number of years after Jan. 1, 1956	*Calendar year*	*Cumulative bond issue*	*Total bonds outstanding*
1	1956	$148,866,000	$148,866,000
5	1960	613,426,000	613,426,000
10	1965	805,271,000	805,271,000
15	1970	888,571,000	853,306,000
20	1975	1,343,417,000	*1,216,101,000*
25	1980	1,377,873,000	1,133,924,000
30	1985	1,442,865,000	1,049,673,000
32	1987	*1,483,378,000*	1,008,317,000
35	1990		877,062,000
40	1995		628,533,000
45	2000		413,786,000
50	2005		278,993,000
55	2010		152,682,000
60	2015		46,021,000
65	2020		18,206,000
70	2025		2,254,000
72	2027		0

Financial Analysis No. 3—Feather River Project Using the High Line Route From the Delta to Castaic Creek Reservoir

The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Quail Lake Forebay, the Alameda-Santa Clara-San Benito Branch and the Castaic Power Development. The estimated capital cost of the plan set forth in this financial analysis is $1,395,522,000 which includes the construction cost, contingencies, engineering and administration and interest during construction.

The water rates that were used in estimating the water revenue shown in the analysis are as follows:

Area	Revenue in dollars per acre-foot
Fresno, Kings and northern Kern Counties	$7.00
Southern Kern County	8.00
Alameda, Santa Clara, San Benito Counties	17.50
Southern California south of Tehachapi Mountains	25.00

The revenues are given for each year in the analysis itself, based on the schedule of anticipated water deliveries.

The financial analysis for this plan, from the beginning of construction to final payout, is set forth in Table 21 and the annual costs and revenues are shown graphically on Plate 18.

It may be noted from the financial analysis that the amounts required from the General Fund in the first 44 years of the project financing, under the assumptions made, vary from zero to $26,469,000.

It may also be noted that in the 45th year after the beginning of construction, and subsequently thereafter, there would be a sizeable surplus net revenue, or an excess of water and power revenues over annual costs, and that no contribution from the General Fund would be required beyond that point to final payout. *This surplus revenue has not been utilized* in the analysis. It could be applied to redemption of outstanding bonds and a shorter payout period realized, or a reduction in the price of water could be made, or returned to the State Treasury in repayment of the advances made from the General Fund.

The total estimated obligation of the General Fund of the State as computed in this analysis is $720,429,000 for the period 1959 to 1997, inclusive, which is about 13.5 percent of the entire income required to meet the annual costs in the period of payout. The average annual obligation for the 39-year period would be about $18,500,000, and the maximum computed amount $26,469,000. The total power revenue, water revenue and obligation of the General Fund for the entire period covered by the financial analysis from the beginning of construction to final payout is set forth in Table 24.

The relation of the cumulative bond issue for this financial analysis to the total amount of bonds outstanding at five-year intervals and in the year where each is a maximum is given in the following tabulation:

Number of years after Jan. 1, 1956	Calendar year	Cumulative bond issue	Total bonds outstanding
1	1956	$148,866,000	$148,866,000
5	1960	613,426,000	613,426,000
10	1965	805,271,000	805,271,000
15	1970	888,571,000	853,306,000
20	1975	1,261,168,000	*1,133,852,000*
25	1980	1,292,427,000	1,048,479,000
30	1985	1,349,996,000	959,500,000
32	1987	*1,387,753,000*	919,319,000
35	1990		$794,445,000
40	1995		558,273,000
45	2000		358,210,000
50	2005		240,127,000
55	2010		132,724,000
60	2015		41,800,000
65	2020		16,559,000
70	2025		2,071,000
72	2027		0

Financial Analysis No. 4—Feather River Project Using the High Line Route From the Delta to Devils Den and an Extension to Wheeler Ridge and Via the Coastal Line to Castaic Creek Reservoir

The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Devils Den, an extension of the aqueduct to Wheeler Ridge, the Alameda-Santa Clara-San Benito Branch and the Coastal Line from Devils Den to Castaic Creek Reservoir and that reservoir. The estimated capital cost of the plan set forth in this financial analysis is $1,549,988,000 which includes the construction cost, contingencies, engineering and administration and interest during construction.

The water rates that were used in estimating the water revenue as shown in the analysis are as follows:

Area	Revenue in dollars per acre-foot
Fresno, Kings and northern Kern Counties	$8.00
Southern Kern County	9.00
Alameda, Santa Clara, San Benito Counties	20.00
Southern California south of Tehachapi Mountains	45.00

The financial analysis for this plan, from the beginning of construction to final layout, is set forth in Table 22.

It may be noted from the financial analysis that the amounts required from the General Fund of the State in the first 41 years of the project financing, under the assumptions made, vary from zero to $22,504,000.

It may be noted that in the forty-second year after beginning of construction, and subsequently thereafter, there would be a sizeable surplus net revenue, or an excess of water and power revenues over annual costs, and that no contribution from the General Fund would be required beyond that point to final payout. This surplus revenue has not been utilized in the analysis. It could be applied to redemption of outstanding bonds and a shorter payout period realized, or a reduction in the price of water could be made, or returned to the State Treasury in repayment of the advances made from the General Fund.

The total estimated obligation of the General Fund of the State as computed in this analysis is $496,842,000 for the period 1959 through 1996, which is about 9.5 percent of the entire income required to meet the annual costs in the period of payout. The average annual obligation for the 38-year period would be about $13,100,000 and the maximum computed amount $22,504,000. The total power revenue, water revenue and obligation of the General Fund for the entire period covered by the financial analysis from the beginning of construction to final payout is set forth in Table 24.

The relation of the cumulative bond issue for this financial analysis to the total amount of bonds outstanding at five-year intervals and in the year where each is a maximum is given in the following tabulation:

Number of years after Jan. 1, 1956	Calendar year	Cumulative bond issue	Total bonds outstanding
1	1956	$148,456,000	$148,456,000
5	1960	607,512,000	607,512,000
10	1965	799,357,000	799,357,000
15	1970	882,657,000	847,714,000
20	1975	1,477,259,000	1,351,016,000
25	1980	1,490,389,000	1,248,361,000
30	1985	1,522,730,000	1,125,061,000
31	1986	*1,542,219,000*	1,100,960,000
35	1990		915,380,000
40	1995		652,703,000
45	2000		424,954,000
50	2005		275,365,000
55	2010		132,317,000
60	2015		22,155,000
65	2020		8,852,000
70	2025		908,000
71	2026		0

Financial Analysis No. 5—Feather River Project Using the High Line Route From the Delta to Pastoria Creek and Via the Long Tunnel Line to Castaic Creek Reservoir

The features include the Oroville Reservoir, Dam and Power Plant, two afterbays, the Feather River Project Aqueduct from the Sacramento-San Joaquin Delta to Pastoria Creek, the Alameda-Santa Clara-San Benito Branch, the Long Tunnel Line to Castaic Creek Reservoir and that reservoir. The estimated capital cost of the plan set forth in this analysis is $1,381,841,000 which includes the construction cost, contingencies, engineering and administration and interest during construction.

The water rates that were used in estimating the water revenue shown in the analysis are as follows:

Area	Revenue in dollars per acre-foot
Fresno, Kings and northern Kern Counties	$8.00
Southern Kern County	9.00
Alameda, Santa Clara and San Benito Counties	20.00
Southern California south of Tehachapi Mountains	35.00

The revenues are given for each year in the analysis itself, based on the schedule of anticipated water deliveries.

The financial analysis for this plan, from the beginning of construction to final payout, is set forth in Table 23.

It may be noted from the financial analysis that the amounts required from the General Fund of the State in the first 42 years of the project financing under the assumptions made, vary from zero to $22,426,000.

It may also be noted that in the forty-third year after the beginning of construction, and subsequently thereafter, there would be a sizeable surplus net revenue, or an excess of water and power revenues over annual costs, and that no contribution from the General Fund would be required beyond that point to final payout. This surplus revenue has not been utilized in the analysis. It could be applied to redemption of outstanding bonds and a shorter payout period realized, to a reduction in the price of water, or returned to the State Treasury in repayment of the advances made from the General Fund.

The total estimated obligation of the General Fund of the State as computed in the analysis is $594,428,000 for the period 1959 to 1997 inclusive, which is about 12.5 percent of the entire income required to meet the annual costs in the period of payout. The average annual obligation for the 39-year period would be about $15,200,000, and the maximum annual amount would be $22,426,000.

The total power revenue, water revenue and obligation of the General Fund for the entire period covered by the financial analysis from the beginning of construction to final payout is set forth in Table 24.

The relation of the cumulative bond issue for this financial analysis to the total amount of bonds outstanding at five-year intervals and in the year where each is a maximum is given in the following tabulation:

Number of years after Jan. 1, 1956	Calendar year	Cumulative bond issue	Total bonds outstanding
1	1956	$148,866,000	$148,866,000
5	1960	613,426,000	613,426,000
10	1965	805,271,000	805,271,000
15	1970	1,004,915,000	969,463,000
20	1975	1,323,452,000	*1,196,133,000*
25	1980	1,335,162,000	1,089,410,000
30	1985	1,360,639,000	948,699,000
31	1986	*1,374,072,000*	921,688,000
35	1990		749,497,000
40	1995		506,088,000
45	2000		301,822,000
50	2005		179,769,000
55	2010		71,648,000
60	2015		16,837,000
65	2020		6,447,000
70	2025		626,000
71	2026		0

Comparison of Total Revenues From All Sources Used for Financial Analyses of Feather River Project

The total revenues, or income, from all sources from the beginning of construction to final payout of all bonds is set forth in Table 24, for the five financial analyses presented herein. The total amounts of the revenues estimated to be realized from the sale of water and power, and the amounts required to be advanced from the General Fund of the State are given in the table.

The total water revenues vary from 57.9 percent of the estimated income from all sources for Financial Analysis No. 3 to 79 percent for Financial Analysis No. 1. The power revenues vary from 13 percent of the estimated income from all sources for Financial Analysis No. 1 to 28.8 percent for Financial Analysis No. 3. The obligation of the General Fund varies from 8 percent of the total income from all sources for Financial Analysis No. 1 to 13.3 percent for Financial analysis No. 3. The financial analyses were computed with water rates to Southern California to the nearest five-dollar amount. An addition of $2 per acre-foot to the water rate of $25 used in Analysis No. 3, and of $1 per acre-foot to the water rate of $35 used in Analysis No. 5 would put the five analyses on about the same basis with relation to requirements from the General Fund.

TABLE 24

Comparison of Total Revenues From All Sources for Five Financial Analyses of Feather River Project to End of Payout Period

Financial Analysis No.	1	2	3	4	5
Power Revenue					
Oroville Power Plant	$800,532,000	$811,480,000	$811,480,000	$800,532,000	$800,532,000
Devil Canyon Power Plant		646,068,000			
Castaic Creek Power Plants			753,020,000		
Total power revenue	$800,532,000	$1,457,548,000	$1,564,500,000	$800,532,000	$800,532,000
Percent of total revenue	13.0	24.3	28.8	15.4	16.8
Water Revenue					
Fresno, Kings and northern Kern Counties	$736,720,000	$655,060,000	$655,060,000	$736,720,000	$736,720,000
Southern Kern County	192,600,000	174,000,000	174,000,000	425,880,000	425,880,000
Alameda, Santa Clara, San Benito Counties	307,800,000	278,400,000	243,600,000	273,600,000	273,600,000
Southern California	3,645,000,000	2,898,000,000	2,070,000,000	2,478,600,000	1,927,800,000
Total water revenue	$4,882,120,000	$4,005,460,000	$3,142,660,000	$3,914,800,000	$3,364,000,000
Percent of total revenue	79.0	66.8	57.9	75.1	70.7
Total obligation of General Fund	496,988,000	531,685,000	720,429,000	497,342,000	594,428,000
Percent of total revenue	8.0	8.9	13.3	9.5	12.5
Total revenue	$6,179,640,000	$5,994,693,000	$5,427,589,000	$5,212,674,000	$4,758,960,000
Total revenues in excess of total annual costs	$1,133,874,000	$1,039,776,000	$638,126,000	$1,121,307,000	$896,765,000

TABLE 19

UE $1,585,139,000

a and San area	Southern California area		Total	Total	Obligation of General Fund	Annual revenues in excess of annual costs
evenue at 22.50 per cre-foot	Acre-feet	Revenue at $45.00 per acre-foot				
			$4,950,000	$4,950,000	$6,023,000	
			4,950,000	4,950,000	6,023,000	
			4,950,000	4,950,000	6,023,000	
			4,950,000	4,950,000	6,023,000	
			4,950,000	19,710,000	2,404,000	
$1,350,000			8,060,000	22,828,000	2,950,000	
1,620,000			9,090,000	21,463,000	4,537,000	
1,890,000			10,120,000	22,226,000	7,391,000	
2,160,000			11,150,000	23,131,000	10,336,000	
2,430,000			12,180,000	24,479,000	13,636,000	
2,700,000			13,514,000	27,946,000	11,775,000	
2,970,000			14,848,000	28,084,000	15,489,000	
3,240,000			16,182,000	28,306,000	17,125,000	
3,510,000			17,516,000	30,265,000	17,571,000	
3,780,000			18,850,000	30,829,000	18,416,000	
4,050,000			19,120,000	31,103,000	18,287,000	
4,320,000			19,390,000	31,368,000	18,168,000	
4,590,000	450,000	$20,250,000	39,910,000	51,884,000	22,899,000	
4,860,000	540,000	24,300,000	44,230,000	56,782,000	20,534,000	
5,130,000	630,000	28,350,000	48,550,000	62,069,000	18,053,000	
5,400,000	720,000	32,400,000	52,870,000	66,313,000	16,895,000	
5,400,000	810,000	36,450,000	56,920,000	71,546,000	13,739,000	
5,400,000	900,000	40,500,000	60,970,000	73,011,000	14,360,000	
5,400,000	990,000	44,550,000	65,020,000	79,230,000	14,278,000	
5,400,000	1,080,000	48,600,000	69,070,000	84,513,000	13,795,000	
5,400,000	1,170,000	52,650,000	73,120,000	89,113,000	15,728,000	
5,400,000	1,260,000	56,700,000	77,170,000	91,859,000	19,449,000	
5,400,000	1,350,000	60,750,000	81,220,000	94,163,000	19,215,000	
5,400,000	1,440,000	64,800,000	85,270,000	99,305,000	17,758,000	
5,400,000	1,530,000	68,850,000	89,320,000	103,277,000	15,874,000	
5,400,000	1,620,000	72,900,000	93,370,000	105,760,000	15,555,000	
5,400,000	1,710,000	76,950,000	97,420,000	110,806,000	12,974,000	
5,400,000	1,800,000	81,000,000	101,470,000	113,684,000	12,762,000	
5,400,000	1,800,000	81,000,000	101,470,000	116,352,000	10,094,000	
5,400,000	1,800,000	81,000,000	101,470,000	115,970,000	10,476,000	
5,400,000	1,800,000	81,000,000	101,470,000	114,812,000	11,702,000	
5,400,000	1,800,000	81,000,000	101,470,000	114,812,000	12,012,000	
5,400,000	1,800,000	81,000,000	101,470,000	113,615,000	6,659,000	
5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		$947,000
5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		10,012,000
5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		12,722,000
5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		15,547,000
5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		18,435,000
5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		22,416,000
5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		24,318,000
5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		25,217,000
5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		26,661,000
5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		28,300,000
5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		28,300,000
5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		28,100,000
5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		33,000,000
5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		38,501,000
5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		45,012,000
5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		57,166,000
5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		57,131,000
5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		57,869,000
5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,150,000
5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,800,000
5,400,000	1,800,000	81,000,000	101,470,000	112,418,000		60,797,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 1

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO SAN DIEGO COUNTY—GENERAL OBLIGATION BOND ISSUE $1,585,139,000

Cumulative bond issue	ANNUAL COSTS: Interest and repayment of bond issue (Debt service)	ANNUAL COSTS: Replacements	ANNUAL COSTS: Operation and maintenance costs	ANNUAL COSTS: Cost of power for pumping	ANNUAL COSTS: General expenses	ANNUAL COSTS: Total	ANNUAL REVENUES: Power Revenues, Oroville Power Plant: Dependable generating capacity in kilowatts	Power Revenues, Oroville Power Plant: Electric energy at power plant bus in millions of kilowatt hours	Power Revenues, Oroville Power Plant: Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues, Fresno, Kings and Northern Kern Counties area: Acre-feet	Fresno, Kings and Northern Kern Counties area: Revenue at $8.00 per acre-foot	Southern Kern County area: Acre-feet	Southern Kern County area: Revenue at $9.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Alameda, Santa Clara and San Benito Counties area: Revenue at $22.50 per acre-foot	Southern California area: Acre-feet	Southern California area: Revenue at $45.00 per acre-foot	Water Revenues: Total	ANNUAL REVENUES: Total	Obligation of General Fund	Annual revenues in excess of annual costs
$148,866,000																					
307,989,000																					
497,628,000																					
554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000				450,000	$3,600,000	150,000	$1,350,000					$4,950,000	$4,950,000	$6,023,000	
613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000					4,950,000	19,710,000	2,404,000	
805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,350,000			8,060,000	22,828,000	2,950,000	
805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,620,000			9,090,000	21,463,000	4,537,000	
805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,890,000			10,120,000	22,226,000	7,391,000	
824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	2,160,000			11,150,000	23,131,000	10,336,000	
854,283,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,430,000			12,180,000	24,479,000	13,636,000	
888,571,000	32,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000	1,138,000	9,104,000	190,000	1,710,000	120,000	2,700,000			13,514,000	27,946,000	11,775,000	
888,571,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,970,000			14,848,000	28,084,000	15,489,000	
888,571,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	3,240,000			16,182,000	28,306,000	17,125,000	
991,071,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,510,000			17,516,000	30,265,000	17,571,000	
1,106,177,000	40,574,000	864,000	1,696,000	5,615,000	496,000	49,245,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,780,000			18,850,000	30,829,000	18,416,000	
1,305,170,000	40,574,000	864,000	1,696,000	5,760,000	496,000	49,390,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	4,050,000			19,120,000	31,103,000	18,287,000	
1,496,657,000	40,574,000	864,000	1,696,000	5,906,000	496,000	49,536,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	4,320,000			19,390,000	31,368,000	18,168,000	
1,496,657,000	55,776,000	1,605,000	2,742,000	14,164,000	496,000	74,783,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	350,000	3,150,000	204,000	4,590,000	450,000	$20,250,000	39,910,000	51,884,000	22,899,000	
1,496,657,000	56,205,000	1,605,000	2,742,000	16,268,000	496,000	77,316,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	350,000	3,150,000	216,000	4,860,000	540,000	24,300,000	44,230,000	56,782,000	20,534,000	
1,496,657,000	56,894,000	1,605,000	2,742,000	18,385,000	496,000	80,122,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	350,000	3,150,000	228,000	5,130,000	630,000	28,350,000	48,550,000	62,069,000	18,053,000	
1,500,095,000	57,676,000	1,605,000	2,742,000	20,689,000	496,000	83,208,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	720,000	32,400,000	52,870,000	66,313,000	16,895,000	
1,515,545,000	57,676,000	1,605,000	2,742,000	22,766,000	496,000	85,285,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	350,000	3,150,000		5,400,000	810,000	36,450,000	56,920,000	71,546,000	13,739,000	
1,543,716,000	57,676,000	1,605,000	2,742,000	24,852,000	496,000	87,371,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	900,000	40,500,000	60,970,000	73,011,000	14,360,000	
1,543,716,000	61,189,000	1,925,000	2,872,000	27,026,000	496,000	93,508,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	990,000	44,550,000	65,020,000	79,230,000	14,278,000	
1,543,716,000	63,812,000	1,925,000	2,872,000	29,203,000	496,000	98,308,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,080,000	48,600,000	69,070,000	84,513,000	13,795,000	
1,546,737,000	68,350,000	1,925,000	2,872,000	31,198,000	496,000	104,841,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,170,000	52,650,000	73,120,000	89,113,000	15,728,000	
1,560,333,000	72,715,000	1,925,000	2,872,000	33,300,000	496,000	111,308,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,260,000	56,700,000	77,170,000	91,859,000	19,449,000	
1,585,139,000	72,715,000	1,925,000	2,872,000	35,370,000	496,000	113,378,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,350,000	60,750,000	81,220,000	94,163,000	19,215,000	
	73,751,000	2,205,000	2,880,000	37,528,000	699,000	117,063,000	410,000	1,972.7	14,035,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,440,000	64,800,000	85,270,000	99,305,000	17,758,000	
	73,751,000	2,205,000	2,880,000	39,616,000	699,000	119,151,000	410,000	1,944.5	13,957,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,530,000	68,850,000	89,320,000	103,277,000	15,874,000	
	73,830,000	2,205,000	2,880,000	41,701,000	699,000	121,315,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,620,000	72,900,000	93,370,000	105,760,000	15,555,000	
	74,182,000	2,205,000	2,880,000	43,814,000	699,000	123,780,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,710,000	76,950,000	97,420,000	110,806,000	12,974,000	
	74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,684,000	12,762,000	
	74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	116,352,000	10,094,000	
	74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	115,970,000	10,476,000	
	74,893,000	2,205,000	2,880,000	45,837,000	699,000	126,514,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	114,812,000	11,702,000	
	75,203,000	2,205,000	2,880,000	45,837,000	699,000	126,824,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	114,812,000	12,012,000	
	68,653,000	2,205,000	2,880,000	45,837,000	699,000	120,274,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,615,000	6,659,000	
	61,047,000	2,205,000	2,880,000	45,837,000	699,000	112,668,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		$947,000
	51,982,000	2,205,000	2,880,000	45,837,000	699,000	103,603,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		10,012,000
	49,272,000	2,205,000	2,880,000	45,837,000	699,000	100,893,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		12,722,000
	46,447,000	2,205,000	2,880,000	45,837,000	699,000	98,068,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,615,000		15,547,000
	43,360,000	2,205,000	2,880,000	45,837,000	699,000	94,981,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		18,435,000
	39,379,000	2,205,000	2,880,000	45,837,000	699,000	91,000,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		22,416,000
	37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
	37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
	37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,416,000		24,518,000
	37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		24,318,000
	36,378,000	2,205,000	2,880,000	45,837,000	699,000	87,999,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		25,217,000
	34,934,000	2,205,000	2,880,000	45,837,000	699,000	86,555,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		26,661,000
	33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		28,300,000
	33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,216,000		28,300,000
	33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		28,100,000
	28,395,000	2,205,000	2,880,000	45,837,000	699,000	80,016,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		33,000,000
	22,894,000	2,205,000	2,880,000	45,837,000	699,000	74,515,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		38,501,000
	13,383,000	2,205,000	2,880,000	45,837,000	699,000	65,004,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		48,012,000
	4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	113,016,000		57,166,000
	4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
	4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
	4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		56,967,000
	4,065,000	2,205,000	2,880,000	45,837,000	699,000	55,686,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		57,131,000
	3,327,000	2,205,000	2,880,000	45,837,000	699,000	54,948,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,817,000		57,869,000
	1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
	1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
	1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,006,000
	1,836,000	2,205,000	2,880,000	45,837,000	699,000	53,457,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,150,000
	1,186,000	2,205,000	2,880,000	45,837,000	699,000	52,807,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,607,000		59,800,000
	0	2,205,000	2,880,000	45,837,000	699,000	51,621,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000	81,000,000	101,470,000	112,418,000		60,797,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 1

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO SAN DIEGO COUNTY—GENERAL OBLIGATION BOND ISSUE $1,585,139,

Water year	Number of years after Jan. 1, 1956	Calendar year	Construction cost including contingencies, engineering and administration	Interest during construction	Bond issue for year	Cumulative bond issue	ANNUAL COSTS: Interest and repayment of bond issue (Debt service)	Replacements	Operation and maintenance costs	Cost of power for pumping	General expenses	Total	ANNUAL REVENUES: Power Revenues — Oroville Power Plant: Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues — Fresno, Kings and Northern Kern Counties area: Acre-feet	Revenue at $8.00 per acre-foot	Southern Kern County area: Acre-feet	Revenue at $9.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Revenue at $22.50 per acre-foot	Southern ar: Acre-feet
	1	1956	$145,235,000	$3,631,000	$148,866,000	$148,866,000																
	2	1957	151,611,000	7,512,000	159,123,000	307,989,000																
	3	1958	177,502,000	12,137,000	189,639,000	497,628,000																
	4	1959	50,746,000	5,946,000	56,692,000	554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000				450,000	$3,600,000	150,000	$1,350,000			
	5	1960	51,719,000	7,387,000	59,106,000	613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000			
	6	1961	55,613,000	8,962,000	64,575,000	678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000			
	7	1962	72,287,000	10,995,000	83,282,000	761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000			
1921	8	1963	41,943,000	2,045,000	43,988,000	805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000			
1922	9	1964				805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,350,000	
1923	10	1965				805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,620,000	
1924	11	1966				805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,890,000	
1925	12	1967	18,347,000	459,000	18,806, 00	824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	2,160,000	
1926	13	1968	29,011,000	1,195,000	30,206,000	854,283,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,430,000	
1927	14	1969	32,257,000	2,031,000	34,288,000	888,571,000	32,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000	1,138,000	9,104,000	190,000	1,710,000	120,000	2,700,000	
1928	15	1970				888,571,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,970,000	
1929	16	1971				888,571,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	3,240,000	
1930	17	1972	100,000,000	2,500,000	102,500,000	991,071,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,510,000	
1931	18	1973	109,799,000	5,307,000	115,106,000	1,106,177,000	40,574,000	864,000	1,696,000	5,615,000	496,000	49,245,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,780,000	
1932	19	1974	188,832,000	10,161,000	198,993,000	1,305,170,000	40,574,000	864,000	1,696,000	5,760,000	496,000	49,390,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	4,050,000	
1933	20	1975	176,656,000	14,831,000	191,487,000	1,496,657,000	40,574,000	864,000	1,696,000	5,906,000	496,000	49,536,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	4,320,000	
1934	21	1976				1,496,657,000	55,776,000	1,605,000	2,742,000	14,164,000	496,000	74,783,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	350,000	3,150,000	204,000	4,590,000	450,000
1935	22	1977				1,496,657,000	56,205,000	1,605,000	2,742,000	16,268,000	496,000	77,316,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	350,000	3,150,000	216,000	4,860,000	540,000
1936	23	1978				1,496,657,000	56,894,000	1,605,000	2,742,000	18,385,000	496,000	80,122,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	350,000	3,150,000	228,000	5,130,000	630,000
1937	24	1979	3,354,000	84,000	3,438,000	1,500,095,000	57,676,000	1,605,000	2,742,000	20,689,000	496,000	83,208,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	720,000
1938	25	1980	14,989,000	461,000	15,450,000	1,515,545,000	57,676,000	1,605,000	2,742,000	22,766,000	496,000	85,285,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	350,000	3,150,000		5,400,000	810,000
1939	26	1981	27,023,000	1,148,000	28,171,000	1,543,716,000	57,676,000	1,605,000	2,742,000	24,852,000	496,000	87,371,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	900,000
1940	27	1982				1,543,716,000	61,189,000	1,925,000	2,872,000	27,026,000	496,000	93,508,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	990,000
1941	28	1983				1,543,716,000	63,812,000	1,925,000	2,872,000	29,203,000	496,000	98,308,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,080,000
1942	29	1984	2,947,000	74,000	3,021,000	1,546,737,000	68,350,000	1,925,000	2,872,000	31,198,000	496,000	104,841,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,170,000
1943	30	1985	13,190,000	406,000	13,596,000	1,560,333,000	72,715,000	1,925,000	2,872,000	33,300,000	496,000	111,308,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,260,000
1944	31	1986	23,795,000	1,011,000	24,806,000	1,585,139,000	72,715,000	1,925,000	2,872,000	35,370,000	496,000	113,378,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,350,000
1945	32	1987					73,751,000	2,205,000	2,880,000	37,528,000	699,000	117,063,000	410,000	1,972.7	14,035,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,440,000
1946	33	1988					73,751,000	2,205,000	2,880,000	39,616,000	699,000	119,151,000	410,000	1,944.5	13,957,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,530,000
1947	34	1989					73,830,000	2,205,000	2,880,000	41,701,000	699,000	121,315,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,620,000
1948	35	1990					74,182,000	2,205,000	2,880,000	43,814,000	699,000	123,780,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,710,000
1949	36	1991					74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
1950	37	1992					74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
1951	38	1993					74,825,000	2,205,000	2,880,000	45,837,000	699,000	126,446,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	39	1994					74,803,000	2,205,000	2,880,000	45,837,000	699,000	126,514,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	40	1995					75,203,000	2,205,000	2,880,000	45,837,000	699,000	126,824,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	41	1996					68,653,000	2,205,000	2,880,000	45,837,000	699,000	120,274,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	42	1997					61,047,000	2,205,000	2,880,000	45,837,000	699,000	112,668,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	43	1998					51,982,000	2,205,000	2,880,000	45,837,000	699,000	103,603,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	44	1999					49,272,000	2,205,000	2,880,000	45,837,000	699,000	100,893,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	45	2000					46,447,000	2,205,000	2,880,000	45,837,000	699,000	98,068,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	46	2001					43,360,000	2,205,000	2,880,000	45,837,000	699,000	94,981,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	47	2002					39,379,000	2,205,000	2,880,000	45,837,000	699,000	91,000,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	48	2003					37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	49	2004					37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	50	2005					37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	51	2006					37,277,000	2,205,000	2,880,000	45,837,000	699,000	88,898,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	52	2007					36,378,000	2,205,000	2,880,000	45,837,000	699,000	87,999,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	53	2008					34,934,000	2,205,000	2,880,000	45,837,000	699,000	86,555,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	54	2009					33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	55	2010					33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	56	2011					33,295,000	2,205,000	2,880,000	45,837,000	699,000	84,916,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	57	2012					28,395,000	2,205,000	2,880,000	45,837,000	699,000	80,016,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	58	2013					22,894,000	2,205,000	2,880,000	45,837,000	699,000	74,515,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	59	2014					13,383,000	2,205,000	2,880,000	45,837,000	699,000	65,004,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	60	2015					4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	61	2016					4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	62	2017					4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	63	2018					4,229,000	2,205,000	2,880,000	45,837,000	699,000	55,850,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	64	2019					4,065,000	2,205,000	2,880,000	45,837,000	699,000	55,686,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	65	2020					3,327,000	2,205,000	2,880,000	45,837,000	699,000	54,948,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	66	2021					1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	67	2022					1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	68	2023					1,980,000	2,205,000	2,880,000	45,837,000	699,000	53,601,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	69	2024					1,836,000	2,205,000	2,880,000	45,837,000	699,000	53,457,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	70	2025					1,186,000	2,205,000	2,880,000	45,837,000	699,000	52,807,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000
Average	71	2026					0	2,205,000	2,880,000	45,837,000	699,000	51,621,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	350,000	3,150,000	240,000	5,400,000	1,800,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 2

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO SAN BERNARDINO—GENERAL OBLIGATION BOND ISSUE $1,483,378,000

ANNUAL COSTS: …erest …nd …yment …of …ond …sue …service)	ANNUAL COSTS: Replacements	ANNUAL COSTS: Operation and maintenance costs	ANNUAL COSTS: Cost of power for pumping	ANNUAL COSTS: General expenses	ANNUAL COSTS: Total	Power Revenues, Oroville Power Plant: Dependable generating capacity in kilowatts	Oroville Power Plant: Electric energy at power plant bus in millions of kilowatt hours	Oroville Power Plant: Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Devil Canyon Power Plant: Dependable generating capacity in kilowatts	Devil Canyon Power Plant: Electric energy at power plant bus in millions of kilowatt hours	Devil Canyon Power Plant: Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues, Fresno, Kings and Northern Kern Counties area: Acre-feet	Fresno, Kings and Northern Kern Counties area: Revenue at $7.00 per acre-foot	Southern Kern County area: Acre-feet	Southern Kern County area: Revenue at $8.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Alameda, Santa Clara and San Benito Counties area: Revenue at $20.00 per acre-foot	Southern California area: Acre-feet	Southern California area: Revenue at $35.00 per acre-foot	Water Revenues: Total	ANNUAL REVENUES: Total	Obligation of General Fund	Annual revenues in excess of annual costs
764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000							450,000	$3,150,000	150,000	$1,200,000					$4,350,000	$4,350,000	$6,623,000	
764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000				450,000	3,150,000	150,000	1,200,000					4,350,000	19,110,000	3,004,000	
,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000				670,000	4,690,000	150,000	1,200,000	60,000	$1,200,000			7,090,000	21,858,000	3,920,000	
,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000				765,000	5,355,000	150,000	1,200,000	72,000	1,440,000			7,995,000	20,368,000	5,632,000	
,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000				860,000	6,020,000	150,000	1,200,000	84,000	1,680,000			8,900,000	21,006,000	8,611,000	
,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000				955,000	6,685,000	150,000	1,200,000	96,000	1,920,000			9,805,000	21,786,000	11,681,000	
,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000				1,050,000	7,350,000	150,000	1,200,000	108,000	2,160,000			10,710,000	23,009,000	15,106,000	
,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000				1,138,000	7,966,000	190,000	1,520,000	120,000	2,400,000			11,886,000	26,318,000	13,403,000	
,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000				1,226,000	8,582,000	230,000	1,840,000	132,000	2,640,000			13,062,000	26,298,000	17,275,000	
,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000				1,314,000	9,198,000	270,000	2,160,000	144,000	2,880,000			14,238,000	26,362,000	19,069,000	
,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000				1,402,000	9,814,000	310,000	2,480,000	156,000	3,120,000			15,414,000	28,163,000	19,673,000	
,575,000	864,000	1,696,000	5,615,000	496,000	49,246,000	410,000	1,225.0	11,979,000				1,490,000	10,430,000	350,000	2,800,000	168,000	3,360,000			16,590,000	28,569,000	20,677,000	
,575,000	864,000	1,696,000	5,760,000	496,000	49,391,000	410,000	1,226.7	11,983,000				1,490,000	10,430,000	350,000	2,800,000	180,000	3,600,000			16,830,000	28,813,000	20,578,000	
,575,000	864,000	1,696,000	5,906,000	496,000	49,537,000	410,000	1,224.9	11,978,000				1,490,000	10,430,000	350,000	2,800,000	192,000	3,840,000			17,070,000	29,048,000	20,489,000	
,946,000	1,669,000	2,750,000	14,164,000	496,000	71,025,000	410,000	1,223.3	11,974,000	110,000	436.8	$3,511,000	1,490,000	10,430,000	350,000	2,800,000	204,000	4,080,000	450,000	$15,750,000	33,060,000	48,545,000	22,480,000	
,375,000	1,669,000	2,750,000	16,268,000	496,000	73,558,000	410,000	1,433.3	12,552,000	132,000	524.2	4,214,000	1,490,000	10,430,000	350,000	2,800,000	216,000	4,320,000	540,000	18,900,000	36,450,000	53,216,000	20,342,000	
,063,000	1,669,000	2,750,000	18,385,000	496,000	76,363,000	410,000	1,785.3	13,519,000	154,000	611.5	4,916,000	1,490,000	10,430,000	350,000	2,800,000	228,000	4,560,000	630,000	22,050,000	39,840,000	58,275,000	18,088,000	
,845,000	1,669,000	2,750,000	20,689,000	496,000	79,449,000	410,000	1,757.3	13,443,000	176,000	698.9	5,618,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	720,000	25,200,000	43,230,000	62,291,000	17,158,000	
,234,000	1,734,000	2,808,000	22,766,000	496,000	82,038,000	410,000	2,187.6	14,626,000	198,000	786.2	6,320,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	810,000	28,350,000	46,380,000	67,326,000	14,712,000	
,234,000	1,734,000	2,808,000	24,852,000	496,000	84,124,000	410,000	1,247.8	12,041,000	220,000	873.6	7,022,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	900,000	31,500,000	49,530,000	68,593,000	15,531,000	
,462,000	2,054,000	2,938,000	27,026,000	496,000	88,976,000	410,000	2,036.3	14,210,000	242,000	961.0	7,725,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	990,000	34,650,000	52,680,000	74,615,000	14,361,000	
,517,000	2,054,000	2,938,000	29,203,000	496,000	93,208,000	410,000	2,484.6	15,443,000	264,000	1,048.3	8,427,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,080,000	37,800,000	55,830,000	79,700,000	13,508,000	
,438,000	2,118,000	2,997,000	31,198,000	496,000	99,247,000	410,000	2,684.8	15,993,000	286,000	1,135.7	9,129,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,170,000	40,950,000	58,980,000	84,102,000	15,145,000	
,286,000	2,118,000	2,997,000	33,300,000	496,000	105,197,000	410,000	2,210.6	14,689,000	308,000	1,223.0	9,831,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,260,000	44,100,000	62,130,000	86,650,000	18,547,000	
,286,000	2,118,000	2,997,000	35,370,000	496,000	107,267,000	410,000	1,575.8	12,943,000	330,000	1,301.4	10,534,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,350,000	47,250,000	65,280,000	88,757,000	18,510,000	
,321,000	2,398,000	3,005,000	37,528,000	699,000	110,951,000	410,000	1,972.7	14,035,000	352,000	1,397.8	11,236,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,440,000	50,400,000	68,430,000	93,701,000	17,250,000	
,890,000	2,463,000	3,069,000	39,616,000	699,000	113,737,000	410,000	1,944.5	13,957,000	374,000	1,485.1	11,938,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,530,000	53,550,000	71,580,000	97,475,000	16,262,000	
,148,000	2,463,000	3,069,000	41,701,000	699,000	116,080,000	410,000	1,374.7	12,390,000	396,000	1,572.5	12,640,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,620,000	56,700,000	74,730,000	99,760,000	16,320,000	
,500,000	2,463,000	3,069,000	43,814,000	699,000	118,545,000	410,000	1,736.6	13,386,000	418,000	1,659.8	13,342,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,710,000	59,850,000	77,880,000	104,608,000	13,937,000	
,142,000	2,463,000	3,069,000	45,837,000	699,000	121,210,000	410,000	1,310.5	12,214,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,289,000	13,921,000	
,353,000	2,463,000	3,069,000	45,837,000	699,000	121,421,000	410,000	2,280.8	14,882,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	109,957,000	11,464,000	
,603,000	2,463,000	3,069,000	45,837,000	699,000	121,671,000	410,000	2,141.7	14,500,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	109,575,000	12,096,000	
,672,000	2,463,000	3,069,000	45,837,000	699,000	121,740,000	410,000	1,720.6	13,342,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	108,417,000	13,323,000	
,982,000	2,463,000	3,069,000	45,837,000	699,000	122,050,000	410,000	1,720.6	13,342,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	108,417,000	13,633,000	
3,607,000	2,463,000	3,069,000	45,837,000	699,000	115,675,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,220,000	8,455,000	
3,184,000	2,463,000	3,069,000	45,837,000	699,000	108,252,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,220,000	1,032,000	
7,119,000	2,463,000	3,069,000	45,837,000	699,000	99,187,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,220,000		$8,033,000
4,409,000	2,463,000	3,069,000	45,837,000	699,000	96,477,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,220,000		10,743,000
1,584,000	2,463,000	3,069,000	45,837,000	699,000	93,652,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,220,000		13,568,000
8,497,000	2,463,000	3,069,000	45,837,000	699,000	90,565,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,021,000		16,456,000
4,516,000	2,463,000	3,069,000	45,837,000	699,000	86,584,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,021,000		20,437,000
2,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,021,000		22,539,000
2,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,021,000		22,539,000
2,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	107,021,000		22,539,000
2,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,821,000		22,339,000
1,515,000	2,463,000	3,069,000	45,837,000	699,000	83,583,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,821,000		23,238,000
0,071,000	2,463,000	3,069,000	45,837,000	699,000	82,139,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,821,000		24,682,000
8,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,821,000		26,321,000
8,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,821,000		26,321,000
8,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,621,000		26,121,000
6,227,000	2,463,000	3,069,000	45,837,000	699,000	78,295,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,621,000		28,326,000
1,919,000	2,463,000	2,069,000	45,837,000	699,000	73,987,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,621,000		32,634,000
4,758,000	2,463,000	3,069,000	45,837,000	699,000	66,826,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,621,000		39,795,000
6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,621,000		47,863,000
6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,422,000		47,664,000
6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,422,000		47,664,000
6,323,000	2,463,000	3,069,000	45,837,000	699,000	58,391,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,422,000		48,031,000
5,782,000	2,463,000	3,069,000	45,837,000	699,000	57,850,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,422,000		48,572,000
5,043,000	2,463,000	3,069,000	45,837,000	699,000	57,111,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,422,000		49,311,000
3,697,000	2,463,000	3,069,000	45,837,000	699,000	55,765,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,212,000		50,447,000
3,256,000	2,463,000	3,069,000	45,837,000	699,000	55,324,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,212,000		50,888,000
2,731,000	2,463,000	3,069,000	45,837,000	699,000	54,799,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,212,000		51,413,000
2,586,000	2,463,000	3,069,000	45,837,000	699,000	54,654,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,212,000		51,558,000
1,937,000	2,463,000	3,069,000	45,837,000	699,000	54,005,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,212,000		52,207,000
383,000	2,463,000	3,069,000	45,837,000	699,000	52,451,000	296,000	1,720.6	10,948,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,023,000		53,572,000
0	2,463,000	3,069,000	45,837,000	699,000	52,068,000	296,000	1,720.6	10,948,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000	1,800,000	63,000,000	81,030,000	106,023,000		53,955,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 2

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO SAN BERNARDINO—GENERAL OBLIGATION BOND ISSUE $1,483,378,000

Water year	Number of years after Jan. 1, 1956	Calendar year	Construction cost including contingencies, engineering and administration	Interest during construction	Bond issue for year	Cumulative bond issue	ANNUAL COSTS						ANNUAL REVENUES											
													Power Revenues						Water Revenues					
													Oroville Power Plant			Devil Canyon Power Plant			Fresno, Kings and Northern Kern Counties area		Southern Kern County area		Alameda, Santa Clara and San Benito Counties area	
							Interest and repayment of bond issue (Debt service)	Replacements	Operation and *maintenance* costs	Cost of power for pumping	General *expenses*	Total	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Acre-feet	Revenue at $7.00 per acre-foot	Acre-feet	Revenue at $8.00 per acre-foot	Acre-feet	Revenue at $20.00 per acre-foot
	1	1956	$145,235,000	$3,631,000	$148,866,000	$148,866,000																		
	2	1957	151,611,000	7,512,000	159,123,000	307,989,000																		
	3	1958	177,502,000	12,137,000	189,639,000	497,628,000																		
	4	1959	50,746,000	5,946,000	56,692,000	554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000							450,000	$3,150,000	150,000	$1,200,000		
	5	1960	51,719,000	7,387,000	59,106,000	613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
	6	1961	55,613,000	8,962,000	64,575,000	678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
	7	1962	72,287,000	10,995,000	83,282,000	761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
1921	8	1963	41,943,000	2,045,000	43,988,000	805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000				450,000	3,150,000	150,000	1,200,000		
1922	9	1964				805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000				670,000	4,690,000	150,000	1,200,000	60,000	$1,200,000
1923	10	1965				805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000				765,000	5,355,000	150,000	1,200,000	72,000	1,440,000
1924	11	1966				805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000				860,000	6,020,000	150,000	1,200,000	84,000	1,680,000
1925	12	1967	18,347,000	459,000	18,806,000	824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000				955,000	6,685,000	150,000	1,200,000	96,000	1,920,000
1926	13	1968	29,011,000	1,195,000	30,206,000	854,283,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000				1,050,000	7,350,000	150,000	1,200,000	108,000	2,160,000
1927	14	1969	32,257,000	2,031,000	34,288,000	888,571,000	32,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000				1,138,000	7,966,000	190,000	1,520,000	120,000	2,400,000
1928	15	1970				888,571,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000				1,226,000	8,582,000	230,000	1,840,000	132,000	2,640,000
1929	16	1971				888,571,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000				1,314,000	9,198,000	270,000	2,160,000	144,000	2,880,000
1930	17	1972	45,000,000	1,125,000	46,125,000	934,696,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000				1,402,000	9,814,000	310,000	2,480,000	156,000	3,120,000
1931	18	1973	86,799,000	3,323,000	90,122,000	1,024,818,000	40,575,000	864,000	1,696,000	5,615,000	496,000	49,246,000	410,000	1,225.0	11,979,000				1,490,000	10,430,000	350,000	2,800,000	168,000	3,360,000
1932	19	1974	142,832,000	6,977,000	149,809,000	1,174,627,000	40,575,000	864,000	1,696,000	5,760,000	496,000	49,391,000	410,000	1,226.7	11,983,000				1,490,000	10,430,000	350,000	2,800,000	180,000	3,600,000
1933	20	1975	157,696,000	11,094,000	168,790,000	1,343,417,000	40,575,000	864,000	1,696,000	5,906,000	496,000	49,537,000	410,000	1,224.9	11,978,000				1,490,000	10,430,000	350,000	2,800,000	192,000	3,840,000
1934	21	1976				1,343,417,000	51,946,000	1,669,000	2,750,000	14,164,000	496,000	71,025,000	410,000	1,223.3	11,974,000	110,000	436.8	$3,511,000	1,490,000	10,430,000	350,000	2,800,000	204,000	4,080,000
1935	22	1977				1,343,417,000	52,375,000	1,669,000	2,750,000	16,268,000	496,000	73,558,000	410,000	1,433.3	12,552,000	132,000	524.2	4,214,000	1,490,000	10,430,000	350,000	2,800,000	216,000	4,320,000
1936	23	1978	7,500,000	188,000	7,688,000	1,351,105,000	53,063,000	1,669,000	2,750,000	18,385,000	496,000	76,363,000	410,000	1,785.3	13,519,000	154,000	611.5	4,916,000	1,490,000	10,430,000	350,000	2,800,000	228,000	4,560,000
1937	24	1979	10,854,000	464,000	11,318,000	1,362,423,000	53,845,000	1,669,000	2,750,000	20,689,000	496,000	79,449,000	410,000	1,757.3	13,443,000	176,000	698.9	5,618,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1938	25	1980	14,989,000	461,000	15,450,000	1,377,873,000	54,234,000	1,734,000	2,808,000	22,766,000	496,000	82,038,000	410,000	2,187.6	14,626,000	198,000	786.2	6,320,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1939	26	1981	27,023,000	1,148,000	28,171,000	1,406,044,000	54,234,000	1,734,000	2,808,000	24,852,000	496,000	84,124,000	410,000	1,247.8	12,041,000	220,000	873.6	7,022,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1940	27	1982	9,000,000	225,000	9,225,000	1,415,269,000	56,462,000	2,054,000	2,938,000	27,026,000	496,000	88,976,000	410,000	2,036.3	14,210,000	242,000	961.0	7,725,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1941	28	1983	10,487,000	493,000	10,980,000	1,426,249,000	58,517,000	2,054,000	2,938,000	29,203,000	496,000	93,208,000	410,000	2,484.6	15,443,000	264,000	1,048.3	8,427,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1942	29	1984	2,947,000	74,000	3,021,000	1,429,270,000	62,438,000	2,118,000	2,997,000	31,198,000	496,000	99,247,000	410,000	2,684.8	15,993,000	286,000	1,135.7	9,129,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1943	30	1985	13,190,000	405,000	13,595,000	1,442,865,000	66,286,000	2,118,000	2,997,000	33,300,000	496,000	105,197,000	410,000	2,210.6	14,689,000	308,000	1,223.0	9,831,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1944	31	1986	31,295,000	1,198,000	32,493,000	1,475,358,000	66,286,000	2,118,000	2,997,000	35,370,000	496,000	107,267,000	410,000	1,575.8	12,943,000	330,000	1,301.4	10,534,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1945	32	1987	7,637,000	383,000	8,020,000	1,483,378,000	67,321,000	2,398,000	3,005,000	37,528,000	699,000	110,951,000	410,000	1,973.7	14,035,000	352,000	1,397.8	11,236,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1946	33	1988					67,890,000	2,463,000	3,069,000	39,616,000	699,000	113,737,000	410,000	1,944.5	13,957,000	374,000	1,485.1	11,938,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1947	34	1989					68,148,000	2,463,000	3,069,000	41,701,000	699,000	116,080,000	410,000	1,374.7	12,390,000	396,000	1,572.5	12,640,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1948	35	1990					68,500,000	2,463,000	3,069,000	43,814,000	699,000	118,545,000	410,000	1,736.6	13,386,000	418,000	1,659.8	13,342,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1949	36	1991					69,142,000	2,463,000	3,069,000	45,837,000	699,000	121,210,000	410,000	1,310.5	12,214,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1950	37	1992					69,353,000	2,463,000	3,069,000	45,837,000	699,000	121,421,000	410,000	2,280.8	14,882,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
1951	38	1993					69,603,000	2,463,000	3,069,000	45,837,000	699,000	121,671,000	410,000	2,141.7	14,500,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	39	1994					69,672,000	2,463,000	3,069,000	45,837,000	699,000	121,740,000	410,000	1,720.6	13,342,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	40	1995					69,982,000	2,463,000	3,069,000	45,837,000	699,000	122,050,000	410,000	1,720.6	13,342,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	41	1996					63,607,000	2,463,000	3,069,000	45,837,000	699,000	115,675,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	42	1997					56,184,000	2,463,000	3,069,000	45,837,000	699,000	108,252,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	43	1998					47,119,000	2,463,000	3,069,000	45,837,000	699,000	99,187,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	44	1999					44,409,000	2,463,000	3,069,000	45,837,000	699,000	96,477,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	45	2000					41,584,000	2,463,000	3,069,000	45,837,000	699,000	93,652,000	353,000	1,720.6	12,145,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	46	2001					38,497,000	2,463,000	3,069,000	45,837,000	699,000	90,565,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	47	2002					34,516,000	2,463,000	3,069,000	45,837,000	699,000	86,584,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	48	2003					32,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	49	2004					32,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	50	2005					32,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	343,500	1,720.6	11,946,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	51	2006					32,414,000	2,463,000	3,069,000	45,837,000	699,000	84,482,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	52	2007					31,515,000	2,463,000	3,069,000	45,837,000	699,000	83,583,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	53	2008					30,071,000	2,463,000	3,069,000	45,837,000	699,000	82,139,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	54	2009					28,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	55	2010					28,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	334,000	1,720.6	11,746,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	56	2011					28,432,000	2,463,000	3,069,000	45,837,000	699,000	80,500,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	57	2012					26,227,000	2,463,000	3,069,000	45,837,000	699,000	78,295,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	58	2013					21,919,000	2,463,000	2,069,000	45,837,000	699,000	73,987,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	59	2014					14,758,000	2,463,000	3,069,000	45,837,000	699,000	66,826,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	60	2015					6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	324,500	1,720.6	11,546,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	61	2016					6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	62	2017					6,690,000	2,463,000	3,069,000	45,837,000	699,000	58,758,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	63	2018					6,323,000	2,463,000	3,069,000	45,837,000	699,000	58,391,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	64	2019					5,782,000	2,463,000	3,069,000	45,837,000	699,000	57,850,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	65	2020					5,043,000	2,463,000	3,069,000	45,837,000	699,000	57,111,000	315,000	1,720.6	11,347,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	66	2021					3,697,000	2,463,000	3,069,000	45,837,000	699,000	55,765,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	67	2022					3,256,000	2,463,000	3,069,000	45,837,000	699,000	55,324,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	68	2023					2,731,000	2,463,000	3,069,000	45,837,000	699,000	54,799,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	69	2024					2,586,000	2,463,000	3,069,000	45,837,000	699,000	54,654,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	70	2025					1,937,000	2,463,000	3,069,000	45,837,000	699,000	54,005,000	305,000	1,720.6	11,137,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	71	2026					383,000	2,463,000	3,069,000	45,837,000	699,000	52,451,000	296,000	1,720.6	10,948,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000
Average	72	2027					0	2,463,000	3,069,000	45,837,000	699,000	52,068,000	296,000	1,720.6	10,948,000	440,000	1,747.2	14,045,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,800,000

TABLE 21

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 3

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,387,753,000

ANNUAL COSTS						ANNUAL REVENUES																	
						Power Revenues						Water Revenues											
						Oroville Power Plant			Castaic Power Development			Fresno, Kings and Northern *Kern Counties area*		Southern Kern *County area*		Alameda, Santa Clara and San *Benito Counties area*		Southern California *area*					
rest d ment f nd ue ervice)	Replacements	Operation *and* maintenance costs	Cost of *power* for pumping	*General* expenses	Total	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions *of kilowatt hours*	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions *of kilowatt hours*	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Acre-feet	Revenue at $7.00 per *acre-foot*	Acre-feet	Revenue at $8.00 per *acre-foot*	Acre-feet	Revenue at $17.50 per acre-foot	Acre-feet	Revenue at $25.00 per acre-foot	Total	*Total*	Obligation of General Fund	Annual revenues in excess *of annual* costs
'64,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000							450,000	$3,150,000	150,000	$1,200,000					$4,350,000	$4,350,000	$6,623,000	
'64,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
'764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
'764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000					4,350,000	4,350,000	6,623,000	
)37,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000				450,000	3,150,000	150,000	1,200,000					4,350,000	19,110,000	3,004,000	
132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000				670,000	4,690,000	150,000	1,200,000	60,000	$1,050,000			6,940,000	21,708,000	4,070,000	
132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000				765,000	5,355,000	150,000	1,200,000	72,000	1,260,000			7,815,000	20,188,000	5,812,000	
526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000				860,000	6,020,000	150,000	1,200,000	84,000	1,470,000			8,690,000	20,796,000	8,821,000	
154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000				955,000	6,685,000	150,000	1,200,000	96,000	1,680,000			9,565,000	21,546,000	11,921,000	
478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000				1,050,000	7,350,000	150,000	1,200,000	108,000	1,890,000			10,440,000	22,739,000	15,376,000	
770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000				1,138,000	7,966,000	190,000	1,520,000	120,000	2,100,000			11,586,000	26,018,000	13,703,000	
201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000				1,226,000	8,582,000	230,000	1,840,000	132,000	2,310,000			12,732,000	25,968,000	17,605,000	
672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000				1,314,000	9,198,000	270,000	2,160,000	144,000	2,520,000			13,878,000	26,002,000	19,429,000	
571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000				1,402,000	9,814,000	310,000	2,480,000	156,000	2,730,000			15,024,000	27,773,000	20,063,000	
574,000	864,000	1,696,000	5,615,000	496,000	49,245,000	410,000	1,225.0	11,979,000				1,490,000	10,430,000	350,000	2,800,000	168,000	2,940,000			16,170,000	28,149,000	21,096,000	
574,000	864,000	1,696,000	5,760,000	496,000	49,390,000	410,000	1,226.7	11,983,000				1,490,000	10,430,000	350,000	2,800,000	180,000	3,150,000			16,380,000	28,363,000	21,027,000	
574,000	864,000	1,696,000	5,906,000	496,000	49,536,000	410,000	1,224.9	11,978,000				1,490,000	10,430,000	350,000	2,800,000	192,000	3,360,000			16,590,000	28,568,000	20,968,000	
889,000	1,679,000	2,507,000	14,164,000	496,000	68,735,000	410,000	1,223.3	11,974,000	129,000	503.1	$4,093,000	1,490,000	10,430,000	350,000	2,800,000	204,000	3,570,000	450,000	$11,250,000	28,050,000	44,117,000	24,618,000	
318,000	1,679,000	2,507,000	16,268,000	496,000	71,268,000	410,000	1,433.3	12,552,000	155,000	604.5	4,917,000	1,490,000	10,430,000	350,000	2,800,000	216,000	3,780,000	540,000	13,500,000	30,510,000	47,979,000	23,289,000	
,007,000	1,679,000	2,507,000	18,385,000	496,000	74,074,000	410,000	1,785.3	13,519,000	181,000	705.9	5,742,000	1,490,000	10,430,000	350,000	2,800,000	228,000	3,990,000	630,000	15,750,000	32,970,000	52,231,000	21,843,000	
,789,000	1,679,000	2,507,000	20,689,000	496,000	77,160,000	410,000	1,757.3	13,443,000	206,000	803.4	6,535,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	720,000	18,000,000	35,430,000	55,408,000	21,752,000	
,098,000	1,752,000	2,574,000	22,766,000	496,000	79,686,000	410,000	2,187.6	14,626,000	232,000	904.8	7,360,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	810,000	20,250,000	37,680,000	59,666,000	20,020,000	
,098,000	1,752,000	2,574,000	24,852,000	496,000	81,772,000	410,000	1,247.8	12,041,000	258,000	1,006.2	8,185,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	900,000	22,500,000	39,930,000	60,156,000	21,616,000	
,812,000	2,072,000	2,704,000	27,026,000	496,000	86,110,000	410,000	2,036.3	14,210,000	284,000	1,107.6	9,010,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	990,000	24,750,000	42,180,000	65,400,000	20,710,000	
,597,000	2,072,000	2,704,000	29,203,000	496,000	90,072,000	410,000	2,484.6	15,443,000	310,000	1,209.0	9,835,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,080,000	27,000,000	44,430,000	69,708,000	20,364,000	
,760,000	2,146,000	2,769,000	31,198,000	496,000	95,369,000	410,000	2,684.8	15,993,000	335,000	1,306.5	10,628,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,170,000	29,250,000	46,680,000	73,301,000	22,068,000	
,089,000	2,146,000	2,769,000	33,300,000	496,000	100,800,000	410,000	2,210.6	14,689,000	361,000	1,407.9	11,453,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,260,000	31,500,000	48,930,000	75,072,000	25,728,000	
,089,000	2,146,000	2,769,000	35,370,000	496,000	102,870,000	410,000	1,575.8	12,943,000	387,000	1,509.3	12,278,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,350,000	33,750,000	51,180,000	76,401,000	26,469,000	
,125,000	2,426,000	2,777,000	37,528,000	699,000	106,555,000	410,000	1,972.7	14,035,000	413,000	1,610.7	13,102,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,440,000	36,000,000	53,430,000	80,567,000	25,988,000	
,588,000	2,499,000	2,851,000	39,616,000	699,000	109,253,000	410,000	1,944.5	13,957,000	439,000	1,712.1	13,927,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,530,000	38,250,000	55,680,000	83,564,000	25,689,000	
,809,000	2,499,000	2,851,000	41,701,000	699,000	111,559,000	410,000	1,374.7	12,390,000	464,000	1,809.6	14,720,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,620,000	40,500,000	57,930,000	85,040,000	26,519,000	
,161,000	2,499,000	2,851,000	43,814,000	699,000	114,024,000	410,000	1,736.6	13,386,000	490,000	1,911.0	15,545,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,710,000	42,750,000	60,180,000	89,111,000	24,913,000	
,804,000	2,499,000	2,851,000	45,837,000	699,000	116,690,000	410,000	1,310.5	12,214,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	91,014,000	25,676,000	
,943,000	2,499,000	2,851,000	45,837,000	699,000	116,829,000	410,000	2,280.8	14,882,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	93,682,000	23,147,000	
,095,000	2,499,000	2,851,000	45,837,000	699,000	116,981,000	410,000	2,141.7	14,500,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240'000	4,200,000	1,800,000	45,000,000	62,430,000	93,300,000	23,681,000	
,164,000	2,499,000	2,851,000	45,837,000	699,000	117,050,000	410,000	1,720.6	13,342,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	92,142,000	24,908,000	
,474,000	2,499,000	2,851,000	45,837,000	699,000	117,360,000	410,000	1,720.6	13,342,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	92,142,000	25,218,000	
,063,000	2,499,000	2,851,000	45,837,000	699,000	110,949,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,945,000	20,004,000	
,613,000	2,499,000	2,851,000	45,837,000	699,000	103,499,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,945,000	12,554,000	
,548,000	2,499,000	2,851,000	45,837,000	699,000	94,434,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,945,000	3,489,000	
,838,000	2,499,000	2,851,000	45,837,000	699,000	91,724,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,945,000	779,000	
,013,000	2,499,000	2,851,000	45,837,000	699,000	88,899,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,945,000		$2,046,000
,926,000	2,499,000	2,851,000	45,837,000	699,000	85,812,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,746,000		4,934,000
,945,000	2,499,000	2,851,000	45,837,000	699,000	81,831,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,746,000		8,915,000
,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,746,000		11,017,000
,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,746,000		11,017,000
,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,746,000		11,017,000
7,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,546,000		10,817,000
5,944,000	2,499,000	2,851,000	45,837,000	699,000	78,830,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,546,000		11,716,000
5,500,000	2,499,000	2,851,000	45,837,000	699,000	77,386,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,546,000		13,160,000
3,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,546,000		14,799,000
3,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,546,000		14,799,000
3,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,346,000		14,599,000
2,734,000	2,499,000	2,851,000	45,837,000	699,000	74,620,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,346,000		15,726,000
8,992,000	2,499,000	2,851,000	45,837,000	699,000	70,878,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,346,000		19,468,000
3,030,000	2,499,000	2,851,000	45,837,000	699,000	64,916,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,346,000		25,430,000
8,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	324,500	1,720.6	11,546,000	516, 00	2,012.4	16,370,000	1,490, 000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,346,000		32,409,000
6,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,147,000		32,210,000
6,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,147,000		32,210,000
5,759,000	2,499,000	2,851,000	45,837,000	699,000	57,645,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,147,000		32,502,000
5,295,000	2,499,000	2,851,000	45,837,000	699,000	57,181,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,147,000		32,966,000
4,557,000	2,499,000	2,851,000	45,837,000	699,000	56,443,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	90,147,000		33,704,000
3,210,000	2,499,000	2,851,000	45,837,000	699,000	55,096,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,937,000		34,841,000
2,918,000	2,499,000	2,851,000	45,837,000	699,000	54,804,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,937,000		35,133,000
2,599,000	2,499,000	2,851,000	45,837,000	699,000	54,485,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,937,000		35,452,000
2,455,000	2,499,000	2,851,000	45,837,000	699,000	54,341,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,937,000		35,596,000
1,805,000	2,499,000	2,851,000	45,837,000	699,000	53,691,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,937,000		36,246,000
327,000	2,499,000	2,851,000	45,837,000	699,000	52,213,000	296,000	1,720.6	10,948,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,748,000		37,535.000
0	2,499,000	2,851,000	45,837,000	699,000	51,886,000	296,000	1,720.6	10,948,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000	1,800,000	45,000,000	62,430,000	89,748,000		37,862,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 3

AQUEDUCT LINE FROM SACRAMENTO-SAN JOAQUIN DELTA TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,387,753,000

Water year	Number of years after Jan. 1, 1956	Calendar year	Construction cost including contingencies, engineering and administration	Interest during construction	Bond issue for year	Cumulative bond issue	ANNUAL COSTS						ANNUAL REVENUES							
													Power Revenues						Water Revenues	
													Oroville Power Plant			Castaic Power Development			Fresno, Kings and Northern Kern Counties area		Southern Kern County area		Alameda, Santa Clara and San Benito Counties area	
							Interest and repayment of bond issue (Debt service)	Replacements	Operation and maintenance costs	Cost of power for pumping	General expenses	Total	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Acre-feet	*Revenue at* $7.00 per acre-foot	Acre-feet	*Revenue at* $8.00 per acre-foot	Acre-feet	*Revenue at* $17.50 per acre-foot
	1	1956	$145,235,000	$3,631,000	$148,866,000	$148,866,000																		
	2	1957	151,611,000	7,512,000	159,123,000	307,989,000																		
	3	1958	177,502,000	12,137,000	189,639,000	497,628,000																		
	4	1959	50,746,000	5,946,000	56,692,000	554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000							450,000	$3,150,000	150,000	$1,200,000		
	5	1960	51,719,000	7,387,000	59,106,000	613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
	6	1961	55,613,000	8,962,000	64,575,000	678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
	7	1962	72,287,000	10,995,000	83,282,000	761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000							450,000	3,150,000	150,000	1,200,000		
1921	8	1963	41,943,000	2,045,000	43,988,000	805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000				450,000	3,150,000	150,000	1,200,000		
1922	9	1964				805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000				670,000	4,690,000	150,000	1,200,000	60,000	$1,050,000
1923	10	1965				805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000				765,000	5,355,000	150,000	1,200,000	72,000	1,260,000
1924	11	1966				805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000				860,000	6,020,000	150,000	1,200,000	84,000	1,470,000
1925	12	1967	18,347,000	459,000	18,806,000	824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000				955,000	6,685,000	150,000	1,200,000	96,000	1,680,000
1926	13	1968	29,011,000	1,195,000	30,206,000	854,283,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000				1,050,000	7,350,000	150,000	1,200,000	108,000	1,890,000
1927	*14*	*1969*	*32,257,000*	*2,031,000*	*34,288,000*	888,571,000	*32,770,000*	*745,000*	*1,675,000*	*4,035,000*	*496,000*	*39,721,000*	*410,000*	*2,117.2*	*14,432,000*				*1,138,000*	*7,966,000*	*190,000*	*1,520,000*	*120,000*	*2,100,000*
1928	15	1970				888,571,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000				1,226,000	8,582,000	230,000	1,840,000	132,000	2,310,000
1929	16	1971				888,571,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000				1,314,000	9,198,000	270,000	2,160,000	144,000	2,520,000
1930	17	1972	23,000,000	575,000	23,575,000	912,146,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000				1,402,000	9,814,000	310,000	2,480,000	156,000	2,730,000
1931	18	1973	75,799,000	2,484,000	78,283,000	990,429,000	40,574,000	864,000	1,696,000	5,615,000	496,000	49,245,000	410,000	1,225.0	11,979,000				1,490,000	10,430,000	350,000	2,800,000	168,000	2,940,000
1932	19	1974	119,208,000	5,527,000	124,735,000	1,115,164,000	40,574,000	864,000	1,696,000	5,760,000	496,000	49,390,000	410,000	1,226.7	11,983,000				1,490,000	10,430,000	350,000	2,800,000	180,000	3,150,000
1933	20	1975	136,917,000	9,087,000	146,004,000	1,261,168,000	40,574,000	864,000	1,696,000	5,906,000	496,000	49,536,000	410,000	1,224.9	11,978,000				1,490,000	10,430,000	350,000	2,800,000	192,000	3,360,000
1934	21	1976				1,261,168,000	49,889,000	1,679,000	2,507,000	14,164,000	496,000	68,735,000	410,000	1,223.3	11,974,000	129,000	503.1	$4,093,000	1,490,000	10,430,000	350,000	2,800,000	204,000	3,570,000
1935	22	1977				1,261,168,000	50,318,000	1,679,000	2,507,000	16,268,000	496,000	71,268,000	410,000	1,433.3	12,552,000	155,000	604.5	*4,917,000*	*1,490,000*	*10,430,000*	*350,000*	*2,800,000*	*216,000*	*3,780,000*
1936	23	1978	5,960,000	149,000	6,109,000	1,267,277,000	51,007,000	1,679,000	2,507,000	18,385,000	496,000	74,074,000	410,000	1,785.3	13,519,000	181,000	705.9	5,742,000	1,490,000	10,430,000	350,000	2,800,000	228,000	3,990,000
1937	24	1979	9,314,000	386,000	9,700,000	1,276,977,000	51,789,000	1,679,000	2,507,000	20,689,000	496,000	77,160,000	410,000	1,757.3	13,443,000	206,000	803.4	6,535,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1938	25	1980	14,989,000	461,000	15,450,000	1,292,427,000	52,098,000	1,752,000	2,574,000	22,766,000	496,000	79,686,000	410,000	2,187.6	14,626,000	232,000	904.8	7,360,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1939	26	1981	27,023,000	1,148,000	28,171,000	1,320,598,000	52,098,000	1,752,000	2,574,000	24,852,000	496,000	81,772,000	410,000	1,247.8	12,041,000	258,000	1,006.2	8,185,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1940	27	1982	5,960,000	149,000	6,109,000	1,326,707,000	53,812,000	2,072,000	2,704,000	27,026,000	496,000	86,110,000	410,000	2,036.3	14,210,000	284,000	1,107.6	9,010,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1941	28	1983	6,360,000	312,000	6,672,000	1,333,379,000	55,597,000	2,072,000	2,704,000	29,203,000	496,000	90,072,000	410,000	2,484.6	15,443,000	310,000	1,209.0	9,835,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1942	29	1984	2,947,000	74,000	3,021,000	1,336,400,000	58,760,000	2,146,000	2,769,000	31,198,000	496,000	95,369,000	410,000	2,684.8	15,993,000	335,000	1,306.5	10,628,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1943	30	1985	13,190,000	406,000	13,596,000	1,349,996,000	62,089,000	2,146,000	2,769,000	33,300,000	496,000	100,800,000	410,000	2,210.6	14,689,000	361,000	1,407.9	11,453,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1944	31	1986	29,755,000	1,160,000	30,915,000	1,380,911,000	62,089,000	2,146,000	2,769,000	35,370,000	496,000	102,870,000	410,000	1,575.8	12,943,000	387,000	1,509.3	12,278,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1945	32	1987	6,526,000	316,000	6,842,000	1,387,753,000	63,125,000	2,426,000	2,777,000	37,528,000	699,000	106,555,000	410,000	1,972.7	14,035,000	413,000	1,610.7	13,102,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1946	33	1988					63,588,000	2,499,000	2,851,000	39,616,000	699,000	109,253,000	410,000	1,944.5	13,957,000	439,000	1,712.1	13,927,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1947	34	1989					63,809,000	2,499,000	2,851,000	41,701,000	699,000	111,559,000	410,000	1,374.7	12,390,000	464,000	1,809.6	14,720,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1948	35	1990					64,161,000	2,499,000	2,851,000	43,814,000	699,000	114,024,000	410,000	1,736.6	13,386,000	490,000	1,911.0	15,545,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1949	36	1991					64,804,000	2,499,000	2,851,000	45,837,000	699,000	116,690,000	410,000	1,310.5	12,214,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1950	37	1992					64,943,000	2,499,000	2,851,000	45,837,000	699,000	116,329,000	410,000	2,280.8	14,882,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
1951	38	1993					65,065,000	2,499,000	2,851,000	45,837,000	699,000	116,981,000	410,000	2,141.7	14,500,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240'000	4,200,000
Average	39	1994					65,164,000	2,499,000	2,851,000	45,837,000	699,000	117,050,000	410,000	1,720.6	13,342,000	516,000	2,012.4	16,370,000	*1,490,000*	*10,430,000*	350,000	2,800,000	*240,000*	*4,200,000*
Average	40	1995					65,474,000	2,499,000	2,851,000	45,837,000	699,000	117,360,000	410,000	1,720.6	13,342,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	41	1996					59,063,000	2,499,000	2,851,000	45,837,000	699,000	110,949,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	42	1997					51,613,000	2,499,000	2,851,000	45,837,000	699,000	103,499,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	43	1998					42,548,000	2,499,000	2,851,000	45,837,000	699,000	94,434,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	44	1999					39,838,000	2,499,000	2,851,000	45,837,000	699,000	91,724,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	45	2000					37,013,000	2,499,000	2,851,000	45,837,000	699,000	88,899,000	353,000	1,720.6	12,145,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	46	2001					33,926,000	2,499,000	2,851,000	45,837,000	699,000	85,812,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	47	2002					29,945,000	2,499,000	2,851,000	45,837,000	699,000	81,831,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	*1,490,000*	*10,430,000*	350,000	2,800,000	*240,000*	*4,200,000*
Average	48	2003					27,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	49	2004					27,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	50	2005					27,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	343,500	1,720.6	11,946,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	51	2006					27,843,000	2,499,000	2,851,000	45,837,000	699,000	79,729,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	52	2007					26,944,000	2,499,000	2,851,000	45,837,000	699,000	78,830,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	53	2008					25,500,000	2,499,000	2,851,000	45,837,000	699,000	77,386,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	54	2009					23,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	55	2010					23,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	334,000	1,720.6	11,746,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	56	2011					23,861,000	2,499,000	2,851,000	45,837,000	699,000	75,747,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	57	2012					22,734,000	2,499,000	2,851,000	45,837,000	699,000	74,620,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	58	2013					18,992,000	2,499,000	2,851,000	45,837,000	699,000	70,878,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	59	2014					13,030,000	2,499,000	2,851,000	45,837,000	699,000	64,916,000	324,500	1,720.6	11,546,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	60	2015					6,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	324,500	1,720.6	11,546,000	516, 00	2,012.4	16,370,000	1,490, 000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	61	2016					6,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	62	2017					6,051,000	2,499,000	2,851,000	45,837,000	699,000	57,937,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	63	2018					5,750,000	2,499,000	2,851,000	45,837,000	699,000	57,645,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	64	2019					5,295,000	2,499,000	2,851,000	45,837,000	699,000	57,181,000	*315,000*	*1,720.6*	11,347,000	516,000	2,012.4	*16,370,000*	*1,490,000*	*10,430,000*	*350,000*	2,800,000	*240,000*	*4,200,000*
Average	65	2020					4,557,000	2,499,000	2,851,000	45,837,000	699,000	56,443,000	315,000	1,720.6	11,347,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	66	2021					3,210,000	2,499,000	2,851,000	45,837,000	699,000	55,096,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	67	2022					2,918,000	2,499,000	2,851,000	45,837,000	699,000	54,804,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	68	2023					2,599,000	2,499,000	2,851,000	45,837,000	699,000	54,485,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	69	2024					2,455,000	2,499,000	2,851,000	45,837,000	699,000	54,341,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	70	2025					1,805,000	2,499,000	2,851,000	45,837,000	699,000	53,691,000	305,000	1,720.6	11,137,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	71	2026					327,000	2,499,000	2,851,000	45,837,000	699,000	52,213,000	296,000	1,720.6	10,948,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000
Average	72	2027					0	2,499,000	2,851,000	45,837,000	699,000	51,886,000	296,000	1,720.6	10,948,000	516,000	2,012.4	16,370,000	1,490,000	10,430,000	350,000	2,800,000	240,000	4,200,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 4

QUEDUCT FROM SACRAMENTO-SAN JOAQUIN DELTA VIA COASTAL LINE TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,542,219,000

	Cumulative bond issue	ANNUAL COSTS: Interest and repayment of bond issue (Debt service)	ANNUAL COSTS: Replacements	ANNUAL COSTS: Operation and maintenance costs	ANNUAL COSTS: Cost of power for pumping	ANNUAL COSTS: General expenses	ANNUAL COSTS: Total	ANNUAL REVENUES: Power Revenues, Oroville Power Plant: Dependable generating capacity in kilowatts	Power Revenues, Oroville Power Plant: Electric energy at power plant bus in millions of kilowatt hours	Power Revenues, Oroville Power Plant: Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues, Fresno, Kings and northern Kern Counties area: Acre-feet	Fresno, Kings and northern Kern Counties area: Revenue at $8.00 per acre-foot	Southern Kern County area: Acre-feet	Southern Kern County area: Revenue at $9.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Alameda, Santa Clara and San Benito Counties area: Revenue at $20.00 per acre-foot	Southern California area: Acre-feet	Southern California area: Revenue at $45.00 per acre-foot	Water Revenues: Total	ANNUAL REVENUES: Total	Obligation of General Fund	Annual revenues in excess of annual costs
000	$148,456,000																					
000	306,337,000																					
000	491,714,000																					
000	548,406,000	$7,616,000	$268,000	$856,000	$1,589,000	$496,000	$10,825,000				450,000	$3,600,000	150,000	$1,350,000					$4,950,000	$4,950,000	$5,875,000	
000	607,512,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	5,875,000	
000	672,087,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	5,875,000	
000	755,369,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	5,875,000	
000	799,357,000	17,889,000	532,000	1,460,000	1,589,000	496,000	21,966,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000					4,950,000	19,710,000	2,256,000	
	799,357,000	19,984,000	745,000	1,675,000	2,730,000	496,000	25,630,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,200,000			7,910,000	22,678,000	2,952,000	
	799,357,000	19,984,000	745,000	1,675,000	2,952,000	496,000	25,852,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,440,000			8,910,000	21,283,000	4,569,000	
	799,357,000	23,369,000	745,000	1,675,000	3,175,000	496,000	29,460,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,680,000			9,910,000	22,016,000	7,444,000	
000	818,163,000	26,969,000	745,000	1,675,000	3,397,000	496,000	33,282,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	1,920,000			10,910,000	22,891,000	10,391,000	
000	848,369,000	31,195,000	745,000	1,675,000	3,721,000	496,000	37,832,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,160,000			11,910,000	24,209,000	13,623,000	
000	*882,657,000*	*32,488,000*	*745,000*	*1,675,000*	*4,035,000*	*496,000*	*39,439,000*	*410,000*	*2,117.2*	*14,432,000*	*1,138,000*	*9,104,000*	*190,000*	*1,710,000*	*120,000*	*2,400,000*			*13,214,000*	*27,646,000*	*11,793,000*	
	882,657,000	35,918,000	864,000	1,696,000	4,316,000	496,000	43,290,000	410,000	1,682.0	13,236,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,640,000			14,518,000	27,754,000	15,536,000	
	882,657,000	37,390,000	864,000	1,696,000	4,703,000	496,000	45,149,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	2,880,000			15,822,000	27,946,000	17,203,000	
000	1,000,214,000	39,289,000	864,000	1,696,000	5,209,000	496,000	47,554,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,120,000			17,126,000	29,875,000	17,679,000	
000	1,137,453,000	40,292,000	864,000	1,696,000	5,615,000	496,000	48,963,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,360,000			18,430,000	30,409,000	18,554,000	
000	1,295,251,000	40,292,000	864,000	1,696,000	5,760,000	496,000	49,108,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	3,600,000			18,670,000	30,653,000	18,455,000	
000	1,477,259,000	40,292,000	864,000	1,696,000	5,906,000	496,000	49,254,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	3,840,000			18,910,000	30,888,000	18,366,000	
	1,477,259,000	55,157,000	964,000	2,478,000	9,599,000	496,000	68,694,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	494,000	4,446,000	204,000	4,080,000	306,000	$13,770,000	34,216,000	46,190,000	22,504,000	
	1,477,259,000	55,585,000	964,000	2,478,000	10,801,000	496,000	70,324,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	522,800	4,705,000	216,000	4,320,000	367,200	16,524,000	37,469,000	50,021,000	20,303,000	
	1,477,259,000	56,274,000	964,000	2,478,000	12,005,000	496,000	72,217,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	551,600	4,964,000	228,000	4,560,000	428,400	19,278,000	40,722,000	54,241,000	17,976,000	
000	1,479,334,000	57,056,000	964,000	2,478,000	13,386,000	496,000	74,380,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	580,400	5,224,000	240,000	4,800,000	489,600	22,032,000	43,976,000	57,419,000	16,961,000	
000	1,490,389,000	57,056,000	964,000	2,478,000	14,562,000	496,000	75,556,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	609,200	5,483,000	240,000	4,800,000	550,800	24,786,000	46,989,000	61,615,000	13,941,000	
000	1,509,600,000	57,056,000	964,000	2,478,000	15,732,000	496,000	76,726,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	638,000	5,742,000	240,000	4,800,000	612,000	27,540,000	50,002,000	62,043,000	14,683,000	
	1,509,600,000	60,545,000	1,014,000	2,600,000	16,994,000	496,000	81,649,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	666,800	6,001,000	240,000	4,000,000	673,200	30,294,000	53,015,000	67,225,000	14,424,000	
	1,509,600,000	63,674,000	1,014,000	2,600,000	18,272,000	496,000	86,056,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	695,600	6,260,000	240,000	4,800,000	734,400	33,048,000	56,028,000	71,471,000	14,585,000	
000	1,511,675,000	67,272,000	1,014,000	2,600,000	19,338,000	496,000	90,720,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	724,400	6,520,000	240,000	4,800,000	795,600	35,802,000	59,042,000	75,035,000	15,685,000	
000	1,522,730,000	71,422,000	1,014,000	2,600,000	20,530,000	496,000	96,062,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	753,200	6,779,000	240,000	4,800,000	856,800	38,556,000	62,055,000	76,744,000	19,318,000	
000	1,542,219,000	71,422,000	1,014,000	2,600,000	21,682,000	496,000	97,214,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	782,000	7,038,000	240,000	4,800,000	918,000	41,310,000	65,068,000	78,011,000	19,203,000	
		72,237,000	*1,054,000*	*2,775,000*	*22,945,000*	*699,000*	*99,710,000*	*410,000*	*1,972.7*	*14,035,000*	*1,490,000*	*11,920,000*	*810,800*	*7,297,000*	*240,000*	*4,800,000*	*979,200*	*44,064,000*	*68,081,000*	*82,116,000*	*17,594,000*	
		72,237,000	1,054,000	2,775,000	24,118,000	699,000	100,883,000	410,000	1,944.5	13,957,000	1,490,000	11,920,000	839,600	7,556,000	240,000	4,800,000	1,040,400	46,818,000	71,094,000	85,051,000	15,832,000	
		72,284,000	1,054,000	2,775,000	25,290,000	699,000	102,102,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	868,400	7,816,000	240,000	4,800,000	1,101,600	49,572,000	74,108,000	86,498,000	15,604,000	
		72,537,000	1,054,000	2,775,000	26,490,000	699,000	103,555,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	897,200	8,075,000	240,000	4,800,000	1,162,800	52,326,000	77,121,000	90,507,000	13,048,000	
		72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,348,000	12,751,000	
		72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	95,016,000	10,083,000	
		72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	94,634,000	10,465,000	
		73,022,000	1,054,000	2,775,000	27,597,000	699,000	105,147,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	93,476,000	11,671,000	
		73,273,000	1,054,000	2,775,000	27,597,000	699,000	105,398,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	93,476,000	11,922,000	
		66,622,000	1,054,000	2,775,000	27,597,000	699,000	98,747,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,279,000	6,468,000	
		59,075,000	1,054,000	2,775,000	27,597,000	699,000	91,200,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,279,000		$1,079,000
		50,214,000	1,054,000	2,775,000	27,597,000	699,000	82,339,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,279,000		9,940,000
		47,504,000	1,054,000	2,775,000	27,597,000	699,000	79,629,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,279,000		12,650,000
		44,679,000	1,054,000	2,775,000	27,597,000	699,000	76,804,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,279,000		15,475,000
		41,592,000	1,054,000	2,775,000	27,597,000	699,000	73,717,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,080,000		18,363,000
		37,611,000	1,054,000	2,775,000	27,597,000	699,000	69,736,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,080,000		22,344,000
		35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,080,000		24,446,000
		35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,080,000		24,446,000
		35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	92,080,000		24,446,000
		35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,880,000		24,246,000
		34,610,000	1,054,000	2,775,000	27,597,000	699,000	66,735,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,880,000		25,145,000
		33,166,000	1,054,000	2,775,000	27,597,000	699,000	65,291,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,880,000		26,589,000
		31,527,000	1,054,000	2,775,000	27,597,000	699,000	63,652 000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,880,000		28,228,000
		31,527,000	1,054,000	2,775,000	27,597,000	699,000	63,652,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,880,000		28,228,000
		31,527,000	1,054,000	2,775,000	27,597,000	699,000	63,652,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,680,000		28,028,000
		25,908,000	1,054,000	2,775,000	27,597,000	699,000	58,033,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,680,000		33,647,000
		19,348,000	1,054,000	2,775,000	27,597,000	699,000	51,473,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,680,000		40,207,000
		11,805,000	1,054,000	2,775,000	27,597,000	699,000	43,930,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,680,000		47,750,000
		3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,680,000		56,450,000
		3,105,000	1,054,000	2,775,000	27'597,000	699,000	35,230,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,481,000		56,251,000
		3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,481,000		56,251,000
		3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,481,000		56,251,000
		3,006,000	1,054,000	2,775,000	27,597,000	699,000	35,131,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,481,000		56,350,000
		2,477,000	1,054,000	2,775,000	27,597,000	699,000	34,602,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,481,000		56,879,000
		1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,271,000		57,587,000
		1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,271,000		57,587,000
		1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,271,000		57,587,000
		1,460,000	1,054,000	2,775,000	27,597,000	699,000	33,585,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,271,000		57,686,000
		932,000	1,054,000	2,775,000	27,597,000	699,000	33,057,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,271,000		58,214,000
			1,054,000	2,775,000	27,597,000	699,000	32,125,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,080,000	80,134,000	91,082,000		58,957,000

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 4

AQUEDUCT FROM SACRAMENTO-SAN JOAQUIN DELTA VIA COASTAL LINE TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,542,219,0

Water year	Number of years after Jan. 1, 1956	Calendar year	Construction cost including contingencies, engineering and administration	Interest during construction	Bond issue for year	Cumulative bond issue	ANNUAL COSTS: Interest and repayment of bond issue (Debt service)	Replacements	Operation and maintenance costs	Cost of power for pumping	General expenses	Total	ANNUAL REVENUES: Power Revenues — Oroville Power Plant: Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues — Fresno, Kings and northern Kern Counties area: Acre-feet	Revenue at $8.00 per acre-foot	Southern Kern County area: Acre-feet	Revenue at $9.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Revenue at $20.00 per acre-foot	Southern California area: Acre-feet	Revenue at $45.00 p acre-foo
	1	1956	$144,835,000	$3,621,000	$148,456,000	$148,456,000																	
	2	1957	150,409,000	7,472,000	157,881,000	306,337,000																	
	3	1958	173,384,000	11,993,000	185,377,000	491,714,000																	
	4	1959	50,746,000	5,946,000	56,692,000	548,406,000	$7,616,000	$268,000	$856,000	$1,589,000	$496,000	$10,825,000				450,000	$3,600,000	150,000	$1,350,000				
	5	1960	51,719,000	7,387,000	59,106,000	607,512,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000				
	6	1961	55,613,000	8,962,000	64,575,000	672,087,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000				
	7	1962	72,287,000	10,995,000	83,282,000	755,369,000	7,616,000	268,000	856,000	1,589,000	496,000	10,825,000				450,000	3,600,000	150,000	1,350,000				
1921	8	1963	41,943,000	2,045,000	43,988,000	799,357,000	17,889,000	532,000	1,460,000	1,589,000	496,000	21,966,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000				
1922	9	1964				799,357,000	19,984,000	745,000	1,675,000	2,730,000	496,000	25,630,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,200,000		
1923	10	1965				799,357,000	19,984,000	745,000	1,675,000	2,952,000	496,000	25,852,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,440,000		
1924	11	1966				799,357,000	23,369,000	745,000	1,675,000	3,175,000	496,000	29,460,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,680,000		
1925	12	1967	18,347,000	459,000	18,806,000	818,163,000	26,969,000	745,000	1,675,000	3,397,000	496,000	33,282,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	1,920,000		
1926	13	1968	29,011,000	1,195,000	30,206,000	848,369,000	31,195,000	745,000	1,675,000	3,721,000	496,000	37,832,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,160,000		
1927	14	1969	32,257,000	2,031,000	34,288,000	882,657,000	32,488,000	745,000	1,675,000	4,035,000	496,000	39,439,000	410,000	2,117.2	14,432,000	1,138,000	9,104,000	190,000	1,710,000	120,000	2,400,000		
1928	15	1970				882,657,000	35,918,000	864,000	1,696,000	4,316,000	496,000	43,290,000	410,000	1,682.0	13,336,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,640,000		
1929	16	1971				882,657,000	37,390,000	864,000	1,696,000	4,703,000	496,000	45,149,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	2,880,000		
1930	17	1972	114,690,000	2,867,000	117,557,000	1,000,214,000	39,289,000	864,000	1,696,000	5,209,000	496,000	47,554,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,120,000		
1931	18	1973	131,024,000	6,215,000	137,239,000	1,137,453,000	40,292,000	864,000	1,696,000	5,615,000	496,000	48,963,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,360,000		
1932	19	1974	147,735,000	10,063,000	157,798,000	1,295,251,000	40,292,000	864,000	1,696,000	5,760,000	496,000	49,108,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	3,600,000		
1933	20	1975	167,505,000	14,503,000	182,008,000	1,477,259,000	40,292,000	864,000	1,696,000	5,906,000	496,000	49,254,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	3,840,000		
1934	21	1976				1,477,259,000	55,157,000	964,000	2,478,000	9,599,000	496,000	68,694,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	494,000	4,446,000	204,000	4,080,000	306,000	$13,77
1935	22	1977				1,477,259,000	55,585,000	964,000	2,478,000	10,801,000	496,000	70,324,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	522,800	4,705,000	216,000	4,320,000	367,200	16,52
1936	23	1978				1,477,259,000	56,274,000	964,000	2,478,000	12,005,000	496,000	72,217,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	551,600	4,964,000	228,000	4,560,000	428,400	19,27
1937	24	1979	2,024,000	51,000	2,075,000	1,479,334,000	57,056,000	964,000	2,478,000	13,386,000	496,000	74,380,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	580,400	5,224,000	240,000	4,800,000	489,600	22,03
1938	25	1980	10,735,000	320,000	11,055,000	1,490,389,000	57,056,000	964,000	2,478,000	14,562,000	496,000	75,556,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	609,200	5,483,000	240,000	4,800,000	550,800	24,78
1939	26	1981	18,422,000	789,000	19,211,000	1,509,600,000	57,056,000	964,000	2,478,000	15,732,000	496,000	76,726,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	638,000	5,742,000	240,000	4,800,000	612,000	27,54
1940	27	1982				1,509,600,000	60,545,000	1,014,000	2,600,000	16,994,000	496,000	81,649,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	668,800	6,001,000	240,000	4,000,000	673,200	30,29
1941	28	1983				1,477,259,000	63,674,000	1,014,000	2,600,000	18,272,000	496,000	86,056,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	695,600	6,260,000	240,000	4,800,000	734,400	33,04
1942	29	1984	2,024,000	51,000	2,075,000	1,511,675,000	67,272,000	1,014,000	2,600,000	19,338,000	496,000	90,720,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	724,400	6,520,000	240,000	4,800,000	795,600	35,80
1943	30	1985	10,735,000	320,000	11,055,000	1,522,730,000	71,422,000	1,014,000	2,600,000	20,530,000	496,000	96,062,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	753,200	6,779,000	240,000	4,800,000	856,800	38,55
1944	31	1986	18,694,000	795,000	19,489,000	1,542,219,000	71,422,000	1,014,000	2,600,000	21,682,000	496,000	97,214,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	782,000	7,038,000	240,000	4,800,000	918,000	41,31
1945	32	1987					72,237,000	1,054,000	2,775,000	22,945,000	699,000	99,710,000	410,000	1,972.7	14,035,000	1,490,000	11,920,000	810,800	7,297,000	240,000	4,800,000	979,200	44,06
1946	33	1988					72,237,000	1,054,000	2,775,000	24,118,000	699,000	100,883,000	410,000	1,944.5	13,957,000	1,490,000	11,920,000	839,600	7,556,000	240,000	4,800,000	1,040,400	46,81
1947	34	1989					72,284,000	1,054,000	2,775,000	25,290,000	699,000	102,102,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	868,400	7,816,000	240,000	4,800,000	1,101,600	49,57
1948	35	1990					72,537,000	1,054,000	2,775,000	26,490,000	699,000	103,555,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	897,200	8,075,000	240,000	4,800,000	1,162,800	52,32
1949	36	1991					72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
1950	37	1992					72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
1951	38	1993					72,974,000	1,054,000	2,775,000	27,597,000	699,000	105,099,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	39	1994					73,022,000	1,054,000	2,775,000	27,597,000	699,000	105,147,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	40	1995					73,273,000	1,054,000	2,775,000	27,597,000	699,000	105,398,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	41	1996					66,622,000	1,054,000	2,775,000	27,597,000	699,000	98,747,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	42	1997					59,075,000	1,054,000	2,775,000	27,597,000	699,000	91,200,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	43	1998					50,214,000	1,054,000	2,775,000	27,597,000	699,000	82,339,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	44	1999					47,504,000	1,054,000	2,775,000	27,597,000	699,000	79,629,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	45	2000					44,679,000	1,054,000	2,775,000	27,597,000	699,000	76,804,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	46	2001					41,592,000	1,054,000	2,775,000	27,597,000	699,000	73,717,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	47	2002					37,611,000	1,054,000	2,775,000	27,597,000	699,000	69,736,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	48	2003					35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	49	2004					35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	50	2005					35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	51	2006					35,509,000	1,054,000	2,775,000	27,597,000	699,000	67,634,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	52	2007					34,610,000	1,054,000	2,775,000	27,597,000	699,000	66,735,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	53	2008					33,166,000	1,054,000	2,775,000	27,597,000	699,000	65,291,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	54	2009					31,527,000	1,054,000	2,775,000	27,597,000	699,000	63,652,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	55	2010					31,527,000	1,054,000	2,775,000	27,597,000	699,000	63,652,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	56	2011					31,527,000	1,054,000	2,775,000	27,597,000	699,000	58,035,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	57	2012					25,908,000	1,054,000	2,775,000	27,597,000	699,000	51,475,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	58	2013					19,348,000	1,054,000	2,775,000	27,597,000	699,000	43,920,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	59	2014					11,805,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	60	2015					3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	61	2016					3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	62	2017					3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,230,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	63	2018					3,105,000	1,054,000	2,775,000	27,597,000	699,000	35,131,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	64	2019					3,006,000	1,054,000	2,775,000	27,597,000	699,000	34,602,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	65	2020					2,477,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	66	2021					1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	67	2022					1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,684,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	68	2023					1,559,000	1,054,000	2,775,000	27,597,000	699,000	33,585,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	69	2024					1,460,000	1,054,000	2,775,000	27,597,000	699,000	33,057,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	70	2025					932,000	1,054,000	2,775,000	27,597,000	699,000	32,125,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08
Average	71	2026						1,054,000	2,775,000	27,597,000	699,000	31,125,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	55,08

FEATHER RIVER PROJECT

FINANCIAL ANALYSIS NO. 5

AQUEDUCT FROM SACRAMENTO-SAN JOAQUIN DELTA VIA LONG TUNNEL LINE TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,374,072,000

Water year	Number of years after Jan. 1, 1956	Calendar year	Construction cost including contingencies, engineering and administration	Interest during construction	Bond issue for year	Cumulative bond issue	ANNUAL COSTS: Interest and repayment of bond issue (Debt service)	Replacements	Operation and maintenance costs	Cost of power for pumping	General expenses	Total	ANNUAL REVENUES: Power Revenues — Oroville Power Plant: Dependable generating capacity in kilowatts	Electric energy at power plant bus in millions of kilowatt hours	Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water Revenues: Fresno, Kings and northern Kern Counties area: Acre-feet	Revenue at $8.00 per acre-foot	Southern Kern County area: Acre-feet	Revenue at $9.00 per acre-foot	Alameda, Santa Clara and San Benito Counties area: Acre-feet	Revenue at $20.00 per acre-foot	Southern California area: Acre-feet	Revenue at $35.00 per acre-foot	T
	1	1956	$145,235,000	$3,631,000	$148,866,000	$148,866,000																		
	2	1957	151,611,000	7,512,000	159,123,000	307,989,000																		
	3	1958	177,502,000	12,137,000	189,639,000	497,628,000																		
	4	1959	50,746,000	5,946,000	56,692,000	554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000				450,000	$3,600,000	150,000	$1,350,000					
	5	1960	51,719,000	7,387,000	59,106,000	613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					
	6	1961	55,613,000	8,962,000	64,575,000	678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					
	7	1962	72,287,000	10,995,000	83,282,000	761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					
1921	8	1963	41,943,000	2,045,000	43,988,000	805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000					
1922	9	1964				805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,200,000			
1923	10	1965				805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,440,000			
1924	11	1966				805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,680,000			
1925	12	1967	18,347,000	459,000	18,806,000	824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	1,920,000			
1926	13	1968	44,622,000	1,585,000	46,207,000	870,284,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,160,000			
1927	14	1969	77,348,000	3,558,000	80,906,000	951,190,000	32,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000	1,138,000	9,104,000	190,000	1,710,000	120,000	2,400,000			
1928	15	1970	50,888,000	2,837,000	53,725,000	1,004,915,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,640,000			
1929	16	1971	60,436,000	4,419,000	64,855,000	1,069,770,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	2,880,000			
1930	17	1972	38,906,000	5,502,000	44,408,000	1,114,178,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,120,000			
1931	18	1973	50,764,000	6,908,000	57,672,000	1,171,850,000	40,575,000	864,000	1,696,000	5,615,000	496,000	49,246,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,360,000			
1932	19	1974	64,814,000	8,701,000	73,515,000	1,245,365,000	40,575,000	864,000	1,696,000	5,760,000	496,000	49,391,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	3,600,000			
1933	20	1975	67,482,000	10,605,000	78,087,000	1,323,452,000	40,575,000	864,000	1,696,000	5,906,000	496,000	49,537,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	3,840,000			
1934	21	1976				1,323,452,000	51,447,000	1,269,000	2,508,000	9,836,000	496,000	65,556,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	494,000	4,446,000	204,000	4,080,000	306,000	$10,710,000	3
1935	22	1977				1,323,452,000	51,375,000	1,269,000	2,508,000	11,089,000	496,000	67,237,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	522,800	4,705,000	216,000	4,320,000	367,200	12,852,000	4
1936	23	1978				1,323,452,000	52,929,000	1,269,000	2,508,000	12,340,000	496,000	69,542,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	551,600	4,964,000	228,000	4,560,000	428,400	14,994,000	4
1937	24	1979	2,246,000	56,000	2,302,000	1,325,754,000	54,773,000	1,269,000	2,508,000	13,770,000	496,000	72,816,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	580,400	5,224,000	240,000	4,800,000	489,600	17,136,000	4
1938	25	1980	9,122,000	286,000	9,408,000	1,335,162,000	55,998,000	1,269,000	2,508,000	15,032,000	496,000	75,303,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	609,200	5,483,000	240,000	4,800,000	550,800	19,278,000	4
1939	26	1981	14,497,000	655,000	15,152,000	1,350,314,000	57,477,000	1,269,000	2,508,000	16,210,000	496,000	77,960,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	638,000	5,742,000	240,000	4,800,000	612,000	21,420,000	4
1940	27	1982				1,350,314,000	59,161,000	1,421,000	2,625,000	17,521,000	496,000	81,224,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	666,800	6,001,000	240,000	4,800,000	673,200	23,562,000	4
1941	28	1983				1,350,314,000	60,476,000	1,421,000	2,625,000	18,853,000	496,000	83,871,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	695,600	6,260,000	240,000	4,800,0 0	734,400	25,704,000	4
1942	29	1984	1,977,000	49,000	2,026,000	1,352,340,000	62,152,000	1,421,000	2,625,000	19,961,000	496,000	86,655,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	724,400	6,520,000	240,000	4,800,000	795,600	27,846,000	5
1943	30	1985	8,047,000	252,000	8,299,000	1,360,639,000	63,933,000	1,421,000	2,625,000	21,201,000	496,000	89,676,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	753,200	6,779,000	240,000	4,800,000	856,800	29,988,000	5
1944	31	1986	12,854,000	579,000	13,433,000	1,374,072,000	63,933,000	1,421,000	2,625,000	22,401,000	496,000	90,876,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	782,000	7,038,000	240,000	4,800,000	918,000	32,130,000	5
1945	32	1987					64,527,000	1,537,000	2,639,000	23,714,000	699,000	93,116,000	410,000	1,972.7	14,035,000	1,490,000	11,920,000	810,800	7,297,000	240,000	4,800,000	979,200	34,272,000	5
1946	33	1988					64,527,000	1,537,000	2,639,000	24,934,000	699,000	94,336,000	410,000	1,941.5	13,957,000	1,490,000	11,920,000	839,600	7,555,000	240,000	4,800,000	1,040,400	36,414,000	6
1947	34	1989					64,579,000	1,537,000	2,639,000	26,150,000	699,000	95,604,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	868,400	7,816,000	240,000	4,800,000	1,101,600	38,556,000	6
1948	35	1990					64,794,000	1,537,000	2,639,000	27,402,000	699,000	97,071,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	897,200	8,075,000	240,000	4,800,000	1,162,800	40,698,000	6
1949	36	1991					65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
1950	37	1992					65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
1951	38	1993					65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	39	1994					65,161,000	1,537,000	2,639,000	28,554,000	699,000	98,590,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	40	1995					65,375,000	1,537,000	2,639,000	28,554,000	699,000	98,804,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	41	1996					58,565,000	1,537,000	2,639,000	28,554,000	699,000	91,994,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	42	1997					50,959,000	1,537,000	2,639,000	28,554,000	699,000	84,388,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	43	1998					41,894,000	1,537,000	2,639,000	28,554,000	699,000	75,323,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	44	1999					39,184,000	1,537,000	2,639,000	28,554,000	699,000	72,613,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	45	2000					36,359,000	1,537,000	2,639,000	28,554,000	699,000	69,788,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	46	2001					33,272,000	1,537,000	2,639,000	28,554,000	699,000	66,701,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	47	2002					29,291,000	1,537,000	2,639,000	28,554,000	699,000	62,720,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	48	2003					27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	49	2004					27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	50	2005					27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	51	2006					27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	52	2007					26,290,000	1,537,000	2,639,000	28,554,000	699,000	59,719,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	53	2008					24,081,000	1,537,000	2,639,000	28,554,000	699,000	57,510,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	54	2009					20,214,000	1,537,000	2,639,000	28,554,000	699,000	53,643,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	55	2010					17,846,000	1,537,000	2,639,000	28,554,000	699,000	51,075,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	56	2011					14,546,000	1,537,000	2,639,000	28,554,000	699,000	47,975,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	57	2012					12,423,000	1,537,000	2,639,000	28,554,000	699,000	45,852,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	58	2013					9,666,000	1,537,000	2,639,000	28,554,000	699,000	43,095,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	59	2014					6,152,000	1,537,000	2,639,000	28,554,000	699,000	39,581,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	60	2015					2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	61	2016					2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	62	2017					2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	63	2018					2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	64	2019					2,310,000	1,537,000	2,639,000	28,554,000	699,000	35,739,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	65	2020					1,860,000	1,537,000	2,639,000	28,554,000	699,000	35,289,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	66	2021					1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	67	2022					1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	68	2023					1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	69	2024					1,039,000	1,537,000	2,639,000	28,554,000	699,000	34,468,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	70	2025					642,000	1,537,000	2,639,000	28,554,000	699,000	34,071,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6
Average	71	2026						1,537,000	2,639,000	28,554,000	699,000	33,429,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	6

FEATHER RIVER PROJECT

TABLE 23

FINANCIAL ANALYSIS NO. 5

UCT FROM SACRAMENTO-SAN JOAQUIN DELTA VIA LONG TUNNEL LINE TO CASTAIC CREEK—GENERAL OBLIGATION BOND ISSUE $1,374,072,000

Cumulative bond issue	Annual costs: Interest and repayment of bond issue (Debt service)	Annual costs: Replacements	Annual costs: Operation and maintenance costs	Annual costs: Cost of power for pumping	Annual costs: General expenses	Annual costs: Total	Annual revenues: Power revenues: Oroville Power Plant: Dependable generating capacity in kilowatts	Annual revenues: Power revenues: Oroville Power Plant: Electric energy at power plant bus in millions of kilowatt hours	Annual revenues: Power revenues: Oroville Power Plant: Revenue at $21 per kilowatt year plus 2.75 mills per kwh.	Water revenues: Fresno, Kings and northern Kern Counties area: Acre-feet	Water revenues: Fresno, Kings and northern Kern Counties area: Revenue at $8.00 per acre-foot	Water revenues: Southern Kern County area: Acre-feet	Water revenues: Southern Kern County area: Revenue at $9.00 per acre-foot	Water revenues: Alameda, Santa Clara and San Benito Counties area: Acre-feet	Water revenues: Alameda, Santa Clara and San Benito Counties area: Revenue at $20.00 per acre-foot	Water revenues: Southern California area: Acre-feet	Water revenues: Southern California area: Revenue at $35.00 per acre-foot	Water revenues: Total	Annual revenues: Total	Obligation of General Fund	Annual revenues in excess of annual costs
$148,866,000																					
307,989,000																					
497,628,000																					
554,320,000	$7,764,000	$268,000	$856,000	$1,589,000	$496,000	$10,973,000				450,000	$3,600,000	150,000	$1,350,000					$4,950,000	$4,950,000	$6,023,000	
613,426,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
678,001,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
761,283,000	7,764,000	268,000	856,000	1,589,000	496,000	10,973,000				450,000	3,600,000	150,000	1,350,000					4,950,000	4,950,000	6,023,000	
805,271,000	18,037,000	532,000	1,460,000	1,589,000	496,000	22,114,000	410,000	2,236.5	$14,760,000	450,000	3,600,000	150,000	1,350,000					4,950,000	19,710,000	2,404,000	
805,271,000	20,132,000	745,000	1,675,000	2,730,000	496,000	25,778,000	410,000	2,239.2	14,768,000	670,000	5,360,000	150,000	1,350,000	60,000	$1,200,000			7,910,000	22,678,000	3,100,000	
805,271,000	20,132,000	745,000	1,675,000	2,952,000	496,000	26,000,000	410,000	1,368.5	12,373,000	765,000	6,120,000	150,000	1,350,000	72,000	1,440,000			8,910,000	21,283,000	4,717,000	
805,271,000	23,526,000	745,000	1,675,000	3,175,000	496,000	29,617,000	410,000	1,271.1	12,106,000	860,000	6,880,000	150,000	1,350,000	84,000	1,680,000			9,910,000	22,016,000	7,601,000	
824,077,000	27,154,000	745,000	1,675,000	3,397,000	496,000	33,467,000	410,000	1,225.7	11,981,000	955,000	7,640,000	150,000	1,350,000	96,000	1,920,000			10,910,000	22,891,000	10,576,000	
870,284,000	31,478,000	745,000	1,675,000	3,721,000	496,000	38,115,000	410,000	1,341.3	12,299,000	1,050,000	8,400,000	150,000	1,350,000	108,000	2,160,000			11,910,000	24,209,000	13,906,000	
951,190,000	32,770,000	745,000	1,675,000	4,035,000	496,000	39,721,000	410,000	2,117.2	14,432,000	1,138,000	9,104,000	190,000	1,710,000	120,000	2,400,000			13,214,000	27,646,000	12,075,000	
1,004,915,000	36,201,000	864,000	1,696,000	4,316,000	496,000	43,573,000	410,000	1,682.0	13,236,000	1,226,000	9,808,000	230,000	2,070,000	132,000	2,640,000			14,518,000	27,754,000	15,819,000	
1,069,770,000	37,672,000	864,000	1,696,000	4,703,000	496,000	45,431,000	410,000	1,277.7	12,124,000	1,314,000	10,512,000	270,000	2,430,000	144,000	2,880,000			15,822,000	27,946,000	17,485,000	
1,114,178,000	39,571,000	864,000	1,696,000	5,209,000	496,000	47,836,000	410,000	1,505.0	12,749,000	1,402,000	11,216,000	310,000	2,790,000	156,000	3,120,000			17,126,000	29,875,000	17,961,000	
1,171,850,000	40,575,000	864,000	1,696,000	5,615,000	496,000	49,246,000	410,000	1,225.0	11,979,000	1,490,000	11,920,000	350,000	3,150,000	168,000	3,360,000			18,430,000	30,409,000	18,837,000	
1,245,365,000	40,575,000	864,000	1,696,000	5,760,000	496,000	49,391,000	410,000	1,226.7	11,983,000	1,490,000	11,920,000	350,000	3,150,000	180,000	3,600,000			18,670,000	30,653,000	18,738,000	
1,323,452,000	40,575,000	864,000	1,696,000	5,906,000	496,000	49,537,000	410,000	1,224.9	11,978,000	1,490,000	11,920,000	350,000	3,150,000	192,000	3,840,000			18,910,000	30,888,000	18,649,000	
1,323,452,000	51,447,000	1,269,000	2,508,000	9,836,000	496,000	65,556,000	410,000	1,223.3	11,974,000	1,490,000	11,920,000	494,000	4,446,000	204,000	4,080,000	306,000	$10,710,000	31,156,000	43,130,000	22,426,000	
1,323,452,000	51,875,000	1,269,000	2,508,000	11,089,000	496,000	67,237,000	410,000	1,433.3	12,552,000	1,490,000	11,920,000	522,800	4,705,000	216,000	4,320,000	367,200	12,852,000	33,797,000	46,349,000	20,888,000	
1,323,452,000	52,929,000	1,269,000	2,508,000	12,340,000	496,000	69,542,000	410,000	1,785.3	13,519,000	1,490,000	11,920,000	551,600	4,964,000	228,000	4,560,000	428,400	14,994,000	36,438,000	49,957,000	19,585,000	
1,325,754,000	54,773,000	1,269,000	2,508,000	13,770,000	496,000	72,816,000	410,000	1,757.3	13,443,000	1,490,000	11,920,000	580,400	5,224,000	240,000	4,800,000	489,600	17,136,000	39,080,000	52,523,000	20,293,000	
1,335,162,000	55,998,000	1,269,000	2,508,000	15,032,000	496,000	75,303,000	410,000	2,187.6	14,626,000	1,490,000	11,920,000	609,200	5,483,000	240,000	4,800,000	550,800	19,278,000	41,481,000	56,107,000	19,196,000	
1,350,314,000	57,477,000	1,269,000	2,508,000	16,210,000	496,000	77,960,000	410,000	1,247.8	12,041,000	1,490,000	11,920,000	638,000	5,742,000	240,000	4,800,000	612,000	21,420,000	43,882,000	55,923,000	22,037,000	
1,350,314,000	59,161,000	1,421,000	2,625,000	17,521,000	496,000	81,224,000	410,000	2,036.3	14,210,000	1,490,000	11,920,000	666,800	6,001,000	240,000	4,800,000	673,200	23,562,000	46,283,000	60,493,000	20,731,000	
1,350,314,000	60,476,000	1,421,000	2,625,000	18,853,000	496,000	83,871,000	410,000	2,484.6	15,443,000	1,490,000	11,920,000	695,600	6,260,000	240,000	4,800,0 0	734,400	25,704,000	48,684,000	64,127,000	19,744,000	
1,352,340,000	62,152,000	1,421,000	2,625,000	19,961,000	496,000	86,655,000	410,000	2,684.8	15,993,000	1,490,000	11,920,000	724,400	6,520,000	240,000	4,800,000	795,600	27,846,000	51,086,000	67,079,000	19,576,000	
1,360,639,000	63,933,000	1,421,000	2,625,000	21,201,000	496,000	89,676,000	410,000	2,210.6	14,689,000	1,490,000	11,920,000	753,200	6,779,000	240,000	4,800,000	856,800	29,988,000	53,487,000	68,176,000	21,500,000	
1,374,072,000	63,933,000	1,421,000	2,625,000	22,401,000	496,000	90,876,000	410,000	1,575.8	12,943,000	1,490,000	11,920,000	782,000	7,038,000	240,000	4,800,000	918,000	32,130,000	55,888,000	68,831,000	22,045,000	
	64,527,000	1,537,000	2,639,000	23,714,000	699,000	93,116,000	410,000	1,972.7	14,035,000	1,490,000	11,920,000	810,800	7,297,000	240,000	4,800,000	979,200	34,272,000	58,289,000	72,324,000	20,792,000	
	64,527,000	1,537,000	2,639,000	24,934,000	699,000	94,336,000	410,000	1,944.5	13,957,000	1,490,000	11,920,000	839,600	7,556,000	240,000	4,800,000	1,040,400	36,414,000	60,690,000	74,647,000	19,689,000	
	64,579,000	1,537,000	2,639,000	26,150,000	699,000	95,604,000	410,000	1,374.7	12,390,000	1,490,000	11,920,000	868,400	7,816,000	240,000	4,800,000	1,101,600	38,556,000	63,092,000	75,482,000	20,122,000	
	64,794,000	1,537,000	2,639,000	27,402,000	699,000	97,071,000	410,000	1,736.6	13,386,000	1,490,000	11,920,000	897,200	8,075,000	240,000	4,800,000	1,162,800	40,698,000	65,493,000	78,879,000	18,192,000	
	65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	1,310.5	12,214,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,108,000	18,460,000	
	65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	2,280.8	14,882,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	82,776,000	15,792,000	
	65,139,000	1,537,000	2,639,000	28,554,000	699,000	98,568,000	410,000	2,141.7	14,500,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	82,394,000	16,174,000	
	65,161,000	1,537,000	2,639,000	28,554,000	699,000	98,590,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	81,236,000	17,354,000	
	65,375,000	1,537,000	2,639,000	28,554,000	699,000	98,804,000	410,000	1,720.6	13,342,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	81,236,000	17,568,000	
	58,565,000	1,537,000	2,639,000	28,554,000	699,000	91,994,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,039,000	11,955,000	
	50,959,000	1,537,000	2,639,000	28,554,000	699,000	84,388,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,039,000	4,349,000	
	41,894,000	1,537,000	2,639,000	28,554,000	699,000	75,323,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,039,000		$4,716,000
	39,184,000	1,537,000	2,639,000	28,554,000	699,000	72,613,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,039,000		7,426,000
	36,359,000	1,537,000	2,639,000	28,554,000	699,000	69,788,000	353,000	1,720.6	12,145,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	80,039,000		10,251,000
	33,272,000	1,537,000	2,639,000	28,554,000	699,000	66,701,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,840,000		13,139,000
	29,291,000	1,537,000	2,639,000	28,554,000	699,000	62,720,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,840,000		17,120,000
	27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,840,000		19,222,000
	27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,840,000		19,222,000
	27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	343,500	1,720.6	11,946,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,840,000		19,222,000
	27,189,000	1,537,000	2,639,000	28,554,000	699,000	60,618,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,640,000		19,022,000
	26,290,000	1,537,000	2,639,000	28,554,000	699,000	59,719,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,640,000		19,921,000
	24,081,000	1,537,000	2,639,000	28,554,000	699,000	57,510,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,640,000		22,130,000
	20,214,000	1,537,000	2,639,000	28,554,000	699,000	53,643,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,640,000		25,997,000
	17,646,000	1,537,000	2,639,000	28,554,000	699,000	51,075,000	334,000	1,720.6	11,746,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,640,000		28,565,000
	14,546,000	1,537,000	2,639,000	28,554,000	699,000	47,975,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,440,000		31,465,000
	12,423,000	1,537,000	2,639,000	28,554,000	699,000	45,852,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,440,000		33,588,000
	9,666,000	1,537,000	2,639,000	28,554,000	699,000	43,095,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,440,000		36,345,000
	6,152,000	1,537,000	2,639,000	28,554,000	699,000	39,581,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,440,000		39,859,000
	2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	324,500	1,720.6	11,546,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,440,000		43,591,000
	2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,241,000		43,392,000
	2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,241,000		43,392,000
	2,420,000	1,537,000	2,639,000	28,554,000	699,000	35,849,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,241,000		43,392,000
	2,310,000	1,537,000	2,639,000	28,554,000	699,000	35,739,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,241,000		43,502,000
	1,860,000	1,537,000	2,639,000	28,554,000	699,000	35,289,000	315,000	1,720.6	11,347,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,241,000		43,952,000
	1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,031,000		44,466,000
	1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,031,000		44,466,000
	1,136,000	1,537,000	2,639,000	28,554,000	699,000	34,565,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,031,000		44,466,000
	1,039,000	1,537,000	2,639,000	28,554,000	699,000	34,468,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,031,000		44,563,000
	642,000	1,537,000	2,639,000	28,554,000	699,000	34,071,000	305,000	1,720.6	11,137,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	79,031,000		44,960,000
		1,537,000	2,639,000	28,554,000	699,000	33,429,000	296,000	1,720.6	10,948,000	1,490,000	11,920,000	926,000	8,334,000	240,000	4,800,000	1,224,000	42,840,000	67,894,000	78,842,000		45,413,000

CHAPTER VI

UPSTREAM FEATURES

Estimates of water requirements and water development plans for the Upper Feather River Service Area have been given consideration in planning the Feather River Project. Included in this area is the drainage basin of the Feather River above Oroville, the Paradise Ridge area (immediately to the west of the Feather River Basin), and the foothill portions of Butte and Yuba Counties whose source of supplemental water supply is the South Fork of the Feather River and tributaries of the North Yuba River. The boundaries of the Upper Feather River Service Area are indicated on Plate 16.

In carrying out the purposes and objectives of the State-wide Water Resources Investigation under direction of the State Water Resources Board, an inventory of the water resources of the Upper Feather River Service Area, as well as those of all other areas in the State, was made, and surveys were conducted to determine the ultimate water requirements. These studies were conducted under authorization contained in Chapter 1541, Statutes of 1947, which has for its objective the formulation of a plan for the full practical conservation, control, protection, and utilization of the State's water resources, both surface and underground, to meet present and future water needs for all beneficial purposes.

The Legislature also provided, by the Flood Control Fund Act of 1946, Chapter 142, Statutes of 1946, and by Chapter 30, Statutes of 1947, funds for a determination of ultimate water requirements and plans for development of the mountainous areas of this State. This study was coordinated with the State-wide Water Resources Investigation. The area studied included the mountain and foothill portions of Butte and Yuba Counties that are also a part of the Upper Feather River Service Area.

In the Budget Act of 1954, authorization and funds were provided for a restudy of the ultimate water needs of the Counties of Butte, Plumas, Lassen, Sierra, Siskiyou, Shasta, Modoc, Trinity, Yuba, Tehama, Glenn, Colusa, Lake, Yolo, and Sutter, with initial attention being given to those portions of the Counties of Butte, Plumas, Lassen, and Sierra within the Feather River Drainage Basin. Activity has been directed in the past few months toward completing the evaluation of water requirements and preliminary cost estimates of water development plans in the Upper Feather River Service Area for inclusion in this report.

PRESENT USE OF WATER IN UPPER FEATHER RIVER SERVICE AREA

Water is presently used in the Upper Feather River Service Area for the irrigation of 87,200 acres of land, for domestic purposes by approximately 35,000 people, by the timber industry to facilitate handling logs, and for the generation of hydro-electric energy. In addition, water is an essential part of the recreational areas that are enjoyed throughout the summer season by a relatively large tourist population.

The North Fork of Feather River has been developed primarily for hydroelectric power purposes by the Pacific Gas and Electric Company, which owns four large reservoirs for the regulation of water for that purpose. These are Mountain Meadows, Lake Almanor, Butt Valley, and Bucks Creek. The present power developments consist of the Hamilton Branch, Caribou No. 1, Rock Creek, Cresta, Big Bend, and Bucks Creek generating plants with an aggregate installed power capacity of 385,000 kilowatts. Construction has just started on the Poe Project, which will add an additional 106,000 kilowatts to the system. Approximately 75,000 acre-feet of water are diverted annually from the West Branch of Feather River for the production of hydroelectric energy in the Butte Creek system and for irrigation, domestic and municipal uses. Two reservoirs, Philbrook on Philbrook Creek, a tributary of the West Branch, and Round Valley on the West Branch provide a limited amount of regulation.

There is considerable irrigation use of water from two tributaries of the North Fork of Feather River. There are 13,960 acres irrigated from Indian Creek and 3,900 acres irrigated from Spanish Creek. The rights of water users of Indian Creek and streams tributary to it have been adjudicated and the stream system is under State Watermaster supervision. Nearly all of the irrigated area is cropped to native meadow grasses, and the present irrigation practice is wild flooding. It has been estimated that in 1950, a year of nearly normal runoff, approximately 42,000 acre-feet of water were applied for beneficial use to land in the Indian Creek system. The estimates were based on rights to continuous flow, and the period of time water was available. In most instances, the use of water by low priority classes was less than one month, while a few of the higher priorities had water available for the entire growing season.

The principal area presently being irrigated from the Middle Fork of Feather River is Sierra Valley. There are about 38,800 acres irrigated in this valley, and the irrigation practice is much the same as in Indian Valley. The elevation of the valley floor is about 5,000 feet, which limits both crop adaptability and production. The native meadows presently support large herds of cattle during a short summer period. There is an importation of water into this valley from the Little Truckee River, amounting to about 7,000 acre-feet per season. The rights of water users of the Middle Fork of Feather River above Beckwourth are adjudicated, and diversions are under the supervision of State watermasters. It is estimated that in 1950 about 65,000 acre-feet of water were diverted for beneficial use in this area. Waters of the Middle Fork also irrigate approximately 3,300 acres in Mohawk Valley. This area lies between Beckwourth and Sloat.

Water from the South Fork of Feather River is relatively unused within the basin, but approximately 27,500 acre-feet of water are diverted annually for use on about 6,300 acres in the Oroville-Wyandotte Service Area. Lost Creek Reservoir on Lost Creek, a tributary to the South Fork of Feather River, has a capacity of 5,800 acre-feet and provides partial regulation for the irrigation supply.

PROBABLE ULTIMATE USE OF WATER IN UPPER FEATHER RIVER SERVICE AREA

The probable nature and extent of ultimate land use were forecast on the basis of data from land classification surveys, which segregated lands in accordance with their suitability for irrigated agriculture and other beneficial water-using purposes. The areas considered suitable for each use are shown on Plate 16.

Mean values of consumptive use of applied water for irrigation were determined from data provided by the University of California at Davis, adjusted during the investigation for mountain and foothill climatic conditions. By multiplication of ultimate land areas by the unit values of water use, an estimate of the total irrigation water requirement, measured in terms of mean seasonal consumptive use of applied water, was determined.

Municipal and recreational water use was forecast on the basis of the probable future populations that could be supported by ultimate development of the timber and mining industry, irrigated agriculture, and the use of the area for summer and winter recreation. It was assumed that such recreational areas as wayside camps, resorts, and organized camps will develop local supplies by wells, springs, or diversions from adjacent creeks in quantity proportionate to a future transient recreational population.

Industrial water use was based on the ultimate development of the timber and mining industry. The future sustained yield of both the public and private commercial timber land was the basis for estimates of water requirement. The cutting of saw timber was assumed as the principal activity although the manufacture of some hardboard is expected to occur under ultimate conditions of development.

Hydroelectric power production and required sustained flows for the maintenance and enhancement of the fishery are functions of the future plans for control and development, and are discussed in the ensuing section, "Plans for Water Supply Development." Additional power development plans of the Pacific Gas and Electric Company for the North Fork of Feather River are, however, not discussed in that section. The company plans generating plants at Butt Valley, Caribou No. 2, Belden, and Poe, adding a total of 364,000 kilowatts of installed power capacity to the North Fork system.

Ultimate irrigation water requirements were determined both as to the consumptive use of applied water and stream diversion requirements. Within the watershed of the Feather River the consumptive use of applied water plus irrecoverable losses comprise the depletion to stream flow. Amounts in excess of the consumptive use of applied water that are diverted to irrigated lands, to provide for conveyance losses, irrigation head, and deep percolation, return to the natural channels for reregulation and become available for downstream beneficial use. Supplemental requirements for water to the Paradise Ridge area and portions of Butte and Yuba Counties outside the watershed boundary of the Feather River deplete the stream flow in the amount of stream diversion requirement. No portion of the water so diverted is available to the Oroville Reservoir. Diversion requirements for industry and recreation are assumed to be equivalent to the consumptive use of applied water.

The feasibility of serving all irrigable lands by water supply development was not used as a criterion in estimating ultimate water requirements. The land classification survey included consideration of the physical characteristics such as topography, soil depth, soil texture, saline or alkaline conditions, high water table conditions, and the presence of rock, and such factors as climatic conditions, ease of irrigation, and present agricultural practices. Those economic factors relating to production and marketing, which are variable among given areas and subject to considerable fluctuation over a period of years, were not considered. Neither were the position of the land, as related to possible water supply, nor the availability of a water supply influencing factors in the land classification. However, reductions were made for possible water using lands which lie in reservoir sites and would be flooded if the reservoirs were constructed. The estimated amounts of irrigable lands in the Upper Feather River Service Area, and the amounts of land now irrigated are given in Table 25. These areas are shown on Plate 16.

The estimated ultimate water requirements of the Upper Feather River Service Area for all uses are given in Table 26.

TABLE 25

Estimated Irrigated and Irrigable Areas in the Upper Feather River Service Area

Area	Acres	
	Present irrigated	Ultimate irrigable
North Fork	29,780	47,700
Middle Fork	46,450	109,700
South Fork	110	800
Total Feather River Basin	76,340	158,200
Paradise Ridge	2,100	23,600
Foothill areas in Butte and Yuba Counties	7,740	44,500
Total Upper Feather River Service Area	86,180	226,300

PLANS FOR WATER DEVELOPMENT IN UPPER FEATHER RIVER SERVICE AREA

Possible plans for the development of water supplies for hydroelectric power production, irrigation use, recreation, and industrial use, are contained in the following paragraphs. Costs are based on current prices of construction, but designs of the features are preliminary in nature, based on data from reconnaissance geologic and topographic surveys and are subject to modification. Existing as well as proposed developments are shown on Plate 17.

North Fork of Feather River

On upper Indian Creek and its tributaries, three possibilities exist for water storage development which would enhance 53 miles of fishing streams, provide resting areas for transient waterfowl, and develop a recreational area for summer vacationists. The proposed 75-foot Antelope Valley Dam on Indian Creek would form a reservoir with a storage capacity of 18,200 acre-feet, and maintain in the stream a minimum flow of 10 second-feet. Dixie Refuge Dam, proposed for construction on Last Chance Creek, would be a structure 50 feet in height storing 14,300 acre-feet of water. Releases from this reservoir would provide a minimum flow of 10 second-feet in 25 miles of stream channel. An additional nine miles of trout stream could be developed by construction of Abbey Bridge Dam and Reservoir on Red Clover Creek. This structure would be 100 feet in height, would store about 8,400 acre-feet of water, and maintain a minimum stream flow of seven second-feet. The estimated capital costs of these three projects are as follows:

Project	*Capital cost*
Antelope Valley Reservoir	$380,000
Dixie Refuge Reservoir	420,000
Abbey Bridge Reservoir	730,000
Total	$1,530,000

Middle Fork of Feather River

The water resources of the Middle Fork of Feather River are entirely undeveloped, even though storage possibilities exist for water-power development, for reregulation of irrigation supplies, and for the enhancement of fishing and recreation.

Grizzly Valley Dam and Reservoir on Grizzly Creek are essential features of a recreational area from

TABLE 26

Estimated Ultimate Mean Seasonal Water Requirements of the Upper Feather River Service Area

(Acre-feet)

Area	Consumptive use of applied irrigation water	Irrigation requirements	Other consumptive water requirements			Required developed water supply
			Urban and farmsteads	Recreation	Industrial	
North Fork	87,900	142,500	7,100	3,200	600	153,400
Middle Fork	188,400	221,600	5,700	1,100	200	228,600
South Fork	1,500	3,100	500	500	200	4,300
Total, Feather River Basin	277,800	367,200	13,300	4,800	1,000	386,300
Paradise Ridge	44,500	59,500	3,300	100	100	*63,000
Foothill Area in Butte and Yuba Counties	98,600	131,000	4,200	0	200	*135,400
Total, Upper Feather River Service Area	420,900	557,700	20,800	4,900	1,300	584,700

* Will ultimately be partially supplied by local development and imported water other than Feather River water.

Portola to Sloat. A minimum stream flow of 50 second-feet throughout this reach of the Middle Fork, maintained by that reservoir, would provide a domestic supply for municipalities, resorts, organized or wayside camps, and fishing. The dam would be an earthfill structure about 90 feet in height, and would create a reservoir of about 49,000 acre-foot capacity.

Frenchman Dam and Reservoir on Little Last Chance Creek, which flows into Sierra Valley, would provide much-needed storage for regulation of irrigation supplies for that valley. The dam would be an earthfill structure about 98 feet in height. It would create a reservoir of about 30,000 acre-foot capacity, which would regulate presently used irrigation water so that a yield of 13,400 acre-feet per season on an irrigation schedule could be maintained.

The estimated capital costs of the two foregoing projects are as follows:

Project	*Capital cost*
Grizzly Valley Reservoir	$398,000
Frenchman Reservoir	717,000
Total	$1,115,000

South Fork of Feather River

The Oroville-Wyandotte Irrigation District has prepared plans to construct and operate a power and irrigation project on the South Fork of Feather River, including works to divert to the South Fork drainage area a portion of the flows of Slate Creek, a tributary of the Yuba River. Other plans have been proposed by the County of Yuba and the Yuba County Water District utilizing essentially the same water and dam sites but with the addition of a portion of the flows of Canyon Creek, also a tributary of the Yuba River. The plans have been reviewed by the Division of Water Resources and presented in a report entitled "Analysis of Plans for Development and Utilization of Water Resources of the South Fork of Feather River," December, 1954. An alternative plan formulated by the Division of Water Resources is presented in that report. This plan is shown on Plate 17 of this report and the features of that plan are as follows:

A diversion dam on Canyon Creek, a tributary of North Yuba River, and a 22,400-foot diversion tunnel with a capacity of 135 second-feet extending to Slate Creek; a diversion dam on Slate Creek and a 11,500-foot diversion tunnel with a capacity of 500 second-feet extending to a tributary of Lost Creek; Little Grass Valley Reservoir on the South Fork of Feather River with a storage capacity of 50,500 acre-feet; a diversion dam on South Fork of Feather River, nine miles downstream from Little Grass Valley Dam, and a 13,900-foot diversion tunnel with a capacity of 250 second-feet extending to a tributary of Lost Creek; Lost Creek Reservoir with a dam at a site just downstream from the existing Lost Creek Dam on Lost Creek, with a capacity of 140,000 acre-feet; a 16,580-foot tunnel leading from Lost Creek Reservoir to the penstocks of the Woodleaf Power Plant; Woodleaf Power Plant with an installed generating capacity of 47,000 kilowatts; a diversion dam below Woodleaf Power Plant and an 18,340-foot tunnel leading to the head of the penstocks of the Forbestown Power Plant; and Forbestown Power Plant with an installed generating capacity of 28,000 kilowatts.

The features for supplying water to the Oroville-Wyandotte area would be Ponderosa Diversion Dam on South Fork of Feather River below Forbestown Power Plant and Miners Ranch conduit, constructed initially for a capacity of 125 second-feet, comprising 6.0 miles of canal, 1.5 miles of flume and 4.4 miles of tunnel along the South Fork of Feather River, terminating at Miners Ranch near Oroville. This conduit could later be enlarged, or constructed initially, to a capacity of 250 second-feet, and extended southerly, running to the east of the Oroville-Wyandotte Irrigation District, a distance of 14.6 miles to the vicinity of Bangor. The extension, called the Bangor Canal, would have a capacity of about 100 second-feet at its upper end and 50 second-feet at its terminus.

To supply irrigation water to the lands in the Yuba County area, the existing Forbestown Ditch could be enlarged to a capacity of 100 second-feet for 12.4 miles from the Lost Creek Dam to French Dry Creek. The water could then be conveyed down the channel of the creek for diversion by the Dobbins and Oregon House Canals. The former canal would have a capacity of 20 second-feet, would divert from the creek at about elevation 2,000 feet and would run southeasterly about 9.3 miles to the vicinity of Dobbins. The Oregon House Canal would have a capacity of 50 second-feet, would divert at about elevation 1,625 feet and would run almost straight south 6.4 miles to a point near Oregon House.

The capital costs of the features described have been estimated by this office on the basis of January, 1953, price levels and include an allowance for interest during construction and an allowance of 25 percent of the estimated construction cost for engineering and contingencies. It should be noted that there has been no material change in construction costs between January, 1953, and the present time.

Following is a tabulation showing the estimated capital costs of the works of the plan of the Division of Water Resources required for the storage of water for generation of power and for initial irrigation service to the Oroville-Wyandotte Irrigation District in the amount of 26,000 acre-feet per year:

Item	*Capital cost*
Little Grass Valley Reservoir	$2,992,000
South Fork Diversion	2,286,000
Canyon Creek Diversion	2,390,000
Slate Creek Diversion	2,957,000
Lost Creek Reservoir	16,123,000
Woodleaf Power Development	10,158,000
Forbestown Power Development	8,558,000
Ponderosa Dam and Afterbay	1,366,000
Miners Ranch Conduit (125 second-feet)	3,403,000
Miscellaneous improvement (Oroville-Wyandotte Irrigation Ditch)	775,000
Total	$51,008,000

The estimated capital cost of the works required to provide for ultimate irrigation demands of the Oroville-Wyandotte area and lands in Yuba County is as follows:

Item	*Capital cost*
Miners Ranch Conduit (250 second-feet)	$5,151,000
Bangor Canal	1,113,000
Enlargements of Forbestown Ditch	672,000
Dobbins Canal	192,000
Oregon House Canal	288,000
Rights of way	10,000
Total	$7,426,000

The total estimated capital cost of the project, including the items shown in the first foregoing capital cost tabulation, a 250-second-foot Miners Ranch Conduit and the other irrigation features set forth in the immediately foregoing cost tabulation, being the Bangor Canal, enlargements of Forbestown Ditch, Dobbins Canal, Oregon House Canal and right of way, would be $55,031,000.

Annual costs for the foregoing works which are estimated to cost $51,008,000, have been computed to be as follows:

Item	*Annual cost*
Interest at 2½ percent per annum	$1,269,000
Repayment (40-year sinking fund)	753,100
Replacements	163,300
Operation and maintenance	169,700
Insurance	9,900
Total	$2,365,000

On the basis of preliminary operation studies, it is estimated that the diversion, storage and power production works of the foregoing plan, estimated to cost $51,008,000, could produce hydroelectric power in the amounts of 75,000 kilowatts of dependable capability and an average annual output of 354,000,000 kilowatt-hours. Applying the values of power and energy derived in the aforementioned report by this office on development of South Fork of Feather River, results in the following estimated annual revenue:

75,000 kilowatts at $21.95	$1,646,200
345,000,000 kilowatts at 2.84 mills	1,005,400
Total annual revenue	$2,651,000

Based upon the foregoing estimated annual cost of $2,365,000 and the estimated revenues of $2,651,000, the plan of development for the South Fork of Feather River excluding the Bangor and Yuba County Canals and including a 125-second-foot Miners Ranch Conduit, operated to deliver about 26,000 acre-feet per year of new water to the Oroville-Wyandotte area, in addition to the presently available supply to that area, with no charge for the new irrigation water, would produce a surplus revenue of $286,000.

If the South Fork project, including the 250-second-foot Miners Ranch Conduit, the Bangor, Dobbins and Oregon House Canals and the enlarged Forbestown Ditch is constructed initially, the annual cost with interest at 2½ percent per annum would be $2,558,000. Assuming that no water is diverted which would reduce the power revenue, or that any reduction in such revenue would be met by charges for water, the total revenue would remain at $2,651,000. Therefore, with an interest rate of 2½ percent and assuming maintenance of full power output, annual power revenues would exceed annual costs of facilities to provide ultimate main canal irrigation service by an amount of $93,500.

CHAPTER VII

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are submitted with reference to the Feather River Project based upon surveys, studies and analyses outlined and presented in this report:

CONCLUSIONS

1. The continued increase in population of California, and the expanding industrial and agricultural development demand the immediate consummation of plans for meeting the increasing state-wide water problems.

2. The development and utilization of local supplies would result only in a partial and inadequate solution of existing water problems. The only adequate solution lies in the transportation of water from surplus areas to areas of deficiency for immediate and future needs.

3. These water problems are of state-wide significance and importance and their solution is a responsibility of the State.

4. The project authorized by the State Legislature in 1951 for construction by the Water Project Authority of the State of California as an initial unit of The California Water Plan offers a solution to the immediate water problems in the major geographic divisions of the State by furnishing supplemental water supplies, adequate in quantity and satisfactory in quality, and added flood protection to a highly developed area on the Feather River. The State as a whole would receive benefits, direct and indirect, from the project.

5. The project is engineeringly feasible.

6. The project is financially feasible under State financing through the issuance and sale of general obligation bonds of the State secured by water and power revenue and contributions from the General Fund of the State.

7. There is need for immediate action to initiate construction of the project.

8. The problems dealt with by the Attorney General in his opinions concerning the county of origin law and the watershed protection law should be solved by the Legislature in such manner as to give assurances to the areas of origin that sufficient water would be available to them as and when required for beneficial uses within their areas and at the same time afford satisfactory assurances to the areas of export of continuity of supply from the project.

RECOMMENDATIONS

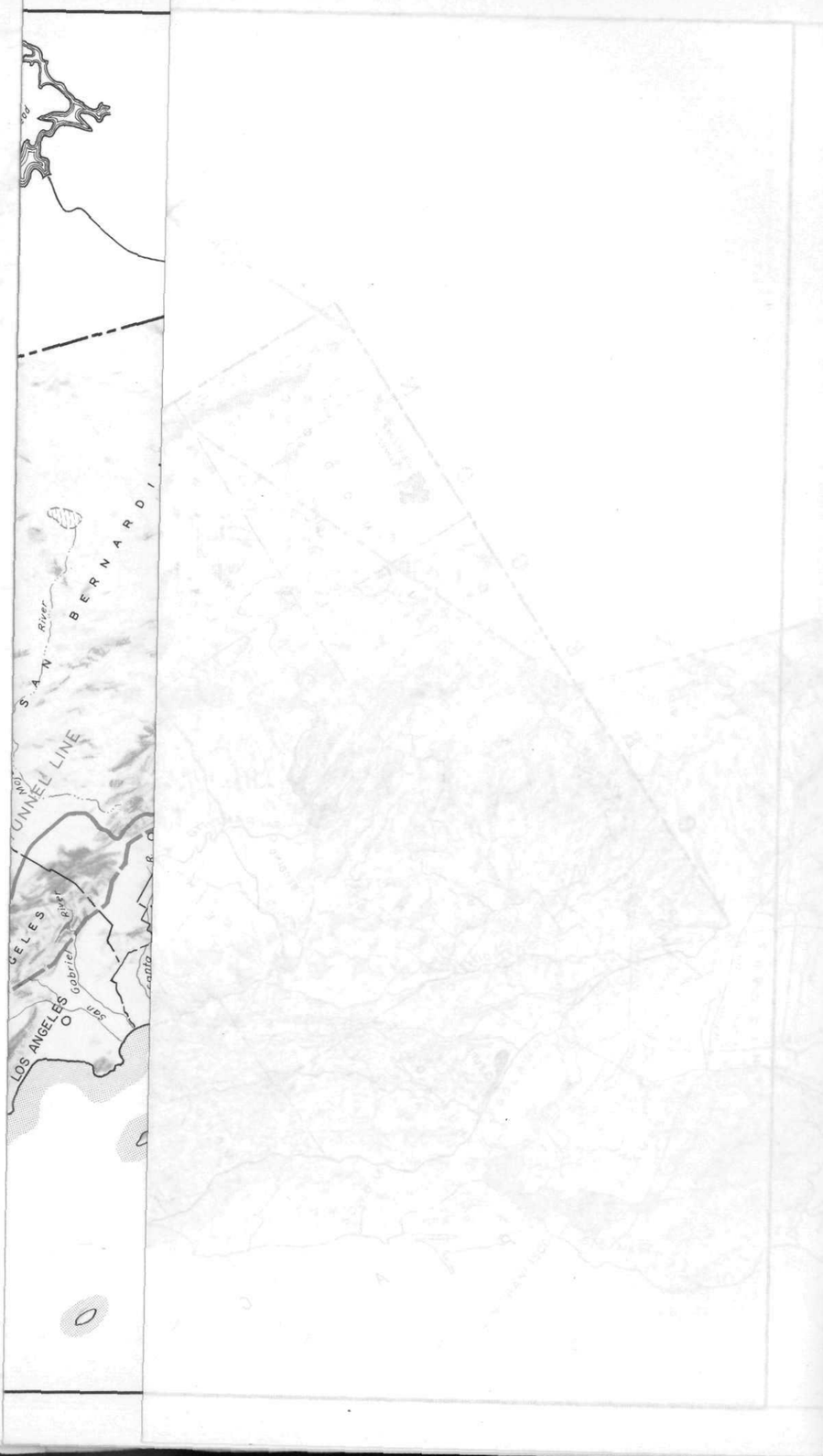
It is recommended that:

1. Adequate funds be appropriated by the Legislature to initiate construction of the Feather River Project (the initial unit of The California Water Plan) as presented in this report.

2. The Legislature consider enactment of legislation for submission to the electorate of a proposal to authorize issuance of bonds in the aggregate amount of $1,500,000,000 to finance construction of the Feather River Project in a step construction program.

3. Upstream features on the North, Middle and South Forks of the Feather River, as set forth in Chapter VI of this report, be included in the Feather River Project.

4. Further works of The California Water Plan be financed and constructed in accordance with a predetermined schedule in order that the excess water supplies of the State be developed and made available for beneficial use as and when the need arises.



APPENDIX

APPENDIX A

STATUS OF WATER RIGHTS

Applications have been filed by the California Department of Finance with the Division of Water Resources to appropriate unappropriated waters of the Feather River which would be used for the Feather River Project. The authority for filing such applications, which cover both the diversion and storage of water, is provided by Section 10500 of Division 6, Part 2, of the State Water Code, which reads as follows:

"10500. The Department of Finance shall make and file applications for any water which in its judgment is or may be required in the development and completion of the whole or any part of a general or coordinated plan looking toward the development, utilization, or conservation of the water resources of the State.

"Any application filed pursuant to this part shall be made and filed pursuant to Part 2 of Division 2 of this code and the rules and regulations of the State Engineer relating to the appropriation of water insofar as applicable thereto.

"Applications filed pursuant to this part shall have priority, as of the date of filing, over any application made and filed subsequent thereto. Until October 1, 1955, or such later date as may be prescribed by further legislative enactment, the statutory requirements of said Part 2 of Division 2 relating to diligence shall not apply to applications filed under this part, except as otherwise provided in Section 10504."

APPLICATIONS FOR APPROPRIATION OF FEATHER RIVER WATER BY DEPARTMENT OF FINANCE

The first applications made by the Department of Finance for the appropriation of Feather River water are Nos. 5629 and 5630, filed on July 30, 1927. Application No. 5629 is for the direct diversion of 1600 second-feet and the storage of 380,000 acre-feet per year of water for the generation of power. Application No. 5630 is for the direct diversion of 1400 second-feet, and the storage of 380,000 acre-feet per year, of water from the Feather River for use for irrigation, domestic, flood control, salinity control and navigation purposes.

By Chapter 1441, Statutes of 1951, the Legislature authorized the addition to the Central Valley Project, separate and apart from all other units thereof, of the units set forth in the "Report on Feather River Project and Sacramento-San Joaquin Diversion Projects Proposed as Features of The California Water Plan" dated 1951. Other filings were made by the Department of Finance for those projects, including Nos. 14443 and 14444, filed on August 24, 1951. Application No. 14444 is for the direct diversion of 11,000 second-feet and the storage of 3,500,000 acre-feet per year of water from the Feather River for the generation of power. Application No. 14443 is for a direct diversion of 1360 second-feet of water from Feather River and 6185 second-feet from Old River and Italian Slough in the Sacramento-San Joaquin Delta and for storage of 3,500,000 acre-feet of water on Feather River and 42,100 acre-feet from Old River and Italian Slough for use for irrigation, domestic, municipal, industrial, recreation, flood control, salinity control and navigation purposes.

In addition to the foregoing applications filed involving water for the Feather River Project as outlined in the 1951 feasibility report, Application 14445 was filed on August 25, 1951, in anticipation of an extension of the project. This application is for direct diversion of 2140 second-feet of water from the Feather River and 8000 second-feet from Italian Slough and Old River, and for storage of 600,000 acre-feet of water per year from Italian Slough. Under this application water is to be used for irrigation, domestic, municipal, industrial, recreation, flood control, salinity control and navigation purposes.

ASSIGNMENT OF APPLICATIONS OF DEPARTMENT OF FINANCE TO WATER PROJECT AUTHORITY

Under the provisions of Section 10504 of the Water Code, the Department of Finance may release or assign its water right applications under certain conditions. The provisions of this section are as follows:

"10504. The Department of Finance may release from priority or assign any portion of any appropriation filed by it under this part when the release or assignment is for the purpose of development not in conflict with such general or coordinated plan. The assignee of any such application, whether heretofore or hereafter assigned, is subject

to all the requirements of diligence as provided in Part 2 of Division 2 of this code. 'Assignee' as used herein includes, but is not limited to, state agencies, commissions and departments, and the United States of America or any of its departments or agencies."

Applications Nos. 14443 and 14444 could have been filed by the Water Project Authority in the interest of the Feather River Project, but on account of the provisions of Section 10500 of the Water Code with regard to diligence in completing the application it was deemed to be to the best interest of the State to have the filings made by the Department of Finance, which is exempted from a show of diligence, and assigned to the Water Project Authority at the time work on the Feather River Project was started. It was also believed that the areas in which the water originates would be better protected in obtaining the water they would ultimately require, by this method of filing, than they would if the filings had been made directly by the Water Project Authority, on account of provisions of Section 10505 of the Water Code restricting such assignments. This section is as follows:

"10505. No priority under this part shall be released nor assignment made of any appropriation that will, in the judgment of the Department of Finance, deprive the county in which the appropriated water originates of any such water necessary for the development of the county."

Attention is also called to the fact that the Feather River Project has been made a unit of the Central Valley Project, and as such, comes under the laws affecting the latter project. One of these is Section 11460, in Part 3 of Division 6 of the Water Code, which provides protection to areas in which water originates, as follows:

"11460. In the construction and operation by the authority of any project under the provisions of this part a watershed or area wherein water originates, or any area immediately adjacent thereto which can conveniently be supplied with water therefrom, shall not be deprived by the authority directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein."

Since work on the Feather River Project had been started, the Executive Officer sent to the Chairman of the Water Project Authority and later presented to the authority at its meeting of June 29, 1954, the following memorandum with reference to the assignment of certain of the Department of Finance filings for Feather River water to the authority in furtherance of the Feather River Project:

"To: MR. FRANK B. DURKEE, *Chairman*
Water Project Authority

FROM: A. D. EDMONSTON

DATE: June 18, 1954

SUBJECT: Assignment of State Filings in Furtherance of the Feather River Project.

"Pursuant to Part 2, Division 6 of the Water Code, the State Department of Finance in 1927 and 1951, filed water right applications with the Division of Water Resources in furtherance of development of the Feather River. The California Legislature by Chapter 1441, Statutes of 1951, authorized construction of the Feather River Project by the Water Project Authority.

"Before the Water Project Authority can complete its application to the Federal Power Commission for license to construct the power features of said project, the Authority must present satisfactory evidence that it has proceeded as far as practicable in perfecting its rights to use water required for the project and before the Authority can give any assurance to agencies desiring to execute contracts for project water or make advance commitments therefor, it will be necessary to secure the water right permits for project purposes. In view of the time required to complete the water right applications, the public notice thereof which must be given, the protest periods which must be allowed and the hearings which will undoubtedly be necessary and other mandatory procedures, it is advisable for the Authority at this time to request assignment of certain of the applications filed by the Department of Finance in furtherance of the Feather River Project.

"It is recommended that this matter be presented at the next Water Project Authority meeting, on June 29, 1954. Attached for your consideration is a suggested draft of a resolution in this regard. I will be available to discuss this matter further in advance of the meeting in the event you so desire."

At the meeting of June 29, 1954, the Executive Officer also presented to the Water Project Authority four reasons why it should at that time request assignment of the Department of Finance filings for the furtherance of the Feather River Project. These reasons are as follows:

"1. The California Legislature by Chapter 1441, Statutes of 1951, authorized construction of the Feather River Project by the Water Project Authority. Since that time the Legislature has provided funds in excess of two million dollars for studies and investigations for the project which studies and investigation have been proceeding.

"2. Request for assignment of State filings is the next logical step in the procedure for the Feather River Project. The Authority should have some assurance of being able to secure the necessary water rights for the project, which assurance can only be given by receiving assignment of such water rights applications that are necessary at this time, completing said applications, giving public notice thereof and participating in the hearings which will undoubtedly be required prior to the issuance of permit. This is the same procedure that was followed by the United States in relation to the Central Valley Project. As soon as it was determined that the United States was to construct the Central Valley Project it requested and received assignment of necessary State filings.

"3. Before the Water Project Authority can complete its application for a license to the Federal Power Commission, which application is now pending before the commission and which license must be secured prior to commencement of construction, the authority must present satisfactory evidence that it has proceeded as far as practicable in perfecting its rights to use water required for the project.

"4. Requests have been received for assurance of firm commitments of a water supply from the project in order that areas interested in securing a water supply therefrom may proceed with the necessary advance water supply planning. Before any such firm commitment can be given by the Water Project Authority and contracts entered into in connection therewith, the Authority must have the necessary water rights."

After discussion of the matter, the authority passed the following resolution:

"WHEREAS, pursuant to Part 2, Division 6, of the Water Code, the Department of Finance has filed with the Division of Water Resources certain water right applications in furtherance of the Feather River Project, a unit of the Central Valley Project, and of The California Water Plan as part of a general or coordinated plan looking toward the development, utilization, or conservation of the water resources of the State, which applications are described generally as follows:

"1. Applications filed on July 30, 1927, in support of the then envisioned Feather River Project (Applications 5629 and 5630).

"2. Applications filed on August 24, 1951, in furtherance of the project outlined in the publication of the State Water Resources Board 'Report on Feasibility of Feather River Project and Sacramento-San Joaquin Delta Diversion Projects Proposed as Features of The California Water Plan', dated May, 1951 (Applications 14443 and 14444).

"WHEREAS, Section 10504 of the Water Code provides that the Department of Finance may assign all or any portion of any appropriation filed by it under Part 2, Division 6, of the Water Code, when the assignment is for the purpose of development not in conflict with such general or coordinated plan; and

"WHEREAS, The Feather River Project is an integral part of the Central Valley Project and a unit of The California Water Plan and is therefore not in conflict with such general or coordinated plan looking toward the development, utilization or conservation of the water resources of the State but is in furtherance thereof; and contemplates the delivery of supplemental water to the Feather River Service Area, Santa Clara and Alameda Counties, areas south of the Tehachapis and the west side and southern portions of the San Joaquin Valley; and

"WHEREAS, The California State Legislature by Chapter 1441, Statutes of 1951, has authorized construction by the Water Project Authority of the Feather River Project; and

"WHEREAS, Studies and investigations pursuant to said Chapter 1441 have been actively proceeding with funds provided by the State Legislature; and

"WHEREAS, Before the Water Project Authority can complete its application to the Federal Power Commission for license to construct the power features of the project it must present satisfactory evidence that it has proceeded as far as practicable in perfecting its rights to use water required for the project; and

"WHEREAS, The authority cannot give firm assurance to agencies desiring to contract for project water, or make advance commitment therefor, until water right permits have been granted; and

"WHEREAS, Ample time must be allowed to complete the necessary water right applications, give public notice thereof, and for the filing of protests in connection therewith; and

"WHEREAS, A hearing will undoubtedly be necessary in connection with said applications; and

"WHEREAS, Certain agencies have expressed concern over not being able to receive commitment at this time relative to securing a supplemental water supply from the Feather River Project;

"NOW, THEREFORE, BE IT RESOLVED, That the Executive Officer is hereby directed to request from the Department of Finance assignment of water right Applications 5629, 5630, 14443, and 14444 as hereinbefore recited in items 1 and 2, hereof at the

earliest practicable date in order that the authority may comply with state and federal laws and procedures requiring that the authority secure water right permits for the Feather River Project;

"AND BE IT FURTHER RESOLVED, That a copy of this resolution be transmitted to the Director of Finance."

Protests From Counties of Origin

Following the adoption of the foregoing resolution by the Water Project Authority on June 29, 1954, protests against the assignment by the Department of Finance of its filings on Feather River to the Water Project Authority were received by the State Engineer from the following agencies:

Plumas County Water Resources Board
Alton Young, Secretary
Sierra County Water Resources Board
Louis Genasci, Chairman
Lassen County Water Resources Committee
J. R. Barron, Chairman
Sierra Valley Soil Conservation District
Bruce Miles, Secretary
Board of Directors
Plumas County Board of Supervisors
M. C. Cloman, Chairman
Oroville-Wyandotte Irrigation District

One of the protests, that from the Sierra County Water Resources Board, signed by Louis Genasci, Chairman, which was received as a telegram, and is similar to those received from the other four of the first five agencies named above, is quoted as follows:

"The Sierra County Water Resources Board hereby protests any filings for water originating in the Feather River watershed until the study now under way by the State Division of Water Resources is completed. Our protest covers normal summer flow and also winter surpluses and applies to applications by individuals, State or Federal agencies. We strongly feel that without having available the results of said study any water rights granted from the Feather River watershed would jeopardize our rights as a county of origin."

On July 16, 1954, the State Engineer sent to Mr. Genasci a letter explaining the filings made for the Feather River Project, the assignment of such filings, the protection to the areas of origin of adequate water supplies, and the reasons for requesting assignment of the Department of Finance filings at this time. This letter, which is similar to those sent to others filing protests, except the Oroville-Wyandotte Irrigation District, is as follows:

"MR. LOUIS GENASCI, *Chairman*
Sierra County Water Resources Board
Loyalton, California

"DEAR MR. GENASCI: Receipt is acknowledged of your telegram of July 12, 1954, expressing the objections of the Sierra County Water Resources Board to any filings for water originating in the Feather River watershed and requesting that no action be taken until completion of the current studies of the ultimate water requirements of certain counties authorized by the Budget Act of 1953.

"The California Legislature by Chapter 1411 Statutes of 1951, authorized construction of the Feather River Project by the Water Project Authority. Since that time the Legislature has provided funds in excess of two million dollars for studies and investigations for the Project which studies and investigation have been and are proceeding with diligence. The Legislature has indicated its desire that a report on financing the Feather River Project be completed at earliest practicable date, if possible before or during the 1955 General Session. This report must of necessity consider the water rights involved. It is believed that this office would be derelict in its duty were that report not to be promptly completed.

"The State filings on the Feather River, made in 1927 and 1951 were filed with the dual objective of implementing the Feather River Project, and protecting the rights of the counties of origin to the water needed for their full development.

"Request for assignment of the necessary State filings is the next logical step in the required procedure in furtherance of the Feather River Project. The Authority must have assurance of acquisition of required water rights for the project which can only be afforded by receiving assignment of such water right applications as are necessary at this time, by completing said applications by giving public notice thereof, and by participating in the hearings prior to the issuance of permit. This is the same procedure that was followed by the United States in relation to the Central Valley Project. As soon as it was determined that the United States was authorized to construct the Central Valley Project, it requested and received assignment of necessary State filings.

"Before the Water Project Authority can complete its application, now pending before the Federal Power Commission, for a license to construct the power features of the project, which must be secured prior to final decision as to project feasibility the authority must present satisfactory evidence that it has proceeded as far as practicable in perfecting its rights to water required for the project.

"Your attention is invited to those provisions of the Water Code which afford protection for counties and areas of origin. Specifically, Section 10505 provides as follows:

'*No priority under this part shall be released nor assignment made of any appropriation that will,* in the judgment of the Department of Finance, *deprive the county in which the appropriated water originates of any such water necessary for the development of the county.*' (emphasis supplied)

"Further protection to areas of origin is afforded by Section 11460, which is contained in Division 6, Part 3, relating to the Central Valley Project, and which is directly applicable to the Water Project Authority in operating the Feather River Project. This section provides as follows:

'In the construction and operation by the Authority of any project under the provisions of this part *a watershed or area wherein water originates*, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom, *shall not be deprived by the authority directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein.*' (emphasis supplied)

The evident objective of these provisions is to require that sufficient water be available to the counties and areas of origin when and as required for the full development of such counties and areas.

"Should the State Department of Finance desire our recommendation concerning the request of the Water Project Authority for assignment of the State filings on the Feather River, I shall recommend that such assignment be made *only* on condition that the rights thereunder of the Water Project Authority shall at all times be subject to the requirements of any county or area in which the water sought to be appropriated originates for such quantities of water as may be necessary for the full development of any such county or area. Further, when and if permits are issued to the Water Project Authority, it is contemplated that all necessary and appropriate terms and conditions will be included to subject the rights of the Authority to the needs of the counties and areas of origin for water for their full development.

"It is not believed necessary to delay assignment of the State filings, as you request, until completion of the current investigation concerning the ultimate water requirements of the counties and areas of origin involved. These studies will provide, in terms of specific quantities, estimates of the amount of water necessary to meet the ultimate consumptive use of applied water plus irrecoverable losses for irrigation and domestic purposes as well as the water requirements for development of mineral and timber resources, maintenance of fish and game, and the development of recreational areas. It is true that these values will be more accurate than any made heretofore. However, insofar as reservations in assignments and permits are concerned, it is believed that a general reservation for *all* the water needed will provide better protection to the counties and areas of origin than naming a specific value.

"Insofar as the amount of *surplus* water which will be made available by the Feather River Project for use downstream and for export, the important factor is the *depletion* of stream flow at the damsite resulting from future upstream use. Estimates have already been made of future stream flow depletion, sufficiently accurate for Project purposes.

"Requests have been received by the Authority for assurance of firm commitments for a water supply from the Project in order that areas interested may proceed with the necessary advance water supply planning. Before any such firm commitment can be given by the Water Project Authority and requisite contracts can be entered into, the Authority must have the necessary water rights. It is believed that all required information is at hand and that these rights can now be acquired with *full* protection to the counties and areas of origin by incorporating in the assignment and subsequent permits a reservation for all the water needed for ultimate development in such counties and areas of origin.

"Your attention is directed to the required procedural steps which will take considerable time *after* assignment of the State filings is made to the Water Project Authority. The applications must be completed and advertised, protests must be received, and necessary hearings held; all before permits can be issued to the Authority. The concerned counties and areas of origin will be afforded ample opportunity to appear at those hearings.

"If you have other comments or questions, we will be pleased to discuss the matter further at your convenience.

Very truly yours,

/s/ A. D. EDMONSTON
State Engineer"

There are also on file with the Director of Finance requests from the Oroville-Wyandotte Irrigation District, the Yuba County Water District, the Board of Supervisors of the County of Yuba and the Richvale Irrigation District, for release from priority or assignment of those portions of the Department of Finance applications involving the waters of the Feather River which are necessary for their projects.

Further Action by Water Project Authority

At the regular meeting of the Water Project Authority on Tuesday, August 31, 1954, further consideration was given to the matter of the assignment to the Water Project Authority of Department of Finance water right filings in behalf of the Feather River Project authorized by the 1951 Legislature for construction by the Water Project Authority. At the conclusion of the meeting, it was agreed by members of the Authority present, without formal action, that the resolution heretofore addressed to the Director of Finance respecting the applications would not be rescinded; and that the Director of Finance would withhold action on the requested assignments of applications heretofore made by that department until such time as the Division of Water Resources has completed its pending studies of present and future water requirements in the Feather River watershed, particularly the area of Butte, Plumas, Sierra and Lassen Counties.

APPENDIX B

STATUS OF APPLICATION TO FEDERAL POWER COMMISSION FOR LICENSE FOR FEATHER RIVER PROJECT

The Water Project Authority of the State of California, at its regular meeting on August 28, 1951, directed the State Engineer, its Executive Officer, to make an application to the Federal Power Commission for license to construct the Feather River Project. Pursuant to their directions the State Engineer transmitted an application for a license for the Feather River Project to Lesher S. Wing, Regional Engineer in San Francisco, on February 15, 1952, by letter dated January 31, 1952. Receipt of this application in the Washington, D. C. office of the Federal Power Commission was acknowledged on February 19, 1952, which date became the official date of filing. Project Number 2100 was assigned to the Feather River Project.

On May 19, 1952, the Oroville-Wyandotte Irrigation District filed a protest with the commission with reference to the Feather River Project on the basis that it would destroy the upper reaches of the existing Palermo Canal and would conflict with its proposed Miners Ranch Diversion Ditch, for which an application (No. 2088) had been previously filed with the Federal Power Commission. In a simultaneous letter to the State Engineer, the Oroville-Wyandotte Irrigation District stated that their intention was not to impede the project but solely to maintain their rights in the case by making a representation within the prescribed time.

On August 11, 1952, the Federal Power Commission transmitted to the State Engineer a copy of a letter addressed to the commission dated July 8, 1952, from the State of California Department of Fish and Game. This letter requested that issuance of a license be made contingent upon observance of certain provisions for fish life, namely:

1. A definite provision for flows to be maintained at all times in the main Feather River downstream from the existing Sutter-Butte Diversion Dam.
2. Provision that adequate screening be provided on all irrigation canals or conduits planned for diversion of water directly from the Feather River if found necessary by the Department of Fish and Game.
3. All diversion dams planned for the main Feather River below the present Sutter-Butte Diversion Dam be designed to facilitate the passage of fish.
4. Surveys be made of the lower portion of the river to determine the feasibility of improving conditions for salmon spawning.

It was also recommended that the recreational potential of the Oroville Reservoir be developed as fully as possible and provision be made during the planning stages for the necessary recreational and sanitary facilities.

On August 26, 1952, the State Engineer acknowledged the above-mentioned letter and stated that a conference had been arranged with the Department of Fish and Game on September 8, 1952, for the purpose of discussing the fish and wildlife problems which might arise from the construction of the Feather River Project.

On November 20, 1952, the Federal Power Commission transmitted to the State Engineer a copy of a letter addressed to it, dated October 31, 1952, from the Acting Secretary of the Interior to Mr. Buchanan, Chairman of the Federal Power Commission. In that letter the acting secretary recommended that the license be granted to the Water Project Authority of the State of California, subject to the stipulations and conditions quoted below:

"1. The Licensee shall cooperate with interested State and Federal agencies in developing a broad land-use plan for the project area which would permit the public maximum free access to project waters and adjacent lands consistent with proper operation of the project; provided that the Licensee may reserve from public access such areas as may be necessary for protection of life, health, and property.

"2. The Licensee shall operate the project works in such a manner so as to maintain in the main Feather River downstream from the Sutter-Butte Diversion Dam such flows as are determined by study and experimentation with the project in operation and as are mutually agreed upon by the Licensee, the California Department of Fish and Game, and the Fish and Wildlife Service, but in no event shall the

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flow in this reach be permitted to fall below 400 cubic feet per second.

"3. The Licensee shall release water from the Oroville Reservoir, for the purpose of maintaining the flows noted in Stipulation 2, from the lowest reservoir outlet.

"4. The Licensee shall maintain a constant rate of flow in the reach of the Feather River downstream from the Sutter-Butte diversion dam during the salmon-spawning period to the extent that this is possible in the operation of the project works. If this is not practicable, the Licensee shall provide for gradually increasing rather than decreasing the flow in this reach during such period insofar as this is possible in the operation of the project works.

"5. Changes in rates of release from the project Afterbay Reservoir shall be gradual and minimal at all times so far as this is consistent with operational requirements.

"6. The Licensee shall undertake such feasible means and measures to increase the spawning and summer-holding capacity of the remaining stream areas available to salmon as may be cooperatively determined necessary by the licensee, the California Department of Fish and Game, and the Fish and Wildlife Service prior to initiation of project construction.

"7. The construction and operation of the project transmission lines shall be subject to the same special conditions as were incorporated in part (F) of the Commission's order of October 13, 1949, being an order superseding an order authorizing the issuance of a license for Project No. 1975, except that paragraph (1) of that part (F) does not appear to be applicable in this case.

"8. The licensee shall compensate the affected Indians for damage to Indian properties caused by the construction of the project in such manner and by such amounts as may be acceptable to the Indians involved and to the Secretary of the Interior."

The letter from the Federal Power Commission also requested from the State Engineer such comments as were deemed appropriate.

On April 7, 1953, the State Engineer submitted to the Federal Power Commission comments on certain portions of the letter referred to and quoted, in part, in the preceding paragraph. These comments, quoted below, are numbered to correspond to the numbering of the quoted proposed stipulations:

1. "The State will be willing to cooperate with all agencies interested in developing a broad land use plan for the Project area. In this connection a contract is now being negotiated with the U. S. Forest Service for a complete inventory of the timber resources on both Forest Service Lands and the public domain, a replanning of the fire protection plan, a revision of the timber management plan for the area affected by the Project, and an engineering study of the relocation, design, and cost of National Forest roads and bridges.

2. "In a portion of the letter from the Department of the Interior preceding the Recommended Stipulations, the Department specifies a tentative schedule of flow in the Feather River below the Sutter-Butte Dam. The State would be willing to abide by any stipulation as to flows below this dam mutually agreed upon and assumes that the flows requested would not be arbitrary or of such magnitude as to interfere with the planned accomplishments of the Project. A study has been made to compare the flows in the schedule submitted by the Department with the anticipated flows below the Sutter-Butte Dam resulting from the proposed operation of the Oroville Reservoir. It was found that the anticipated flows fell below the specified minimum flows in about 25 months out of the 324 months in the period studied 1921-47. In no case did the deficiency of flow exceed 400 second-feet, and in many cases the deficiency was much less. In no case would the deficiency occur during periods of critically low runoff. It is believed that the minimum flows specified by the Department could be satisfied without detriment to the accomplishments of the Feather River Project. However, arbitrary stipulation of a minimum flow of 400 second-feet below the Sutter-Butte Dam is contrary to the spirit of the first part of the proposed stipulation 2 and is also contrary to the suggestion of the Department of the Interior that there be coordinated operation of the Oroville Reservoir with the Shasta and Folsom Reservoirs of the Central Valley Project, which would require variations of releases from Oroville Reservoir to conform to releases from the other two reservoirs. Before any stipulation is made as to minimum flows to be maintained below the Sutter-Butte Dam, considerable study should be given to the minimum amounts of water actually needed to establish and maintain fish spawning areas.

3. "Consideration is being given to revisions in the plans for the dam as submitted with the application to the Federal Power Commission for a license, to provide for an outlet or outlets lower than those shown on the original plans. It is assumed that in specifying releases from the lowest outlets the Department of the Interior had in mind the penstock outlets, as these are the lowest ones shown on the plans filed, and this would be satisfactory to the State. It is believed, however, that since the temperature of the water is the criterion so far as fish life is concerned, the operator of the dam should be given some discretion in making releases of water through it so long as the temperature requirement is met.

4. "This requirement is reasonable and it is believed can be complied with to the satisfaction of all interests.

5. "The requirement also is reasonable and it is believed can be complied with to the satisfaction of all interests.

6. "From an examination of the report of the California Department of Fish and Game entitled 'Fisheries Problems of the Feather River With a Special Reference to the Proposed Oroville Dam' it is concluded that nearly all of the present spawning areas of the Feather River lie below the Oroville Afterbay Dam site. With maintenance of proper water temperatures in the river below that dam by releases from the lower portions of the reservoir it is believed that the fisheries of the Feather River would be greatly improved rather than injured. However, the State will be willing to cooperate with the other agencies in preserving spawning and summer holding areas in the stream below the Afterbay Dam.

7. "The transmission lines designed for the Project would consist of one single and one double 230 kilovolt circuits with normal operating capacity of about 150,000 kilowatts per circuit. These lines would transmit the outputs from generators rated at 465,000 kilowatts, and which probably would have capacities considerably in excess of this amount. In case of failure of one circuit the other two circuits could probably be overloaded to a capacity of 175,000 kilowatts each. This is less than the total required capacities. It is seen, therefore, that the three circuits would be fully loaded for normal operation and in case of a circuit failure there would be insufficient capacity for carrying the full load until repairs were made. It would therefore appear that there would be no dependable excess capacity on these lines.

8. "It is the intention of the State to fully compensate all Indians for their lands which would be inundated by the proposed Oroville and Oroville Afterbay reservoirs. It is believed, however, that the stipulation should provide for payment of the fair market value as determined by all parties involved, or by disinterested appraisers, instead of an amount 'acceptable to the Indians'."

The Federal Power Commission acknowledged this letter on April 10, 1953, and forwarded a copy to the Secretary of the Interior on May 21, 1953.

On December 24, 1953, the Federal Power Commission transmitted to the State Engineer a copy of a letter dated November 5, 1953, from the Secretary of the Interior giving the latter's reaction to comments No. 2 and No. 8 contained in the State Engineer's letter of April 7, 1953. These are quoted as follows:

Discussion of State Engineer's Comment 2:

"We are confident that it will be possible cooperatively to arrive at mutually accepable flows to be applicable under this stipulation. One point, it is plain, does need clarification. This stipulation requires that flows for the preservation of fishery resources be determined by study and experimentation with the project in operation and that a minimum flow of 400 cubic feet per second be provided. Our Fish and Wildlife Service sees no conflict between the stipulation of a minimum flow of 400 c. f. s. and the spirit of the first part of this proposed stipulation, as the Authority contends. The specified 400 c. f. s. is the absolute minimum. In most months flows in excess of the minimum will be essential; it is these minimum monthly flows in excess of 400 c. f. s. that are to be determined by study and experimentation."

Discussion of State Engineer's Comment 8:

"As stated in our letter of October 31, 1952, the Oroville Reservoir would affect two parcels of Indian lands, Parcel 1, the Enterprise Rancheria, and Parcel 2, the allotment of John Pinkey. Our Bureau of Indian Affairs is now making a survey and appraisal of the above Indian lands. This survey will determine the status of ownership, whether tribal, allotted, or other. When this information is at hand, we will be glad to inform you, in the near future, regarding methods and procedures for the procurement of Indian lands involved in power project No. 2100.

"This Department will not object to steps being taken by the affected Indians and the Water Project Authority to reach agreement as to the value of the affected lands, subject to subsequent approval by the Secretary or his duly authorized representative."

The above-mentioned letter was acknowledged by the State Engineer on January 15, 1954, at which time he requested a conference with representatives of the U. S. Fish and Wildlife Service regarding stipulation 2 proposed in the letter of October 31, 1952, from the Secretary of the Interior.

This letter was acknowledged January 22, 1954, by the Federal Power Commission and was forwarded to the Secretary of the Interior on February 5, 1954. The Secretary of the Interior brought this matter to the attention of the Fish and Wildlife Service and a conference was held on March 19, 1954.

On March 22, 1954, in a letter to the Federal Power Commission, the State Engineer wrote as follows:

"On March 19, 1954, a conference was held between representatives of the U. S. Fish and Wildlife Service, California Department of Fish and Game and the California Division of Water Resources. The purpose of the meeting was to discuss a proposed stipulation, numbered "2" in the Department of Interior's letter to the commission dated October 31, 1952, with reference to being made a part of the license for the Feather River Project.

"At that conference it was decided that the three above mentioned agencies would cooperate in making a determination of the relationship between flow and available salmon spawning gravel areas on the Feather River below the Sutter-Butte Dam (near Haslebusch). The study is to be undertaken jointly and accomplished during 1954. On completion of the study, a tentative schedule of flows that will be required for the preservation of the fishing resources is to be formulated for maximum, minimum and average years.

"It is requested that action on the application for license be deferred until the results of the flow studies are available."

A report has been prepared by the California Department of Fish and Game entitled, "The Relationship Between Flow and Available Salmon Spawning Gravel Areas on the Feather River Below Sutter-Butte Dam," January, 1955, in which the relationship between flow and available salmon spawning gravel areas on the Feather River below the Sutter-Butte Dam is resolved.

On June 16, 1953, the Federal Power Commission transmitted to the State Engineer comments by the Secretary of Agriculture contained in a letter dated May 1, 1953, relative to the application for license for the Feather River Project and invited the State Engineer to submit such comments as were deemed appropriate. The Secretary of Agriculture recommended that the license be granted subject to certain conditions which are quoted below:

"Conditions of License.

"In evaluating the foregoing it is our judgment that the Oroville Dam, reservoir, power plant and attendant facilities as proposed by the Water Project Authority of the State of California, constitute a desirable development of national forest lands and resources, provided adequate compensation for the various losses is made. If a license is granted to the Water Project Authority of the State of California, this Department deems it necessary for the adequate protection and utilization of the Plumas and Lassen National Forests to include standard form L-6 'Terms and Conditions of License for Unconstructed Major Projects Affecting Navigable Water and Lands of the United States' and the following supplemental provisions:

"1. The licensee shall provide such additional fire fighting personnel, equipment, and facilities as may be determined by the Regional Forester to be necessary to prevent and suppress forest fires along the margins of the Oroville reservoir within the Forest Service protection zone.

"2. The licensee shall relocate or replace all the existing Forest Service, County and other local roads and bridges inundated by the reservoir, including the following:

"Forest Service roads:

"(a) The old Utah Construction road (No. 2237) on the North Fork Feather River in the vicinity of Berry Creek.

"(b) The Midas Mine section of the Island Bar road (No. 2132) in the vicinity of Sucker Run Creek and South Fork Feather River. The relocations and standards shall be subject to the approval of the Forest Service.

"County Roads:

"(a) The Quincy-Oroville road (No. 2425) in the vicinity of Bidwell Bar.

"(b) The Feather Falls-Oroville road (No. 2224) in the vicinity of Enterprise.

"(c) South Fork Feather River road (No. 2023) in the vicinity of Enterprise.

"The locations and standards shall be subject to the joint approval of the Forest Service and the County of Butte.

"State Division of Forestry road:

"(a) The Powell Creek section of the Ponderosa Way (No. 19, 19).

"The location and standards shall be subject to the joint approval of the Forest Service and State Division of Forestry.

"The road numbers above refer to those used on the Forest Service Transportation Plan."

On July 3, 1953, the State Engineer, in a letter to the Federal Power Commission with reference to the comments quoted in the preceding paragraph, called attention to the fact that the California State Department of Public Works, Division of Water Resources, had entered into a cooperative agreement with the U. S. Forest Service Office in San Francisco under which the latter office agreed to prepare a detailed report relative to matters which, in the main, correspond to those included in the comments by the Secretary of Agriculture. In conclusion this letter stated:

"It is the intention of the Division of Water Resources to recommend the relocation or reconstruction of all Forest Service, county and other roads, and railroads, affected by the construction of the Oroville Reservoir and provisions for such additional protection of the forests as may be necessitated by the construction of the project, and to include in the final cost estimates for the Feather River Project the costs of these items. It is believed, however, that the aforementioned report by the U. S. Forest Service should be completed, and the findings therein discussed by the parties to the agreement, before definite stipulations with reference to the matters covered by the report are made a part of the license for the Feather River Project."

This letter was received and acknowledged by the Federal Power Commission on July 7, 1953, and forwarded to the Secretary of Agriculture for pertinent comments on August 14, 1953.

The Regional Forester of the California Region of United States Forest Service, by letter of December 17, 1954, has transmitted "Report to State Engineer of California on Effect of Proposed Oroville Reservoir on National Forest and Public Domain Land and Lands Protected by California Division of Forestry," 1954. The costs of the items referred to in the letter of the State Engineer quoted above have been included in the cost estimates presented in this report.

On September 14, 1953, a revised application for license was submitted to the Federal Power Commission. This revised application included changes in the layout of the project which had been shown desirable during further study. Receipt of this application was acknowledged September 23, 1953, by the Federal Power Commission.

On December 7, 1953, the Federal Power Commission requested by letter the following supplementary information with respect to the revised application:

"To facilitate the review of this application it would be desirable to obtain the following additional information with respect to the main Oroville dam:

"1. Submit an Exhibit L drawing showing in plan and elevation the two earthen dikes mentioned on page (3) of your application.

"2. An Exhibit L drawing showing the upstream elevation for the spillway structure;

"3. Submit bore-hole and other exploration data, including a detailed geologic report based on this data showing the suitability of the foundation for the main Oroville dam;

"4. Submit a statement covering the criteria used for fixing the design of the main dam such as (a) sliding factor 'u'; (b) factor of safety against overturning; (c) shear-friction factor of safety and allowable shear used in such computation; (d) uplift factor for all horizontal sections within the dam; and (e) allowable stresses for concrete and foundation rock. These criteria should be given for empty reservoir with and without earthquake allowance, and for full reservoir with and without earthquake allowance."

On January 15, 1954, the State Engineer, the Executive Officer of the Water Project Authority, transmitted the following supplementary data to the Federal Power Commission in accordance with the request noted in the preceding paragraph:

"1. Exhibit L-9, 'Oroville Dam and Spillway, Upstream Elevations'. Original tracing, seven contact prints and seven reduced prints for insertion in the bound volumes, previously furnished.

"2. Exhibit L-10 'Auxiliary Earth Dams, General Plans, Profiles and Sections'. Same number of copies as mentioned above for Exhibit L-9.

"3. 'Design Criteria for the Oroville Dam'.

"4. 'Geologic Report on Preliminary Exploration of the Oroville Dam Site, Butte County, California'. One copy.

"5. Appendixes to the above mentioned Geologic Report. One copy."

Additional data in response to item 4 of the request were included in the body of the letter.

On January 19, 1954, the Federal Power Commission acknowledged receipt of the data mentioned in the preceding paragraphs.

In Appendix A "Status of Water Rights," there is discussed the assignment of state filings in furtherance of the Feather River Project. At a meeting on June 29, 1954, the State Engineer and executive officer of the Water Project Authority presented to that body four reasons why it should at that time request assignment of the Department of Finance filings for water of the Feather River to the authority. Reason No. 3 was as follows:

"3. Before the Water Project Authority can complete its application for a license to the Federal Power Commission, which application is now pending before the Commission and which license must be secured prior to commencement of construction, the authority must present satisfactory evidence that it has proceeded as far as practicable in perfecting its rights to use water required for the project."

The action of the Director of Finance with respect to the requested assignment, and a discussion of protests to such assignment, is discussed in Appendix A of this report.

APPENDIX C

SUMMARY GEOLOGIC REPORT ON OROVILLE DAM SITE

Exploration at the Oroville dam site has been conducted intermittently by the Division of Water Resources from 1952 to the present time. When the first money was made available by the Legislature for exploration of the site, it was deemed desirable to devise a program to best utilize the limited funds. Therefore, the Board of Consultants and personnel of the Division of Water Resources concluded that the best approach would be to first establish that the rock in the lower portion of the dam site, that which would support the greatest mass of concrete and the highest loads, was of satisfactory quality. Therefore, exploration was concentrated on the lower elevations of the site and later expanded to cover the entire area. The total exploration program, to date, has been of a preliminary nature designed to establish the suitability of the foundation, and to delimit any serious geologic anomalies which could preclude construction of a large dam.

REGIONAL GEOLOGY

The Oroville dam site is situated in the Sierra Nevada geomorphic province. The province is characterized by steep, rugged topography marked by deep canyons draining the region in a westerly direction. The streams, of which the Feather River is one, are large and persistent and have great erosive power, as they are fed by snowpacks on the high continuous crest line. The rocks of the region consist of Sierran granitic types with a belt of older metamorphosed sedimentary and igneous rocks along the west and northwest flank of the mountains. These rocks, known as the basement complex, are capped in places by much younger volcanics and by occasional remnants of auriferous gravels from old river channels. Along the westerly margin of the region, continental and marine sediments cover the basement complex. The area in general, and particularly near the Oroville dam site, is considered to be only slightly seismically active.

GEOLOGY OF THE DAM SITE

The Oroville dam site is situated in the belt of metamorphic rocks mentioned above. The foundation rock is predominately an exceptionally hard, medium- to fine-grained, gray to black amphibolite. The term amphibolite implies that the rock is metamorphosed and contains a high percentage of the dark-colored amphibole minerals. One to three feet of residual soil covers the rocks between scattered outcrops on the abutments while the exposed rock near the river channel is fresh due to constant washing. Sand, gravel and boulders occupy the river bottom and some immediately adjacent areas.

As a result of deformation through the ages the foundation rock is sheared and fractured and has developed a foliation which strikes approximately across the river and dips steeply upstream at the dam site. Joint systems are pronounced and tend to make the rock appear blocky. Some joint planes are open enough to allow downward percolation of water, and it is not uncommon to find these planes coated with films of sticky, red mud, infiltrated downward with water from the surface into the fresh rock.

EXPLORATION OF FOUNDATION ROCK

Exploration Tunnels

To examine the structure, quality and peculiarities of the rock in the lower reaches of the dam site an exploration tunnel was driven into each abutment approximately 500 feet below crest elevation of the proposed dam.

Excavation of the tunnels was started in September, 1952, and they were completed in April, 1953. Two drifts were added to each tunnel during the period from November, 1953, to February, 1954. The bores average five feet wide and seven feet high and offer an excellent opportunity to observe both the weathered and fresh portions of the rock penetrated. Locations of the tunnels and drifts are shown on Plate A. The alignment of the tunnels was planned to cross as much geologic structure as possible, to attain a reasonable depth of cover in the fresh rock, and to traverse the entire abutment areas. The drifts were later constructed to observe several of the more notable shear zones along their strike. They were excavated along such zones in order to gain knowledge of the characteristics of a few shears which would serve as criteria for interpretation of data involving other similar shear planes at the dam site.

The left abutment tunnel was started in a small ravine near the downstream limits of the area which might be occupied by the dam. The bore was driven into the hillside until about 170 feet of cover was attained, and then turned left to parallel the abut-

ment. The tunnel terminates about 50 feet beneath a small ravine near the upstream limits of the proposed dam. The total length of the bore is 975 feet. The rock penetrated by this tunnel is thoroughly oxidized and weathered for the first 120 feet from the portal. The rock beyond is generally fresh and shows less signs of weathering as greater depth is attained. The most important shear zone encountered during exploration at the site is located 245 feet from the portal in this tunnel. The zone contains 12 inches of soft, compressible clay gouge followed by about 15 feet of fractured rock. This zone was the subject of considerable study, for it appeared to strike across the entire left abutment. However, subsequent exploration with core holes and a drift from the tunnel did not reveal any indication of the zone continuing across the abutment. It was therefore assumed that the zone is local where encountered in the tunnel and could only be more accurately delimited by later exploration.

The rock encountered beyond 300 feet in the left abutment tunnel is considered to be sufficiently strong and sound for the foundation of the dam. The vertical cover above the 300-foot mark is 72 feet. Numerous small shear planes and strong joint systems are present in the fresh portion of the rock but none of these is considered serious where encountered in this tunnel.

Two drifts were later added to the left abutment tunnel. The first drift was excavated along a narrow shear zone. The alignment was planned so that this bore would again intersect the shear zone encountered in the main bore at 245 feet. As previously indicated, the main zone was not intersected by the drift, suggesting that some of the shears may be discontinuous. The bore did penetrate several small intersecting shear planes which gave an opportunity to evaluate the quality and condition of rock where this type of structure occurs. The cover above this drift varies from 74 to 45 feet. The cover above the second drift varies from 130 to 111 feet. Drift two was driven along a narrow shear zone varying from 2 to 12 inches in width. It was noted, in this drift, that these narrow shear zones commonly have void spaces, the largest examined being seven inches wide and 24 inches long. These voids commonly are wet and contain red mud, even at these depths. Similar voids can now be anticipated and will require treatment.

The right abutment tunnel was started near the upstream limits of the area which might be occupied by the dam. The tunnel was driven into the hill to gain cover rapidly and then turned left so that the entire abutment area could be penetrated. The tunnel is 932 feet long and the maximum cover attained was 100 feet. The rock is oxidized and weathered for a distance of 105 feet from the portal but the tunnel penetrates hard, fresh rock beyond. The vertical cover above the weathered-fresh rock contact is 42 feet. Numerous narrow shear zones are penetrated by this bore.

Drifts were driven from the right abutment tunnel along each of the two most prominent shear zones, one of which varies from two to four feet in width and the other averages about two feet in width. These drifts were driven from the main bore toward the surface in order to help estimate the depth to which stripping might be necessary along these larger shear zones. It was determined from observations in these drifts that it may be necessary to strip more material along and adjacent to these larger shear zones. Where these zones intersect, the surrounding area may also require special treatment below the normal stripping depth.

Diamond Drill Core Holes

Forty-four diamond drill core holes, totaling 5,369 feet of hole, were drilled by the Division of Water Resources between March, 1953 and November, 1954. Thirty-four of the holes were drilled on the abutments and 10 holes were drilled to cross the channel section. The drill holes on the abutments were located so as to give an indication of the necessary stripping depth and to reveal and locate foundation areas which might require future exploration. The holes drilled beneath the channel were for the purpose of determining if serious shear zones were present and also to determine the quality of the rock below river channel elevation. These holes also helped to determine the shape of the channel section and the depth of fill concealed beneath the water surface. Nine additional core holes had been previously drilled at the site by the United States Bureau of Reclamation and the United States Corps of Engineers, Department of the Army. Locations of all core holes drilled at the dam site are shown on Plate A.

All holes drilled by the Division of Water Resources were inclined. The direction and inclination of each hole was adjusted to crossent the strike of the structure, to cut the maximum section of rock, and yet attain a reasonable vertical depth with a short drill hole. Holes on the abutments had an average inclination of 60 degrees from the horizontal while those drilled beneath the channel ranged from 35 degrees to 56 degrees from the horizontal. All holes drilled were water-tested under pressure. Pressures up to 300 pounds per square inch were used in fresh sections of rock. Ordinarily, water losses under high pressure were low in the fresh rock.

Generally, the restricted core drilling program which has been completed, has made data available which indicate that the rock is perfectly satisfactory

PLATE A

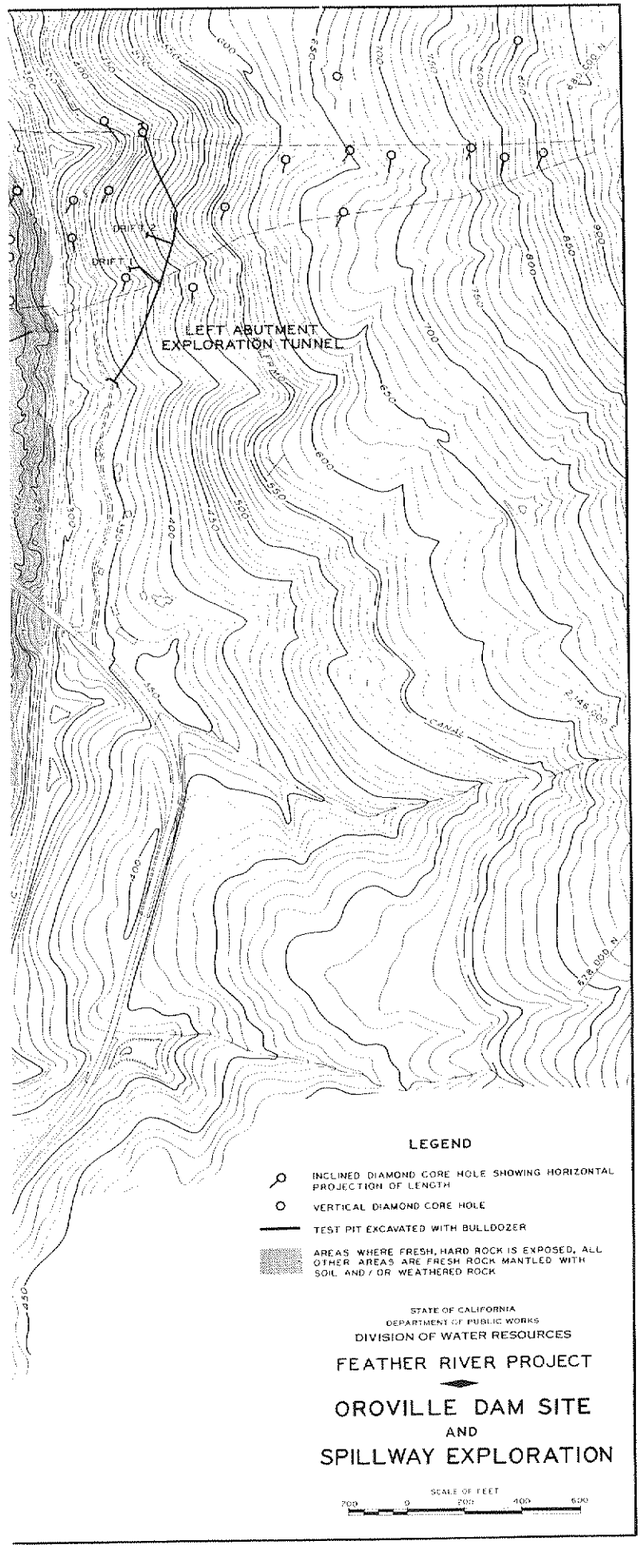
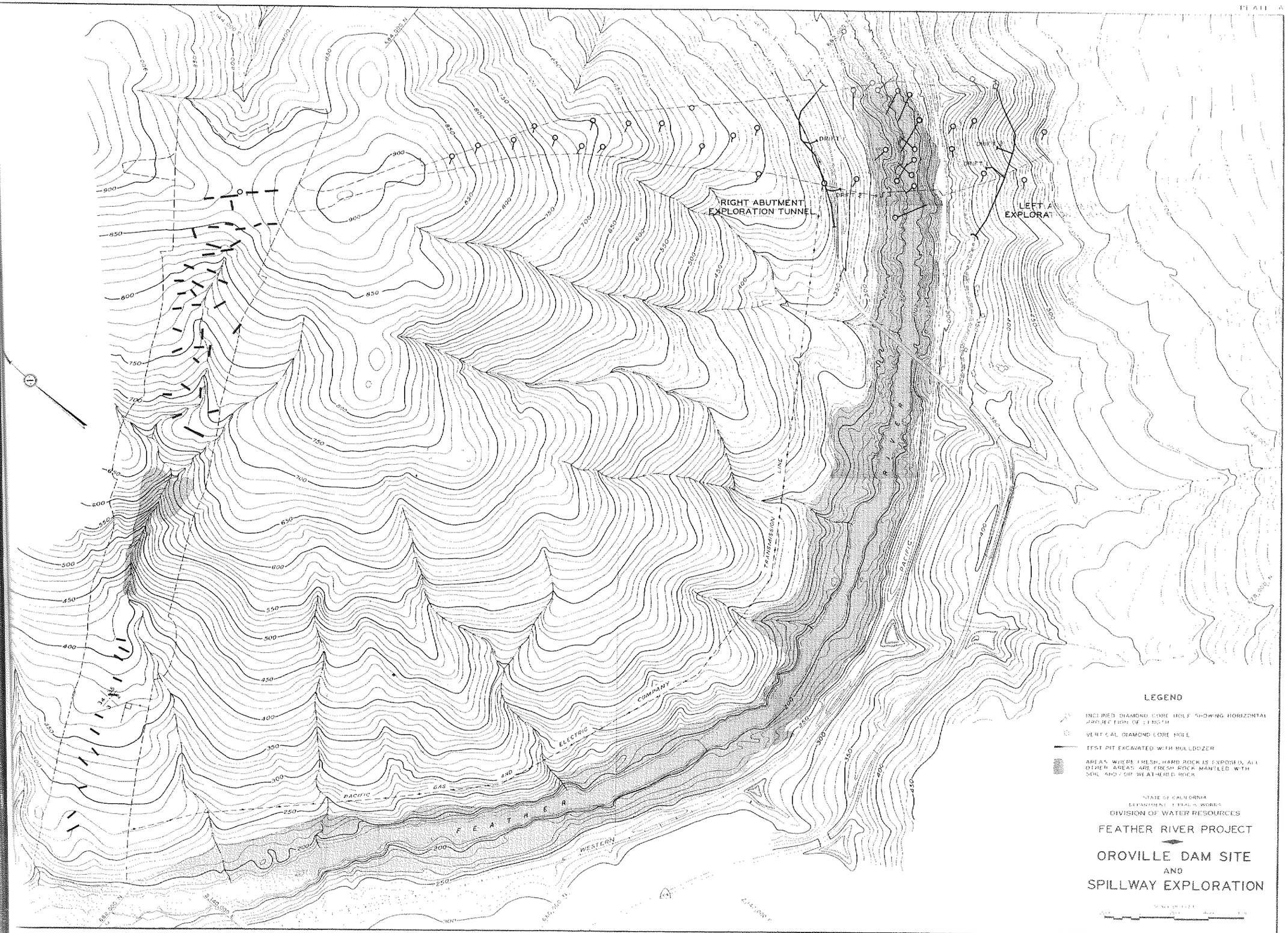


PLATE A


RIGHT ABUTMENT EXPLORATION TUNNEL
DRIFT 1
DRIFT 2
DRIFT 3
DRIFT 4
LEFT A
EXPLORAT
TRANSMISSION LINE
PACIFIC GAS AND ELECTRIC COMPANY
F E A T H E R
R I V E R
PACIFIC
& WESTERN
RAILROAD
LEGEND
INCLINED DIAMOND CORE HOLE SHOWING HORIZONTAL PROJECTION OF LENGTH
VERTICAL DIAMOND CORE HOLE
TEST PIT EXCAVATED WITH BULLDOZER
AREAS WHERE FRESH HARD ROCK IS EXPOSED, ALL OTHER AREAS ARE FRESH ROCK MANTLED WITH SOIL AND/OR WEATHERED ROCK
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF WATER RESOURCES
FEATHER RIVER PROJECT
OROVILLE DAM SITE
AND
SPILLWAY EXPLORATION

n foundation, although a few holes show anomalies hich can only be resolved by future exploration. reliminary estimates of stripping based upon the xploration thus far completed, indicate that stripping will range from 10 to 90 feet and will probably verage about 50 feet on both abutments. Further xploration will be necessary to refine these estimates.

pillway Exploration

Fifty-one trenches were excavated with a bulldozer long the proposed line of the spillway structure and he spillway channel. It was found that an average of three to four feet of overburden could be removed ith this equipment. A firm foundation of weathered ock should be expected in the upper and lower portion of the spillway channel at depths comparable to hose found on the dam site abutments. For several undred feet along the central portion of the spillway hannel line fresh rock is exposed and shaping of this ection can be accomplished only by drilling and blasting. The trenches and area of fresh rock are depicted on Plate A.

EXPLORATION FOR AGGREGATES

Areas with potential aggregate sources were examined briefly during the period of exploration at the dam site. Four main areas have been examined and the materials tested. Morris Ravine, approximately three miles downstream from the dam site, and Pentz, approximately 12 miles northwest of the site, contain quantities of sand. These materials were tested and found to be unsuitable, since about 60 per cent of the sand would have to be wasted due to an excess of fines. These areas also lack the necessary coarse aggregate. Thompson Flat, an area approximately four miles downstream from the dam site, was test drilled with seven shallow holes. It was found that the Thompson Flat area does not contain a sufficient supply of aggregate. Dredger tailings, available in unlimited quantities near the City of Oroville, were examined and determined to contain suitable quality coarse aggregate. Several test holes drilled into the sand which normally underlies the tailings indicate that abundant quantities of sand are present although more exploration will be necessary to determine the available quantity in a localized area. Preliminary tests indicate the sands are also suitable. Where sand and coarse aggregate are located in the same area, a single plant could handle the entire aggregate processing operation. This would be more desirable than several plants processing materials from several sources.

CONCLUSIONS

The rock at the Oroville dam site, based on exploration thus far made, is of excellent quality and geologically adequate and competent for the foundation of a dam of the proposed height. A few minor imperfections in the rock have been located, although flaws, such as those located, are to be expected in any foundation rock. The program of exploration has, thus far, been designed to establish the suitability of the rock for foundation purposes, and to locate areas of weakness. Future exploration will be desirable to delimit the areas of imperfection, and the relative importance of each, so that plans for correction can be prepared before construction. Refinement of the preliminary stripping estimates can also be accomplished by further exploration.

APPENDIX D

ESTIMATED COST OF THE 1870 TUNNEL THROUGH THE TEHACHAPI MOUNTAI

Several plans are under consideration for carrying the Feather River Project across the Tehachapi Mountains into Southern California. One of these plans, the "Long Tunnel Route," would convey water through these mountains in a tunnel which has been designated the "1870 tunnel" because its north portal would be located at an elevation of 1870 feet. The location of this tunnel is shown on Plate B.

The 1870 tunnel would be no ordinary tunnel. It would be 26.7 miles long and pass through a very active seismic region that has experienced several major earthquakes within historic times. Six major faults would have to be crossed, the most notable of which are the San Andreas fault, which is the longest in the State, and the Garlock fault, which is the second longest. These two major faults intersect about eight miles west of the tunnel line, a situation which in itself portends the existence of fractured rock and general tunneling difficulties. The existence of more than 160 springs in the vicinity of the tunnel line indicates that heavy inflows of water are to be expected whenever faults or zones of fractured rock are encountered. Ground water may often be under considerable pressure due to the great thickness of the tunnel cover in which this water is stored. Two hot springs exist near the south portal location indicating that drainage and air conditioning problems will probably be encountered in that area. Pockets of natural gas may be trapped within the sedimentary formations to be tunneled.

The construction of the 1870 tunnel would pose difficult problems. Obviously, its cost would be great. A preliminary estimate of the cost of this tunnel is set forth herein. This estimate is preceded by a description of the geological investigation leading to the estimate and by a brief description of the tunnel project as envisaged at the present time.

GEOLOGIC INVESTIGATION

Approximately one and one-half years were spent in reconnaissance, detailed geologic mapping, investigation of earthquake hazards, and inspection of springs in the Tehachapi Mountain region. Libraries and universities were canvassed for maps and reports. Geologists and geophysicists from local universities and oil companies were consulted. The crew of geologists engaged in this work varied from one to eig number.

A Feather River Project consulting board or nels, comprising Raymond A. Hill, consulting neer, chairman; Ole Singstad, tunnel consultant Dr. George D. Louderback, consulting geol which was engaged on December 1, 1953, period reviewed the progress of the work and on two sions examined the tunnel site in the field. On ruary 7, 1955, another member, Carl R. Rankin sulting hydraulic engineer, was engaged for consulting board.

Geologic investigation was aimed toward lo the most feasible route for a low level tunne toward collecting data essential for the compilat a preliminary estimate of its cost. The 1870 t line was selected as the best route for such a t

Results of the geologic investigation are conc on Plate C, on which are presented a detailed ge map, a geologic section along the tunnel lin brief comments pertaining to anticipated tun conditions.

DESCRIPTION OF THE 1870 TUNNEL PROJECT

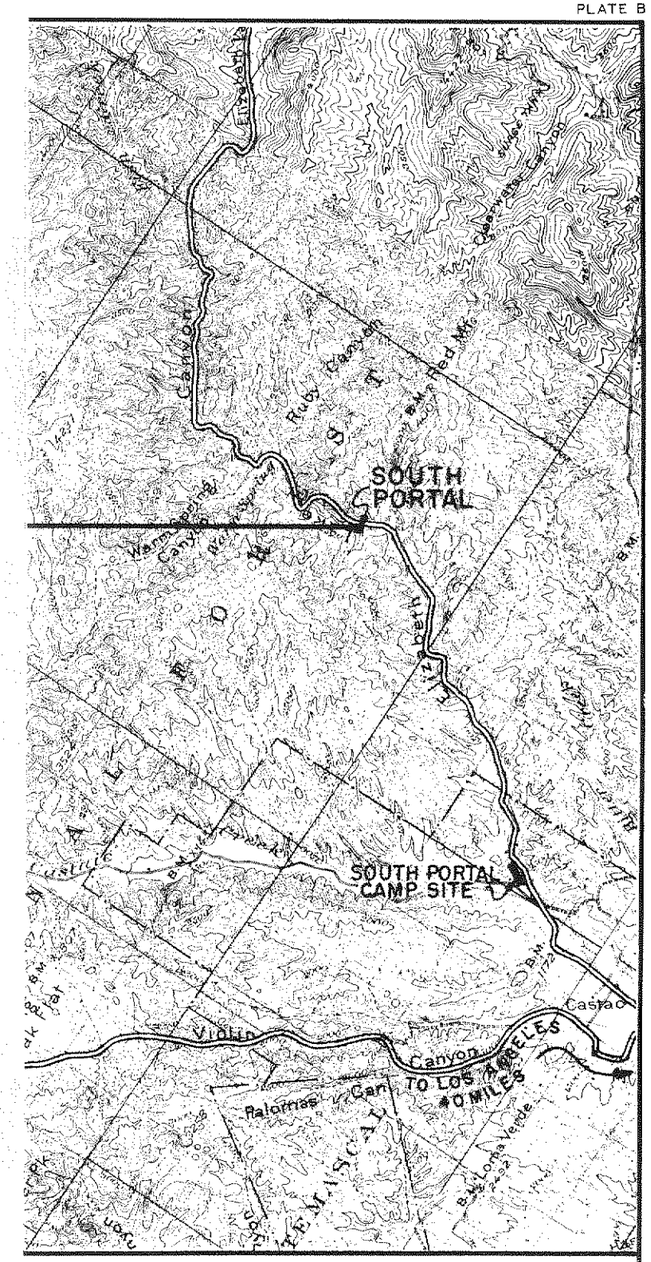
The 1870 tunnel would extend from Pastoria located about four miles east of Grapevine, to a in Elizabeth Lake Canyon about two miles sou of Warm Springs. The tunnel length would b miles. The alignment is shown on Plates B and

Tunnel slope would be toward the south, dro from an elevation of 1,870 feet at the north por 1,778 feet at the south portal.

The completed tunnel would be concrete throughout. It would have a circular cross-s with an inside diameter of 20 feet. It would signed to operate either as a partially filled ch or as a pressure conduit.

A minimum of three shafts would be requi expedite tunnel construction. The three cons would be permanent structures, since they wo needed for access to effect speedy repairs in ev future earthquake damage. Locations of shaf shown on Plate B and in section on Plate C shafts have been designated Tehachapi, Liebr Bear Canyon and are respectively 1,850, 1,70 1,600 feet deep. The depths indicated extend i

PLATE B



STATE OF CALIFORNIA
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DIVISION OF WATER RESOURCES
FEATHER RIVER PROJECT

VICINITY OF 1870 TUNNEL LINE

SCALE OF MILES
0 1 2

TEHACHAPI MTNS.

WEST ANTELOPE VALLEY

TO LANCASTER 30 MILES

BOUNDARY LINE

SAWMILL MOUNTAIN

Oak Grove Canyon

TEHACHAPI SHAFT SITE

OSO CAMP SITE

LIEBRE SHAFT SITE

BEAR CANYON SHAFT SITE

SOUTH PORTAL

NORTH PORTAL CAMP SITE

NORTH PORTAL

LIEBRE MOUNTAIN

KELLY RANCH CAMP SITE

SOUTH PORTAL CAMP SITE

Castac Valley

Bear Canyon

Tejon Pass

Alamos Canyon

LOS ANGELES & VENTURA CO.

Cañada de Los Alamos

BOUNDARY LINE

TO LOS ANGELES 40 MILES

Violin Canyon

Palomas Canyon

Oak Flat

Whitaker Pk.

Redrock Mt. Canyon

Warm Spring Canyon

Ruby Canyon

Clearwater Canyon

Cuddy Canyon

Maxy Canyon

Gold Hill Canyon

Black Mt.

Snowy Peak

White Mountain

Bear Mts.

Quail Lake

Castaic Creek

Liebre Creek

Fish Creek

Big Oak Flat

Baldwin Verde

Castaic

99

138

LEGEND

PAVED ROAD

DIRT ROAD

PROPOSED ROAD

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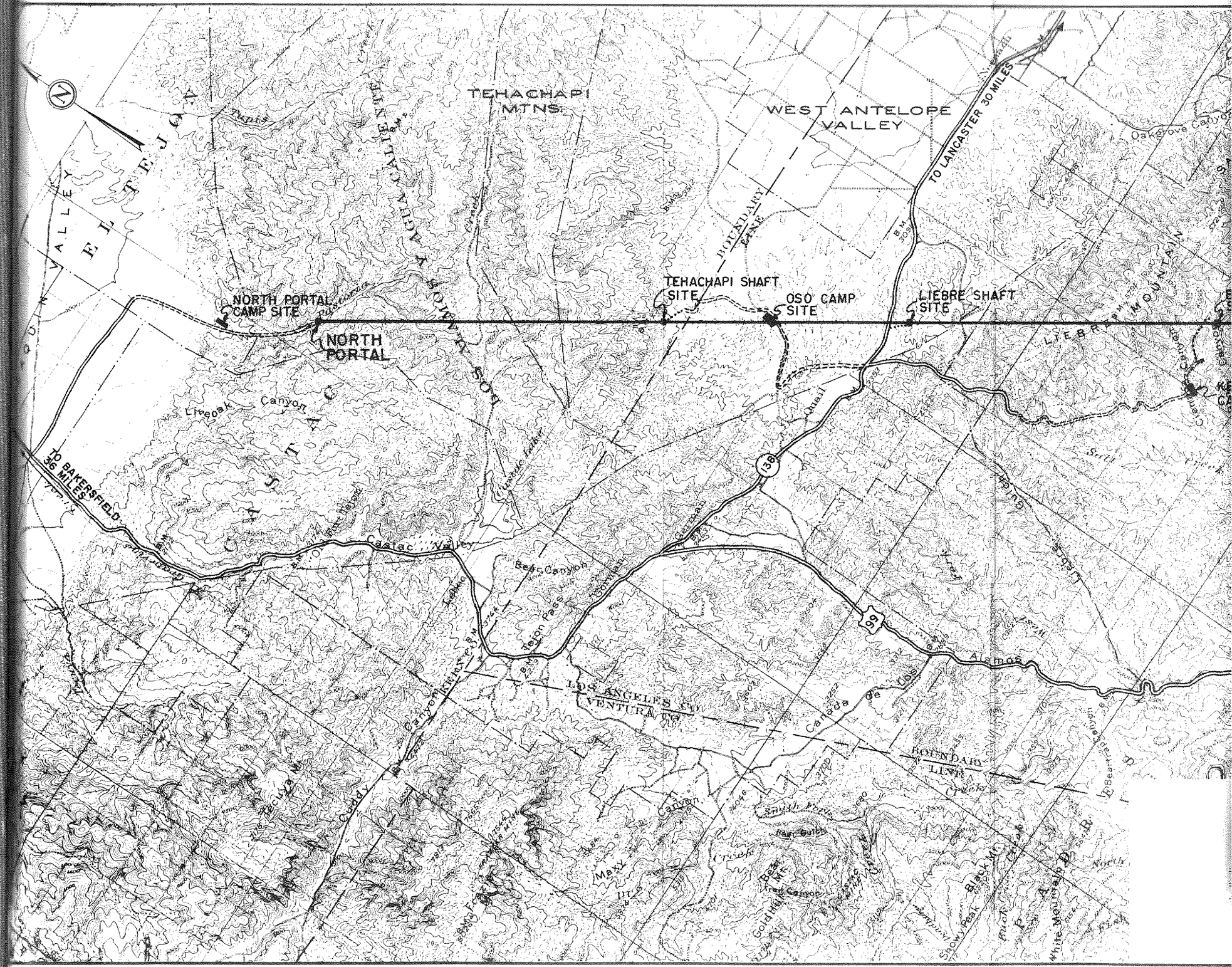
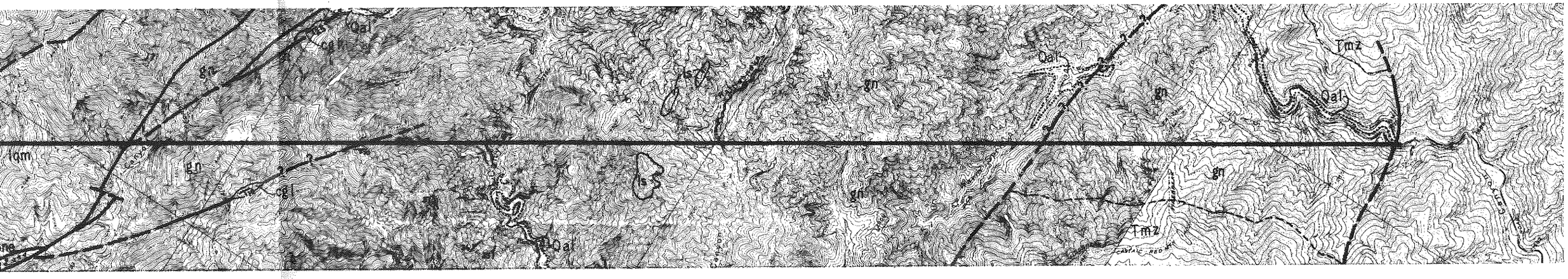
FEATHER RIVER PROJECT

VICINITY OF 1870 TUNNEL LINE

SCALE OF MILES


TEHACHAPI MTNS.
WEST ANTELOPE VALLEY
TO LANCASTER 30 MILES
BOUNDARY LINE
TEHACHAPI SHAFT SITE
OSO CAMP SITE
LIEBRE SHAFT SITE
NORTH PORTAL CAMP SITE
NORTH PORTAL
LIEBRE MOUNTAIN
QUAIL VALLEY
TEJON
Liveoak Canyon
TO BAKERSFIELD 36 MILES
Caslac Valley
Bear Canyon
Tejon Pass
Oso Canyon
Cañada de Uvas
Alamos
LOS ANGELES CO.
VENTURA CO.
Pecho Mt.
Oaky Canyon
Maxy Ridge
Bear Mt.
Gold Hill
Black Mt.
Snow Peak
White Mountain
Oakgrove Canyon
Bear Canyon
Quail
Smith Fork
Bear Gulch
Creek
Canyon
Ridge
Mt.
Peak
Spring
Ranch
Trail
Road
Fault
Pass
Creek
Fork
North
South
East
West
N
99
138



L E G E N D

SEDIMENTARY ROCKS

QUATERNARY	RECENT	Qal	ALLUVIUM
		Qls	LANDSLIDES
	PLEISTOCENE	Qt	TERRACE DEPOSITS AND OLDER ALLUVIUM
TERTIARY	PLIOCENE	Tld	LAKE DEPOSITS
	MIOCENE	Tcs	CONTINENTAL SEDIMENTS
		Tsm	SANTA MARGARITA FORMATION
	PALEOCENE	Tmz	MARTINEZ FORMATION

VOLCANIC ROCKS

TERTIARY	MIOCENE?	Tv	ANDESITE

PLUTONIC ROCKS

JURASSIC OR CRETACEOUS		leqm	LEBEC QUARTZ MONZONITE
		tlg	TEJON LOOKOUT GRANITE
		lqm	LIEBRE QUARTZ MONZONITE

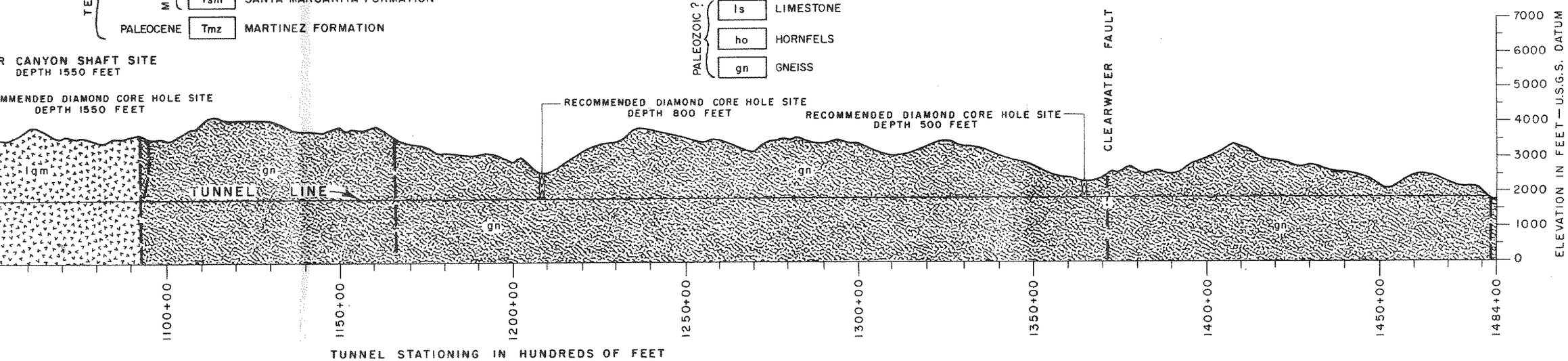
METAMORPHIC ROCKS

PALEOZOIC ?		ls	LIMESTONE
		ho	HORNFELS
		gn	GNEISS

Station 1370+00 to 1373+00 (Distance 300 feet)
Clearwater fault zone. Completely crushed rock containing gouge and possibly some running ground. Hot water initial inflows up to 10 cfs, average 5 cfs. Initial pressures up to 230 psi. Temperature up to 120°F. No gas.

Station 1373+00 to 1440+00 (Distance 6700 feet)
Hard gneiss, moderately jointed, moderately blocky, and seamy. Inflow less than 5 cfs, possible pressure 880 psi. Temperature less than 80°F. No gas.

Station 1440+00 to 1472+00 (Distance 3200 feet)
Hard gneiss, strongly jointed, very blocky and seamy. Inflow less than 2 cfs. Temperature less than 75°F. No gas.



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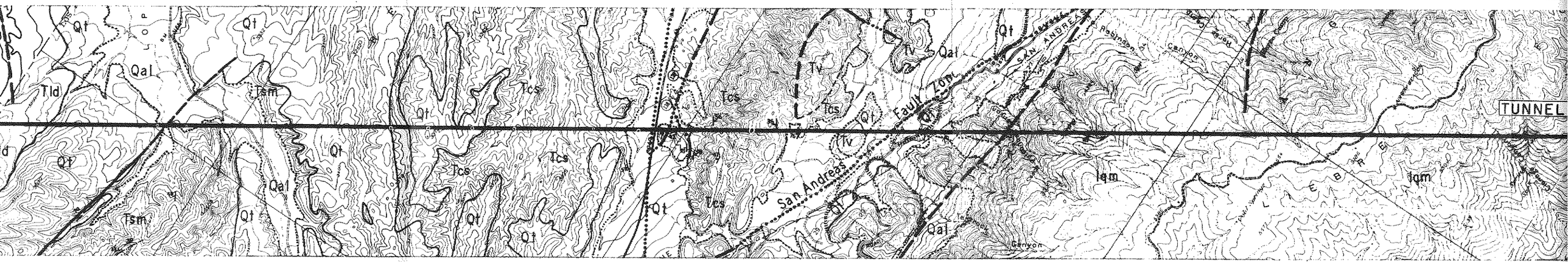
FEATHER RIVER PROJECT

GEOLOGY IN VICINITY OF 1870 TUNNEL LINE



nes of running or
n 80°F. No gas.

nes of deeply
nel line inter-
ld initial flows
n 80°F. No gas.

Station 468+00 to 753+00 (Distance 28500 feet)
Section requires considerable subsurface exploration. Rock type and condition at tunnel grade unknown. Expect sedimentary formations similar to those exposed at surface; 80 per cent (22810 feet) moderately cemented sandstones; 15 per cent (4270 feet) soft shale; 5 per cent (1420 feet) moderately cemented conglomerate.
Tunnel line passes beneath Antelope Valley, a large ground water basin. Faults or fissures may extend beneath this basin to tunnel grade producing large constant flows of water up to 50 cfs. Pressures up to 600 psi. Temperatures to 100°F. Gas and/or oil a distinct possibility.

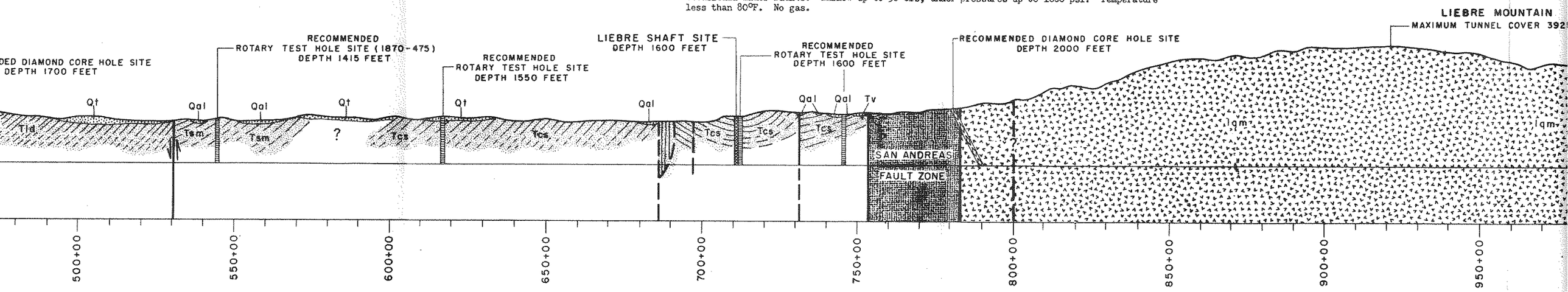
Station 753+00 to 785+00 (Distance 3200 feet)
San Andreas fault zone. Completely crushed, squeezing rock and possibly running ground. Initial inflow 10 to 25 cfs, under pressures up to 750 psi. Temperature less than 100°F. Possibility of gas.

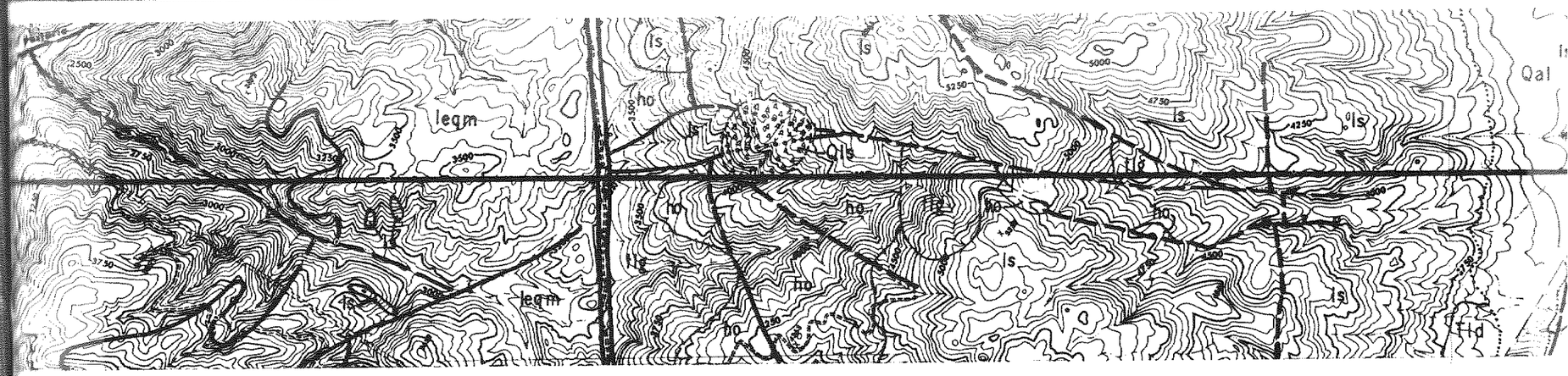
Station 785+00 to 800+00 (Distance 1500 feet)
Hard granitic type rock. Strongly jointed, very blocky and seamy. Initial flows up to 50 cfs. Pressures up to 750 psi. Temperature less than 90°F. No gas.

Station 800+00 to 1090+00 (Distance 29000 feet)
Hard granitic type rock, moderately jointed, moderately blocky and seamy. Cut by occasional minor faults. Inflow up to 50 cfs, under pressures up to 1600 psi. Temperature less than 80°F. No gas.

Station 1090+00 to 1095+00 (Distance 500 feet)
Liebre fault zone. Completely crushed rock containing gouge zo
ground. Local initial inflows to 50 cfs. Pressures up to 750 psi.
of hot water. Temperatures less than 85°F. No gas.

Station 1095+00 to 1370+00 (Distance 27500 feet)
Hard fresh gneiss, moderately jointed, moderately blocky and se
crushed, saturated rock near fault at station 1167+00. Initial infl
pressure 1050 psi. Fissures may carry hot water 100° to 120°F. loca
springs in Warm Springs Canyon and Castaic Creek. No gas.





...ed. Very blocky and seamy. Inflow

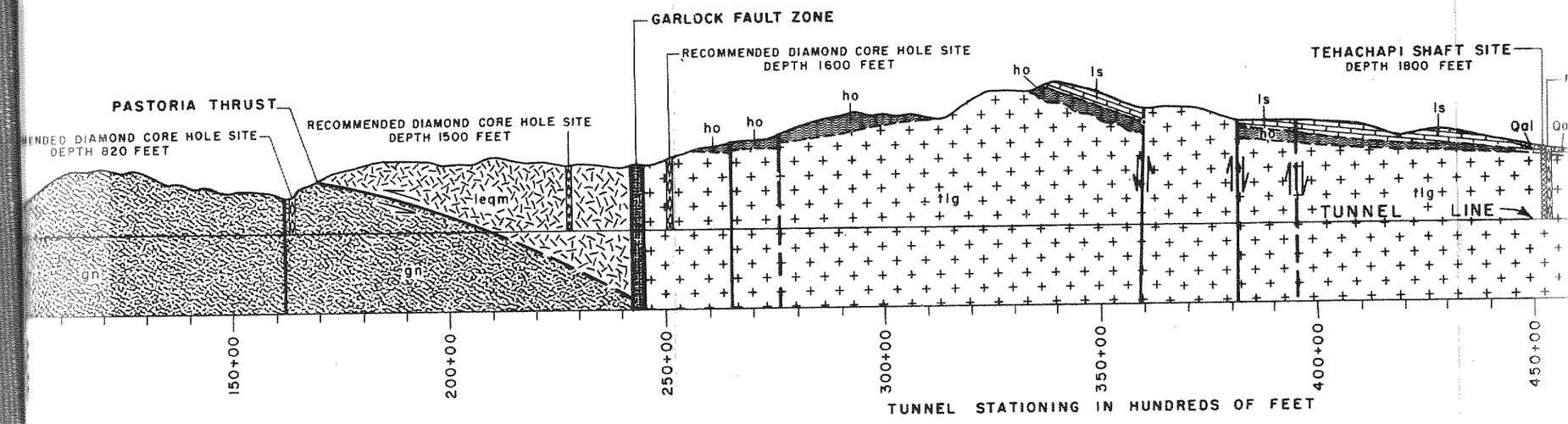
...y blocky and seamy. Occasional zones ... brief heavy flows up to 5 cfs, under ... 80°F. No gas.

Station 161+00 to 162+00 (Distance 100 feet)
Probable fault zone. Soft, saturated, completely crushed gneiss. Initial inflow 20 to 40 cfs. Initial pressures up to 650 psi. Temperature less than 80°F. No gas.

Station 162+00 to 240+00 (Distance 7800 feet)
Fresh gneiss, hard, moderately jointed, moderately blocky and seamy. Pastoria thrust fault intersected in this interval. At fault 500 feet of completely crushed and saturated rock. Initial inflows up to 20 cfs with initial pressures up to 750 psi. In balance of section initial flows less than 10 cfs with initial pressures up to 500 psi. Temperature less than 80°F. No gas.

Station 240+00 to 250+00 (Distance 1000 feet)
Garlock fault zone. Completely crushed rock, possibly con... squeezing ground. Inflow 50 cfs, pressure 600 psi. Temperature...

Station 250+00 to 468+00 (Distance 21800 feet)
Fresh to moderately weathered granite. Hard with occasiona... weathered rock. Moderately blocky and seamy and moderately joi... sects five known faults in this section. More may exist. Fault... up to 50 cfs with initial pressures up to 1300 psi. Temperature...



...balance 100 feet below tunnel grade to allow for skip ...kets and sumps.

COST ESTIMATE

The Division of Water Resources wishes to acknowledge the help of tunnel and shaft contractors ...l of other agencies whose guidance and assistance ...e invaluable in preparing this estimate. Special ...nks are due Merrill and R. E. Dixon of the Dixon ...nstruction Company who supplied cost data and ...o reviewed and criticized the estimate. Mr. B. A. ...ters of the Grafe-Callahan Company was of con...rable assistance in the estimation of shaft costs. ...ts of dewatering were estimated under the direc...n of William Beadle of the Byron Jackson Pump ...mpany. Many other agencies and individuals con...uted to the estimate, most of which are listed as ...llows:

...ner Tank Mfg. Co., Los Angeles
...llen Equipment Co., Los Angeles, Mr. Clarence O'Brien
American Blower Co., Los Angeles, Mr. Badt
Bechtel Corporation, Los Angeles
Bethlehem Pacific Coast Steel Co., Los Angeles, Mr. Earl A. Dillon
Buffalo Forge Co., Los Angeles, Mr. G. Knauff
Byron Jackson Pump Co., Los Angeles, Mr. William N. Beadle
California Institute of Technology, Dr. Charles F. Richter
Commercial Shearing and Stamping Co., Youngstown, Mr. Thomas White, Mr. C. C. Cotton
Continental Drilling Co., Los Angeles, Mr. Fred Thies
L. E. Dixon Co., San Gabriel, Mr. Merrill Dixon, Mr. R. E. Dixon
Dorr Co., Los Angeles
Fairchild Aerial Survey Co., Mr. Woods Heinrick
Gardner Denver Co., Los Angeles, Mr. Chet Enright
General Electric Co., Los Angeles, Mr. Don Carson
Mr. John Gist, Contractor and Civil Engineer
Grafe-Callahan Co., Los Angeles, Mr. B. A. Peters
Hercules Powder Co., Los Angeles, Mr. William F. McCandlish
Hoag Construction Co., Los Angeles, Mr. Lester Hoag
Ingersoll Rand Co., Los Angeles
Interstate Restaurant Supply Co., Los Angeles
Mr. Allan H. James, Mining engineer and geologist
Jeffrey Mfg. Co., Columbus, Ohio, Mr. A. E. Condon
E. A. Johnson and Co., Los Angeles

TABLE 1

Estimated Construction Funds Required—26.7 Mile, 1870 Tunnel—Pastoria Creek to Elizabeth Lake Canyon

Item	First year	Second year	Third year	Fourth year	Fifth year
...n of camp	$802,000				
...ction facilities and utilities	1,160,000				
...three shafts	2,905,000	$726,000			
...excavation	2,914,000	12,919,000	$17,886,000	$17,302,000	$14,242,000
...ing	366,000	3,628,000	3,872,000	3,162,000	771,000
...nnel supports	1,558,000	7,790,000	6,880,000	5,921,000	5,039,000
...e lining				7,388,000	767,000
...ation	19,000	86,000	80,000	82,000	62,000
...ing	30,000	619,000	421,000	368,000	1,067,000
...ventilation	12,000	89,000	275,000	408,000	440,000
...ering	46,000	587,000	821,000	752,000	558,000
...ering roads and camps	109,000	468,000	646,000	609,000	492,000
...ering shafts and hoists		25,000	39,000	37,000	31,000
...tor's overhead and profit	2,568,000	9,136,000	9,790,000	12,320,000	7,657,000
...total	$12,489,000	$36,073,000	$40,710,000	$48,349,000	$31,126,000
...ing and contingencies	3,122,000	9,018,000	10,178,000	12,087,000	7,781,000
...t during construction	390,000	1,527,000	2,838,000	4,420,000	5,503,000
Total funds required	$16,001,000	$46,618,000	$53,726,000	$64,856,000	$44,410,000

Item	Sixth year	Seventh year	Eighth year	Ninth year	Total
...n of camp					$802,000
...ction facilities and utilities					1,160,000
...three shafts					3,631,000
...excavation	$9,741,000	$7,007,000	$1,435,000		83,446,000
...ing	236,000	170,000	44,000		12,249,000
...nnel supports	728,000	374,000	75,000		28,365,000
...e lining	12,313,000	10,995,000	9,511,000		40,974,000
...ation	9,000	4,000	1,000		343,000
...ing	1,336,000	806,000	1,390,000	$846,000	6,877,000
...ventilation	288,000	254,000	14,000		1,780,000
...ering	410,000	336,000	76,000		3,586,000
...ering roads and camps	378,000	277,000	95,000	13,000	3,087,000
...ering shafts and hoists	26,000	16,000	8,000	2,000	184,000
...tor's overhead and profit	8,809,000	6,974,000	4,852,000	339,000	62,445,000
...total	$34,274,000	$27,207,000	$17,501,000	$1,200,000	$248,929,000
...ing and contingencies	8,569,000	6,802,000	4,375,000	300,000	62,232,000
...t during construction	6,711,000	7,729,000	8,470,000	8,717,000	46,305,000
Total funds required	$49,554,000	$41,738,000	$30,346,000	$10,217,000	$357,466,000

Joy Mfg. Co., Los Angeles, Mr. T. G. Weir, Mr. W. L. Norman, Mr. R. E. Schneider
Keystone Engineering Co., Mr. John Baker
Koppers Co., Los Angeles
Los Angeles City Public Works Department, Mr. Lloyd Aldrich, City Engineer
Los Angeles County Fire Department
Los Angeles Department of Water and Power, Mr. Samuel B. Morris
Metropolitan Water District, Mr. Robert Diemer
Mission Appliance Corp., Los Angeles
Moran Engineering Co., Los Angeles, Mr. Ray Moran
Nordberg Manufacturing Co., Milwaukee, Mr. L. S. Schwab
Philpot Co., Monrovia, Mr. G. S. Philpot
Pomona College, Dr. A. O. Woodford
Purdy Co., Los Angeles
Ramapo-Ajax Co., Los Angeles Richfield Oil Co., Mr. Clifton W. Johnson*
San Diego State College, Mr. Baylor Brooks
Santa Fe Tank and Tower Co., Los Angeles
Schlumberger Well Surveying Corp., Los Angeles
Shell Oil Company, Mr. A. M. Taurie
Southern California Edison Co., Los Angeles, Mr. John Parker
Southern California Pipe and Casing Co., Azusa, Mr. Riehatz
State of California, Division of Architecture, Mr. Robert Palen
State of California, Division of Forestry
State of California, Division of Highways
State of California, Division of Mines, Mr. Richard Stewart
State of California, Division of Industrial Safety, Mr. I. S. Reid
J. B. Stringfellow Co., Riverside, Mr. J. B. Stringfellow
Sutorbilt Co., Los Angeles, Mr. Schneider
Trojan Powder Co., Los Angeles, Mr. A. St. John
United Geophysical Co., Mr. Flint Agee
United States Forestry Service
University of California at Los Angeles, Dr. John Crowell, Dr. John McGill
University of Southern California, Dr. Thomas Clements, Dr. Richard Merriam
Walsh Construction Co., New York, Mr. Wayne Wilmarth
Western Consolidated Steel Co., Los Angeles, Mr. Walter Cates
Westinghouse Co., Los Angeles, Mr. Brouse

* Deceased.

The total cost of the 1870 tunnel is estimated to be $357,466,000 including interest during construction. An itemized estimate setting forth costs by years is presented in Table 1. The cost estimate is based on a six-day work week. The sequence and approximate duration of construction operations based on a five six and seven-day work week are shown on Plate D.

A detailed report has been prepared entitled, "Preliminary Estimate of the Cost of Constructing the 1870 Tunnel with Recommendations" January 31, 1955. That report includes the geologic investigations description of tunnel, construction program for constructing the tunnel and the method followed in estimating the costs shown in Table 1 of the appendix. This report was submitted to the consulting board of tunnels and their comments have been received by letter. The letters follow:

SINGSTAD & BAILLIE
CONSULTING ENGINEERS
24 STATE STREET
NEW YORK 4, N. Y.

February 8, 1955

MR. A. D. EDMONSTON, *State Engineer*
Division of Water Resources
Public Works Building, P. O. Box 1079
Sacramento 5, California

DEAR MR. EDMONSTON:

I received your letter of January 26, 1955, transmitting a copy of the "*Preliminary Estimate of the Cost of Constructing Tunnel 1870 With Recommendations.*" I have reviewed the estimate of cost and have discussed it with Mr. Raymond Hill, both by long distance telephone and on Thursday, February 3, at a conference with him in my New York Office, at which time we both discussed it with you by telephone to Sacramento. In view of the fact that Mr. Hill was leaving for South America on February 4 to be gone two weeks, he asked me to make a brief report to you promptly, expressing our joint views as we are in substantial accord. He also asked me to discuss the report with Mr. Carl Rankin by telephone on Monday, February 7, which I did.

I explained to him that Mr. Hill and I consider the estimate of cost a very workmanlike job, presenting a fair picture based on the basic assumptions which, of necessity, have to be classified merely as assumptions, due to the almost total absence of underground exploratory work necessary to determine with any degree of accuracy the difficulties to be expected during the driving of such a tunnel at this location and its cost. Both Mr. Hill and I feel that the assumptions as to ground conditions made by the estimators may tend toward the optimistic side and we both feel that the cost estimate, pending much more extensive subsurface exploration, may be considered a minimum.

Mr. Rankin as I understand it from my telephone conversation, does not differ materially from this view although he seems to be somewhat more optimistic regarding the possible difficult ground conditions which may be encountered in driving the proposed tunnel.

Very truly yours,

/s/ OLE SINGSTAD

CARL R. RANKIN
CONSULTING ENGINEER
180 SOUTH ORANGE GROVE AVE.
PASADENA, CALIFORNIA

MR. A. D. EDMONSTON, *State Engineer*
Division of Water Resources
Public Works Building, Post Office Box 1079
Sacramento 5, California

February 12, 1955

Subject: Feather River Project
Tunnel No. 1870

DEAR MR. EDMONSTON:

Copy of the Preliminary Estimate of the Cost of Constructing Tunnel 1870 with the Recommendations together with your letter of January 26, 1955, addressed to Mr. Paul Beerman, Director of Water Department, City of San Diego, has been transmitted to me by Mr. Beerman.

I reviewed the report and much of the data used in making the estimate with Mr. Bookman and Mr. Jones of your Division on January 31 to get some of the background in regard to investigations for the location of the tunnel and the method and information used in making the estimate of cost. Since that time I have reviewed the plans, profile, geological data and the proposed method of attack in driving this tunnel and the anticipated progress as set forth in the report.

On February 1, I talked with Mr. Raymond Hill in regard to ground and water conditions which may be encountered in driving this tunnel and the present lack of exploratory work to determine underground conditions.

On February 7, I talked to Mr. Ole Singstad, by telephone, in regard to probable ground and water conditions and the necessity of making extensive exploration before a full report on cost for this work can be made.

I am of the opinion that the estimate of cost as reported by your Division of Water Resources has been carefully prepared and is as accurate as may be determined as a preliminary estimate at this time. The estimate is based upon experience in other difficult tunnels and necessarily upon broad assumptions as to ground and water conditions to be encountered in penetrating the Tehachapi Mountain Range.

I am in full accord with Mr. Hill and Mr. Singstad that very extensive subsurface exploratory work is necessary before ground and water conditions are known, the best tunnel location secured and an accurate estimate of cost can be made.

Yours very truly,

/s/ CARL R. RANKIN

GEORGE D. LOUDERBACK
107 Ardmore Road
BERKELEY 7, CALIFORNIA

MR. A. D. EDMONSTON, *State Engineer*
Division of Water Resources
Public Works Building, P. O. Box 1079
Sacramento 5, California

February 19, 1955
Feather River Project
Tunnel 1870

Attention: Theodore Neuman, Principal Hydraulic Engineer

DEAR SIR:

In accordance with your letter of February 18, I have gone over the "Preliminary Estimate of the Cost of Constructing Tunnel 1870 with Recommendations" which you sent me.

I consider it a well conceived and carefully prepared report based as it is on expert testimony and advice from those with experience on a number of important and recent tunnel operations, and on a well considered attempt to apply this experience to the conditions inferred from observations along the line of the proposed tunnel 1870.

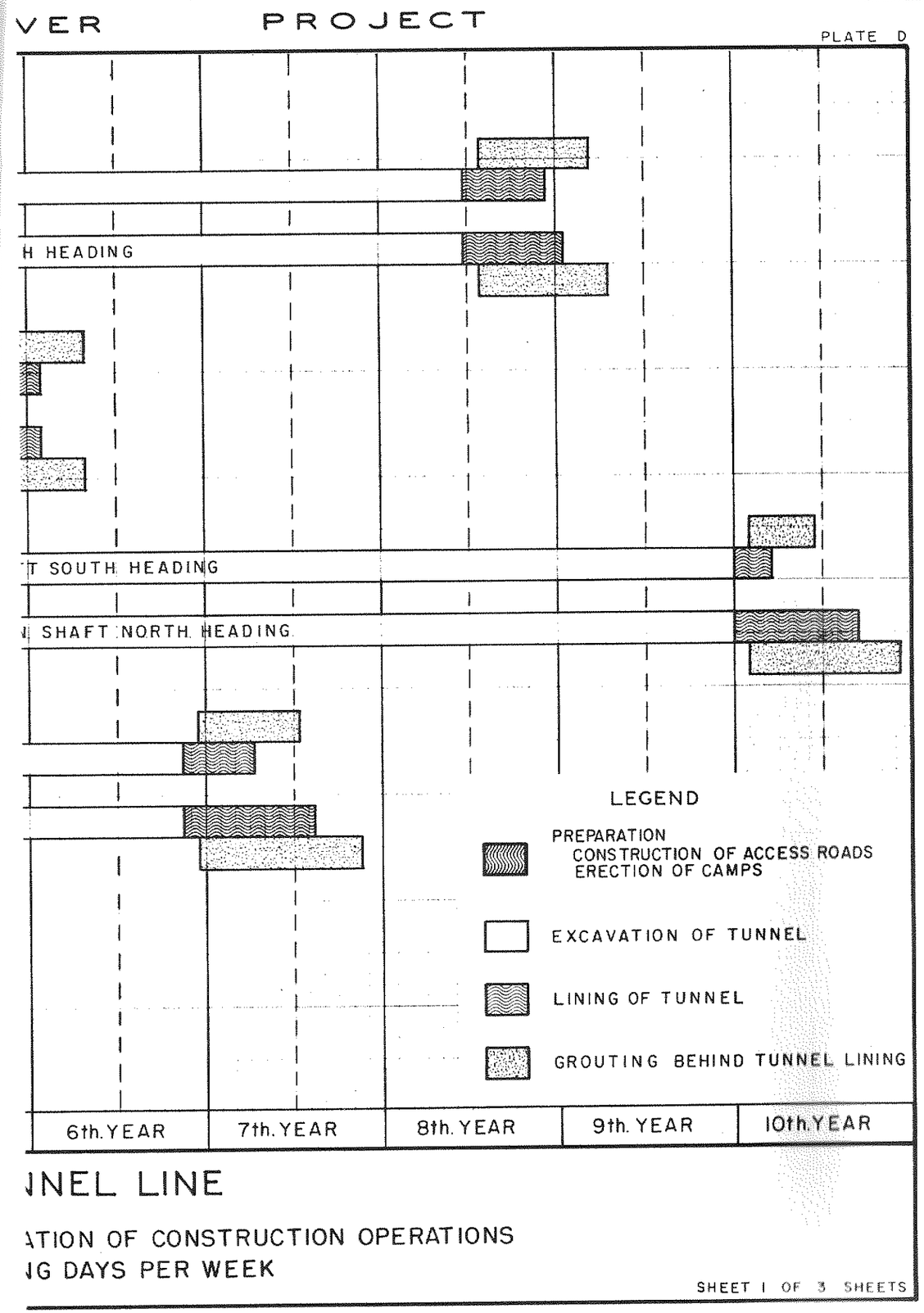
I have gone over the details as far as known of the geology as exposed on the surface and find that the variations have been reasonably considered as to their probable effects in depth on working conditions and costs, and I think that the report probably represents as good a preliminary estimate, on a moderately conservative basis, as could be made at the present time.

As those who prepared the estimate have noted it has been prepared practically entirely on the basis of surface studies which are of course very important and in fact indispensable. But the tunnel is planned to lie at a third of a mile more or less below the surface along much of its course, and some 3,900 feet or more in its deeper stretches, and these are

considerable depths at which to estimate physical conditions from surface observations. Conditions that may be brought about by water, temperature, gas, unstable ground, etc., may have marked unfavorable effects on cost, time of construction, and safety. I would therefore emphasize recommendation 1 of the report (concerning exploratory work).

Yours sincerely,

/s/ GEORGE D. LOUDERBACK
Consulting Geologist



FEATHER RIVER PROJECT

PLATE D

NORTH PORTAL HEADING

TEHACHAPI SHAFT NORTH HEADING

TEHACHAPI SHAFT

TEHACHAPI SHAFT SOUTH HEADING

LIEBRE SHAFT NORTH HEADING

LIEBRE SHAFT

LIEBRE SHAFT SOUTH HEADING

BEAR CANYON SHAFT NORTH HEADING

BEAR CANYON SHAFT

BEAR CANYON SHAFT SOUTH HEADING

SOUTH PORTAL HEADING

LEGEND

PREPARATION
CONSTRUCTION OF ACCESS ROADS
ERECTION OF CAMPS

EXCAVATION OF TUNNEL

LINING OF TUNNEL

GROUTING BEHIND TUNNEL LINING

1st. YEAR	2nd. YEAR	3rd. YEAR	4th. YEAR	5th. YEAR	6th. YEAR	7th. YEAR	8th. YEAR	9th. YEAR	10th. YEAR

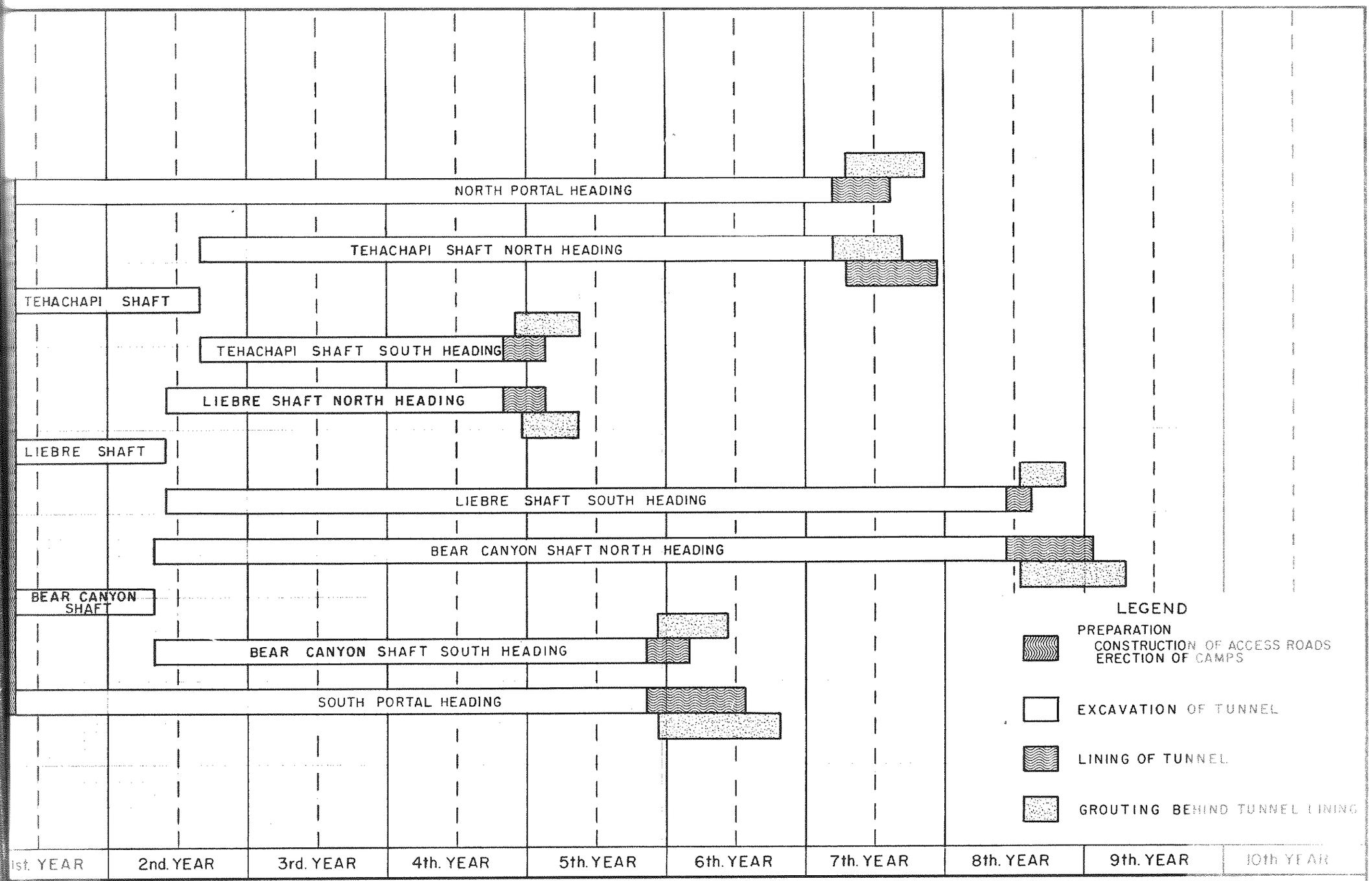
1870 TUNNEL LINE

SEQUENCE AND APPROXIMATE DURATION OF CONSTRUCTION OPERATIONS
BASED ON FIVE WORKING DAYS PER WEEK

SHEET 1 OF 3 SHEETS

ISION OF WATER RESOURCES

FEATHER RIVER PROJECT



1870 TUNNEL LINE

SEQUENCE AND APPROXIMATE DURATION OF CONSTRUCTION OPERATIONS
BASED ON SIX WORKING DAYS PER WEEK

SHEET 2 OF 5 SHEETS

UNION OF WATER

FEATHER RIVER PROJECT

NORTH PORTAL HEADING

TEHACHAPI SHAFT NORTH HEADING

TEHACHAPI SHAFT

TEHACHAPI SHAFT SOUTH HEADING

LIEBRE SHAFT NORTH HEADING

LIEBRE SHAFT

LIEBRE SHAFT SOUTH HEADING

BEAR CANYON SHAFT NORTH HEADING

BEAR CANYON SHAFT

BEAR CANYON SHAFT SOUTH HEADING

SOUTH PORTAL HEADING

LEGEND

PREPARATION
CONSTRUCTION OF ACCESS ROADS
ERECTION OF CAMPS

EXCAVATION OF TUNNEL

LINING OF TUNNEL

GROUTING BEHIND TUNNEL LINING

1st. YEAR	2nd. YEAR	3rd. YEAR	4th. YEAR	5th. YEAR	6th. YEAR	7th. YEAR	8th. YEAR	9th. YEAR	10th. YEAR

1870 TUNNEL LINE

SEQUENCE AND APPROXIMATE DURATION OF CONSTRUCTION OPERATIONS
BASED ON SEVEN WORKING DAYS PER WEEK

SHEET 3 OF 3 SHEETS

...ION OF WATER RESOURCES

APPENDIX E-1

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921							
January	810	2,493	0	0	403	403	220.0
February	514	2,900	0	0	414	414	198.0
March	833	3,000	0	7	826	833	154.0
April	611	3,000	4	73	195	268	154.0
May	696	3,339	6	110	419	529	198.0
June	364	3,500	8	139	218	357	211.9
July	171	3,499	9	146	246	392	230.5
August	150	3,269	9	146	301	447	255.8
September	134	2,963	6	73	320	393	218.0
October	139	2,698	5	36	241	277	150.3
November	156	2,555	3	0	200	200	107.2
December	245	2,508	0	0	260	260	138.8
Totals	4,823	----	50	730	4,043	4,773	2,236.5
1922							
January	192	2,493	0	0	166	166	88.4
February	410	2,519	0	0	362	362	193.8
March	383	2,567	0	7	113	120	65.7
April	797	2,830	4	73	275	348	198.0
May	1,316	3,275	5	110	976	1,086	198.0
June	619	3,500	8	139	472	611	286.0
July	207	3,500	9	146	282	428	251.9
August	163	3,270	9	146	314	460	263.1
September	142	2,964	6	73	328	401	222.6
October	156	2,699	6	36	258	294	159.4
November	174	2,555	3	0	218	218	116.7
December	351	2,508	0	0	366	366	195.6
Totals	4,910	----	50	730	4,130	4,860	2,239.2
1923							
January	312	2,493	0	0	286	286	152.4
February	214	2,519	0	0	166	166	88.8
March	303	2,567	0	7	98	105	57.4
April	557	2,765	4	73	29	102	57.4
May	398	3,216	6	110	6	116	67.8
June	176	3,492	8	139	22	161	95.5
July	112	3,499	10	146	187	333	195.7
August	92	3,268	9	146	248	394	225.5
September	80	2,957	6	73	267	340	188.6
October	90	2,691	5	36	186	222	120.5
November	56	2,554	3	0	130	130	69.7
December	88	2,477	0	0	93	93	49.2
Totals	2,478	----	51	730	1,718	2,448	1,368.5
1924							
January	110	2,472	0	0	123	123	65.6
February	304	2,459	0	0	195	195	104.2
March	159	2,568	0	7	99	106	57.4
April	189	2,621	4	73	32	105	57.4
May	128	2,701	6	110	0	110	59.9
June	117	2,713	7	139	12	151	82.0
July	123	2,672	8	146	213	359	192.7
August	128	2,428	7	146	291	437	225.5
September	120	2,112	5	73	309	382	188.6
October	134	1,845	3	36	212	248	118.9
November	140	1,728	2	0	147	147	69.7
December	135	1,719	0	0	104	104	49.2
Totals	1,787	----	42	730	1,737	2,467	1,271.1

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1925							
January	137	1,750	0	0	138	138	65.6
February	662	1,749	0	0	115	115	57.4
March	292	2,296	0	7	102	109	57.4
April	439	2,479	5	73	33	106	57.4
May	314	2,807	6	110	0	110	61.3
June	156	3,005	7	139	6	145	82.0
July	103	3,009	8	146	199	345	192.7
August	113	2,759	8	146	272	418	225.5
September	79	2,446	5	73	291	364	188.6
October	71	2,156	4	36	201	237	118.9
November	82	1,986	2	0	142	142	69.7
December	107	1,924	0	0	100	100	49.2
Totals	2,555	----	45	730	1,599	2,329	1,225.7
1926							
January	130	1,931	0	0	134	134	65.6
February	551	1,927	0	0	113	113	57.4
March	320	2,365	0	7	101	108	57.4
April	734	2,577	4	73	30	103	57.4
May	228	3,204	6	110	0	110	63.6
June	108	3,316	8	139	2	141	82.0
July	102	3,275	9	146	189	335	192.7
August	106	3,033	9	146	258	404	225.5
September	94	2,726	5	73	277	350	188.6
October	95	2,465	4	36	190	226	118.9
November	367	2,330	4	0	185	185	97.6
December	237	2,508	0	0	252	252	134.6
Totals	3,072	----	49	730	1,731	2,461	1,341.3
1927							
January	307	2,493	0	0	280	280	149.6
February	1,168	2,520	0	0	688	688	154.0
March	674	3,000	0	7	667	674	154.0
April	818	3,000	4	73	241	314	154.0
May	578	3,500	7	110	461	571	198.0
June	288	3,500	8	139	141	280	166.3
July	169	3,500	9	146	244	390	229.3
August	155	3,270	9	146	306	452	258.7
September	136	2,964	6	73	322	395	218.9
October	147	2,699	5	36	250	286	155.0
November	271	2,555	4	0	314	314	168.3
December	193	2,508	0	0	208	208	111.1
Totals	4,904	----	52	730	4,122	4,852	2,117.2
1928							
January	224	2,493	0	0	197	197	105.1
February	336	2,520	0	0	288	288	154.4
March	1,258	2,568	0	7	819	826	154.0
April	613	3,000	5	73	195	268	154.0
May	362	3,340	6	110	94	204	119.7
June	183	3,492	7	139	29	168	99.6
July	154	3,500	9	146	229	375	220.8
August	113	3,270	9	146	264	410	234.6
September	85	2,964	6	73	271	344	190.7
October	86	2,699	6	36	188	224	121.8
November	72	2,555	3	0	130	130	69.7
December	107	2,494	0	0	108	108	57.6
Totals	3,593	----	51	730	2,812	3,542	1,682.0

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1929							
January	107	2,493	0	0	123	123	65.6
February	186	2,477	0	0	107	107	57.4
March	237	2,556	0	7	99	106	57.4
April	239	2,687	4	73	31	104	57.4
May	276	2,818	6	110	0	110	61.2
June	161	2,978	7	139	7	146	82.0
July	110	2,986	9	146	200	346	192.7
August	122	2,741	7	146	273	419	225.5
September	88	2,437	6	73	291	364	188.6
October	84	2,155	4	36	201	237	118.9
November	67	1,998	2	0	142	142	69.7
December	770	1,921	0	0	198	198	101.3
Totals	2,447	----	45	730	1,672	2,402	1,277.7
1930							
January	274	2,493	0	0	247	247	131.8
February	357	2,520	0	0	308	308	165.2
March	554	2,569	0	7	284	291	159.3
April	545	2,832	5	73	28	101	57.4
May	338	3,271	7	110	0	110	64.3
June	154	3,492	7	139	0	139	82.4
July	107	3,500	9	146	182	328	192.7
August	97	3,270	9	146	248	394	225.5
September	81	2,964	6	73	267	340	188.6
October	80	2,699	5	36	183	219	118.9
November	86	2,555	2	0	130	130	69.7
December	77	2,509	0	0	93	93	49.2
Totals	2,750	----	50	730	1,970	2,700	1,505.0
1931							
January	150	2,493	0	0	123	123	65.6
February	156	2,520	0	0	107	107	57.4
March	258	2,569	0	7	98	105	57.4
April	192	2,722	4	73	32	105	57.4
May	118	2,805	5	110	0	110	60.6
June	128	2,808	7	139	10	149	82.0
July	126	2,780	8	146	208	354	192.7
August	127	2,544	7	146	284	430	225.5
September	117	2,234	5	73	301	374	188.6
October	124	1,972	4	36	207	243	118.9
November	129	1,849	3	0	144	144	69.7
December	243	1,831	0	0	101	101	49.2
Totals	1,868	----	43	730	1,615	2,345	1,225.0
932							
January	202	1,973	0	0	132	132	65.6
February	179	2,043	0	0	114	114	57.4
March	460	2,108	0	7	104	111	57.4
April	507	2,457	4	73	33	106	57.4
May	540	2,854	5	110	0	110	62.3
June	254	3,279	8	139	1	140	82.0
July	111	3,385	10	146	185	331	192.7
August	95	3,155	9	146	253	399	225.5
September	79	2,842	6	73	272	345	188.6
October	80	2,570	4	36	187	223	118.9
November	68	2,423	3	0	133	133	69.7
December	81	2,355	0	0	94	94	49.2
Totals	2,656	----	49	730	1,508	2,238	1,226.7

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1933							
January	156	2,342	0	0	125	125	65.6
February	116	2,373	0	0	110	110	57.4
March	339	2,379	0	7	101	108	57.4
April	285	2,510	5	73	33	106	57.4
May	336	2,684	6	110	0	110	60.5
June	238	2,904	7	139	7	146	82.0
July	115	2,989	8	146	200	346	192.7
August	115	2,750	7	146	272	418	225.5
September	82	2,440	6	73	291	364	188.6
October	83	2,152	4	36	200	236	118.9
November	72	1,995	2	0	142	142	69.7
December	154	1,923	0	0	100	100	49.2
Totals	1,991	----	45	730	1,581	2,311	1,224.9
1934							
January	236	1,977	0	0	132	132	65.6
February	265	2,081	0	0	113	113	57.4
March	208	2,233	0	7	103	110	57.4
April	235	2,421	4	73	35	108	57.4
May	162	2,544	5	110	0	110	58.9
June	121	2,591	6	139	13	152	82.0
July	135	2,554	8	146	219	365	192.7
August	134	2,316	6	146	298	444	225.5
September	127	2,000	6	73	316	389	188.6
October	117	1,732	4	36	218	254	118.9
November	140	1,591	2	0	152	152	69.7
December	133	1,577	0	0	107	107	49.2
Totals	2,103	----	41	730	1,706	2,436	1,223.3
1935							
January	237	1,603	0	0	141	141	65.6
February	201	1,699	0	0	121	121	57.4
March	287	1,779	0	7	111	118	57.4
April	1,213	1,948	4	73	35	108	57.4
May	752	3,049	6	110	193	303	175.9
June	305	3,402	7	139	151	290	172.1
July	113	3,500	9	146	188	334	196.2
August	114	3,270	9	146	264	410	234.9
September	77	2,965	7	73	267	340	188.6
October	81	2,695	5	36	183	219	118.9
November	62	2,552	3	0	130	130	69.7
December	80	2,481	0	0	93	93	49.2
Totals	3,522	----	50	730	1,877	2,607	1,443.0
1936							
January	573	2,468	0	0	410	410	220.0
February	867	2,631	0	0	498	498	154.0
March	514	3,000	0	7	507	514	154.0
April	588	3,000	4	73	240	313	179.6
May	387	3,271	7	110	49	159	93.1
June	228	3,492	8	139	73	212	126.1
July	114	3,500	9	146	189	335	197.0
August	114	3,270	9	146	265	411	235.1
September	79	2,964	6	73	267	340	188.6
October	76	2,697	5	36	183	219	118.9
November	56	2,549	3	0	131	131	69.7
December	59	2,471	0	0	93	93	49.2
Totals	3,655	----	51	730	2,905	3,635	1,785.3

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1937							
January	85	2,437	0	0	124	124	65.6
February	209	2,398	0	0	108	108	57.4
March	436	2,500	6	7	98	105	57.4
April	595	2,830	4	73	76	149	84.4
May	616	3,272	7	110	278	388	227.9
June	245	3,493	8	139	91	230	136.3
July	112	3,500	10	146	187	333	195.7
August	97	3,269	9	146	248	394	225.5
September	79	2,963	6	73	267	340	188.6
October	81	2,696	5	36	183	219	118.9
November	293	2,553	3	0	336	336	179.6
December	953	2,507	0	0	461	461	220.0
Totals	3,801	----	52	730	2,457	3,187	1,757.3
1938							
January	284	2,999	0	0	312	312	176.0
February	675	2,971	0	0	648	648	154.0
March	1,220	2,998	0	7	1,212	1,219	154.0
April	1,456	2,999	4	73	878	951	154.0
May	1,643	3,500	7	110	1,527	1,637	154.0
June	737	3,499	8	139	591	730	220.0
July	239	3,498	10	146	314	460	270.3
August	194	3,267	9	146	345	491	280.9
September	165	2,961	6	73	351	424	235.1
October	175	2,696	4	36	277	313	169.8
November	172	2,554	3	0	216	216	115.6
December	180	2,507	0	0	195	195	103.9
Totals	7,140	----	51	730	6,866	7,596	2,187.6
1939							
January	191	2,492	0	0	164	164	87.6
February	145	2,519	0	0	107	107	57.4
March	200	2,557	0	7	98	105	57.4
April	277	2,742	4	73	31	104	57.4
May	128	2,911	6	110	0	110	61.4
June	90	2,923	7	139	8	147	82.0
July	86	2,859	9	146	206	352	192.7
August	103	2,584	7	146	282	428	225.5
September	87	2,252	5	73	301	374	188.6
October	87	1,960	4	36	208	244	118.9
November	72	1,799	2	0	147	147	69.7
December	103	1,722	0	0	104	104	49.2
Totals	1,659	----	44	730	1,656	2,386	1,247.8
1940							
January	583	1,721	0	0	134	134	65.6
February	1,096	2,170	0	0	287	287	154.0
March	1,330	2,979	0	7	1,303	1,310	154.0
April	809	2,999	4	73	231	304	154.0
May	404	3,500	7	110	287	397	198.0
June	213	3,500	8	139	66	205	121.7
July	174	3,500	10	146	249	395	232.0
August	149	3,269	8	146	300	446	255.4
September	147	2,964	6	73	333	406	225.3
October	161	2,699	4	36	264	300	162.5
November	131	2,556	3	0	175	175	93.8
December	626	2,509	0	0	407	407	220.0
Totals	5,823	----	50	730	4,036	4,766	2,036.3

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir: Irrigation requirement in Feather River Service Area 1,000 acre-feet	Releases from reservoir: Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Releases from reservoir: Total available for power generation 1,000 acre-feet	Electric energy output 1,000,000 kilowatt hours
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1941							
January	674	2,728	0	0	517	517	286.0
February	980	2,885	0	0	865	865	154.0
March	835	3,000	0	7	828	835	154.0
April	729	3,000	4	73	193	266	154.0
May	912	3,460	7	110	754	864	154.0
June	393	3,500	8	139	246	385	228.7
July	239	3,500	10	146	314	460	270.5
August	178	3,269	9	146	329	475	272.0
September	161	2,963	6	73	347	420	232.9
October	168	2,698	4	36	271	307	166.5
November	192	2,555	3	0	235	235	126.0
December	695	2,509	0	0	531	531	286.0
Totals	6,156	----	51	730	5,430	6,160	2,484.6
1942							
January	881	2,673	0	0	554	554	220.0
February	991	3,000	0	0	991	991	154.0
March	407	3,000	0	7	502	509	286.0
April	942	2,808	4	73	270	343	198.0
May	870	3,493	7	110	746	856	198.0
June	575	3,500	8	139	428	567	286.0
July	255	3,500	10	146	330	476	279.7
August	186	3,269	9	146	337	483	276.6
September	163	2,963	6	73	349	422	234.1
October	164	2,698	5	36	266	302	164.0
November	257	2,555	3	0	301	301	161.3
December	411	2,508	0	0	426	426	227.1
Totals	6,102	----	52	730	5,500	6,230	2,684.8
1943							
January	940	2,493	0	0	433	433	220.0
February	556	3,000	0	0	556	556	198.0
March	1,028	3,000	0	7	1,021	1,028	154.0
April	719	3,000	4	73	271	344	198.0
May	445	3,371	7	110	207	317	186.9
June	291	3,492	8	139	137	276	163.8
July	193	3,499	10	146	268	414	243.3
August	164	3,268	9	146	314	460	263.4
September	149	2,963	6	73	335	408	226.5
October	157	2,698	4	36	260	296	160.4
November	165	2,555	3	0	209	209	112.0
December	143	2,508	0	0	158	158	84.3
Totals	4,950	----	51	730	4,169	4,899	2,210.6
1944							
January	156	2,493	0	0	130	130	69.2
February	251	2,519	0	0	202	202	108.3
March	388	2,568	0	7	118	125	68.6
April	416	2,831	4	73	29	102	57.4
March	504	3,141	6	110	37	147	85.6
June	207	3,492	8	139	53	192	113.9
July	131	3,499	10	146	206	352	206.8
August	143	3,268	9	146	294	440	251.8
September	107	2,962	6	73	292	365	202.8
October	110	2,698	4	36	212	248	134.8
November	204	2,556	3	0	248	248	132.7
December	255	2,509	0	0	270	270	143.9
Total	2,872	----	50	730	2,091	2,821	1,575.8

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir: Irrigation requirement in Feather River Service Area 1,000 acre-feet	Releases from reservoir: Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Releases from reservoir: Total available for power generation 1,000 acre-feet	Electric energy output 1,000,000 kilowatt hours
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1945							
January	172	2,494	0	0	146	146	77.8
February	719	2,520	0	0	487	487	264.0
March	367	2,752	0	7	280	287	159.0
April	437	2,832	4	73	29	102	57.4
May	467	3,163	6	110	21	131	76.2
June	239	3,403	8	139	85	224	132.9
July	133	3,500	10	146	207	353	207.9
August	123	3,270	9	146	274	420	240.3
September	107	2,964	6	73	293	366	202.9
October	116	2,699	4	36	218	254	138.1
November	199	2,557	3	0	243	243	130.2
December	773	2,510	0	0	528	528	286.0
Totals	3,852	----	50	730	2,811	3,541	1,972.7
1946							
January	496	2,755	0	0	521	521	286.0
February	286	2,730	0	0	446	446	242.4
March	401	2,570	0	7	132	139	76.0
April	549	2,832	5	73	32	105	59.6
May	420	3,271	7	110	82	192	112.5
June	227	3,492	8	139	72	211	125.5
July	164	3,500	10	146	239	385	226.3
August	125	3,269	8	146	276	422	241.4
September	106	2,964	6	73	292	365	202.4
October	102	2,699	4	36	204	240	130.4
November	187	2,556	3	0	232	232	123.9
December	206	2,509	0	0	221	221	118.1
Totals	3,269	----	51	730	2,749	3,479	1,944.5
1947							
January	120	2,494	0	0	123	123	65.6
February	350	2,491	0	0	271	271	145.3
March	476	2,570	0	7	207	214	116.9
April	381	2,832	4	73	29	102	57.4
May	186	3,107	6	110	0	110	62.9
June	154	3,177	7	139	4	143	82.0
July	89	3,181	9	146	193	339	192.7
August	81	2,922	8	146	264	410	225.5
September	71	2,585	6	73	284	357	188.6
October	129	2,293	4	36	195	231	118.9
November	125	2,187	3	0	137	137	69.7
December	103	2,172	0	0	96	96	49.2
Totals	2,265	----	47	730	1,803	2,533	1,374.7
1948							
January	373	2,178	0	0	126	126	65.6
February	143	2,426	0	0	108	108	57.4
March	262	2,463	0	7	100	107	57.4
April	854	2,616	4	73	121	194	108.8
May	735	3,272	7	110	390	500	286.0
June	434	3,500	8	139	287	426	253.0
July	142	3,500	10	146	217	363	213.6
August	95	3,269	9	146	248	394	225.5
September	79	2,961	6	73	267	340	188.6
October	80	2,694	5	36	183	219	118.9
November	115	2,550	3	0	154	154	82.3
December	134	2,508	0	0	149	149	79.5
Totals	3,446	----	52	730	2,350	3,080	1,736.6

FEATHER RIVER PROJECT

Operation of Oroville Reservoir for Flood Control, Water Supplies and Power Generation—Continued

1921-1951 (By Months)

Year and month	Present impaired inflow to reservoir 1,000 acre-feet	Reservoir storage on first day of month 1,000 acre-feet	Reservoir evaporation loss 1,000 acre-feet	Releases from reservoir			Electric energy output 1,000,000 kilowatt hours
				Irrigation requirement in Feather River Service Area 1,000 acre-feet	Power generation or waste through flood control outlets or over spillway 1,000 acre-feet	Total available for power generation 1,000 acre-feet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1949							
January	105	2,493	0	0	123	123	65.6
February	143	2,475	0	0	108	108	57.4
March	425	2,510	0	7	98	105	57.4
April	577	2,830	4	73	59	132	74.9
May	446	3,271	6	110	109	219	128.2
June	154	3,492	8	139	0	139	82.4
July	92	3,499	9	146	182	328	192.7
August	88	3,254	9	146	249	395	225.5
September	59	2,938	6	73	268	341	188.6
October	64	2,650	5	36	185	221	118.9
November	86	2,488	3	0	131	131	69.7
December	83	2,440	0	0	93	93	49.2
Totals	2,322	----	50	730	1,605	2,335	1,310.5
1950							
January	306	2,430	0	0	216	216	115.1
February	552	2,520	0	0	492	492	264.0
March	522	2,580	0	7	264	271	148.1
April	759	2,831	4	73	242	315	178.8
May	602	3,271	6	110	265	375	219.9
June	258	3,492	7	139	104	243	144.0
July	111	3,500	9	146	186	332	195.3
August	85	3,270	9	146	248	394	225.5
September	74	2,952	7	73	267	340	188.6
October	179	2,679	5	36	262	298	161.5
November	739	2,555	3	0	401	401	220.0
December	1,045	2,890	0	0	935	935	220.0
Totals	5,232	----	50	730	3,882	4,612	2,280.8
1951							
January	666	3,000	0	0	666	666	176.0
February	746	3,000	0	0	746	746	198.0
March	516	3,000	0	7	509	516	198.0
April	549	3,000	4	73	201	274	156.9
May	503	3,271	7	110	165	275	161.5
June	197	3,492	8	139	42	181	107.5
July	109	3,500	9	146	184	330	194.2
August	86	3,270	9	146	248	394	225.5
September	75	2,953	7	73	267	340	188.6
October	109	2,681	5	36	194	230	124.8
November	189	2,555	2	0	233	233	124.7
December	633	2,509	0	0	533	533	286.0
Totals	4,378	----	51	730	3,988	4,718	2,141.7
Annual mean	3,625	2,609	50	730	2,843	3,573	1,720.6

APPENDIX E-2

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies			Water utilization				Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1921									
January	4,028	403	5,331	318	21	428	767	4,564	0
February	3,269	414	3,683	308	19	467	794	2,889	0
March	2,630	826	3,456	439	21	308	768	2,688	0
April	1,855	195	2,050	587	21	335	943	1,107	0
May	2,306	419	2,725	681	22	415	1,118	1,607	0
June	1,894	218	2,112	652	21	12	685	1,427	0
July	939	246	1,185	735	22	213	960	225	21
August	870	301	1,171	697	22	240	959	212	89
September	620	320	940	556	21	221	798	142	178
October	627	241	868	454	21	219	694	174	67
November	647	200	847	393	20	409	822	25	175
December	1,352	260	1,612	313	22	430	765	847	0
Totals	21,937	4,043	25,980	6,123	253	3,697	10,073	15,907	530
1922									
January	1,067	166	1,233	318	21	525	864	369	0
February	2,889	362	3,251	308	19	467	794	2,457	0
March	1,870	113	1,983	420	21	308	749	1,234	0
April	2,048	275	2,323	587	21	335	943	1,380	0
May	4,027	976	5,003	681	22	415	1,118	3,885	0
June	3,257	472	3,729	652	21	12	685	3,044	0
July	1,054	282	1,336	738	22	213	973	363	0
August	977	314	1,291	703	22	240	965	326	0
September	602	328	930	566	21	221	808	122	206
October	684	258	942	454	21	219	694	248	10
November	905	218	1,123	393	20	409	822	301	0
December	2,694	366	3,060	313	22	430	765	2,295	0
Totals	22,074	4,130	26,204	6,133	253	3,794	10,180	16,024	216
1923									
January	1,901	286	2,187	318	21	525	864	1,323	0
February	1,001	166	1,167	308	19	467	794	373	0
March	899	98	997	436	21	308	765	232	0
April	1,960	29	1,989	538	21	335	894	1,095	0
May	1,895	6	1,901	681	22	416	1,119	782	0
June	1,154	22	1,176	652	21	12	685	491	0
July	842	187	1,029	725	22	213	960	69	118
August	723	248	971	700	22	240	962	9	239
September	543	267	810	565	21	221	807	3	264
October	554	186	740	440	21	219	680	60	126
November	539	130	669	393	20	256	669	0	130
December	574	93	667	313	22	332	667	0	93
Totals	12,585	1,718	14,303	6,069	253	3,544	9,866	4,437	970
1924									
January	535	123	658	318	21	319	658	0	123
February	683	195	878	317	19	542	878	0	195
March	516	99	615	415	21	179	615	0	99
April	462	32	494	535	0	0	535	—41	32
May	692	0	692	626	21	45	692	0	0
June	645	12	657	581	21	55	657	0	12
July	716	213	929	658	21	250	929	0	213
August	710	291	1,001	663	22	316	1,001	0	291
September	525	309	834	526	21	287	834	0	309
October	514	212	726	443	21	262	726	0	212
November	647	147	794	393	21	380	794	0	147
December	847	104	951	313	23	567	903	48	56
Totals	7,492	1,737	9,229	5,788	232	3,202	9,222	7	1,689

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies			Water utilization				Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1925									
January	719	138	857	318	22	517	857	0	138
February	3,506	115	3,621	308	19	612	939	2,682	0
March	1,402	102	1,504	430	21	608	1,059	445	0
April	2,091	33	2,124	573	21	535	1,129	995	0
May	1,900	0	1,900	681	22	514	1,217	683	0
June	1,091	6	1,097	652	21	109	782	315	0
July	780	199	979	730	21	213	964	15	184
August	675	272	947	700	21	226	947	0	272
September	528	291	819	561	22	236	819	0	291
October	581	201	782	454	21	219	694	88	113
November	630	142	772	393	21	358	772	0	142
December	705	100	805	313	21	430	764	41	59
Totals	14,608	1,599	16,207	6,113	253	4,577	10,943	5,264	1,199
1926									
January	840	134	974	318	21	575	914	60	74
February	3,331	113	3,444	308	20	467	795	2,649	0
March	1,040	101	1,141	435	21	308	764	377	0
April	2,125	30	2,155	578	21	335	934	1,221	0
May	808	0	808	681	21	106	808	0	0
June	635	2	637	624	13	0	637	0	2
July	685	189	874	699	22	153	874	0	189
August	684	258	942	697	21	224	942	0	258
September	498	277	775	546	21	208	775	0	277
October	540	190	730	454	22	254	730	0	190
November	1,316	185	1,501	393	21	417	831	670	0
December	1,809	252	2,061	313	21	619	953	1,108	0
Totals	14,311	1,731	16,042	6,046	245	3,666	9,957	6,085	990
1927									
January	2,247	280	2,527	318	22	689	1,029	1,498	0
February	6,505	688	7,193	308	19	478	805	6,388	0
March	2,618	667	3,285	439	22	308	769	2,516	0
April	3,390	241	3,631	587	21	335	943	2,688	0
May	2,451	461	2,912	681	21	416	1,118	1,794	0
June	1,953	141	2,094	652	21	12	685	1,409	0
July	889	244	1,133	737	22	213	972	161	83
August	867	306	1,173	699	21	240	960	213	93
September	551	322	873	564	21	221	806	67	255
October	625	250	875	454	21	219	694	181	69
November	1,421	314	1,735	393	21	409	823	912	0
December	1,212	208	1,420	313	21	430	764	656	0
Totals	24,729	4,122	28,851	6,145	253	3,970	10,368	18,483	500
1928									
January	1,336	197	1,533	318	22	525	865	668	0
February	1,753	288	2,041	317	20	472	809	1,232	0
March	4,603	819	5,422	425	22	308	755	4,667	0
April	2,617	195	2,812	587	21	335	943	1,869	0
May	1,465	94	1,559	681	21	416	1,118	441	0
June	642	29	671	638	21	12	671	0	29
July	704	229	933	699	22	212	933	0	229
August	695	264	959	697	22	240	959	0	264
September	515	271	786	544	21	221	786	0	271
October	505	188	693	453	21	219	693	0	188
November	692	130	822	393	20	409	822	0	130
December	753	108	861	313	21	527	861	0	108
Totals	16,280	2,812	19,092	6,065	254	3,896	10,215	8,877	1,219

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies			Water utilization				Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1929									
January	512	123	635	318	21	296	635	0	123
February	819	107	926	308	19	599	926	0	107
March	653	99	752	422	22	308	752	0	99
April	606	31	637	569	20	48	637	0	31
May	716	0	716	681	22	13	716	0	0
June	662	7	669	651	18	0	669	0	7
July	682	200	882	706	21	155	882	0	200
August	654	273	927	697	22	208	927	0	273
September	490	291	781	543	21	217	781	0	291
October	490	201	691	445	21	225	691	0	201
November	428	142	570	392	21	157	570	0	142
December	1,357	198	1,555	313	22	689	1,024	531	0
Totals	8,069	1,672	9,741	6,045	250	2,915	9,210	531	1,474
1930									
January	1,231	247	1,478	318	21	689	1,028	450	0
February	1,369	308	1,677	308	20	612	940	737	0
March	1,839	284	2,123	423	22	615	1,060	1,063	0
April	1,070	28	1,098	585	20	493	1,098	0	28
May	783	0	783	675	21	87	783	0	0
June	680	0	680	648	20	12	680	0	0
July	679	182	861	701	22	138	861	0	182
August	672	248	920	697	22	201	920	0	248
September	504	267	771	543	20	208	771	0	267
October	511	183	694	429	21	244	694	0	183
November	490	130	620	389	21	210	620	0	130
December	438	93	531	313	23	195	531	0	93
Totals	10,266	1,970	12,236	6,029	253	3,704	9,986	2,250	1,131
1931									
January	701	123	824	318	21	485	824	0	123
February	558	107	665	308	19	338	665	0	107
March	618	98	716	416	21	279	716	0	98
April	518	32	550	546	4	0	550	0	32
May	675	0	675	649	21	5	675	0	0
June	622	10	632	581	22	29	632	0	10
July	676	208	884	658	22	204	884	0	208
August	655	284	939	663	22	254	939	0	284
September	483	301	784	526	20	238	784	0	301
October	441	207	648	442	21	185	648	0	207
November	458	144	602	383	19	200	602	0	144
December	1,472	101	1,573	313	23	566	902	671	0
Totals	7,877	1,615	9,492	5,803	235	2,783	8,821	671	1,514
1932									
January	903	132	1,035	318	22	680	1,029	6	126
February	1,494	114	1,608	317	20	635	972	636	0
March	1,259	104	1,363	439	21	599	1,059	304	0
April	1,088	33	1,121	587	20	514	1,121	0	33
May	2,005	0	2,005	681	22	544	1,217	788	0
June	1,697	1	1,698	652	21	297	970	728	0
July	697	185	882	733	21	128	882	0	185
August	684	253	937	698	22	217	937	0	253
September	543	272	815	555	21	239	815	0	272
October	505	187	692	454	22	216	692	0	187
November	497	133	630	391	21	218	630	0	133
December	543	94	637	313	21	303	637	0	94
Totals	11,915	1,508	13,423	6,138	254	4,569	10,961	2,462	1,283

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies: Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Water supplies: Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Water supplies: Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water utilization: Water used for fulfilling the purposes of the Central Valley Project	Water utilization: Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water utilization: Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Water utilization: Total diversions and uses of waters of the delta	Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1933									
January	716	125	841	318	22	501	841	0	125
February	513	110	623	308	20	295	623	0	110
March	958	101	1,059	437	21	601	1,059	0	101
April	681	33	714	586	20	108	714	0	33
May	949	0	949	671	21	257	949	0	0
June	1,115	7	1,122	651	20	451	1,122	0	7
July	709	200	909	719	21	169	909	0	200
August	698	272	970	697	22	251	970	0	272
September	525	291	816	543	21	252	816	0	291
October	512	200	712	436	21	255	712	0	200
November	452	142	594	393	21	180	594	0	142
December	966	100	1,066	313	23	566	902	164	0
Totals	8,794	1,581	10,375	6,072	253	3,886	10,211	164	1,481
1934									
January	1,024	132	1,156	318	21	689	1,028	128	0
February	1,120	113	1,242	308	19	612	939	303	0
March	1,016	103	1,119	437	22	313	772	347	0
April	505	35	540	563	0	0	563	—23	35
May	593	0	593	642	0	0	642	—49	0
June	577	13	590	581	9	0	590	0	13
July	651	219	870	658	22	190	870	0	219
August	644	298	942	663	21	258	942	0	298
September	470	316	786	526	20	240	786	0	316
October	447	218	665	445	21	199	665	0	218
November	730	152	882	391	21	470	882	0	152
December	664	107	771	313	22	436	771	0	107
Totals	8,450	1,706	10,156	5,845	198	3,407	9,450	706	1,358
1935									
January	1,548	141	1,689	318	22	689	1,029	660	0
February	1,007	121	1,128	308	19	612	939	189	0
March	1,574	111	1,685	412	22	627	1,061	624	0
April	3,644	35	3,679	533	21	401	955	2,724	0
May	2,076	193	2,269	681	21	416	1,118	1,151	0
June	1,687	151	1,838	652	21	12	685	1,153	0
July	769	188	957	728	22	207	957	0	188
August	669	264	933	700	21	212	933	0	264
September	514	267	781	561	21	199	781	0	267
October	547	183	730	454	21	255	730	0	183
November	513	130	643	393	20	230	643	0	130
December	587	93	680	313	22	345	680	0	93
Totals	15,135	1,877	17,012	6,053	253	4,205	10,511	6,501	1,125
1936									
January	2,396	410	2,806	318	21	689	1,028	1,778	0
February	5,197	498	5,695	317	20	590	927	4,768	0
March	1,947	507	2,454	439	21	308	768	1,686	0
April	2,147	240	2,387	587	21	335	943	1,444	0
May	2,161	49	2,210	681	21	416	1,118	1,092	0
June	1,391	73	1,464	652	21	12	685	779	0
July	800	189	989	726	22	213	961	28	161
August	663	265	928	699	21	208	928	0	265
September	517	267	784	562	21	201	784	0	267
October	538	183	721	454	22	245	721	0	183
November	480	131	611	393	21	197	611	0	131
December	568	93	661	313	22	326	661	0	93
Totals	18,805	2,905	21,710	6,141	254	3,740	10,135	11,575	1,100

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies: Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Water supplies: Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Water supplies: Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water utilization: Water used for fulfilling the purposes of the Central Valley Project	Water utilization: Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water utilization: Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Water utilization: Total diversions and uses of waters of the delta	Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1937									
January	706	124	830	318	21	491	830	0	124
February	2,251	108	2,359	308	19	612	939	1,420	0
March	2,631	98	2,729	384	22	538	944	1,785	0
April	2,248	76	2,324	587	21	335	943	1,381	0
May	2,774	278	3,052	681	21	416	1,118	1,934	0
June	1,395	91	1,486	652	21	12	685	801	0
July	776	187	963	724	22	213	959	4	183
August	687	248	935	697	21	217	935	0	248
September	521	267	788	558	21	209	788	0	267
October	553	183	736	454	22	254	730	6	177
November	1,908	336	2,244	393	21	409	823	1,421	0
December	4,487	461	4,948	313	21	430	764	4,184	0
Totals	20,937	2,457	23,394	6,069	253	4,136	10,458	12,936	999
1938									
January	2,119	312	2,431	318	21	524	863	1,568	0
February	6,784	648	7,432	308	19	467	794	6,638	0
March	7,469	1,212	8,681	371	22	308	701	7,980	0
April	4,428	878	5,306	587	21	335	943	4,363	0
May	4,928	1,527	6,455	681	21	416	1,118	5,337	0
June	3,471	591	4,062	652	21	12	685	3,377	0
July	1,109	314	1,513	743	22	213	978	535	0
August	950	345	1,295	715	21	240	976	319	26
September	940	351	1,291	561	21	221	803	488	0
October	798	277	1,075	454	22	219	695	380	0
November	755	216	971	393	21	409	823	148	68
December	840	195	1,035	313	21	430	764	271	0
Totals	34,681	6,866	41,547	6,096	253	3,794	10,143	31,404	94
1939									
January	687	164	851	318	21	512	851	0	164
February	622	107	729	308	19	402	729	0	107
March	1,088	98	1,186	432	22	386	840	346	0
April	827	31	858	587	21	250	858	0	31
May	655	0	655	681	0	0	681	—26	0
June	643	8	651	623	20	8	651	0	8
July	699	206	905	699	21	185	905	0	206
August	686	282	968	697	22	249	968	0	282
September	507	301	808	543	21	244	808	0	301
October	476	208	684	453	21	210	684	0	208
November	432	147	579	390	21	168	579	0	147
December	542	104	646	313	21	312	646	0	104
Totals	7,864	1,656	9,520	6,044	230	2,926	9,200	320	1,558
1940									
January	2,725	134	2,859	318	21	689	1,028	1,831	0
February	6,150	287	6,437	317	20	635	972	5,465	0
March	4,963	1,303	6,266	439	21	599	1,059	5,207	0
April	3,218	231	3,449	587	21	521	1,129	2,320	0
May	2,153	287	2,440	681	22	475	1,178	1,262	0
June	1,026	66	1,092	652	21	12	685	407	0
July	730	249	979	711	21	213	945	34	215
August	704	300	1,004	697	22	240	959	45	255
September	523	333	856	552	21	221	794	62	271
October	603	264	867	452	21	219	692	175	89
November	669	175	844	391	21	409	821	23	152
December	3,740	407	4,147	313	22	430	765	3,382	0
Totals	27,204	4,036	31,240	6,110	254	4,663	11,027	20,213	982

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1941									
January	5,417	517	5,934	318	21	524	863	5,071	0
February	5,976	865	6,841	308	19	467	794	6,047	0
March	4,340	828	5,168	394	22	308	724	4,444	0
April	4,405	193	4,598	549	21	335	905	3,693	0
May	3,703	754	4,457	681	21	416	1,118	3,339	0
June	2,006	246	2,252	652	21	12	685	1,567	0
July	1,105	314	1,419	740	22	213	975	444	0
August	982	329	1,311	707	21	240	968	343	0
September	765	347	1,112	562	21	221	804	308	39
October	693	271	964	454	22	219	695	269	2
November	723	235	958	393	21	409	823	135	100
December	3,758	531	4,289	313	21	430	764	3,525	0
Totals	33,873	5,430	39,303	6,071	253	3,794	10,118	29,185	141
1942									
January	4,785	554	5,339	318	21	524	863	4,476	0
February	5,833	991	6,824	308	19	467	794	6,030	0
March	1,712	502	2,214	438	22	308	768	1,446	0
April	2,876	270	3,146	587	21	335	943	2,203	0
May	3,169	746	3,915	681	21	416	1,118	2,797	0
June	2,687	428	3,115	652	21	12	685	2,430	0
July	1,137	330	1,467	739	22	213	974	493	0
August	1,000	337	1,337	701	21	240	962	375	0
September	869	349	1,218	550	21	221	792	426	0
October	676	266	942	454	22	219	695	247	19
November	1,176	301	1,477	393	21	409	823	654	0
December	1,917	426	2,343	313	21	430	764	1,579	0
Totals	27,837	5,500	33,337	6,134	253	3,794	10,181	23,156	19
1943									
January	4,626	433	5,059	318	21	525	864	4,195	0
February	2,907	556	3,463	308	19	467	794	2,669	0
March	4,433	1,021	5,454	439	21	308	768	4,686	0
April	2,757	271	3,028	587	21	335	943	2,085	0
May	2,049	207	2,256	681	22	415	1,118	1,138	0
June	1,372	137	1,509	652	21	12	685	824	0
July	879	268	1,147	726	22	213	961	186	82
August	856	314	1,170	699	22	240	961	209	105
September	502	335	927	554	21	221	796	131	204
October	631	260	891	454	21	219	694	197	63
November	605	209	814	393	21	400	814	0	209
December	613	158	771	313	21	430	764	7	151
Totals	22,320	4,169	26,489	6,124	253	3,785	10,162	16,327	814
1944									
January	656	130	786	318	21	446	785	1	129
February	1,250	202	1,452	317	20	560	897	555	0
March	1,401	118	1,519	424	21	308	753	766	0
April	774	29	803	585	21	197	803	0	29
May	1,295	37	1,332	681	22	514	1,217	115	0
June	819	53	872	651	21	51	723	149	0
July	721	206	927	724	22	181	927	0	206
August	657	294	951	697	22	232	951	0	294
September	520	292	812	563	20	229	812	0	292
October	553	212	765	454	21	250	725	40	172
November	1,064	248	1,312	393	21	409	823	489	0
December	1,517	270	1,787	313	22	431	766	1,021	0
Totals	11,227	2,091	13,318	6,120	254	3,808	10,182	3,134	1,122

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies			Water utilization				Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1945									
January	918	146	1,064	318	21	525	864	200	0
February	3,770	487	4,257	308	19	467	794	3,463	0
March	1,726	280	2,006	439	21	308	768	1,238	0
April	1,309	29	1,338	587	21	335	943	395	0
May	1,817	21	1,838	681	22	415	1,118	720	0
June	1,438	85	1,523	652	21	12	685	838	0
July	837	207	1,044	736	22	213	971	73	134
August	774	274	1,048	703	22	240	965	83	191
September	546	293	839	578	21	221	820	19	274
October	771	218	989	454	21	219	694	295	0
November	1,343	243	1,586	393	20	409	822	764	0
December	4,912	528	5,440	313	22	430	765	4,675	0
Totals	20,161	2,811	22,972	6,162	253	3,794	10,209	12,763	599
1946									
January	2,548	521	3,069	318	21	525	864	2,205	0
February	1,144	445	1,589	308	19	467	794	795	0
March	1,473	132	1,605	436	21	308	765	840	0
April	1,641	32	1,673	587	21	335	943	730	0
May	2,068	82	2,150	681	22	415	1,118	1,032	0
June	921	72	993	652	21	12	685	308	0
July	790	239	1,029	719	22	213	954	75	164
August	726	276	1,002	697	22	240	959	43	233
September	550	292	842	559	21	221	801	41	251
October	569	204	773	454	21	219	694	79	125
November	821	232	1,053	393	20	409	822	231	1
December	993	222	1,215	313	22	430	765	450	0
Totals	14,244	2,749	16,993	6,117	253	3,794	10,164	6,829	774
1947									
January	568	123	691	318	21	352	691	0	0
February	1,051	271	1,322	308	19	612	939	383	0
March	1,571	207	1,778	435	22	336	793	985	0
April	827	29	856	586	21	249	856	-0	29
May	719	0	719	681	21	17	719	-0	0
June	602	4	606	623	0	0	623	-17	4
July	653	193	846	699	21	126	846	0	193
August	652	264	916	697	21	198	916	0	264
September	500	284	784	545	21	218	784	0	284
October	711	195	906	454	22	430	906	0	195
November	598	137	735	393	22	320	735	0	137
December	524	96	620	313	21	286	620	0	96
Totals	8,976	1,803	10,779	6,052	232	3,144	9,428	1,351	1,202
1948									
January	1,510	126	1,636	318	21	689	1,028	608	0
February	504	108	612	317	19	276	612	0	108
March	1,016	100	1,116	418	22	620	1,060	56	44
April	2,548	121	2,669	584	21	525	1,130	1,539	0
May	2,609	390	2,999	681	21	515	1,217	1,782	0
June	2,030	287	2,317	652	21	87	760	1,557	0
July	851	217	1,068	710	22	213	945	123	94
August	836	248	1,084	697	21	240	958	126	122
September	744	267	1,011	550	21	221	792	219	48
October	609	183	792	454	22	219	695	97	86
November	627	154	781	393	21	367	781	0	154
December	790	149	939	313	22	431	766	173	0
Totals	14,674	2,350	17,024	6,087	254	4,403	10,744	6,280	656

FEATHER RIVER PROJECT

Water Uses in and Diversions From the Sacramento-San Joaquin Delta With Coordinated Operation of Feather River Project and Central Valley Project—Continued

1921-1951 (By Months)

Quantities in Thousands of Acre-feet

Year and month	Water supplies			Water utilization				Surplus flows into Suisun Bay in excess of 4,500 second-feet, the estimated flow necessary to repel saline waters from the delta	Water specifically required from Oroville Reservoir to supply Feather River Project and Central Valley Project uses and diversions
	Inflow to Sacramento-San Joaquin Delta, modified by present developments and the operation of Folsom Reservoir and excluding the flow of the Feather River	Release and spill from Oroville Reservoir, with operation primarily for power generation, less irrigation diversions in the Feather River Service Area	Total inflow to the delta available to meet the water requirements of the Central Valley Project and the Feather River Project	Water used for fulfilling the purposes of the Central Valley Project	Water diverted to South San Francisco Bay Area to meet a portion of the ultimate supplemental water requirements of Santa Clara, Alameda and San Benito Counties	Water diverted through the Feather River Project Aqueduct to meet the supplemental water requirements of western Fresno, Kings and Kern Counties and Southern California	Total diversions and uses of waters of the delta		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1949									
January	554	123	677	318	21	338	677	0	123
February	674	108	782	308	20	454	782	0	108
March	2,740	98	2,838	434	21	549	1,004	1,834	0
April	1,675	59	1,734	587	21	335	943	791	0
May	1,649	109	1,758	681	21	416	1,118	640	0
June	762	0	762	651	22	12	685	77	0
July	680	182	862	699	21	142	862	0	182
August	687	249	936	697	21	218	936	0	249
September	546	268	814	543	20	251	814	0	268
October	481	185	666	454	22	190	666	0	185
November	538	131	669	393	21	255	669	0	131
December	525	93	618	313	22	283	618	0	93
Totals	11,511	1,605	13,116	6,078	253	3,443	9,774	3,342	1,339
1950									
January	1,574	216	1,790	318	21	689	1,028	762	0
February	2,140	492	2,632	308	19	612	939	1,693	0
March	1,500	264	1,764	435	21	391	847	917	0
April	2,043	242	2,285	587	21	335	943	1,342	0
May	2,079	265	2,344	681	22	416	1,119	1,225	0
June	1,351	104	1,455	651	21	12	684	771	0
July	781	186	967	705	22	213	940	27	159
August	706	248	954	697	22	235	954	0	248
September	552	267	819	555	21	226	802	17	250
October	1,116	262	1,378	454	21	219	694	684	0
November	3,922	401	4,323	393	20	409	822	3,501	0
December	6,302	935	7,237	313	22	430	765	6,472	0
Totals	24,066	3,882	27,948	6,097	253	4,187	10,537	17,411	657
1951									
January	3,681	666	4,347	318	22	524	864	3,483	0
February	3,958	746	4,704	308	20	467	795	3,909	0
March	1,938	509	2,447	437	21	308	766	1,681	0
April	1,270	201	1,471	587	21	335	943	528	0
May	1,710	165	1,875	681	22	416	1,119	756	0
June	782	42	824	652	21	12	685	139	0
July	695	184	879	721	21	137	879	0	184
August	716	248	964	697	21	246	964	0	248
September	546	267	813	547	21	245	813	0	267
October	677	194	871	454	21	265	740	131	63
November	1,078	233	1,311	393	20	409	822	489	0
December	3,551	533	4,084	313	22	430	765	3,319	0
Totals	20,602	3,988	24,590	6,108	253	3,794	10,155	14,435	762
Annual-mean	16,887	2,843	19,730	6,067	248	3,768	10,084	9,646	952

APPENDIX E-3

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1921							
January	424	1,609	1	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	210	1,745	10	182	85	157	424
August	238	1,521	7	182	85	157	424
September	219	1,328	6	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,661	----	51	1,010	849	1,847	3,706
1922							
January	520	1,513	1	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	210	1,745	10	182	85	157	423
August	237	1,522	7	182	85	157	424
September	219	1,329	6	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,756	----	51	1,010	849	1,847	3,706
1923							
January	520	1,513	0	40	85	157	282
February	462	1,751	1	51	84	142	277
March	305	1,935	2	61	85	156	302
April	332	1,936	3	51	85	151	287
May	411	1,978	7	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	6	131	85	152	368
October	217	1,174	3	81	0	157	238
November	353	1,150	2	40	0	152	192
December	329	1,209	1	30	85	157	272
Totals	3,509	----	51	1,010	849	1,847	3,706
1924							
January	316	1,265	1	40	85	157	282
February	536	1,298	1	51	84	147	282
March	177	1,551	1	61	85	156	302
April	0	1,425	3	51	85	151	287
May	44	1,135	5	40	85	157	282
June	55	892	7	121	85	152	358
July	248	582	7	182	85	157	424
August	313	399	4	182	85	157	424
September	284	284	4	131	85	152	368
October	259	196	2	81	0	157	238
November	377	215	1	40	0	152	192
December	561	399	0	30	85	157	272
Totals	3,170	----	36	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1925							
January	512	688	0	40	85	157	282
February	606	918	1	51	84	142	277
March	602	1,246	1	61	85	156	302
April	529	1,545	3	51	85	151	287
May	509	1,784	6	40	85	157	282
June	109	2,005	9	121	85	152	358
July	211	1,747	10	182	85	157	424
August	223	1,524	7	182	85	157	424
September	233	1,316	7	131	85	152	368
October	217	1,174	3	81	0	157	238
November	354	1,150	2	40	0	152	192
December	426	1,310	1	30	85	157	272
Totals	4,531	----	50	1,010	849	1,847	3,706
1926							
January	570	1,463	1	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	105	1,977	6	40	85	157	282
June	0	1,794	8	121	85	152	358
July	152	1,428	9	182	85	157	424
August	222	1,147	6	182	85	157	424
September	206	939	6	131	85	152	368
October	252	771	3	81	0	157	238
November	508	782	2	40	0	152	192
December	426	1,186	1	30	85	157	272
Totals	3,630	----	48	1,010	849	1,847	3,706
1927							
January	682	1,339	0	40	85	157	282
February	473	1,739	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,931	----	51	1,010	849	1,847	3,706
1928							
January	519	1,513	0	40	85	157	282
February	467	1,749	1	51	84	147	282
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	522	1,360	1	30	85	157	272
Totals	3,858	----	51	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1929							
January	293	1,609	1	40	85	157	282
February	593	1,619	1	51	84	142	277
March	305	1,934	1	61	85	156	302
April	47	1,936	3	51	85	151	287
May	13	1,693	6	40	85	157	282
June	0	1,418	8	121	85	152	358
July	153	1,052	8	182	85	157	424
August	206	773	6	182	85	157	424
September	215	549	5	131	85	152	368
October	223	391	2	81	0	157	238
November	155	374	1	40	0	152	192
December	683	336	1	30	85	157	272
Totals	2,886	----	43	1,010	849	1,847	3,706
1930							
January	683	746	1	40	85	157	282
February	606	1,146	1	51	84	142	277
March	609	1,474	1	61	85	156	302
April	488	1,780	3	51	85	151	287
May	86	1,978	6	40	85	157	282
June	11	1,776	8	121	85	152	358
July	137	1,421	9	182	85	157	424
August	199	1,125	6	182	85	157	424
September	206	894	6	131	85	152	368
October	241	726	3	81	0	157	238
November	268	726	2	40	0	152	192
December	194	740	1	30	85	157	272
Totals	3,668	----	47	1,010	849	1,847	3,706
1931							
January	480	661	0	40	85	157	282
February	334	859	1	[c]33	[c]55	[d]127	215
March	276	977	1	[c]40	[c]55	[d]142	237
April	0	1,015	2	[c]33	[c]55	[d]137	225
May	5	788	5	[c]27	[c]55	[d]142	224
June	29	564	6	[c]79	[c]55	[d]137	271
July	202	316	6	[d]118	[c]56	[d]142	316
August	252	196	4	[d]118	[c]55	[d]142	315
September	236	129	3	[c]85	[c]55	[d]138	278
October	183	84	1	63	0	153	216
November	197	50	0	40	0	152	192
December	560	55	0	30	85	157	272
Totals	2,754	----	29	706	611	1,726	3,043
1932							
January	682	343	0	40	85	157	282
February	628	743	1	51	84	147	282
March	593	1,088	1	61	85	156	302
April	509	1,378	3	51	85	151	287
May	509	1,597	6	40	85	157	282
June	294	1,818	9	121	85	152	358
July	127	1,745	10	182	85	157	424
August	215	1,438	7	182	85	157	424
September	236	1,222	6	131	85	152	368
October	214	1,084	3	81	0	157	238
November	216	1,057	2	40	0	152	192
December	300	1,079	0	30	85	157	272
Totals	4,523	----	48	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1933							
January	496	1,107	0	40	85	157	282
February	292	1,321	1	51	84	142	277
March	595	1,335	1	61	85	156	302
April	107	1,627	3	51	85	151	287
May	254	1,444	6	40	85	157	282
June	446	1,410	8	121	85	152	358
July	167	1,490	9	182	85	157	424
August	249	1,224	7	182	85	157	424
September	250	1,042	6	131	85	152	368
October	252	918	3	81	0	157	238
November	179	929	2	40	0	152	192
December	561	914	1	30	85	157	272
Totals	3,848	----	47	1,010	849	1,847	3,706
1934							
January	682	1,202	1	40	85	157	282
February	606	1,601	1	51	84	142	277
March	310	1,929	2	61	85	156	302
April	0	1,935	3	51	85	151	287
May	0	1,645	6	40	85	157	282
June	0	1,357	8	121	85	152	358
July	188	991	8	182	85	157	424
August	255	747	6	182	85	157	424
September	238	572	5	131	85	152	368
October	197	437	2	81	0	157	238
November	465	394	1	40	0	152	192
December	432	666	0	30	85	157	272
Totals	3,373	----	43	1,010	849	1,847	3,706
1935							
January	682	826	0	40	85	157	282
February	606	1,226	1	51	84	142	277
March	620	1,554	2	61	85	156	302
April	397	1,870	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	205	1,745	10	182	85	157	424
August	211	1,516	7	182	85	157	424
September	197	1,296	7	131	85	152	368
October	253	1,118	3	81	0	157	238
November	228	1,130	2	40	0	152	192
December	342	1,164	1	30	85	157	272
Totals	4,164	----	51	1,010	849	1,847	3,706
1936							
January	682	1,233	0	40	85	157	282
February	584	1,633	1	51	84	147	282
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	206	1,522	7	182	85	157	424
September	199	1,297	7	131	85	152	368
October	243	1,121	3	81	0	157	238
November	195	1,123	2	40	0	152	192
December	323	1,124	0	30	85	157	272
Totals	3,703	----	50	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1937							
January	486	1,175	1	40	85	157	282
February	606	1,378	1	51	84	142	277
March	533	1,706	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	210	1,745	10	182	85	157	424
August	215	1,521	7	182	85	157	424
September	207	1,305	6	131	85	152	368
October	252	1,138	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	4,095	----	51	1,010	849	1,847	3,706
1938							
January	519	1,513	0	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	210	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,757	----	51	1,010	849	1,847	3,706
1939							
January	507	1,513	0	40	85	157	282
February	398	1,738	1	51	84	142	277
March	382	1,858	2	61	85	156	302
April	248	1,936	3	51	85	151	287
May	0	1,894	6	40	85	157	282
June	8	1,606	8	121	85	152	358
July	183	1,248	9	182	85	157	424
August	246	998	6	182	85	157	424
September	241	814	6	131	85	152	368
October	208	681	3	81	0	157	238
November	167	648	2	40	0	152	192
December	309	621	0	30	85	157	272
Totals	2,897	----	46	1,010	849	1,847	3,706
1940							
January	682	658	0	40	85	157	282
February	628	1,058	1	51	84	147	282
March	593	1,403	2	61	85	156	302
April	515	1,692	3	51	85	151	287
May	471	1,917	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	4,617	----	51	1,010		1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1941							
January	519	1,513	0	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,757	----	51	1,010	849	1,847	3,706
1942							
January	519	1,513	0	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,757	----	51	1,010	849	1,847	3,706
1943							
January	519	1,513	0	40	85	157	282
February	462	1,750	1	51	84	142	277
March	305	1,934	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	396	1,149	2	40	0	152	192
December	426	1,351	1	30	85	157	272
Totals	3,748	----	51	1,010	849	1,847	3,706
1944							
January	441	1,504	0	40	85	157	282
February	554	1,663	1	51	84	147	282
March	305	1,934	2	61	85	156	302
April	195	1,935	3	51	85	151	287
May	509	1,840	6	40	85	157	282
June	51	2,061	9	121	85	152	358
July	180	1,745	10	182	85	157	424
August	230	1,491	7	182	85	157	424
September	227	1,200	6	131	85	152	368
October	247	1,143	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,770	----	50	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1945							
January	519	1,513	1	40	85	157	282
February	462	1,749	1	51	84	142	277
March	305	1,933	1	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,757	----	51	1,010	849	1,847	3,706
1946							
January	519	1,513	1	40	85	157	282
February	462	1,749	1	51	84	142	277
March	305	1,933	1	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	238	1,522	7	182	85	157	424
September	219	1,329	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	3,757	----	51	1,010	849	1,847	3,706
1947							
January	348	1,513	1	40	85	157	282
February	606	1,578	1	51	84	142	277
March	333	1,906	1	61	85	156	302
April	247	1,936	3	51	85	151	287
May	16	1,893	6	40	85	157	282
June	0	1,621	8	121	85	152	358
July	125	1,255	9	182	85	157	424
August	195	947	6	182	85	157	424
September	216	712	6	131	85	152	368
October	426	554	3	81	0	157	238
November	317	739	2	40	0	152	192
December	284	862	0	30	85	157	272
Totals	3,113	----	46	1,010	849	1,847	3,706
1948							
January	683	874	0	40	85	157	282
February	274	1,275	1	51	84	147	282
March	614	1,266	1	61	85	156	302
April	519	1,577	3	51	85	151	287
May	509	1,806	6	40	85	157	282
June	86	2,027	9	121	85	152	358
July	211	1,746	10	182	85	157	424
August	238	1,523	7	182	85	157	424
September	219	1,330	7	131	85	152	368
October	217	1,174	3	81	0	157	238
November	363	1,150	2	40	0	152	192
December	426	1,319	1	30	85	157	272
Totals	4,359	----	50	1,010	849	1,852	3,711

FEATHER RIVER PROJECT

Operation of San Luis Reservoir and Feather River Project Aqueduct—Continued

1921-1951 (By Months)

(Quantities in Thousands of Acre-feet)

Year and month	Water delivered at San Luis Forebay from Feather River Project Aqueduct	Reservoir storage on first day of month	Reservoir evaporation loss	Water supplies provided for			
				Western Fresno County	Western Kern and Kings Counties	Southern California	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1949							
January	335	1,472	1	40	85	157	282
February	449	1,524	1	51	84	142	277
March	544	1,695	2	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	140	1,745	10	182	85	157	424
August	215	1,451	7	182	85	157	424
September	249	1,235	6	131	85	152	368
October	188	1,110	3	81	0	157	238
November	253	1,057	2	40	0	152	192
December	281	1,116	0	30	85	157	272
Totals	3,409	----	50	1,010	849	1,847	3,706
1950							
January	682	1,125	1	40	85	157	282
February	605	1,524	1	51	84	142	277
March	387	1,851	1	61	85	156	302
April	332	1,935	3	51	85	151	287
May	411	1,977	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	211	1,745	10	182	85	157	424
August	233	1,522	7	182	85	157	424
September	224	1,324	7	131	85	152	368
October	217	1,173	3	81	0	157	238
November	405	1,149	2	40	0	152	192
December	426	1,360	1	30	85	157	272
Totals	4,145	----	51	1,010	849	1,847	3,706
1951							
January	519	1,513	1	40	85	157	282
February	462	1,749	1	51	84	142	277
March	305	1,933	2	61	85	156	302
April	332	1,934	3	51	85	151	287
May	412	1,976	6	40	85	157	282
June	12	2,100	9	121	85	152	358
July	135	1,745	10	182	85	157	424
August	244	1,446	7	182	85	157	424
September	242	1,259	6	131	85	152	368
October	262	1,127	3	81	0	157	238
November	405	1,148	2	40	0	152	192
December	426	1,359	0	30	85	157	272
Totals	3,756	----	50	1,010	849	1,847	3,706
Annual-mean	3,731	----	48	1,000	841	1,844	3,686

APPENDIX F

BUDGET REQUIRED FOR ACQUISITION OF RIGHTS OF WAY FOR FIRST STEP OF CONSTRUCTION OF FEATHER RIVER PROJECT AND BUDGET REQUIRED FOR DEVELOPING PLANS AND SPECIFICATIONS FOR FIRST STEP OF CONSTRUCTION PROGRAM TO ADVERTISING FOR BIDS

The costs of acquisition of lands and improvements required for the Feather River Project are included in Chapter II of the report in the total estimated costs. This appendix sets forth the costs of acquisition of lands and improvements which would be incurred for the first step of the construction program. The cost of developing plans and specifications for the first step of construction has also been included in the cost estimates set forth in Chapter II. This appendix gives the detail of the cost of developing these plans and specifications for the project to the extent that would be required for advertising for bids on the first step of the construction program.

ACQUISITION OF RIGHTS OF WAY

The following tabulation gives the estimated cost of the lands, improvements and severance damages required for the first step of construction of the Feather River Project. The item of contingencies shown in the table is 15 percent of the direct cost except for the first two listed items where 10 percent was used. The item for administration and engineering is 20 percent of the direct cost, except for the Big Bend Power Plant where a lower percent was used.

The cost of right of way for the Feather River Project Aqueduct, as estimated, contemplates the purchase of sufficient width for a future paralleling conduit.

The negotiation of water right and other necessary agreements is an item to which no direct cost, as such, is attributable; however, an item of $200,000 has been included to cover state costs of administration and engineering in this connection.

It will be noted that the amount required for acquisition of rights of way for the first step of construction of the Feather River Project is about $43,000,000, of which the purchase of the Big Bend Power Plant would be about $31,000,000.

DEVELOPMENT OF PLANS AND SPECIFICATIONS FOR THE FIRST STEP OF CONSTRUCTION PROGRAM

The total estimated construction costs, presented in the foregoing report, include the engineering and administrative costs incident to the work. Of the total amount set forth for this purpose, a certain part will have to be expended at the outset for the purpose of making detailed surveys, completing foundation explorations, conducting certain laboratory investigations, and the preparation of plans and specifications. A two-year period has been estimated for this work, although plans and specifications for some of the items required could be issued and construction started within one year. Among such items are: railroad and highway relocation, clearing, excavation, etc. The initiation of construction on other items, such as the afterbay dams and spillway could be deferred

Item	*Estimated direct cost*	*Contingencies*	*Administration and engineering*	*Total cost*
Acquisition of lands and improvements for Oroville Dam and Reservoir	$2,473,000	$247,000	$494,000	$3,214,000
Acquisition of Big Bend Power Plant	27,000,000	2,700,000	1,350,000	31,050,000
Right of way for Western Pacific Railroad relocation	44,000	7,000	9,000	60,000
Right of way for State Highway relocation, Oroville Reservoir	109,000	16,000	22,000	147,000
Right of way for Feather River Railway relocation	14,000	2,000	3,000	19,000
Right of way for Butte County Road relocations	6,000	1,000	2,000	9,000
Acquisition of lands and improvements for San Luis Dam and Reservoir	1,850,000	278,000	370,000	2,498,000
Right of way for State Highway relocation, San Luis Reservoir	11,000	2,000	2,000	15,000
Right of way for Feather River Project Aqueduct from Intake to Wheeler Ridge	4,418,000	663,000	884,000	5,965,000
Negotiation of water right and other agreements	0	0	200,000	200,000
	$35,925,000	$3,916,000	$3,336,000	$43,177,000

for a year or two and completion of the whole first step still be within the scheduled period.

The surveys, explorations and investigations accomplished to date are of a preliminary nature, being sufficient to form a basis for this report. While all completed work would be utilized in preparation of the final designs, these data must be supplemented by additional surveys, explorations and investigations as described in the following paragraphs.

Additional foundation exploration will be required at the main Oroville dam site to supplement that already done under the preliminary investigation and to cover those areas heretofore unexplored, as stated in Appendix C. Exploration will also be required of the spillway and spillway channel sites and at the sites for the dams for Afterbays Nos. 1 and 2.

At the sites of the earth dams, both adjacent to the spillway, in Bidwell Bar Canyon, and near Lime Saddle, conventional earth materials investigations will have to be made.

To date the investigation of aggregates for concrete has been a bare minimum, sufficient only to establish with a fair degree of certainty that the fine aggregates occurring under the dredger tailings piles located near Oroville are of satisfactory quality. The coarse aggregates from that source are now being used on various other projects and are believed to be qualitatively satisfactory. Visual examination assured that, in the general area, an abundance of aggregate will be found. Before the construction of the Oroville Dam can be put under contract, however, an area must be located, quantitatively proved, acquired and reserved to the contractor. This will require extensive quantitative exploration to prove an area of perhaps 400 acres.

Investigation of the properties of the materials for concrete is a matter which has not been undertaken at all. An extensive investigation program on materials available for use for concrete construction will have to be initiated immediately after a decision is reached to construct the project. To accomplish this a concrete laboratory should be established, which may serve for routine control throughout the construction period. A complete investigation of both the coarse and fine aggregates available for concrete should be completed under the program.

A hydraulic model study of the main spillway is now being conducted. This will provide necessary data for the design of this important part of the project. There are, however, other hydraulic features which will require hydraulic model studies to provide complete assurance for the final design.

The location of the Feather River Project Aqueduct from the intake to the south line of Merced County has been projected on topographic maps, but has never been staked on the ground. It will be necessary to locate this portion of the aqueduct line on the ground.

Only very preliminary sub-surface exploration has been made over the route of the Feather River Project Aqueduct. Prior to the preparation of plans and specifications and issuance for bidding, a more extensive exploratory program would be completed. In connection with this same program more complete information on the foundation conditions at the site of the pumping plants will also have to be determined.

Incomplete information presently exists as to subsurface conditions at the site of San Luis Dam and at possible locations for borrow pits. This information must also be obtained before final design and issuance of plans and specifications can be undertaken.

Adequate maps of the San Luis Reservoir area and of the route for relocation of State Highway Sign Route 152, a portion of which would be inundated by the reservoir, must be obtained. Photogrammetric mapping of the reservoir area and the highway route would also be undertaken during the first year.

The cost estimates as presented in the report for the coastal line and as previously stated therein, are of a preliminary nature and for one possible route. There are other possible locations for this line that should be established for comparative cost. In order to ascertain whether an aqueduct via a coastal route is competitive in cost with the high line route, additional mapping, geological investigation and cost estimates of several possible coastal lines should be made.

The preparation of contract plans and specifications for the Feather River Project is, of course, the prime objective toward which the foregoing investigations and studies would be directed. For convenience of discussion the plans and specifications may be divided into the following groups:

1. Oroville dam, power plant and afterbays
2. Oroville permanent buildings
3. Western Pacific Railroad relocation (except major bridges)
4. Highway relocations, State Highway Sign Route 24
5. County and Forest Service road relocations (except major bridges)
6. Feather River railway relocation (except major bridges)
7. Major bridges (W. P. R. R. 1st, 2d and 3d crossings of Feather River, South Fork Bridge and Middle Fork Bridge)
8. Power line relocations
9. Telephone line relocations
10. Feather River Aqueduct, intake to Wheeler Ridge
11. San Luis Dam and appurtenances
12. Highway relocation, State Sign Route 152
13. Pumping Plants I, II-A and III

Of these items, plans and specifications for Item No. 2 could best be done under a service agreement with Division of Architecture; Items 4, 7 and 12 under a service agreement with Division of Highways; and Items 8 and 9 by the respective utility companies involved under suitable service agreements.

The remaining items, 1, 3, 5, 6, 10, 11 and 13, could best be done by an engineering organization set up in the Division of Water Resources utilizing the present personnel engaged in the preliminary studies as a cadre.

The estimated amount that would have to be expended up to the time of advertisement for bids for the first step of the construction program is given in the following budget:

Budget Required for Developing Plans and Specifications for First Step of Construction Program

Surveys, Exploration and Investigations	
Foundation drilling, Oroville Dam and Spillway	$55,000
Exploratory tunnels, Oroville Dam	40,000
Exploratory shafts, Oroville Spillway	9,500
Test excavation, Oroville Dam, 60,000 c. y.	240,000
Test grouting, Oroville Dam	5,000
Exploration for earth dams	5,000
Foundation drilling, Afterbay No. 1	10,500
Foundation exploration, Afterbay No. 2	11,500
Exploration of aggregate sources	84,000
Survey party at Oroville Dam	84,000
Concrete Laboratory investigation, 2 years, salaries and expenses	135,000
Concrete Laboratory, equipment	30,000
Soils Laboratory, salaries and expenses, 2 years	50,000
Hydraulic model study, Davis	12,000
Hydraulic model study, Denver	10,000
Feather River Project Aqueduct, location survey, intake to south line Merced County	60,000
Feather River Project Aqueduct, subsurface exploration, intake to Wheeler Ridge	$60,000
San Luis Dam, foundation exploration	132,500
San Luis Dam, borrow pit exploration	30,000
San Luis Dam, reservoir and highway relocation, mapping	22,000
Coastal line, mapping	150,000
Coastal line, geologic investigations	50,000
Coastal line, cost estimates, design	87,000
Railroad and County Road relocation, surveys	127,000
Subtotal	$1,500,000
Preparation of Plans and Specifications by Division of Water Resources Organization	
Dam Design	
Oroville Dam, Afterbay, and San Luis Dam	$611,000
Power and Pumping Plant Design	
Oroville Power Plant, and Pumping Plants I, II-A and III	768,000
Aqueduct Design	416,000
Subtotal	$1,796,000
Preparation of Plans and Specifications by Other Organizations Under Service Agreements	
By Division of Highways	
State highway relocation, Oroville	$80,000
Joint bridge over West Branch Feather River	134,000
Joint bridge over South Fork Feather River	57,000
County road bridge over Middle Fork Feather River	28,000
State highway relocation, San Luis Reservoir (including bridges)	120,000
By Division of Architecture	
Permanent buildings	35,000
By Private Engineers	
Western Pacific bridges	50,000
Subtotal	$504,000
Grand total	$3,800,000

APPENDIX G

COMMUNICATIONS FROM PACIFIC GAS AND ELECTRIC COMPANY

WALTER DREYER
Vice-president
and
Chief Engineer

PACIFIC GAS AND ELECTRIC COMPANY
245 Market Street
SAN FRANCISCO 6, CALIFORNIA

August 17, 1954

MR. A. D. EDMONSTON
State Engineer, P. O. Box 1079
Sacramento 5, California

DEAR MR. EDMONSTON:

At the conference of January 15, 1954, attended by you, Mr. A. O. Olson, Mr. N. R. Sutherland, Mr. R. H. Gerdes, and myself, it was agreed that the Company would assist you and your staff in the development of estimates covering four elements of the State proposal for power generation on Feather River and conveyance of water to the San Joaquin Valley and to Southern California. These elements were as follows:

Item 1. Compensation for inundation of the Company's Big Bend (Las Plumas) project.

Item 2. Sale by the State of power to be generated at the Oroville and Afterbay dams.

Item 3. Operation of Oroville reservoir.

Item 4. Cost of supplying power for Project pumping.

As to Item 1, we supplied, by letter dated November 12, 1953, a table entitled "Preliminary Engineering Studies of the Value of Big Bend Project and Facilities Which Would Be Rendered Idle by Construction of Oroville Reservoir." These figures had been given to you in January 1953 and have been discussed somewhat generally at various times.

As to Item 2, conclusions are dependent upon studies being made by the State under Item 3.

As to Item 3, general considerations were discussed with your staff on February 11 and the two tables described below given to them by Company representatives.

a. Suggested Schedules for Power Generation of Feather River Project—Kilowatt Hours per Kilowatt of Useful Capacity.

b. Estimated Net Effect of P. G. & E. Storage Operations on Flow of Feather River at Oroville. (Historical and proposed ultimate operations covering the critical period 1928-1936, inclusive.) These data were later expanded to cover the period 1921-1946 inclusive, and to include a second type of operation with smaller cyclic draft on Lake Almanor. This additional data was forwarded to you on June 25, 1954.

As to Item 4, preliminary data concerning pumping requirements were furnished us by Mr. Olson on February 9, additional data at a meeting on April 6 and the latest data forwarded by letter on April 12, 1954. The data cover estimated average monthly pumping loads for continuous pumping and for two assumptions of off-peak pumping.

We have reviewed these estimates of pumping requirements and have estimated the cost of supplying the necessary power from the Company system. On the basis of these studies, I am forwarding herewith an estimate of the cost of supplying power to the project pumping plants under the several conditions given us by your staff.

These estimated charges are based on present conditions as to construction costs, plant efficiencies, fuel prices, financing, taxes, wage levels and related costs. These figures are not to be taken as a firm proposal but as the best estimates we can make at this time. The increment energy cost, i.e., 3 mills in the table—could change materially with a change in the price of fuel, and would make it necessary to include a fuel clause in any agreement for purchase of the power.

It is believed that Oroville reservoir and power plants can be operated so that definite amounts of capacity and energy in excess of project's dependable capacity and energy can be reliably available during the summer months even under most adverse conditions. The State would benefit by reserving and allocating such excess reliable power to supply a portion of the summer pumping demand of Pumping Plants 1, 2, and 3, thus reducing the maximum power demand to be supplied to the pumps by the Company. If the State's studies show such allocation of power to be feasible, the Company could exchange power for a reasonable service charge, dependent upon the amount of Oroville power so assigned.

The matter of possible low cost off-peak power from atomic fuel has been discussed with Mr. Olson. It is practically certain that nuclear power plants will be constructed well before the project pumps go into operation, which your estimates for the larger installations show to be in the year 1969. In a recent article by Francis K. McCune, General Manager of the General Electric Company's Atomic Products Division, it was estimated that the total cost of firm power from nuclear plants which might be practical within five years will be about the same as power generated in today's conventional steam plants, but that the operating costs will be considerably lower. His article shows possible fuel costs with a boiling reactor to be 1.35 mills per kilowatt hour and as low as 1.0 mill with a large graphite-moderated, water-cooled reactor.

Financial Analysis No. 4 in the 1951 Feasibility Report on this project shows the annual cost of on-peak pumping power to be estimated at more than fifty-six million dollars or about half of the total annual cost of the 1¼ billion dollar project. Under the off-peak prices shown on the attached sheet, the cost of pumping power would be cut about forty percent. As energy from nuclear power plants becomes available there could be further substantial reduction in off-peak power costs. Such reduction would justify a large capital investment to permit off-peak pumping and still produce an overall saving in the total annual cost of the project.

In view of these possibilities, it would appear that a thorough study of the use of off-peak pumping should be made by your staff before final decisions are reached regarding the water conveyance facilities of the project.

We will appreciate receiving the results of the studies being made in your office on the above mentioned Item 3 so we can complete our study of Item 2.

Very truly yours,

/s/ WALTER DREYER

STATE FEATHER RIVER PROJECT
ESTIMATED COST FOR SUPPLYING POWER FOR PROJECT PUMPING

Company to supply electric service at pumping plant sites at suitable voltage for large pump installations.

State to construct pumping plants and receive power from Company's low tension bus. Pump prime movers assumed to be synchronous motors capable of operating at full load at 95% leading power factor.

Power to be supplied on either of the following bases at State option.

1. **On-Peak Power.** Highest kw demand in 12-month period.

2. **Off-Peak Power** up to a specified maximum demand subject to increase on reasonable advance notice. Company would schedule operation of the pumping plant so as to pump an average weekly flow of water specified by the State within the limits of the specified maximum demand, the available pumps and motors (including spares), and the available forebay and afterbay storage capacity. Excess pumping facilities and forebay and afterbay storage capacity (or equivalent) should be provided in either of the following two combinations:

a. Available pumping capacity of not less than twice the average pumping capacity required and not less than 3½ acre feet of both forebay and afterbay effective storage capacity for each second foot of average weekly flow of water specified.

b. Available pumping capacity of not less than 2½ times the average pumping capacity required and not less than 1½ acre-feet of both forebay and afterbay effective storage capacity for each second foot of average weekly flow of water specified.

3. State could provide for a pumping plant to be served in part with On-Peak Power and in part with Off-Peak Power and specify the maximum demand for each. Transfer from one class to the other could be made on reasonable advance notice.

4. Costs based on present conditions as to construction costs, plant efficiencies, fuel prices, financing, taxes, wage levels and related costs.

	Delivered to pumping plants numbered		
	1 and 2	*3, 4 and 5*	*6*
On-Peak Power			
Cost per kw per month	$2.50	$2.80	$2.90
Off-Peak Power			
Cost per kw per month	$0.125	$0.325	$0.35
Increment energy cost all plants			
Per kilowatt hour—mills		3.00	

WALTER DREYER
Vice-President
and
Chief Engineer

PACIFIC GAS AND ELECTRIC COMPANY
245 Market Street
SAN FRANCISCO 6, CALIFORNIA

December 2, 1954

State of California
Oroville Project

MR. A. D. EDMONSTON, *State Engineer*
Public Works Building
P. O. Box 1079, Sacramento 5, California

DEAR MR. EDMONSTON:

Under date of August 17, 1954 I wrote to you summarizing the status of studies being made by the staff of the Engineering Department of Pacific Gas and Electric Company in connection with the proposed Oroville Dam project of the State of California.

At that time I also gave you our estimate of the unit costs of supplying power for operation of project pumps on an on-peak and on an off-peak basis. These costs were estimated by assuming the pumping plant sizes and locations as presented in your letter of April 12, 1954 and were based on present conditions

with respect to construction costs, plant efficiencies, fuel prices (oil at $1.85 per barrel) financing, taxes, wage levels and related costs, and would of course have to be modified to comply with any changes in these fundamental items at the time the pumps commence operation. It is our understanding that the State is now studying and may adopt a plan which would increase the pumping installation in the vicinity of Los Banos and cause other significant changes, any or all of which may affect the cost of supplying pumping power.

In this letter I am advising you of the results of our studies as to (1) the unit values of Oroville power at Oroville dam and in the vicinity of Tracy as estimated on the basis of current steam-electric power costs, and (2) the value of the Company's Big Bend Project as estimated on the same basis.

I. Value of Oroville Power Estimated on Basis of Current Power Costs

According to an understanding reached in the latest discussions between members of our respective engineering staffs, we have based our studies upon the State's plans for a 440,000 kilowatt .9 power factor installation at Oroville, with an afterbay but without an afterbay plant. Unit values of the Oroville power were estimated from the unit cost of producing and delivering at 230 kilovolts equivalent power from a modern Company-owned steam-electic plant located in the Delta area. For this purpose we have estimated that the unit cost of the assumed steam plant would be $125 per kilowatt and that related step-up facilities and transmission to the general vicinity of Tesla would be $18 per kilowatt. On the basis of (a) the above unit capital costs, (b) an incremental net output of 684 kilowatt hours per barrel of oil and oil priced at $1.85 per barrel, (c) financing and wage levels as of the middle of 1954, and (d) taxes on income 4% State and 47% Federal, we have estimated the unit values of Oroville power delivered at 230 kilovolts to Company lines (1) at Oroville plant and (2) from terminal facilities in the vicinity of Tracy. For power delivered in the vicinity of Tracy, it is assumed that the State, under all conditions would make delivery at a power factor not exceeding 95% lagging.

The unit values for aforesaid conditions at these two delivery points are as follows:

	Estimated unit values of power delivered at 230 kilovolts	
	At Oroville Plant	*In vicinity of Tracy*
1. Dependable capacity (per kilowatt year)	$20.83	$24.42
2. Non-dependable capacity (per kilowatt year)	$4.20	$4.50
3. Usable energy (per kilowatt hour)	2.73 mills	2.86 mills

The unit value for dependable capacity at Oroville is based on 400,000 dependable kilowatts being made available. It would differ for other amounts of dependable capacity because the Company would construct transmission facilities to handle the maximum output of the Oroville plant. We estimate that the price at Oroville would change 8 cents per kilowatt year for each 10,000 kilowatt change in dependable capacity.

Non-dependable capacity, i.e., capacity in excess of dependable, must be known in advance to be available for continuous periods of at least six months duration.

As stated before, these unit values are based on the currently estimated cost of producing equivalent power in steam-electric plants with oil priced at $1.85 per barrel, and would have to be modified to conform to conditions at the time the plant is constructed. Thereafter the unit values should be subject to change with changes in the price of oil.

As previously stated the above figures are based on the cost of power generated in a Company-owned steam-electric plant and, for delivery at Oroville, power transmitted over Company facilities. In using these unit values in appraising the economic benefit of the Feather River Project to the people of California, consideration should also be given to the fact that for delivery at Oroville, the Company would pay taxes to the State and to local agencies amounting to about $230,000 per year on the facilities it would install to carry the power to load centers, whereas such taxes would be lost if the State made delivery at Tracy. A loss of Federal taxes would amount to about $300,000 per year.

II. Value of Big Bend Plant as Estimated on Basis of Current Power Costs

The value of the power output of the Company's Big Bend Project and of the potential output from an additional generating unit which can be installed at the downstream end of the existing building has been estimated on the same basis of steam electric costs as were used above for the evaluating of the output of the proposed Oroville plant. The estimated net value on this basis was $27,000,000. Since it is possible that the price of oil in the future may exceed $1.85 per barrel and other factors may change from those used in this analysis, it is our recommendation that for your present purposes you use a figure in round numbers of $33,000,000.

The above estimate excludes land values other than Big Bend Project lands, the value of transmission lines emanating from the Big Bend plant rendered non-useful under the proposed plan, and the value of lines and other facilities inundated or otherwise damaged by the Oroville Reservoir.

III. Value of Headwater Improvements to Oroville Project

The value of the headwater benefits to the Oroville Project is of such complex nature that we have not attempted to resolve it at this time. However a rough study prorating the annual cost of upstream storage facilities on the basis of the respective gross heads available to the Company and to the State, allocates about $130,000 per year to the State.

I believe that the cost data in this letter, together with the data in my letter of August 17, 1954, gives you all of the information you requested. If you need additional information or wish to discuss the contents of these letters or any other problems connected with the power phases of the project, we will be pleased to meet with you at your convenience.

We have not prepared prices which the Company might pay for the use of falling water at Oroville dam since it is our understanding that for the present you do not desire this information.

Very truly yours,

/s/ WALTER DREYER

APPENDIX H

QUESTIONS PROPOUNDED BY ATTORNEY ROBERT TAYLOR ADAMS PURSUANT TO HIS REQUEST MADE AT THE WATER PROJECT AUTHORITY MEETING ON AUGUST 31, 1954, TOGETHER WITH ANSWERS THERETO AS PREPARED BY THE DIVISION OF WATER RESOURCES

1. **Question:** Once the assignment of the state water filings of 1927 and 1951 has been made to the Water Project Authority, if individuals or entities below the dam are subsequently allowed by the Water Project Authority to use water covered by the said state water filings and such water is actually committed to beneficial use, as a practical matter will the counties of origin and individuals therein ever be able thereafter to exercise the rights reserved to the counties of origin, thereby terminating the earlier beneficial use to which the water (of which the state water filings are the subject) has been committed?

Answer: It will be the recommendation of the State Engineer to the Department of Finance, in the event such a recommendation is requested, that the assignment to the Water Project Authority of Department of Finance filings for the Feather River Project be made subject to a reservation of all the water which the counties and areas of origin can reasonably use for full development either now or in the future. Such a reservation, it is believed, fulfills the mandate of Section 10505, Water Code, that the Department of Finance shall not assign any portion of any appropriation that will in the judgment of the Department deprive the county in which the appropriated water originates of any such water necessary for the development of the county. It is anticipated that similar conditions will be inserted by the State Engineer in any permits issued to the Water Project Authority and will therefore act as a limitation on anyone receiving water from the Project. Such being the case, the counties of origin could at any time, by making appropriate application to the Division of Water Resources, obtain the water needed for their development even though it might previously have been put to beneficial use on an interim basis under the Feather River Project. It is our opinion that such is the legislative intent as expressed in Sections 10504 and 10505 of the Water Code.

2. **Question:** Is there any way by which a downstream user outside of, or below, the counties of origin could acquire a water right out of water covered by the said state filings, superior to a user in a county of origin who fixes his right and beneficial use at a later time?

Answer: Under the present laws of this state, a downstream water user receiving water from the Feather River Project, under the state filings, could not acquire a right to the use of water thereunder superior in right to a user in a county of origin who fixes his right and beneficial use at a later time.

3. **Question:** In Sections 10505 and 11460 of the California State Water Code and in explanations of these sections, the terms "*necessary full development*" or "*need*" of the counties of origin are used. What do these terms, necessary full development and need, mean? We would appreciate having these terms defined so as to fix a dependable definition of them.

(a) **Question:** Is the need of the counties of origin defined as the full extent of beneficial use of water to which such water may in the future be put in the counties of origin?

Answer: The needs of the counties of origin may be defined as the full amount of water which can be put to reasonable beneficial use therein at any time in the future.

(b) **Question:** Can need be defined as prospective beneficial use in the counties of origin?

Answer: Yes. See answer to Question 3(a).

(c) **Question:** If, in the future the entire waters of the Feather River were to be consumed by users above the dam, and users below the dam, then, if it were established that water could be put to beneficial use above the dam, would a water permit be granted to a prospective user above the dam, which permit would run adversely and be superior to a user below the dam using storage water covered by the state filings of 1927 and 1951, wherein the user below the dam had previously committed the water to beneficial use?

Answer: Under the terms of the assignment as contemplated (see answers to prior questions), the counties and areas of origin would have a preferential right to the entire amount of water covered by the state filings for the Feather River Project

for use in such counties and areas if it could be established that all the water were reasonably required for beneficial use therein irrespective of whether use had been made thereof elsewhere. Attention is directed to the fact, however, that because of the physical limitations the counties and areas of origin will by their use deplete the flow of the Feather River at Oroville only to a relatively minor extent even under conditions of full development. The maximum possible depletion that can occur by virtue of use in the counties of origin will not affect the feasibility of the Project. It should be further noted that in certain areas within the counties of origin the naturally occurring water supplies tributary thereto are not sufficient for the needs of such areas under conditions of full development.

(d) **Question:** Does need and future development mean (as set out in Sections 10505 and 11460 of the State Water Code) beneficial use at any time in the future, and not limited to the estimated beneficial use as can best be determined at the time of the transfer of the state water filings?

Answer: Need for future development as described in Sections 10505 and 11460 of the Water Code means all the water required for reasonable beneficial use at any time in the future. Such amounts of water may either be estimated at the time of the assignment and reserved therein or may be provided for by a reservation in general terms. We wish to emphasize that if a specific quantity of water is reserved at the time of the actual assignment, protection for future development of the counties of origin under the state filings will be limited to the amount specified at the time of the transfer of the filings. If, however, the reservation is in general terms there would be no limitation as to the amount of water the counties of origin could use providing such use is reasonable and beneficial.

4. **Question:** What specific advantages to the counties of origin are gained by having a general reservation over a specific reservation? (The word reservation here is used to mean the reservation as expressed in Sections 10505 and 11460 of the California State Water Code.)

Answer: See answer to Question 3(d). The principal advantages to the counties of origin to be gained by having a general reservation is that the general reservation would, in effect, reserve for those areas all the water that may ultimately be needed for reasonable beneficial use in the future. This general reservation would provide for various factors which are unknown at the present time while a specific reservation, being necessarily based on an estimate might provide for either too small or too great an amount. A specific reservation would limit the amount of water that would be available to the counties of origin under the state filings.

5. **Question:** How in the future, after the transfer of filings is made, will people below the dam and in the export areas acquire rights to the water appropriated by the 1927 and 1951 filings?

Answer: It is contemplated that entities desiring to receive water from the Feather River Project will contract initially with the Water Project Authority for such water as may be necessary for their use. Ultimately licenses will be issued to the water users themselves for the water actually put to beneficial use under the Project. This is the procedure proposed to be used in connection with projects of the United States Bureau of Reclamation.

(a) **Question:** After transfer of the filings how will people above the dam obtain specific rights to the water which is being reserved for their future development?

Answer: Subsequent to the transfer of state filings for the Feather River Project, those desiring to develop water above the dam under the county of origin reservation will file applications to appropriate the water needed with the Department of Public Works, Division of Water Resources, and establish that the water is reasonably required for beneficial use within the county of origin. The application will be advertised, a period allowed for the filing of protests and hearings held if necessary. This is the same procedure followed on any application filed. The proposed general reservation in the assignment of the State filings will act as an estoppel to the Water Project Authority or any other operator of the Project or to any beneficiaries downstream from protesting such applications. The right as evidenced by issuance of license will be acquired by actual application to beneficial use.

6. **Question:** Is it possible that the exact wording of the request for assignment of the state filings of 1927 and 1951 as made by the California Water Project Authority, could be amended to include the specific reservation as expressed in Sections 10505 and 11460? Will the exact wording of the assignments of the 1927 and 1951 filings contain the reservation, and if so, in what specific words?

Answer: It is assumed that the "specific reservation" referred to in this question is the general reservation as contained in Section 10505 of the Water Code. At the last meeting of the Water Project Authority on August 31, 1954, the State Engineer submitted a memorandum on water right applications of Department of Finance affecting the Feather River Project in which he recommended that the Depart-

ment in considering the request of the Authority for assignment of the 1927 and 1951 applications give full consideration to the future needs of the counties of origin. His recommendation is that any assignment be:

"* * * subject at all times to the requirements of any county or area in which the water sought to be appropriated originates, for such water as may be necessary for the full development of any such county or area."

Whether the Director of Finance will follow the recommendation is not known at this time.

The request by the Water Project Authority for assignment could be amended to incorporate the Authority's acknowledgment of the need for a reservation in favor of the counties of origin, but this is not considered necessary.

(a) **Question**: Will the exact wording of the water permit to be issued to the California Water Project Authority for water covered by the 1927 and 1951 filings contain the reservation, and if so, in what specific words?

Answer: If the Department of Finance assigns the subject water right applications to the Water Project Authority and the assignment contains the reservation as recommended in the answer in Question 6, it is anticipated that the State Engineer will insert the same condition in any water right permits that may be issued to the Water Project Authority.

(b) **Question**: Will the exact wording of the water license to be issued to users of water covered in the 1927 and 1951 filings (below the dam) contain the reservation, and if so, in what specific words?

Answer: It is anticipated that any licenses which may be ultimately issued to the users of water under the State filings will contain a similar reservation for the future needs of the areas of origin as indicated in the answers in foregoing Questions 6 and 6(a).

(c) **Question**: Will the exact wording of the contract by which the water stored and covered by the 1927 and 1951 filings is set over to prospective users contain the reservation, and if so, in what specific words?

Answer: It is anticipated that any contract which would be entered into between the Water Project Authority and the users of water from the Project will also contain a reservation as indicated in the answers to Questions 6, 6(a), and 6(b).

7. **Question**: Had the Division of Water Resources or other agencies of the State Government made previous studies of water available in the Feather River basin, and of the feasibility of the Feather River Dam, prior to the present study now being undertaken? What will the present study now being undertaken show that the previous studies have not shown? Do you anticipate that the present study now being undertaken will show anything which will upset or change the conclusions reached on the basis of the previous studies of these matters?

Answer: Previous studies of water available for the Feather River Project have been made by Division of Water Resources other than those now being made pursuant to the authorization contained in the 1954 legislation. In this connection, please refer to the report entitled "Feasibility of the Feather River and Sacramento-San Joaquin Delta Diversion Projects", 1951, State Water Resources Board, and to Bulletin No. 26 of the Division of Water Resources entitled "Sacramento River Basin", 1931. The 1954 investigation will give more refined estimates of the ultimate water requirements of the basin not only for irrigation, domestic and hydroelectric purposes but also for the future development of mineral and timber resources, for maintenance of fish and game, and for recreational development. In this connection, the ultimate uses for other than irrigation and domestic purposes are largely non-consumptive and will have a minor net effect on the depletion of stream flow into the proposed Oroville Reservoir. In addition, the current investigation will provide for a determination as to whether or not water is available in those areas of origin in which there is actually a need therefor. In this connection the Sierra Valley Area may have an ultimate need for water which exceeds the possible supplies available from the sources tributary thereto. We firmly believe that the current investigation will not develop anything which will differ materially from previous studies insofar as ultimate depletion of stream flow at Oroville which is the significant factor insofar as feasibility of the Feather River Project is concerned.

(a) **Question**: Please give the estimated figures which you now have regarding the total amount of water to be used for the Oroville Dam.

Answer: The Feather River is the most important tributary of the Sacramento River. It has a drainage area above the Oroville dam site of about 3,600 square miles, with a mean annual runoff of about 4,500,000 acre-feet of water. A large reservoir capacity is required to regulate the magnitude of its erratic flows, to prevent flood damage and to conserve the waters for domestic irrigation and industrial supplies, navigation, salinity control, production of electric power, and other uses.

The State-authorized Feather River Project includes the Oroville Dam and Reservoir in Butte County, with a capacity of 3,500,000 acre-feet of water; Oroville Power Plant, with an installed capacity of 440,000 kilowatts; Oroville Afterbay and Afterbay Power Plant; a 150-mile transmission line from Oroville to Bethany, in Contra Costa County; Terminal Substation and Switchyard; a cross channel to divert project water from the Sacramento River to the westerly area of the Sacramento-San Joaquin Delta; and conduits and pump lifts to convey water to the San Francisco Bay Area, a distance of 115 miles, and to the west side of the San Joaquin Valley and to Southern California, a distance of 570 miles.

Studies made indicate that there are available in the channels of the Sacramento-San Joaquin Delta surplus waters to the extent of 600,000 acre-feet monthly for a period of five to eight months of every year. The Feather River Project will utilize the surplus waters of both the Feather River and the Delta region for project purposes.

The project, based upon initial studies, will:

1. Provide a firm water supply for 322,000 acres of irrigable land in the Feather River Service Area. The supply of 970,000 acre-feet annually would be adequate to meet all future needs of the area.

2. Flood flows below the dam which have reached a recorded maximum of 230,000 second-feet would be reduced to between 50,000 and 100,000 second-feet, giving flood protection to an area with a market value of $340,000,000.

3. A minimum of 232,000 and a maximum of 400,000 kilowatts of power generating capacity would be made available and an average of 1¾ billion kilowatt hours of electric power would be generated annually.

4. A sufficient amount of water could be made available in the Sacramento-San Joaquin Delta to permit a constant diversion of 3,930 second-feet from that area, which is equal to 2,845,000 acre-feet annually, or

5. Supply 127,000 acre-feet of water annually through the Santa Clara-Alameda Diversion to areas in Santa Clara and Alameda Counties.

6. Supply 945,000 acre-feet of water annually through the San Joaquin Valley-Southern California Diversion to areas in Fresno, Kings and Kern Counties on the west side of the San Joaquin Valley.

7. Supply 1,773,000 acre-feet of water annually through the San Joaquin Valley-Southern California Diversion to areas south of the Tehachapi Mountains.

(b) **Question**: Please give the estimated figures regarding the amount of water to be exported from the Oroville Dam.

Answer: The 1951 feasibility report shows that an average annual release of 1,007,500 acre-feet from the reservoir would be required in order to provide a continuous flow of 3,930 second feet for export from the Delta.

(c) **Question**: Please give the estimated figures of the amount of water to be used in the Feather River basin below the Oroville Dam.

Answer: As stated in the answer to Question 7(a), operation of Oroville Reservoir would provide a firm water supply for the gross area of 322,200 acres of irrigable land in the Feather River Service Area. These lands will require a diversion of 970,000 acre-feet annually which amount is 270,000 acre-feet more than was used in the historical year of largest diversion and almost 500,000 acre-feet more than was historically available in the dry year of 1931. It is emphasized that the Feather River Project will not in any way interfere with existing rights. The Project will provide the supplemental water needed for a full supply for the area in excess of present rights.

8. **Question**: Are there amounts of unappropriated water in the Feather River watershed which will not be committed either to use below the dam or for export? If so, what are these amounts? Is there an amount of water, which will not be committed to use below the dam or for export, equivalent to or in excess of the anticipated full development water requirement of the counties of origin lying above the Oroville Dam?

Answer: Yes, there are amounts of unappropriated water in the Feather River which will not be needed for the Feather River Project. The Project *cannot "commit" to use* on a *permanent basis* those waters reasonably needed for full development of the counties of origin. Until needed there, however, they will be put to use on an interim basis downstream. It would be illogical and uneconomical to do otherwise since if not so used, they would waste to the ocean. No permanent rights can be acquired by virtue of interim beneficial use of these waters.

The Project studies show that, based upon the records of historical impaired flow for the period 1921 to 1947, the average annual waste over the spillway and through the flood control outlets would have been substantially greater than the maximum possible depletion of flow at Oroville due to full development in the watershed above.

9. **Question**: In what way can the counties of origin perfect their rights to water included within the reservation set forth in Sections 10505 and 11460 of the State Water Code? Should this be accomplished by filings on the water by individuals or by the counties? Is it possible for the counties to file on such water but to be forgiven the requirement of showing diligence?

Answer: No further action is necessary by the counties of origin at this time in order to protect their rights to water included within the reservation set forth in Sections 10505 and 11460 of the Water Code. No purpose could be served by either individuals or the counties filing on the water now when they have no immediate prospect for the use thereof. Neither counties nor individuals are exempt from the showing of diligence as required by the Water Code. Attention is directed, however, to Section 10500 of the Water Code which requires action by the Legislature every four years in relieving the state filings from diligence. Should these periodic extensions not be granted by the Legislature, the entire structure of state filings together with its county of origin provisions would be in jeopardy. The protection afforded the counties of origin under the state filings applies even after the applications have been assigned provided that conditions are inserted in the assignment for their protection.

10. **Question:** Are the state water filings of 1927 and 1951 for definite amounts of water or for all unappropriated or surplus water? Are there any other amounts of water in the Feather River basin over and above present decreed or perfected or filed upon rights and over and above the state water filings of 1927 and 1951?

Answer: The state filings of 1927 and 1951 are for definite quantities of unappropriated water. Although there has never been a complete determination of the rights on the Feather River our studies indicate that there is water available in the Feather River over and above the requirements for the Feather River Project and prior rights.

11. **Question:** At the present time there is an express statutory protection for the counties of origin under Section 10505, which requires the Department of Finance not to make any release or assignment which in its judgment would deprive the counties of origin of water necessary for their development. As soon as the assignment of the filings is made by the Department of Finance to the Water Project Authority, that statute no longer is applicable or a protection to the counties. Is that correct?

Answer: We do not agree that once the Department of Finance applications are assigned, the statutes are no longer applicable which afford protection to the counties. This reservation for the areas of origin is a continuing responsibility on the assignees of these filings.

(a) **Question:** Section 11460 purports to provide a similar protection after the state filings are transferred to the Water Project Authority. Is the protection of Section 11460 a better or poorer protection to the counties of origin and why?

Answer: It is our view that Section 11460 of the Water Code provides for an entirely different type of protection than that afforded under Section 10505. Section 10505 is applicable to the assignment of applications filed by the Department of Finance and refers only to the counties of origin. Section 11460 applies to any operator of the Central Valley Project and is a prohibition against the export of water when it is reasonably needed within the watershed or adjacent areas. In some areas the protection afforded under Section 11460 is in addition to that afforded under Section 10505 of the Water Code.

12. **Question:** Will the results of the studies now being undertaken be available to the counties of origin and the inhabitants therein at any time except immediately prior to transfer of filings to the California Water Project Authority? Will there be opportunities for the counties of origin and individuals therein to review and consider the findings and determine how they will affect such counties and individuals resident therein?

Answer: The basic data obtained in the course of the studies now underway pursuant to the 1954 legislation are available at any time to those interested. Ample opportunity will be afforded the counties and all other interested entities to review, comment, and submit recommendations on the report before it is finally published.

(a) **Question:** What steps and to whom should counties and individuals therein apply to get data of reports now being written?

Answer: Anyone desiring to secure data on the reports now being prepared may request such information from the State Engineer or may call at the Division's office and obtain the same.

13. **Question:** Why is it necessary that the proposed assignments be made now? It has been suggested that an assignment would be premature, especially in light of the fact that studies are now being made of the needs of the counties of origin and the feasibility of the Feather River Dam at Oroville.

Answer: Assignment of these State filings is the next logical step in connection with the construction of the Feather River Project. Subsequent to the assignment of the applications, considerable time will be required for their completion, advertisement, the receiving of protests in connection therewith, hearings which must be held and the decision which must be rendered. Only after this detailed proceeding which is required by law, can permits be issued. This required procedure is time consuming and might well result in delay of the Feather River Project in the event the assignments are not executed in the near future. It is not believed that assignment at this time would be premature as we are confident that the current studies will not adversely affect the feasibility of the Project. Further, if a general reservation for the needs of the counties of origin is included in the assignment, there can be no adverse effect on such counties by assigning the applications now.

14. **Question:** Why is it necessary to transfer *all rights* now, if amounts to be reserved for needs of the counties of origin are unknown?

Answer: It is *not proposed* to transfer *all rights* to the Water Project Authority. As heretofore stated, we believe the assignment should be made subject to a reservation of all the water which the areas and counties of origin can reasonably use for full development either now or in the future. See answers to prior questions.

15. **Question:** Is the Federal Power Commission advised of the indefiniteness of water rights to be assigned here and of the reservation to the counties of origin proposed?

Answer: In the showing which the Water Project Authority must make with the Federal Power Commission for a power license for the Feather River Project, the Authority must demonstrate that it has proceeded as far as practicable in obtaining the necessary water rights for the project under applicable State law. In this connection Exhibits C, D, and E required by the Rules and Regulations of the Commission in an application for power license for a proposed major project state as follows:

"**Exhibit C.** If special hydroelectric, waterpower, or irrigation laws of the State or States involved pertain to the construction of the applicant's project, submit copies of such laws or reference thereto. (General State incorporation acts are not desired.)

"**Exhibit D.** Evidence that the applicant has complied with the requirements of the laws of the State or States within which the project is to be located with respect to bed and banks and to the appropriation, diversion, and use of water for power purposes and with respect to the right to engage in the business of developing, transmitting, and distributing power, and in any other business, necessary to effect the purposes of the license applied for, including a certificate of convenience and necessity, if required. This evidence shall be accompanied by a statement of the steps that have been taken and the steps that remain to be taken to acquire franchise or other rights from States, counties, and municipalities before the project can be completed and put into operation.

"**Exhibit E.** The nature, extent, and ownership of water rights which the applicant proposes to use in the development of the project covered by application, together with satisfactory evidence that the applicant has proceeded as far as practicable in perfecting its rights to use sufficient water for proper operation of the project works. A certificate from the proper State agency setting forth the extent and validity of the applicant's water rights shall be appended if practicable. In case the approval or permission of one or more State agencies is required by State law as a condition precedent to the applicant's right to take or use water for the operation of the project works, duly certified evidence of such approval or permission, or a showing of cause why such evidence cannot be reasonably submitted shall also be filed. When a State certificate is involved, one certified copy and three uncertified copies shall be submitted."

In the past the Power Commission has not concerned itself with any reservations for the counties of origin.

(a) **Question:** Is all the water in the 1927 and 1951 filings necessary to be transferred to justify issuance by the Federal Power Commission of a power license? Is not the necessary implication of the assignment and consequently of the application to the Federal Power Commission that all water in the 1927 and 1951 filings is transferred to the California Water Project Authority, not subject to the reservation of the counties of origin?

Answer: We do not believe that the assignment of State filings as proposed nor the applications to the Federal Power Commission carry the implication that the water rights are not subject to the reservations of the counties of origin.

16. **Question:** Will the Federal Power Commission grant a license without the assignment of the state water filings of 1927 and 1951? (The license herein referred to is that for the Oroville dam.)

Answer: We have no specific information whether the Federal Power Commission would grant a license without the applicant having obtained or filed the necessary water right applications. In applications for power license, however, the Commission does require information as to water rights. In this regard refer to the answers to Question 15.

17. **Question:** Is it possible and feasible to float bonds to finance the Oroville Dam when the water rights for the dam are subject to a general reservation as defined above?

Answer: Information is not at hand as to whether difficulty would be encountered in selling bonds to finance the Feather River Project for the reason that water rights were subject to a general reservation for the counties of origin. In this connection, information in our files, however, indicates that an assignment of State filings is necessary before the bond

houses will place bonds for a specific project on the market. In connection with the Oakdale and South San Joaquin Irrigation Districts' Tri-Dam project, the Districts on April 24, 1953, stated in part as follows:

"We are advised by the Districts' financial advisers that the prospectus describing the bond issues should be in the hands of the bond buyers within the next several weeks. This prospectus cannot be printed until the matter of water rights is completely cleared up. At the moment, lack of execution and delivery by your Department of the assignment in question is a cloud upon the title of the Districts to the water rights therein referred to and could seriously delay the issuance of said prospectus and thereby jeopardize the entire Tri-Dam Project, which, as you know, is a project involving three dams and three powerhouses and the expenditure of approximately $48,000,000."

The important item seems to be the execution of the assignment rather than specific concern as to the exact conditions which may have been contained therein. As above stated we have already made a sufficient investigation to demonstrate that future stream flow depletion by use in the counties of origin will not adversely affect the feasibility of the Feather River Project.

18. **Question**: When will the Federal Power Commission, or other agency of the Federal Government, act on the request for a power license or make such other authorization as is required before building of the dam?

Answer: At the present time the Water Project Authority has pending before the Federal Power Commission an application for a power license for the Feather River Project. As soon as that application is completed, to the satisfaction of the Commission, it is presumed that action in connection therewith will follow within a reasonable short time thereafter.

19. **Question**: How is it possible for the Federal Government to grant any sort of license or authorization when this large and undefined reservation is imposed upon the amount of water available for the dam?

Answer: As heretofore stated, depletion of streamflow resulting from development in the counties of origin is neither large or undefined and cannot be of sufficient magnitude to affect the feasibility of the Project. The engineering staff of the Commission are familiar with the hydrology of the Feather River area and are cognizant of these facts. This is a question of fact and not of law.

20. **Question**: What part of the State Water Code relevant to this discussion of the rights of the counties of origin must be renewed every two or four years? Is it true that no specific part of the State Water Code must be renewed, except for the specific provision now in existence in the State Water Code which exempts the State of California from showing diligence on its 1927 and 1951 filings?

Answer: The part of the Water Code which must be renewed every four years in connection with the Department of Finance filings is Section 10500 which extends the exemption from diligence under the State filings.

21. **Question**: Is it anticipated that in the event the assignment of the water filings of 1927 and 1951 is made to the Water Project Authority, and the Water Project Authority thereafter, or the assignees thereof, fail to show diligence, that the water rights covered by the 1927 and 1951 filings will be lost and the said water will thereafter become unappropriated water? Is it anticipated that the permit issued to the Water Project Authority may contain a reservation providing for return to the Department of Finance of the filings in the event that diligence is not shown?

Answer: In the event of assignment of the 1927 and 1951 filings to the Water Project Authority for the Feather River Project and subsequent abandonment of the Project, it is anticipated that the Authority would reassign the applications to the Department of Finance. The Director of Finance might, if he deemed it desirable, insert a reversionary clause in the assignment to provide for such an eventuality. It is not believed that the permit would be the proper place for such a reversionary clause but that it should be covered in the assignment.

22. **Question**: Does the application to the Federal Government for license or other authorization for power contain the reservation to the counties of origin?

Answer: The application to the Federal Power Commission for license contains no reservation for the county of origin. It is not believed that this matter is properly referred to in an application to the Commission. As stated in the answer to Question 15, however, the Water Project Authority must present to the Commission "satisfactory evidence that the applicant has proceeded as far as practicable in perfecting its rights to use sufficient water for proper operation of project works."

23. **Question**: Is it not true that there is a conflict, legal or practical, between the large appropriations for study of the needs of the counties of origin and the feasibility of the Feather River Project, and the assignment of the state water filings of 1927 and 1951, now proposed to be made prior to completion of these studies?

Answer: It is not believed that there is any conflict, legal or practical between the appropriations for investigations of the feasibility of the Feather River Project and those made by the 1954 Legislature for investigation of the needs of the counties of origin, and the assignment of the state water filings as proposed. The Legislature, by Chapter 1441, Statutes of 1951, directed and authorized the Department of Public Works, through the State Engineer to conduct investigations, surveys, and studies, and the preparation of plans and specifications for the construction of the Feather River Project and Sacramento-San Joaquin Delta Diversion Projects as authorized and to submit them to the Water Project Authority for approval. Since the 1951 statutes over $2,000,000 has been appropriated by the Legislature for this work. Legislative Committees have repeatedly requested that these studies be completed and report rendered thereon at the earliest practicable time, indicating their interest in seeing the Project expedited. As before stated, if action to obtain the necessary water rights is not initiated now, construction of the Project may well be delayed. We reiterate our opinion that the current studies of the needs of the counties of origin will not develop anything which will affect the feasibility of the Project and that assignment of the State filings as proposed cannot adversely affect such counties.

(a) **Question**: It would appear that the mandate of the State Legislature requires a study of these things prior to the assignment being made. There is authorization by the State Legislature for something which directly conflicts with the assignment, but there is no direct authorization by the State Legislature for the assignment. Therefore, does it not appear that the assignment is contrary to the direct mandate of the State Legislature?

Answer: We do not believe the Legislature intended work on the Feather River Project should cease, nor that the Project should be delayed, pending the results of the recent investigations authorized by it, nor do we believe in view of the physical situation as previously explained in the answers to the foregoing questions, that there is any necessity thereof.

24. **Question**: What is the significance of Section 10505 of the State Water Code of California as to the judgment of the Department of Finance? What is its discretion, if any?

Answer: It is believed that the discretion of the Department of Finance is very broad but that it was intended to be an informed discretion based upon the facts and circumstances in each case, in order that the Director of Finance may properly exercise his judgment under Section 10505 of the Water Code. He has in the past requested full information in the matter. It is assumed that he will follow that course in this instance.

25. **Question**: Conceding the desirability of the Oroville Dam, how can the counties of origin and upstream users intelligently decide as to how their rights referred to in the Counties of Origin Act would be affected by the dam, at least until the two reports (feasibility of the project and dam and needs of the counties of origin) are completed?

Answer: The counties of origin and users of water above Oroville can not be, either practically or legally interfered with by construction of Oroville Dam. Please refer to prior statements herein.

26. **Question**: Is it true that the counties of origin and residence therein must depend upon the state filings of 1927 and 1951 for their protection under the reservation contained in Section 10505 and 11460 of the State Water Code?

Answer: It is true that Sections 10505 and 11460 of the Water Code provide the major reliance for protection to the counties of origin and residents therein. However, under Section 1253 of the Water Code, the Department of Public Works, acting through the State Engineer, to a broad extent has control in the public interest, of water sought to be appropriated. The State Engineer has repeatedly stated his view that the future needs of the counties of origin for water must be recognized and protected.

27. **Question**: Is it true that use of water for power, as well as export, is within the Counties of Origin Act?

Answer: The counties of origin law applies to all applications filed by the Department of Finance, including those applications for power purposes as well as export purposes.

28. **Question**: On page 2, paragraph 2 of Mr. Edmonston's letter of explanation, "estimates have already, etc. * * *." What are these estimates specifically? Why then are they not specifically expected in the assignment of the water filing of 1927 and 1951 in acre feet or other measure?

Answer: It is estimated that the maximum mean net depletion of Feather River above Oroville under conditions of full development upstream will be about 261,000 acre-feet per annum. It is our view as stated in the answers to prior questions that a general reservation rather than a reservation of this specific amount will afford better protection to the counties of origin in this regard.

29. **Question**: What amount in acre feet has been estimated of future stream-flow depletion due to future upstream development above the Oroville Dam?

Answer: See answer to Question 28.

(a) **Question:** What amount in acre feet has been requested of the Water Project Authority by various interests below the Oroville Dam?

Answer: No specific amounts have as yet been requested of the Water Project Authority by various interests below Oroville Dam in connection with the availability of water from the Project. Numerous requests have been received, however, from the San Diego, Los Angeles, Antelope Valley, San Joaquin Valley, Santa Clara and Feather River Service Areas for information relative to receiving a supply of water from the Feather River Project.

Submitted:

/s/ HARVEY O. BANKS
Assistant State Engineer

/s/ HENRY HOLSINGER
Principal Attorney

Approved:

/s/ A. D. EDMONSTON
State Engineer

Dated: November 5, 1954

APPENDIX I

OPINIONS OF ATTORNEY GENERAL WITH REFERENCE TO ASSIGNMENT OF STATE FILINGS AND PROTECTION OF COUNTIES AND WATERSHEDS OF ORIGIN

OPINION
of
EDMUND G. BROWN
Attorney General
WALLACE HOWLAND
Assistant Attorney General
and
ADOLPHUS MOSKOVITZ
Deputy Attorney General

No. 53/298
January 5, 1955

The HONORABLE EDWIN J. REGAN, SENATOR FROM THE FIFTH SENATORIAL DISTRICT, has asked for our complete analysis of the scope and effect of Water Code sections 10505, 11460 and 11463, including particularly our opinion on the following questions:

1) Are these code sections constitutional under article XIV, section 3, of the California Constitution?

2) Under these code sections would water appropriated for use in areas outside the county where the water originates, or the watershed where the water originates and areas immediately adjacent thereto, be made available later for use in such local areas, if the water became necessary for their development at some time in the future?

3) Are Water Code sections 11460 and 11463 applicable to the United States in the construction and operation of the Central Valley Project?

4) Can the State Engineer, in the proper exercise of his power to condition appropriations of water in the public interest under Water Code section 1253, effectuate the protection contemplated by Water Code sections 11460 and 11463?

The conclusions may be summarized as follows:

1) Water Code sections 10505, 11460 and 11463, properly construed and applied, do not violate article XIV, section 3, of the California Constitution.

2) In the circumstances specified in the statute, Water Code sections 10505 and 11460 would require that water which had been put to use in the operation of the Central Valley Project in areas outside the county of origin, or the watershed of origin and areas immediately adjacent thereto, be withdrawn from such outside areas and made available for use in the specified areas of origin.

3) Water Code sections 11460 and 11463 are applicable to the United States in its operation of the Central Valley Project insofar as the law of California is concerned, but compliance therewith is dependent upon the fact that the United States has affirmatively elected to comply with state law in this respect.

4) The State Engineer is empowered to insert conditions in appropriation permits issued on applications assigned by the Department of Finance under section 10504 which are consistent and coextensive with conditions stipulated by the Department of Finance under sections 10504 and 10505. Further, the State Engineer is empowered to insert in permits issued to any state or federal agency engaged in the construction or operation of the Central Valley Project, as conditions of such permits, the limitations upon the powers of such agencies set forth in Water Code sections 11460 and 11463; however, such limitations are imposed upon such agencies by virtue of the statute, regardless of their inclusion or omission from any such permit granted and issued by the State Engineer.

ANALYSIS

I. General Discussion of Water Code Sections 10505, 11460 and 11463

Water Code section 10505 is commonly referred to as the "county of origin" statute. Water Code sec-

tions 11460 and 11463 are the principal operative provisions of what is commonly known as the "watershed protection" statute. These two statutes were enacted at different times and appear in different parts of the Water Code[1]. However, they have a common purpose, i.e., to reserve for the areas where water originates some sort of right to such water for future needs which is preferential or paramount to the right of outside areas, even though the outside areas may be the areas of greatest need or the areas where the water is first put to use as the result of operations of the Central Valley Project.

None of these sections have been involved in litigation to date. Consequently, they have not been interpreted or construed by any court. While the general legislative intent seems clear, legal minds may differ as to the effect of the statutory enactments when applied to a specific set of facts. Inasmuch as we have been requested to give a "complete analysis of the scope and effect" of these provisions, we have endeavored to depict them in actual operation. However, it must be recognized that contrary arguments may be made to contravene some of the views expressed herein and that the conclusions reached may be considered only as reflecting our best judgment as to the effect of statutes the phraseology of which is not beyond dispute.

The breadth of the inquiry here made makes it desirable to preface our analysis with a few general observations. The development of a co-ordinated statewide water plan and the embodiment of its initial phases in the Central Valley Project has not been without controversy. Fundamentally the controversy is an economic one, arising from the fact that water has always been in short supply throughout the history of the State. Our water law had its inception in the law of property. The very term "water right" implies a permanent, vested property right to be owned and enjoyed by one owner to the exclusion of all others. Some of the bitterest and most protracted litigation has been over the conflicting interests in water.

Beginning in the 1920's, however, increased engineering knowledge and technological development gave promise of transforming an economy of water scarcity to one of sufficiency for all. Initially the problem was one of capturing and distributing the surplus waters of the North to the arid but fertile regions of the San Joaquin Valley. More recently another factor has been added arising from the extremely rapid growth in population of the southern part of the State. In any event, it was conceived as early as the mid-1920's that the capturing, storing, distributing and putting the waters of the State to beneficial use, in their aggregate quantity, was a task so enormous that it was beyond the capability of privately financed enterprise and must, therefore, necessarily devolve upon the public agencies of the State for its financing and execution. This injection of the State into the ownership and operation of large project works obviously required changes in existing water law. Distribution of the aggregate water resources of the State by a public agency acting in the public interest could not, and cannot be effected wholly within the framework of a water law whose "first in time" and "appropriation to beneficial use" concepts are adequate and equitable in the settlement of controversies between the limited interests of plaintiff and defendant in private litigation.

Legislatively, the die was cast in 1927 with the enactment of the Feigenbaum Act, chapter 286 of the Statutes of 1927. The act is discussed in more detail later herein. Suffice it here to say that its effect was:

(a) to authorize the State itself to file on any and all of the unappropriated waters of the State which might be needed in the execution of a general or co-ordinated plan for the development and use of the water resources of the State as a whole;

(b) to subordinate to such State filings any further assertion of private rights to such unappropriated water; and

(c) to limit State action in releasing the priority of its filings or the assignment thereof to instances where such action would result in water development not in conflict with the general or co-ordinated plan.

This enactment was made on the recommendation of a joint Senate-Assembly interim committee that:

"* * * the State of California should at once take the necessary steps, either through its proper officials or by legislation, to file on, or withdraw from filing by private parties, the water rights to be utilized and required for the consummation of the co-ordinated plan." (i.e., the plan for the development of the water resources of California then being formulated by the State Engineer.) (Sen. Jour. 47th Sess., 1927, p. 446.)

Prior to 1927 the law for many years had contained a provision substantially as now codified in section 102, viz:

"All water within the State is the property of the people of the State, but the right to the use of water may be acquired by appropriation in the manner provided by law."

Taken literally, this section would apply to *all* water in the State, including that already privately owned at the time of its enactment. However, as the Supreme Court has pointed out, "It should not require discussion or authority to demonstrate that the state cannot in this manner take private property for public use" (*San Bernardino* v. *Riverside* (1921), 186 Cal. 7, 29-30). Consequently, the statute has been restricted in its application to exclude water rights which vested prior to its passage. Thus, it applies only to unappropriated water (*Palmer etc.* v. *Railroad Commission* (1914), 167 Cal. 163, 175).

The effect of the 1927 legislation was to withdraw the then unappropriated waters of the State filed on by the Department of Finance from any further appropriation by private parties. And, if any further implementation of prior law was needed, the 1927 act established a procedure whereby, within the concepts applicable to privately owned water rights, the State in its role as trustee for the people could fairly be said to perfect its own "right" to water needed for the general or co-ordinated plan to the exclusion of all other persons or parties.

II. The Origins of the "County of Origin" Preference

In the interpretation and evaluation of present preferences to counties of origin, it is important to bear in mind the scope and size of the co-ordinated water plan envisaged at the time of its passage. Southern California was then directing its efforts almost exclusively towards the procurement of Colorado River water and distribution of the waters of northern California was conceived of only in terms of the San Joaquin Valley.

Almost without exception, the reports and documents relating to the general or co-ordinated plan speak of taking only the "surplus" or "excess" waters of the Sacramento River to areas of deficient supply in the San Joaquin Valley. In a 1925 report to the Legislature, the Department of Public Works stated:

"Further, while the 1921-23 studies demonstrated that there is more than enough water in the Sacramento Valley for its own use, they also show that the surplus of easily developed water is not so great but that its residents would be gravely concerned that the cost of their own water development might not be increased by exportations. * * * In fact, the whole discussion of the diversion of surplus waters from the Sacramento River into the San Joaquin Valley, must be predicated from the institution of a co-ordinated development in both valleys that gives full protection against present or future loss to the owners of vested rights and to present users of water as well as to those *potential* users whose lands lie tributary to streams from which exportations of water are proposed." (Bull. No. 9, Div. of Engineering and Irrigation, Dept. of Public Works (1925) p. 18.)

Commencing with the 1925 session of the Legislature, a series of bills was introduced to protect the counties of origin against exportation of water which might be needed by them in their own future development. Obviously any such legislation would be a departure from existing water law which required actual reduction to beneficial use as a prerequisite to the establishment of a water right by appropriation. Little wonder, then, that the proponents of such legislation ran into difficulty in drafting an acceptable formula whereby uncertain future rights might be presently acquired. The problem is, in fact, still with us today.

The 1925 Legislature passed Assembly Bill 607 which would have reserved for use in the county of origin fifteen per cent of all water appropriated for export. The measure was pocket vetoed by the Governor, presumably in the light of a letter to him from the Director of Public Works and State Engineer dated May 13, 1925, in which it was stated:

"This Department is in sympathy with the object proposed to be obtained by the language of A.B. 607, but the procedure is so involved and the outcome so questionable, that we doubt the propriety of the measure becoming a law."

Another proposal, Assembly Bill 1079, provided that all diversions outside a watershed of origin would be subject to a reservation of all water necessary to supply uses within the watershed. It was reported without recommendation by the committee and no further action was taken.

At the beginning of the 1927 session the Legislature received a report from the Department of Public Works concerning the coordinated plan. It contained several statements to the effect that only "surplus" waters would be exported from one area to another. Under the heading of recommendations it was stated that:

"The new supplies for the deficient areas would be taken from regions of surplus after providing for their complete development." (Bull. No. 12, Div. of Engrg. & Irrig., Dept. of Public Works (1927) p. 48, see also pp. 26, 36.)

As already stated, the 1927 Legislature passed the Feigenbaum Act permitting the State to assert a priority, as against subsequent private appropriators, to such of the then unappropriated waters of the State as might be needed for the general or co-ordinated plan. It also passed another so-called "fifteen per cent" bill, similar to Assembly Bill 607 of the

[1] All references to section, part and division are to the Water Code, unless otherwise indicated. Emphasis appearing in quotations has been added.

1925 session, only to have it again pocket vetoed by the Governor.

The 1929 session of the Legislature had before it a report of a Joint Committee of the Senate and Assembly Dealing with the Water Problems of the State. With regard to the protection of the interests of the counties of origin, this report stated:

> "In supplying areas of deficiency of water from areas of surplus only such water as is not needed to serve vested or other property rights, or necessary for supplying the uses and purposes hereinbefore mentioned should be considered and *no water should be diverted from the area of origin which is now or which may ever be required for any beneficial use within such area of origin.*" (Report of Joint Committee, January 18, 1929, p. 19.)

In a supplemental report, the joint committee recommended the following policy:

> "4. It shall be the policy of the state to extend to the areas of surplus water, from which, under the coordination policy or the development thereof, areas of deficient water may obtain a supply, definite and valid assurance that such areas of surplus from which water is or may be taken shall have a right to ample water for their *ultimate needs*, superior and prior to that of the areas of deficiency to make use of such surplus * * *." (Supplemental Report of Joint Committee, April 9, 1929, p. 5.)

During the 1929 session, the Assembly passed another "fifteen per cent" bill (A.B. 1150) which died in the Senate committee to which it was referred.

The 1931 Legislature received from the Division of Water Resources a "Report to the Legislature of 1931 on State Water Plan." This report again emphasized that the State plan contemplated only the transfer from one area to another of water which was surplus. It stated:

> "Under this plan, the basins favored with water in excess of their needs would be furnished a regulated supply in accordance with the requirements of their ultimate development. Waters in excess of their needs would be conveyed to areas of deficiency * * *." (Bull. No. 25, Div. of Water Resources, Dept. of Public Works, January 1, 1931, p. 35.)

Another and more detailed report issued the same year reiterated that:

> "* * * There is and will be a deficiency of supplies" (in the San Joaquin River basin). "In the Sacramento River Basin, on the other hand, the water supply if adequately regulated and conserved, is larger than will be required for ultimate development of that basin. * * *" (Bull. No. 26, Div. of Water Resources, Dept. of Public Works, 1931, p. 30; see also p. 45)

On March 31, 1931 the Legislature received the "Report of the Joint Committee of the Senate and Assembly Dealing with the Water Problems of the State." Therein (p. 29) the Committee repeated its previous recommendation that no water should be diverted from the area of origin "which is now or which may ever be required for any beneficial use within such area of origin."

At the Regular Session of the 1931 Legislature, A.B. 540 proposed a new formula for the protection of the future interests of the areas of origin. It was opposed because of its vague phraseology, and its doubtful efficacy, but not because of its intent to protect the rights of areas of origin. (See letter from State Engineer to Secretary, Irrigation Districts Association of California, March 21, 1931). The bill died in committee.

However, another solution to the problem was found more acceptable. In 1931, the Legislature was called upon to amend the Feigenbaum Act of 1927 by extending the date to which State filings would be exempted from requirements of diligence. S.B. 141 was introduced for this purpose and in its original form was limited to that object. However, it was amended before final passage to provide a further restriction on the authority of the Department of Finance to release from priority or to assign any of the state's filings. In assaying the importance of this amendment, it should be noted that by this time the State had already filed some 25 applications on many of the major streams flowing into the Central Valley. As thus amended and passed, S.B. 141 (Calif. Stats. 1931, Ch. 720, p. 1514) provided that:

> "* * * no such priority shall be released, or assignment made of any such appropriation that will, in the judgment of the state department of finance, deprive the county in which "such appropriated water originates, of any such water necessary for the development of such county."

This proviso is now codified as section 10505 of the Water Code. In the light of its legislative background the following conclusions may be drawn:

(1) The engineering plans developed by the State were predicated upon the reservation to "area of origin" of water sufficient to meet their ultimate needs, and upon findings that there was a sufficient "surplus" over and above such ultimate requirements to make feasible the transportation of such surplus to areas of deficient water supply and, specifically, to the San Joaquin Valley.

(2) The Joint Committee of the Legislature repeatedly advocated a policy for enactment into law with such clarity that it is reiterated here:

> "4. It shall be the policy of the state to extend to the areas of surplus water * * * definite and valid assurance that such areas of surplus from which water is or may be taken shall have a right to ample water for their ultimate needs, superior and prior to that of the areas of deficiency to make use of such surplus."

(3) In the three sessions of the Legislature prior to 1931, attempts had been made to enact a law which would protect the future interests of areas of origin.

(4) In 1927, in order to make possible a co-ordinated development of the water resources of several major watersheds by public agencies of the State, the State was authorized to and promptly initiated action to perfect its own "right" to the then unappropriated waters needed for such purpose.

(5) With the "water rights" to the unappropriated waters filed upon by the State itself, and all persons declared subject to the priority of the State's filings, it was conceived that the desired protection for the future interests of the counties of origin could be obtained by placing restrictions upon the authority of State officials to alienate or dispose of the priorities thus vested in the State. This, then, must be taken to be the intent and effect of what is now section 10505 of the Water Code.

(6) Difficulties with the granting of a preference to vague and undefined "mountain regions" (A.B. 540, 1931 session) were eliminated by granting the preference, in effect, to the "counties of origin," a term readily definable for the purposes of the Feigenbaum Act with sufficient exactitude to satisfy constitutional requirements.

III. Analysis of Section 10505

In order that section 10505 may properly be viewed in its context, the entire text of Part 2 of Division 6 of the Water Code, excepting section 10506 which is not relevant to this discussion, is here set forth:

> 10500. "The Department of Finance shall make and file applications for any water which in its judgment is or may be required in the development and completion of the whole or any part of a general or coordinated plan looking toward the development, utilization, or conservation of the water resources of the State.
>
> "Any application filed pursuant to this part shall be made and filed pursuant to Part 2 of Division 2 of this code and the rules and regulations of the State Engineer relating to the appropriation of water insofar as applicable thereto.
>
> "Applications filed pursuant to this part shall have priority, as of the date of filing, over any application made and filed subsequent thereto. Until October 1, 1955, or such later date as may be prescribed by further legislative enactment, the statutory requirements of said Part 2 of Division 2 relating to diligence shall not apply to applications filed under this part, except as otherwise provided in Section 10504."
>
> 10504. "The Department of Finance may release from priority or assign any portion of any appropriation filed by it under this part when the release or assignment is for the purpose of development not in conflict with such general or co-ordinated plan. The assignee of any such application, whether heretofore or hereafter assigned, is subject to all the requirements of diligence as provided in Part 2 of Division 2 of this code. 'Assignee' as used herein includes, but is not limited to, state agencies, commissions and departments, and the United States of America or any of its departments or agencies."
>
> 10505. "No priority under this part shall be released nor assignment made of any appropriation that will, in the judgment of the Department of Finance, deprive the county in which the appropriated water originates of any such water necessary for the development of the county."

Section 10505 is limited in its application to water filed on by the Department of Finance under section 10500. However, section 10500 continues to authorize the filing of applications on unappropriated water which, in the judgment of the Department of Finance, "is or *may be* required" for "the whole or any part of *a* general or coordinated plan." In the light of the background and the date of enactment of this section, it is not confined in its application to any particular "plan," as, for example, the specific "State Water Plan" defined in section 10000 and adopted and approved by section 10002. Neither is it limited to the water requirements of any particular project, such as the Central Valley Project which is the subject matter of Part 3 of Division 6 of the Water Code.

The applications filed to date under section 10500 number more than forty. They may well cover substantially all of the water not previously appropriated or otherwise vested in private ownership within the watersheds involved.

It will be noted that section 10504 authorizes assignment of State applications without limitation as to the identity of the assignee. From this it seems obvious that the Legislature contemplated that assignments would be made to two different classes of assignees, viz:

(a) To the agency or agencies to be eventually authorized to effectuate the general or coordinated plan by constructing and operating project works. Such assignments would, of course, be for the purpose of development not in conflict with the plan,

and could be made by the Department of Finance as a routine matter.

(b) To private persons, corporations, municipalities, districts and others, but only in the event that the development and use of the water proposed by the assignee was found to be not in conflict with the general or coordinated plan.

When section 10505 was enacted in 1931, the general or coordinated plan had not yet evolved to the point where it had legislative sanction. There was still no agency of the State authorized to do anything towards effectuating the plan still in its formulative stage. Section 10505 is cast in such language as to make its provisions applicable to *all* assignments made by the Department of Finance, regardless of the identity of the assignee. "*No* priority shall be released nor assignment made. . . ." which, in the judgment of the Department of Finance, would deprive the county of origin of water needed in its future development. Both the legislative intent and the effect of this provision seem clear: that the priority granted to counties of origin should be applicable to *all* water covered by State filings under section 10500, regardless of whether such filings are assigned to an agency of the State to effectuate the general or coordinated plan, or to some other assignee for development not in conflict with such plan.

Section 10505 has one feature in common with all legislation which confers discretionary authority upon a State agency or official—the protection which it offers is not absolute. Under section 10505, a preferential right is preserved for the counties of origin from the assignment or release of priority of State filings only to the extent that the Department of Finance may have reserved such a right.

Whether an assignment or release shall be made is left to "the judgment of the Department of Finance". The department is not required to hold a hearing before making its judgment. Thus, the section is satisfied if, before making an assignment or release, the department determines in good faith on the basis of information then available to it that the water covered by the application is not necessary for the development of the county of origin, or that the conditions inserted in the assignment or release will adequately preserve for those in the county a preferential right to use the water when they need it.[2] A mere error in judgment by the department in making its determination would not invalidate its action. The action of an administrative body involving the exercise of discretion may be successfully challenged in the courts only if it is arbitrary, capricious, or entirely lacking in evidentiary support. (*Tulare Water Co.* v. *State Water Commission*, (1921) 187 Cal. 533, 538, 202 Pac. 874, 877; *Mann* v. *Tracy* (1921) 185 Cal. 272, 274, 196 Pac. 484, 485; *Brock* v. *Superior Court*, (1952) 109 Cal. App. 2d 594, 605, 241 P. 2d 283, 290; *Roussey* v. *City of Burlingame*, (1950) 100 Cal. App. 2d 321, 326, 223 P. 2d 517, 520.)

Section 10505 requires that "the county in which the appropriated water originates" be protected from deprivation of any such water necessary for the development of the county. The common sense meaning of the word "originates" in this context would seem to be falls in the form of precipitation". The protection afforded by the section to each county relates only to the water which falls as precipitation within that county's boundaries. But the need to be considered is that of the entire county, regardless of whether the place of need is in a different watershed from the place where the water originates. That is, each county is to be regarded as a unit, and all water originating therein which is covered by Department of Finance applications is, to the extent that such water may be needed anywhere therein, subject to the protection of the statute. Hence, the place of use of the water is the sole standard by which the preference is established, and the extent of the preference is limited to the aggregate amount of water which falls in the form of precipitation upon the county in question.

A person desiring water for use in a county of origin for development not in conflict with the general or co-ordinated plan must first apply to the Department of Finance for an unconditional assignment of so much of the State's application filed under section 10500 as may be necessary to satisfy his needs. Such action is necessary since any application which such person might otherwise initiate and file would be subject to the priority of the State's application.

It is the function of the Department of Finance to determine whether such an application for an unconditional assignment satisfies the conditions laid down in sections 10504 and 10505. The granting of such an unconditional assignment establishes the preferential or priority status of the application so assigned as against an earlier assignee of the department who has been exporting water out of the county of preference subject to a reservation in his assignment which protects the county of origin preference.

Upon the granting by the Department of Finance of such an unconditional assignment, the application so assigned must then be pursued to permit before the State Engineer under sections 1200-1800. Determination of all of the questions involved in the processing of an application to permit are still for the State Engineer in the exercise of his normal functions concerning the granting of appropriative permits.

[2] A more detailed discussion of the functions and responsibilities of the Department of Finance in making assignments under Sections 10504 and 10505 is found in Opinion 54/159.

IV. Analysis of Sections 11460 and 11463

Sections 11460 through 11463 are codifications of section 11 of the Central Valley Project Act of 1933 (chapter 1042 of the Statutes of 1933). They provide as follows:

11460. "In the construction and operation by the authority of any project under the provisions of this part a watershed or area wherein water originates, or an area immediately adjacent thereto which can conveniently be supplied with water therefrom, shall not be deprived by the authority directly or indirectly of the prior right to all of the water reasonably required to adequately supply the beneficial needs of the watershed area, or any of the inhabitants or property owners therein."

11461. "In no other way than by purchase or otherwise as provided in this part shall water rights of a watershed, area, or the inhabitants be impaired or curtailed by the authority, but the provisions of this article shall be strictly limited to the acts and proceedings of the authority, as such, and shall not apply to any persons or State agencies."

11462. "The provisions of this article shall not be so construed as to create any new property rights other than against the authority as provided in this part or to require the authority to furnish to any person without adequate compensation therefor any water made available by the construction of any works by the authority."

11463. "In the construction and operation by the authority of any project under the provisions of this part, no exchange of the water of any watershed or area for the water of any other watershed or area may be made by the authority unless the water requirements of the watershed or area in which the exchange is made are first and at all times met and satisfied to the extent that the requirements would have been met were the exchange not made, and no right to the use of water shall be gained or lost by reason of any such exchange."

At the outset, it should be noted that these provisions apply only to any project described in part 3 of division 6.

By section 11460 the Water Project Authority is prohibited from depriving certain described areas directly or indirectly of the prior right to certain water. Some comment seems desirable concerning the descriptions of the areas of preference. The areas to be protected are (1) "a watershed or area wherein water originates," and (2) "an area immediately adjacent thereto which can conveniently be supplied with water therefrom."

In the first category, the term "watershed" must be taken as synonymous with the term "area wherein water originates." Otherwise, the latter term would be completely indefinite. It is obvious that an "area wherein water originates," without further qualification, could be as large or as small as one desired to make it. For example, the entire State of California is an area wherein water originates. On the other hand, a "watershed" is capable of fairly accurate delineation. It is defined as "The whole region or area contributing to the supply of a river or lake; drainage area; catchment area or basin" (Webster's New International Dictionary, 2d ed. unabridged, 1941, p. 2886). A reasonable and practicable construction of a statute which avoids fatal uncertainty is, of course, to be preferred (*Drummey* v. *State Board of Funeral Directors*, (1939) 13 Cal. 2d 75, 80, 87 P. 2d 848, 851). Thus, the first type of area to receive protection is a watershed, i.e., the region or area which contributes to the supply of the stream in question.

The second category of area described extends the protection of the statute beyond the confines of the particular watershed to any immediately adjacent area which can conveniently be served with water from that watershed. The word "adjacent" means "lying near or close at hand" (Funk & Wagnall's New Standard Dictionary). "Objects are adjacent when they lie close to each other, but not necessarily in actual contact" (Webster's New International Dictionary, 2d ed. unabridged 1941, p. 32). But the word "immediately" qualifying the word "adjacent" indicates that the area must adjoin the watershed.

The extent of the area immediately adjacent to the watershed which is subject to protection is ascertainable from the remainder of the description. It is that adjoining territory which "can conveniently be supplied with water" from the watershed. The requirement of convenience in supplying the water implies the necessity that there be no difficult problems in effecting such supply and that delivery be clearly feasible, from both a financial and an engineering point of view.

Although the question is not entirely free from doubt, in our opinion this description is stated with sufficient certainty of language and exactitude to constitute a valid enactment.

A civil statute cannot be held void for uncertainty if any reasonable and practical construction can be given to its language. Mere difficulty in ascertaining its meaning or the fact that it is susceptible of different interpretations will not render it nugatory (*Clark* v. *City of Pasadena* (1951), 102 Cal. App. 2d 198, 205, 227, 227 P. 2d 306). Proof of what is "convenient" is no more difficult than what is "reasonable" and falls within the category of "problems

which in their nature are not subject to precise definition, but which tribunals exercising judicial functions must determine'' (*Gin S. Chow* v. *City of Santa Barbara* (1933), 217 Cal. 673, 706). However, if litigation and the need for judicial construction is to be minimized, in all candor it must be stated that the certainty of this description leaves something to be desired.

The quantity of water as to which the prior right for use in the described areas is to be preserved is—

> ''* * * all of the water reasonably required to adequately supply the beneficial needs of the watershed, area, or any of the inhabitants or property owners therein.''

The words ''the water'' means the water which originates, i.e., falls as precipitation in the particular watershed. This is borne out by reference to the original enactment from which section 11460 is derived, which contains the more precise words, ''said water'' (Calif. Stats. 1933, ch. 1042, sec. 11, p. 2650). How much water is reasonably required to supply the beneficial needs of the watershed, the adjacent area and the inhabitants and property owners therein is a question of fact depending upon the circumstances in a particular case at any given time.

The scheme of things intended by sections 11460-11463 seems clear:

1) Section 11460 has the effect of reserving to the entire body of inhabitants and property owners in watersheds of origin a priority as against the Water Project Authority in establishing their own water rights in the usual manner as their needs increase from time to time up to the maximum of either their ultimate needs or the yield of the particular watershed.

2) The establishment of this priority does not create or vest in any individual person a presently definable ''water right'' in the conventional sense of the term. This is the unmistakable meaning of the limitation in section 11462:

> ''The provisions of this article shall not be so construed as to create any new property rights other than against the authority . . . .''

This means simply what it says: No inhabitant of a watershed of origin [2] becomes possessed of any presently vested title or right to any specific quantity of water as a result of this statute. As the need of such an inhabitant develops he must comply with the general water law of the state, both substantively and procedurally, to apply for and perfect a water right for water which he then needs and can then put to beneficial use (Secs. 1200-1800). However, when he makes such an application, as a member of the class of persons protected by the statute, his application is not to be gainsaid, denied or limited by reason of any activity on the part of the Water Project Authority. Specifically, this means that if, prior to the development of the applicant's increased needs, the authority had been exporting from the watershed in question water required to supply the applicant's increased needs, such use by the authority would not justify denial of the application. Assuming the application to be otherwise meritorious, the State Engineer would grant a permit in the usual form, and the authority would thereafter be compelled to honor the water right thus created and vested.

3) The priority thus reserved to inhabitants of watersheds of origin by section 11460 may not in any way be defeated by any action or proceeding by the authority. In interpreting sections 11460-11463, it must be constantly borne in mind that the priority is a reservation granted to an entire class of citizens *in the aggregate*. The class is ascertainable at any given time with constitutional exactitude, but the individual inhabitants and property owners comprising it will change and vary over the years. No definable property right is created or presently vested in any particular individual. As to any particular individual the grant of the statute is wholly inchoate. Its potential maximum is the individual's ultimate need for water which can be beneficially used up to the capability of the watershed. It can only be defined momentarily, from time to time, as the needs of the individual develop and, by actually putting more water to beneficial use, he is able to establish a ''water right'' in himself in the usual form and manner. This is not to say that the grant of the statute is unconstitutional for vagueness, but it does mean that the reserved priority is not susceptible of being presently purchased, condemned or otherwise acquired by the authority.

Such being the case, the authority is precluded from any action which would have the effect of presently defeating or destroying the priority. Our view in this respect is predicated upon the following reasons:

a) Section 11460 is contained in article 4, under the heading ''Limitation of Powers'' of the authority. It expressly prohibits the authority from depriving the watershed of origin or its inhabitants ''directly or indirectly of the *prior* right'' to water needed in the future. The word ''prior'' as used in this section means paramount, preferred or superior. Section 11462 establishes beyond doubt that this priority in right exists *as against the authority*.

b) The legislative background of the priority makes it difficult to conceive that the Legislature intended that the authority could destroy the priority by condemnation. Since the priority exists only as against the authority, such a construction would completely destroy the effect of section 11460 and make its enactment an idle gesture. We must reject such an interpretation. Hence, we conclude that section 11460 not only creates the priority in inhabitants of a watershed of origin but constitutes a limitation on the legal powers of the authority granted by other provisions of the Water Code.

It must be borne in mind that section 11575 empowers the authority to acquire water rights and other property for the purpose of constructing, maintaining and operating the Central Valley Project ''by gift, exchange, purchase or eminent domain proceedings.'' Section 11580 expressly confers upon the authority the power of condemnation when other means of acquisition fail.

Section 11461 provides in part that:

> ''In no other way than by purchase or otherwise as provided in this part shall water rights of a watershed, area, or the inhabitants be impaired or curtailed by the authority * * *.''

In the original statute from which these sections were derived, section 11461 immediately follows the provisions of section 11460 as the next sentence of the same paragraph (Calif. Stats. 1933, ch. 1042, sec. 11, p. 2650). Consequently, it must be taken in that context. We deem the intent and effect of section 11461 to be as follows:

a) It is a qualification on the scope of section 11460, in that it authorizes the curtailment and impairment of the ''*water rights* of a watershed, area or its inhabitants,'' if that be the result of acquisition of such water rights by the authority by purchase, gift, exchange or condemnation.

b) It is a reaffirmation of the powers granted the authority under section 11575 to acquire ''water rights,'' and indicates a legislative intent that these powers as applied to a watershed of origin are not wholly nullified by section 11460. We thus have a grant of the power of eminent domain by section 11575, a limitation on the power in section 11460, and a qualification of that limitation in section 11461. What can this mean? Needless to say every effort must be made to save the statute from ambiguity and to give it effect. In our view, the sections taken together mean that

1) The inchoate priority of inhabitants of a watershed of origin granted by section 11460 may not presently be defeated or destroyed by acquisition or any other action on the part of the authority;

2) When the priority is asserted by such an inhabitant and with its aid he acquires and becomes vested with a water right in accordance with sections 1200-1800, such water right may be purchased or condemned by the authority if necessary for purposes of the project.

Any other interpretation would have either of the following results: On the one hand, if the priority be considered subject to immediate condemnation under sections 11461 and 11575, the result is a complete frustration of section 11460. On the other hand, if section 11460 be deemed to create a permanent ''water right'' which, even after it has been perfected and vested, may not be acquired or condemned by the authority when essential for project purposes, then section 11461 becomes meaningless and of no consequence. If either of these results was, in fact, within the legislative contemplation, then it must be concluded that the sections referred to are mutually inconsistent and conflicting.

The question may well be asked whether, under our interpretation, the priority is of little real consequence since, although the priority may not be presently condemned or otherwise defeated by the authority, any vested water right which may eventuate from it can be condemned. We do not believe this necessarily follows. On the contrary, we believe that the statute effectuates the legislative intent and confers extremely valuable rights upon watersheds of origin. Its very effectiveness depends upon the distinction made between (a) the power of the authority to condemn a ''water right'' after it has come into being in accordance with the provisions of the law of appropriative rights and become vested in a particular individual, and (b) the total lack of power on the part of the authority to in any way defeat the operation of the preference in its inchoate form and prior to its ripening into an individually owned ''water right.'' It was by this means that the Legislature was able to create and preserve the intended preference for the watershed of origin as a whole, without having to presently define and resolve the present property rights of countless individuals. It was by this means that the Legislature was able to achieve its objective with a minimum of confusion and with no substantial departure from well established water law, both procedural and substantive, concerning the assertion and protection of water rights as between individual citizens of the state. Finally, it preserves the effectiveness of the authority in carrying out its intended functions.

In resolving the questions presented, it is significant that sections 11460-11463 are cast in terms of a legislative directive to an agency of the State concerning the manner in which it is to deal with the unappropriated waters of the State withdrawn from private appropriation as the result of State applications made under section 10500. Our entire discussion

[2] For brevity, as used herein, the word "inhabitants" includes also the "property owners" specified in section 11460. Similarly, the term "watershed of origin" is used to denote all of the preferred areas described in section 11460.

here concerns the future right of inhabitants of a watershed of origin to satisfy their future needs. By definition, then, we are not concerned with water which was in private ownership prior to State filings under 10500. Water which has been put to use since the State applications were filed and which is covered by such applications is subject to the priority thereof; and water not yet presently in use but which will be needed at a later date has not yet been applied for; and it is with these two cases—i.e. unappropriated waters covered by the State's filings under section 10500—that we are concerned.

Section 11462 is important in two respects. It provides that:

> "The provisions of this article (Secs. 11460-11465) shall not be so construed as to create any new property rights other than against the authority as provided in this part * * * ."

It is this provision which effectively prevents any attempt to construe the priority granted in sections 11460 and 11463 as a "water right" in the conventional sense of the term which, if it existed, would be susceptible of individual ownership as against any and all persons and entities. Section 11462 further provides that the provisions of sections 11460-11465 shall not be construed:

> "* * * to require the authority to furnish to any person without adequate compensation therefor any water made available by the construction of any works by the authority."

This provision has important financial results. It is obvious that certain of the project works are so situated in a watershed of origin that their storage and stream regulation capabilities augment the natural flow of the stream within the watershed of origin. It is most probable, and each case would present a question of fact for determination, that there are instances where the ultimate needs of the inhabitants of the watershed of origin can only be fully met by some degree of augmentation and regulation of the natural flow of the stream. Section 11460 assures such inhabitants of the prior right to water sufficient for their ultimate needs. However, this does not mean that they are entitled to water "made available by the construction of any works by the authority" without paying adequate compensation for the benefits actually received from the existence and operation of the project works. Having to pay for benefits received does not detract anything from the benefit or effect of the priority granted. It is simple equity to the taxpayers of the State as a whole. It is the purpose and effect of this provision of section 11462 to make it crystal clear that no person entitled to the priority reserved by section 11460 is thereby entitled to receive free of charge water which is made available by the construction of any project works by the authority. Charges appropriate to such cases may be fixed and established by the authority pursuant to section 11455.

There remains for consideration the effect of section 11463. Like section 11460, this section applies in the construction and operation by the authority of any project under the provisions of part 3 of division 6. It is a limitation on the power of the Water Project Authority to supply the needs of a watershed of origin from which water is being exported by means of the importation of water from another watershed. No such exchange may be made by the authority:

> "* * * unless the water requirements of the watershed or area in which the exchange is made are first and at all times met and satisfied to the extent that the requirements would have been met were the exchange not made, and no right to the use of water shall be gained or lost by reason of any such exchange."

In practical operation, this provision has the effect of making the priority granted to watersheds of origin by section 10460 effective as against both agreements and operational practices of the authority which result in the exchange of water between watersheds, as well as the outright exportation of water from the watershed of origin.

Section 11463 does not create any new or additional priority or preference. However, it prohibits the exportation of water under an exchange arrangement which would impair the fulfillment of the water requirements of the watershed from which such exportation is being made "to the extent that the requirements would have been met were the exchange not made." This qualification makes this section consistent with section 11460 since the preference granted by the latter section is limited to the amount of water which originates in the watershed in question. In the event that a particular watershed cannot fulfill the needs of its inhabitants, the proviso in section 11463 quoted above would become effective to prevent any part of the requirements of such watershed from being filled by water being imported into that watershed under the exchange arrangement to replace water being exported. That such is the intent of the proviso is made doubly clear by the clause which immediately follows: "* * * and no right to the use of water shall be gained or lost by reason of any such exchange."

Subject to the foregoing, the "requirements" of the watershed protected by section 11463 are those which it may have at any time in the future. This is the meaning of the condition that "unless the water requirements of the watershed * * * are first and at all times met" no exchange may be made by the authority. In this connection, it will be noted that the prohibition is not merely against the execution of an exchange contract or any other form of specific agreement. Instead the prohibition is against a particular type of operating practice, i.e., the exchange of water from one watershed for that of another, regardless of whether the basis of such practice is a contract, agreement, or unilateral policy or practice.

The uncertainties which would otherwise arise by reason of this section are mitigated, from a practical viewpoint, by the overall power of the authority to purchase or condemn any and all "water rights" needed for operation of the project when and as such "water rights" come fully into being and are vested in a particular individual under the applicable general law.

V. Constitutionality of Sections 10505, 11460-11463

As interpreted and construed herein, sections 10505 and 11460-11463 are in our opinion constitutional.

The Legislature has ample authority to control the disposition of unappropriated water in the State. "These excess waters constitute the public waters of the state to be used, regulated and controlled by the state or under its direction" (*Meridian, Ltd.* v. *San Francisco* (1939), 13 Cal. 2d 424, 445, 90 P 2d 537, 547).

The specific question has been asked whether, in reserving water for future use in areas of origin as provided in sections 10505, 11460 and 11463, the Legislature has exercised this authority in violation of article XIV, section 3 of the California Constitution which provides:

> "It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. The right to water or to the use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water Riparian rights in a stream or water course attach to, but to no more than so much of the flow thereof as may be required or used consistently with this section, for the purposes for which such lands are, or may be made adaptable, in view of such reasonable and beneficial uses; *provided, however,* that nothing herein contained shall be construed as depriving any riparian owner of the reasonable use of water of the stream to which his land is riparian under reasonable methods of diversion and use, or of depriving any appropriator of water to which he is lawfully entitled. This section shall be self-executing, and the Legislature may also enact laws in the furtherance of the policy in this section contained."

The immediate occasion for the passage of this amendment in 1928 was the widespread dissatisfaction with the judicial rule upholding the right of a riparian landowner to enjoin any use by appropriators of water from the stream to which his land is riparian which would reduce the natural flow of the stream past his land, even if enforcement of this right might result in a waste of water. (*Herminghaus* v. *Southern California Edison Co.* (1926), 200 Cal. 252 Pac. 607; *Lux* v. *Haggin* (1886), 69 Cal. 255, 390, 10 Pac. 674, 753). The effect of the amendment is to deny a riparian landowner the remedy of injunction to prevent the use by others of water which he himself cannot use reasonably and beneficially (*Peabody* v. *City of Vallejo* (1935), 2 Cal. 2d 351, 368, 40 P. 2d 486, 492).

The amendment does not forbid the maintenance of preferences for prospective uses, so long as the water is made available for interim use by others who have a present need for it. Thus, the preservation of a preferential right to the use in the future of water not presently needed, despite the present need and use of such water by others, was expressly held constitutional under article XIV, section 3, both in the case of riparian rights (*Tulare Irr. Dist.* v. *Lindsay-Strathmore Irr. Dist.* (1935), 3 Cal. 2d 489, 525 45 P. 2d 972, 986, 1014); and in the case of pueblo rights (*City of Los Angeles* v. *City of Glendale* (1934), 23 Cal. 2d 68, 75, 142 P. 2d 289, 293).

There are other examples of paramount or preferential rights which may be exercised in the future so as to supersede rights already being exercised. The California Supreme Court has approved a condition, in a permit to appropriate water for power generating purposes, making the right subordinate to future domestic use of the water (*East Bay M. U. Dist.* v. *Department of Public Works* (1934), 1 Cal. 2d 476, 35 P. 2d 1027). This condition was inserted for the purpose of carrying out the legislative policy expressed in section 106. Sections 106.5, 1203, and 1460 to 1464, which grant a preference to applications for future municipal use, and section 10500, which gives a preference to the applications filed by the Department of Finance, are as yet untested in the courts.

Neither section 10505 nor sections 11460 and 11463 prohibit interim use by others of water which may be reserved in the manner provided and as interpreted herein. To be constitutional, the sections must be construed to permit such interim use, and that is how we construe them.

VI. Reversion of Water to Areas of Preference When Needed

From what has already been said, it follows that the interim use of water reserved for counties of origin under section 10505, or for watersheds of origin under sections 11460 and 11463 is subject to termination whenever such water becomes necessary for development of such areas of preference and proper applications to appropriate the water for use therein are filed and granted. In such case there would be no right of reimbursement for the project works which had been used for the interim use of the water exported.

Until recently, however, this consideration has been academic in view of the fact that the Central Valley Project to date has been of such scope that all of the legislation considered herein is predicated upon a project conception and engineering data indicating that a surplus or excess of water exists over and above the ultimate needs of the counties and other areas of origin for which the reserved priorities have been granted (supra, II).

Today we have under consideration the addition of large units to the existing Central Valley Project. More important, perhaps, is the proposed expansion of the areas of deficieney to be served with project water to include territory lying south of the Tehachapis. The Division of Water Resources is engaged in an up-to-date survey of the needs of the areas of origin, and upon its findings much will depend.

As the next phase of the State's coordinated plan for water development evolves, it may be that the effect of the reserved priorities now granted will impair the financial feasibility of certain project works required to transport present surpluses the great distance to Southern California. Future sound water development may therefore make it desirable that the Legislature provide a definite, quantitative ceiling on the preferential rights of areas of origin to the future use of water. One basis of limitation might be the ultimate needs of a given watershed but not to exceed the flow of the stream in its natural state. The logic underlying this suggestion is that any increase over the natural flow of the stream is directly attributable to the storage and stream regulation resulting from project works financed by the people of the entire State and that inhabitants of the watershed of origin would in all fairness be entitled only to their pro rata share of any such augmentation of the natural flow.

VII. Application of Sections 11460 and 11463 to the United States in the Construction and Operation of the Central Valley Project

The prohibitions contained in sections 11460-11463 are limited by their terms to the Water Project Authority. Therefore, these sections standing alone would not apply to the United States.

Purely of its own force, State law could not control the United States in its construction and operation of the Central Valley Project. The project was authorized by the Act of Congress of August 26, 1937 (50 U. S. Stat. 850) and is, therefore, free from State regulation except to the extent that Congress may have affirmatively elected to comply with State law (*United States* v. *Gerlach Live Stock Co.* (1950), 339 U. S. 725, 739; *Mayo* v. *United States* (1943), 319 U. S. 441, 445, 448; *Kauffman* v. *Kauffman* (1949), 93 Cal. App. 2d 808, 811, 210 P. 2d 29, 32.) The law thus firmly established is not altered by the adoption of the amendment to article XIV, section 4, of the California Constitution at the 1954 general election.

However, an affirmative election by Congress to comply with certain aspects of State law is contained in section 8 of the Federal Reclamation Act of 1902 which provides that:

> "* * * Nothing in this Act shall be construed as affecting nor intended to affect or is in any way to interfere with the laws of any State or Territory relating to the control, appropriation, use of distribution or water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this Act, shall proceed in conformity with such laws * * *" (32 U. S. Stat. 390, 43 USC sec. 383).

This provision was made applicable to the Central Valley Project by the federal statute which "reauthorized" the project (sec. 2, Act of August 26, 1937, 50 U. S. Stat. 850). In our opinion, sections 11460 and 11463 are so inseparably concerned with irrigation in their application to the Central Valley Project as to fall within the purview of section 8 of the Federal Reclamation Act, *supra*. The significant thing is that sections 11460 and 11463 state the law of California concerning the use and distribution of water involved in the construction and operation of the Central Valley Project. It is true, that these sections are specifically addressed to the Water Project Authority and are stated in terms of limitations on its powers. However, this fact is predicated upon the further fact that, so far as State law is concerned, the Water Project Authority is the one and only agency of the State authorized to construct, maintain and operate the project. Consequently, from the viewpoint of the Secretary of the Interior, seeking to ascertain the law of California concerning the distribution and use of Central Valley Project water in order that he may obey the mandate of section 8 of the Reclamation Act that he "shall proceed in conformity with such laws," the law of California is to be found in sections 11460 and 11463. And, insofar as the United States appropriates water for the purposes of the project and seeks to avail itself of the priorities established by the State applications filed under section 10500, it is bound to comply with the county of origin preferences established as a condition of any assignment of such applications by virtue of section 10505.

It must be recognized, however, that the general election to conform to State law contained in section 8 of the Federal Reclamation Act is not controlling upon the United States to the extent that State law may be inconsistent with other and more specific provisions of federal law. That is, a specific federal provision, if it existed, would govern the general. However, no federal statute of which we are aware prohibits or prevents federal compliance with the declaration of State law contained in sections 11460 and 11463.

This conclusion is apparently shared by the United States Department of the Interior. Over a period of years, federal officials have consistently taken the position that the United States is bound to observe the provisions of sections 11460 and 11463 in its operation of the project. A number of their official utterances are collected in a letter to Congressman Clair Engle from the Regional Director, United States Bureau of Reclamation, dated November 15, 1948 (printed in Cong. Rec. Feb. 21, 1949, 81st Cong., vol. 95 p. A-961). Likewise, the "Comprehensive Departmental Report on the Development of the Water and Related Resources of the Central Valley Basin," submitted to Congress by the Department of the Interior (Aug. 1949, Senate Doc. 113, 81st Cong., 1st Sess., pp. 39, 64-65, 104, 121-122, 125), makes numerous references to protection of counties and watersheds of origin. Conformity with State law in this regard was further assured in an official statement of federal policy set forth in the report to the Legislature by the Joint Committee on Rivers and Flood Control, entitled "Proposed Klamath and Trinity River Diversions and Other Projects of the Central Valley" (May, 1945, pp. 49-51; printed in Sen. Jour. June 4, 1945, p. 3393).

In 1951 the Legislature added section 11128 to the Water Code, providing that:

> "The limitations prescribed in Section 11460 and 11463 shall also apply to any agency of the State or Federal Government which shall undertake the construction or operation of the project, or any unit thereof, including, besides those specifically described, additional units which are consistent with and which may be constructed, maintained, and operated as a part of the project and in furtherance of the single object contemplated by this part." (Calif. Stats. 1951, ch. 1325, p. 3216).

It seems obvious that the intent of this section was to make it clear that the interpretation of federal officials was consistent with the purpose of the Legislature in 1933 in enacting sections 11460 and 11463. It removes any doubt but that, so far as State law is concerned, these sections do declare the law of the State for purposes of federal compliance therewith pursuant to section 8 of the Reclamation Act.

In concluding on this subject, it should be pointed out that nothing contained in State law restricts the power of the United States to acquire by exercise of its power of eminent domain either water rights already vested in individual ownership or the unappropriated waters of the State. The reason is that the same federal statute which reauthorized the Central Valley Project and made section 8 of the Federal Reclamation Act applicable thereto also expressly empowered the Secretary of the Interior to acquire all property, including water rights, necessary for the authorized purposes of the project by proceedings in eminent domain or otherwise (50 U. S. Stat. 850).

VIII. Power of State Engineer to Impose in Appropriation Permits Conditions to Effectuate the Protection Contemplated by Sections 10505, 11460 and 11463

Section 1253 provides:

> "The department (acting through the State Engineer, Sec. 1050.5) shall allow the appropriation for beneficial purposes of unappropriated water under such terms and conditions as in its judgment will best develop, conserve, and utilize in the public interest the water sought to be appropriated."

We have been asked whether, in the proper exercise of his power under this section, the State Engineer may effectuate the protection of areas of origin provided for in sections 10505, 11460 and 11463.

Section 1253 is a codification of part of section 15 of the Water Commission Act (Calif. Stats. 1913, ch. 586, p. 1021) as amended in 1921 (Calif. Stats. 1921, ch. 329, p. 443). Sections 1254 and 1255 are codifications of the remainder of section 15 of the act. They provide as follows:

> 1254. "In acting upon applications to appropriate water the department shall be guided by the policy that domestic use is the highest use and irrigation is the next highest use of water."
>
> 1255. "The department shall reject an application when in its judgment the proposed appropriation would not best conserve the public interest."

The exercise of the authority to grant permits under section 15 of the Water Commission Act has been held to be an administrative, not a judicial, function. (*East Bay M. U. Dist.* v. *Department of Public Works* (1934), 1 Cal. 2d 476, 35 P. 2d 1027; *Tulare Water Co.* v. *State Water Commission,* supra; *Mojave River Irr. Dist.* v. *Superior Court* (1927), 202 Cal. 717, 721-722, 262 Pac. 724, 725). The delegation of discretion by the Legislature to administrative agencies and officers is permissible and is not an unconstitutional delegation of legislative power, if the delegating statute establishes "an ascertainable standard to guide the administrative body." (*State Board* v. *Thrift-D-Lux Cleaners,* (1953) 40 Cal. 2d 436, 448, 254 P. 2d 29, 36.)

Section 1253 is a statute generally applicable to the granting of water appropriations. In conjunction with section 1255 it contemplates that the State Engineer act on permit applications in the light of what is, in his judgment, the public interest. In the delegation of legislative authority, the standard prescribed for the guidance of the agency or official in whom discretionary power is vested is inseparable from the particular agency or official in whom such trust is reposed. Conversely, where separate trusts are reposed in two agencies or officials, one may not presume to exercise the discretion vested in the other.

Section 10505 has a specific, as compared to a general, applicability to the appropriation of water. Strictly speaking, it is not concerned with the granting of permits to appropriate water at all. It deals solely with the terms and conditions upon which applications already filed by the Department of Finance on behalf of the State itself shall be assigned or the priority thereof released to others. The determination of these terms and conditions the Legislature has specifically entrusted to the Department of Finance. The question is whether "in the judgment of the Department of Finance" the requested release or assignment will deprive the county of origin of water needed for its development. Only the Department of Finance can exercise such judgment.

In a letter dated September 21, 1939, to the Director of Finance, the Attorney General ruled that in view of section 10505 the Department of Finance must either (a) make a bona fide finding of fact that the assignment in question will not deprive the county of origin of water for future development or (b) include a reservation for adequate supplies of water for the future development of the county. In either case, the granting of an assignment by the Department of Finance is, in effect, a certification by the responsible head of that department that the purpose underlying section 10505 has been served and that the full measure of protection has been granted to the county of origin. When the assignee seeks to process the assigned application to permit before the State Engineer, the question of the need for and the extent of protection to the county of origin has already been determined by the one agency expressly authorized and directed by the Legislature to make this determination. Nothing in section 1253, or any other provision of applicable law, authorizes or even permits the State Engineer to re-evaluate and re-determine the issue already resolved by the Department of Finance. Needless to say, the State Engineer may, and probably should, incorporate into any permit issued such provisions and reservations as may have been stipulated by the Department of Finance as a condition of assigning the application underlying the permit. However, this is quite a different thing from the exercise by the State Engineer of his own judgment concerning the need for protecting the county of origin; for the latter there is no warrant.

A different situation exists with respect to sections 11460 and 11463. These sections, unlike 10505, do not require the exercise of discretion by an administrative official in order to make them operative. Instead, they express a limitation on the power of the public agencies, state and federal, to which they are directed. The law of the State so established is a matter of which the State Engineer is bound to take cognizance in passing on applications for water permits.

Such action by the State Engineer may involve the issuing of permits to (1) an inhabitant of a watershed of origin, seeking to obtain additional water to meet his increased needs, or (2) an assignee of an application filed by the state under section 10500.

As to the first category, in passing upon the application of a person qualifying for the priority granted by section 11460, the State Engineer is to be guided by the provisions of sections 11460-11463 *in addition to* the other standards provided by law for his guidance in issuing water permits (secs. 1200-1800). That is to say that an application, otherwise meritorious, made by a person who qualifies for the preference granted by these sections, is not to be denied or modified or conditioned as the result of any agreement, policy or practice on the part of the public agency constructing or operating the Central Valley Project which would deprive the applicant of any water from the watershed in question to which he would otherwise be lawfully entitled. In these circumstances the action of the State Engineer would be limited to the granting of the permit in proper form, but such action on his part would be a necessary prerequisite to the judicial enforcement of the mandates of sections 11460-11463.

As to any assignee under section 10504 of an application filed by the State, reference has already been made to the exclusive functions of the Department of Finance with respect thereto pursuant to section 10505. As noted, the State Engineer may incorporate into his permit all pertinent terms and reservations which were made a condition of the assignment by the Department of Finance.

If the assignee is an agency of the State engaged in the construction or operation of the Central Valley Project it is firmly bound, as a matter of law, by the provisions of sections 11460-11463 taken in conjunction with section 11128. And if the assignee is an agency of the federal government similarly engaged, it also is bound to comply with sections 11460 and 11463, not by operation of California law alone, however, but as a result of the operation of section 8 of the Federal Reclamation Act considered in conjunction with the law of California (see discussion, *supra,* VII). Therefore, as to either state or federal agencies engaged in construction and operation of the Central Valley Project, the State Engineer may incorporate into his permit as conditions thereof the limitations on the powers of such assignees established by sections 11460 and 11463. However, it should be noted that the statute imposes the limitations in any event, regardless of their inclusion or omission from the permit.

OPINION
of
EDMUND G. BROWN
Attorney General;
ADOLPHUS MOSKOVITZ,
Deputy Attorney General.

No. 54/159
January 5, 1955

The Honorable Pauline L. Davis, Member of the Assembly from the Second District, has asked our opinion on a series of questions arising out of a request by the Water Project Authority of the State of California that the Department of Finance assign to the authority for use in the proposed Feather River Project (Wat. Code sec. 11260) Applications Nos. 5629, 5630, 14443 and 14444 to appropriate water from the Feather River, which were originally filed by the Department of Finance pursuant to Water Code section 10500. A study of the water needs of the counties where the water covered by these applications originates is now being conducted by the Division of Water Resources pursuant to an appropriation contained in Item 249 of the Budget Act of 1954, but has not yet been completed. The specific questions we have been asked are as follows:

1. What evidence or other information that water covered by an application filed by the Department of Finance, pursuant to Water Code section 10500, is not necessary for development of a county where such water originates must the Department of Finance have before it can exercise its judgment as to whether an assignment of such application is permissible under Water Code section 10505, which prohibits any assignment that will deprive a county in which the appropriated water originates of any such water necessary for development of the county?

2. Could the Department of Finance properly base its judgment on recommendations of the Division of Water Resources if the department knows that the studies of the water needs of the counties of origin, pursuant to a specific appropriation therefor by the Legislature, have not been completed?

3. If the Department of Finance makes an assignment which specifies that it is subject to a reservation of all the water originating in any county which is necessary for development of that county, and on that basis finds that the assignment will not deprive any county in which the appropriated water originates of any such water necessary for development of such county, would the Department of Finance then be exercising the judgment committed to it by law or would it be attempting to delegate to the Division of Water Resources or the Water Project Authority its mandatory statutory duty to exercise its judgment in determining the water necessary for the counties of origin?

4. Since the requirements of due diligence become applicable to applications filed by the Department of Finance under Water Code section 10500 after they are assigned, is there any possibility that rights under the applications would be endangered if the Feather River applications were assigned and the statutory requirements of diligence were not thereafter met? If, for example, because of lack of funds the Water Project Authority could not proceed with diligence under the applications and there were other applications for the same water, the holders of which were ready to proceed with diligence, what would be the rights of such other applicants?

Our answers to these questions may be sumarized as follows:

1. Before the Department of Finance, pursuant to Water Code section 10505, can make an absolute assignment of an application filed under Water Code section 10500, it needs some data on the water needs of the counties where the water covered by such application originates, and on the water resources available to fill those needs, from which it can conclude that the assignment will not deprive such county of any such water necessary for its development. The amount and type of information necessary depends upon the facts of the particular case, and unless the Department of Finance acted arbitrarily, capriciously or entirely without evidentiary support, its decision could not be successfully challenged. But the department can make an assignment conditioned by a reservation of all water necessary for development of the counties of origin without any such data, since such a reservation would withhold from assignment whatever amount of water is from time to time determined to be needed in the counties of origin.

2. A finding by the Department of Finance, based upon advice of the Division of Water Resources, that an absolute assignment of an application will not deprive the counties of origin of needed water would not necessarily be improper merely because current studies of the water needs of such counties have not been completed. The fact that current studies of the water needs of counties of origin have not been completed would be completely immaterial if the assignment were not absolute, but were conditioned by a general reservation of all water necessary for development of the counties of origin.

3. An assignment of the Feather River applications conditioned by a general reservation of all the water originating in any county of origin which is necessary for development of that county would not constitute a delegation of any mandatory statutory duty of the Department of Finance. The Department of Finance has no duty to determine the amount of water necessary for development of counties of origin; its duty is to refrain from making any assignment of its applications which, in its judgment, will deprive a county in which water originates of any such water necessary for development of the county.

4. If the applications are assigned to the Water Project Authority, the authority will be subject to the requirements of part 2 of division 2 of the Water Code relating to diligence in correcting and publicizing applications, in constructing the necessary works, and in putting the water to beneficial use. Failure to comply with the time limits therein provided or to exercise "due diligence" in constructing the works and utilizing the water for beneficial purposes could result in cancellation of the applications and consequent freeing of the water for appropriation by later applicants. What constitutes "due diligence" depends upon the facts and circumstances of each case.

ANALYSIS

The questions asked require an analysis of Water Code sections 10500 to 10505.* They provide as follows:

10500. "The Department of Finance shall make and file applications for any water which in its judgment is or may be required in the development and completion of the whole or any part of a general or coordinated plan looking toward the development utilization, or conservation of the water resources of the State.

"Any application filed pursuant to this part shall be made and filed pursuant to Part 2 of Division 2 of this code and the rules and regulations of the State Engineer relating to the appropriation of water insofar as applicable thereto.

"Applications filed pursuant to this part shall have priority, as of the date of filing, over any application made and filed subsequent thereto. Until October 1, 1955, or such later date as may be prescribed by further legislative enactment, the statutory requirements of said Part 2 of Division 2 relating to diligence shall not apply to applications filed under this part, except as otherwise provided in Section 10504."

10504. "The Department of Finance may release from priority or assign any portion of any appropriation filed by it under this part when the release or assignment is for the purpose of development not in conflict with such general or coordinated plan. The assignee of any such application, whether heretofore or hereafter assigned, is subject to all the requirements of diligence as provided in Part 2 of Division 2 of this code. 'Assignee' as used herein includes, but is not limited to, state agencies, commissions and departments, and the United States of America or any of its departments or agencies."

10505. "No priority under this part shall be released nor assignment made of any appropriation that will, in the judgment of the Department of Finance, deprive the county in which the appropriated water originates of any such water necessary for the development of the county."

The first three questions concern specifically the meaning of section 10505. A general discussion of this section is contained in Opinion No. 53/298, in which we pointed out that the purpose of the section is to reserve for use in each county where water originates such amount of the water originating there and filed on by the Department of Finance under section 10500 as may be necessary now and in the future for development of that county. This reservation is accomplished by forbidding the Department of Finance to release the priority of or assign any application filed by it under section 10500 if, in its judgment, the release of priority or assignment* will result in depriving a county of origin of such needed water.

It is important at the outset to note the precise responsibility which has been delegated to the Department of Finance by section 10505. That responsibility is to refrain from making any assignment of any application filed under section 10500 if, in the judgment of the department, that particular assignment will deprive the users within a county of origin of water originating there which is necessary for development of the county. There is no requirement that the Department of Finance determine the water needs of a county, as long as it can discharge its delegated responsibility without such a determination. The real question involved in the first three questions listed above, therefore, is whether the department can reasonably conclude that an assignment will not have this forbidden result and hence may be made under section 10505, unless the department first ascertains the probable ultimate water needs in the county and the water resources available to fill them.

* Hereinafter section references are to the Water Code unless otherwise expressly designated.

* For the sake of simplicity, and because the questions we have been asked deal with the assignment and not the release of priority of appropriations, we shall limit our discussion hereinafter to assignments.

It seems clear to us that it would not be proper to make an absolute assignment of the whole or any portion of an application without some knowledge of the water needs and the water resources of the counties of origin. For only with such information can the department really consider whether the water covered by the application proposed to be assigned will or will not be needed. The amount and type of information which would be necessary would, of course, depend upon the circumstances of each case. And since, by section 10505, the decision is to be made "in the judgment of the Department of Finance," the determination of the department that its information is sufficient and that on the basis of that information the assignment will not prejudice the development of any county of origin would be subject to challenge only if arbitrary, capricious or entirely lacking in evidentiary support (*Tulare Water Co.* v. *State Water Com.* (1921) 187 Cal. 533, 538, 202 Pac. 874, 877; *Mann* v. *Tracy* (1921) 185 Cal. 272, 274, 196 Pac. 484, 485; *Brock* v. *Superior Court* (1952) 109 Cal. App. 2d 595, 605, 241 P. 2d 283, 290; *Roussey* v. *City of Burlingame* (1950) 100 Cal. App. 2d 321, 326, 223 P. 2d 517, 520).

The fact that studies of the water needs of the counties of origin and the water resources available to fill those needs are under way, but have not yet been completed, would not of itself make arbitrary, capricious or entirely lacking in evidentiary support a decision by the Department of Finance that an absolute assignment of the Feather River applications is now proper under section 10505. Advice from the Division of Water Resources or other information in the hands of the department might be a sufficient basis for such a decision. In any event, our understanding is that it is not proposed to make an absolute assignment of the Feather River applications. For this reason we will not discuss further the amount and type of information which the Department of Finance should have before it may make an absolute assignment.

The absence of information which the Department of Finance believes is sufficient to enable it to decide that an absolute assignment is proper does not, however, disable the department from acting. The mandate of the statute is that the department should not make an assignment that will deprive the counties of origin of needed water. If an assignment can be so conditioned that this result will not occur, there is nothing in the statute that prevents the department from making the assignment, despite the lack of data upon which the department can base a prediction as to the future quantitative water needs of the counties of origin. This, as we understand it, is what is proposed in the requested assignment of the Feather River applications. The assignment is to be conditioned by a general reservation of all the water originating in any county which is necessary for development of that county.

We know of no reason why such a reservation would not be effective and enforceable. An assignment of four applications to appropriate water in the Sacramento River and in the Sacramento-San Joaquin Delta, containing a similar reservation, has already been made to the United States for use in the Central Valley Project (Water Project Authority, Report on a Complete Management Survey in Connection with State Acquisition or Operation of the Central Valley Project (1953), III-43, III-44). And by a previous opinion this office approved the legality of this type of assignment (1 Ops. Cal. Atty. Gen. 632 (1943)).

We have been asked, however, whether such a general reservation does not attempt to delegate to others the mandatory nondelegable statutory duty of the Department of Finance to exercise its judgment in determining the water necessary for development of the counties of origin. This question assumes that the statute imposes on the Department of Finance the duty to determine the water needs of counties of origin before the department may make an assignment. If this assumption were correct, an assignment containing a general reservation would be invalid, for it clearly does leave open for later decision by others the question as to how much of the water covered by the assigned application is necessary for development of the counties of origin and thus is reserved from the assignment (see Opinion No. 53/298). But as we have already explained, this assumption is not, in our opinion, correct. The question on which the Department of Finance is required to exercise its judgment is whether a particular assignment will deprive a county of origin of needed water. When the department determines that an assignment, which expressly reserves in general terms whatever quantity of water may ultimately be needed in counties of origin, will not result in such a deprivation, it has exercised its judgment as directed by the statute. The further question of the precise quantitative needs of each county of origin with respect to an assigned Department of Finance application may be decided whenever and before whomever it first arises in concrete form.

The last question asked concerns specifically the effect of certain portions of sections 10500 and 10504. Section 10500 provides that an application filed pursuant thereto by the Department of Finance shall have priority, as of the date of filing, over any application made and filed thereafter, and that, except as otherwise provided in section 10504, the statutory requirements of part 2 of division 2 of the Water Code relating to diligence shall not apply to any such application until October 1, 1955, or such later date as may be prescribed by further legislation. Section 10504 provides that an assignee of any such application is subject to all the requirements of diligence as provided in part 2 of division 2 of the Water Code. In the light of these provisions, we have been asked whether the rights under the Feather River applications might be endangered if the applications were assigned to the Water Project Authority and then, because of lack of funds or for any other reason, the authority was unable to proceed with diligence while later applicants for the same water were ready to proceed with diligence.

The advantage of the exemption of an application filed under section 10500 from the generally applicable requirements of diligence in part 2 of division 2 of the Water Code is that the priority of the application as of the date of its filing is maintained even though the actual use of the water may be long delayed. But if the application is assigned, the requirements of diligence become applicable, presumably on the theory that no assignment will be requested or made unless the assignee is ready to proceed to perfect it by diligently constructing the necessary utilization works and actually putting the water to beneficial use.

Part 2 of division 2 of the Water Code, to which we are directed by section 10504 for the requirements relating to diligence, is entitled "Appropriation of Water" and is composed of sections 1200 through 1801. The significant sections appear to be the following:

1270. "A defective application made in a bona fide attempt to conform to the rules and regulations of the department and to the law secures to the applicant a priority of right as of the date of the application until he is notified in what respect his application is defective, and the applicant shall be allowed 60 days after notice of the defect in which to file an amended and perfected application."

1271. "If, within the 60 day period, the applicant does not file an amended and perfected application, the application shall be rejected and canceled, unless for good cause shown the department allows the applicant to file a further amended and perfected application."

1310. "If the application is for more than three cubic feet per second or for more than 200 acre-feet per annum of storage the notice of application shall be published in accordance with this acticle."

1311. "Upon receipt of notice of an application coming under this article, the applicant shall cause it to be published as directed by the department."

1312. "The notice shall be published at the expense of the applicant within 15 days of the date of issuance of the notice and in a newspaper having a general circulation and published within the county wherein the point of diversion lies, or, if there are points of diversion in more than one county, in each county in which a point of diversion lies."

1313. "In case there is no newspaper published within the appropriate county publication shall be made in a newspaper having a general circulation within the county."

1314. "The notice shall be published at least once a week for three consecutive weeks."

1315. "Proof of publication shall be filed by the applicant within 60 days from the date of issuance of the notice."

1316. "Proof of publication shall be by copy of the notice as published attached to and made a part of the affidavit of the publisher or foreman of the newspaper publishing the notice."

1320. "Notice of an application for three cubic feet or less per second or for 200 acre-feet or less per annum of storage shall be given by posting and mailing in accordance with this article."

1321. "Upon the date of issuance of notice of an application coming under this article the department shall mail three copies of the notice to the applicant by registered mail and shall also send a copy by registered mail to each person who is known to the department and who in its judgment is interested in the application because of ownership or location in the vicinity of the proposed appropriation."

1322. "The applicant shall post the notice within 15 days of the date of issuance thereof in at least two conspicuous places in the locality to be affected by the proposed appropriation."

1323. "Proof of posting shall be by affidavit of the applicant or the person posting notice on behalf of the applicant and shall be filed within 40 days from the date of issuance of notice."

1395. "Actual construction work upon any project shall begin within the time specified in the permit, which time shall not be less than 60 days from the date of the permit."

1396. "The construction of the work thereafter and the utilization of water for beneficial purposes shall be prosecuted with due diligence in accordance with this division, the terms of the permit, and the rules and regulations of the department."

1397. "The work shall be completed and the water applied to beneficial use in accordance with this division, the rules and regulations of the department, and the terms of the permit and within the period specified in the permit."

1398. "The period specified in the permit for beginning construction work, for completion of construction work, for application of water to beneficial use, or any or all of these periods may, for good cause shown, be extended by the department."

1410. "If the work is not commenced, prosecuted, and completed, or the water applied to beneficial use as contemplated in the permit and in accordance with this division and the rules and regulations of the department, the department shall, after notice in writing and mailed in a sealed, postage prepaid and registered letter addressed to the permittee at the address given in his application, and after a hearing, revoke the permit and declare the water subject to further appropriation."

1450. "Any application properly made gives to the applicant a priority of right as of the date of the application until such application is approved or rejected. Such priority continues only so long as the provisions of law and the rules and regulations of the department are followed by the applicant."

These sections concern diligence at two stages of the appropriations procedure. At the application stage, they provide that within specified time limits the application must be amended if it is faulty (secs. 1270, 1271) and that notice of the application must be published or posted and mailed (secs. 1310-1323).

The more important requirements apply after a permit has been issued. They provide that construction of the work and utilization of the water for beneficial purposes shall be prosecuted with "due diligence in accordance with this division, the terms of the permit, and the rules and regulations of the department" (sec. 1396) and that initiation and completion of construction of the works and utilization of the water shall be accomplished within the periods specified by the State Engineer in the permit, which may be extended by the State Engineer for good cause shown (secs. 1395, 1397, 1398). Failure to abide by these rules is a ground for revoking the permit, which frees the water for further appropriation (sec. 1410), while compliance with these rules will maintain the priority of the applicant as of the date of the application (sec. 1450).

Although these sections have never been judicially construed, it is our opinion that the reference to "due diligence" in section 1396 probably imposes an obligation which in certain circumstances may not be discharged simply by compliance with the time limits set forth in the permit. We believe this to be so because unless the requirement of "due diligence" meant something more or different than observance of the deadlines in the permit, there would have been no reason to include it in the statute.

"What constitutes due diligence must be determined on the facts of each case. It is a question of fact for the jury" (1 Wiel, Water Rights in the Western States (3d ed. 1911) 414). In an early California case, it was held that to constitute diligence, "only such indications and evidences of appropriation are required, as the nature of the case and the facts of the country will admit of, and are under the circumstances and at the time practicable—and surveys, notices, stakes and blazing of trees, followed by work and actual labor, without any abandonment, will in every case, where the work is completed, give title to water over subsequent claimants" (*Kimball* v. *Gearhart* (1859) 12 Cal. 27, 29, 50). Under these general principles, it has uniformly been held that pecuniary inability of a claimant to complete the construction work within a reasonable time does not excuse his failure to exercise diligence (*Mitchell* v. *Canal etc. Co.* (1888) 75 Cal. 464, 482, 17 Pac. 246, 251; *N. C. & S. C. Co.* v. *Kidd* (1869) 37 Cal. 282, 314; *Kimball* v. *Gearhart* (1859) 12 Cal. 27, 31). The most recent California decision on the question of diligence concluded that lack of diligence was established as a matter of law by a claimant's unexplained delay of 18 years in seeking to dissolve an injunction, imposed shortly after he initiated his claim, against his using the intended diversion works (*Sierra Land etc. Co.* v. *Cain Irr. Co.* (1933) 219 Cal. 82, 25 P. 2d 223).

Thus, assignment of the Feather River applications to the Water Project Authority would subject them under existing law to the danger of cancellation if the authority were unable to comply with the deadlines for actions contained in the permits issued thereunder or if the authority failed to proceed diligently under the circumstances. This would free the water for appropriation by subsequent applicants.

APPENDIX J

ULTIMATE EXPORTABLE WATER FROM SACRAMENTO RIVER BASIN UNDER THE CALIFORNIA WATER PLAN

This appendix presents the results of studies which show that in addition to furnishing a complete supply for the probable ultimate water requirements for all lands in the Sacramento River Basin, it would be possible to furnish from the runoff tributary to that basin an average supply in the Delta of about 10,500,000 acre-feet per season for export to areas of deficiency in California.

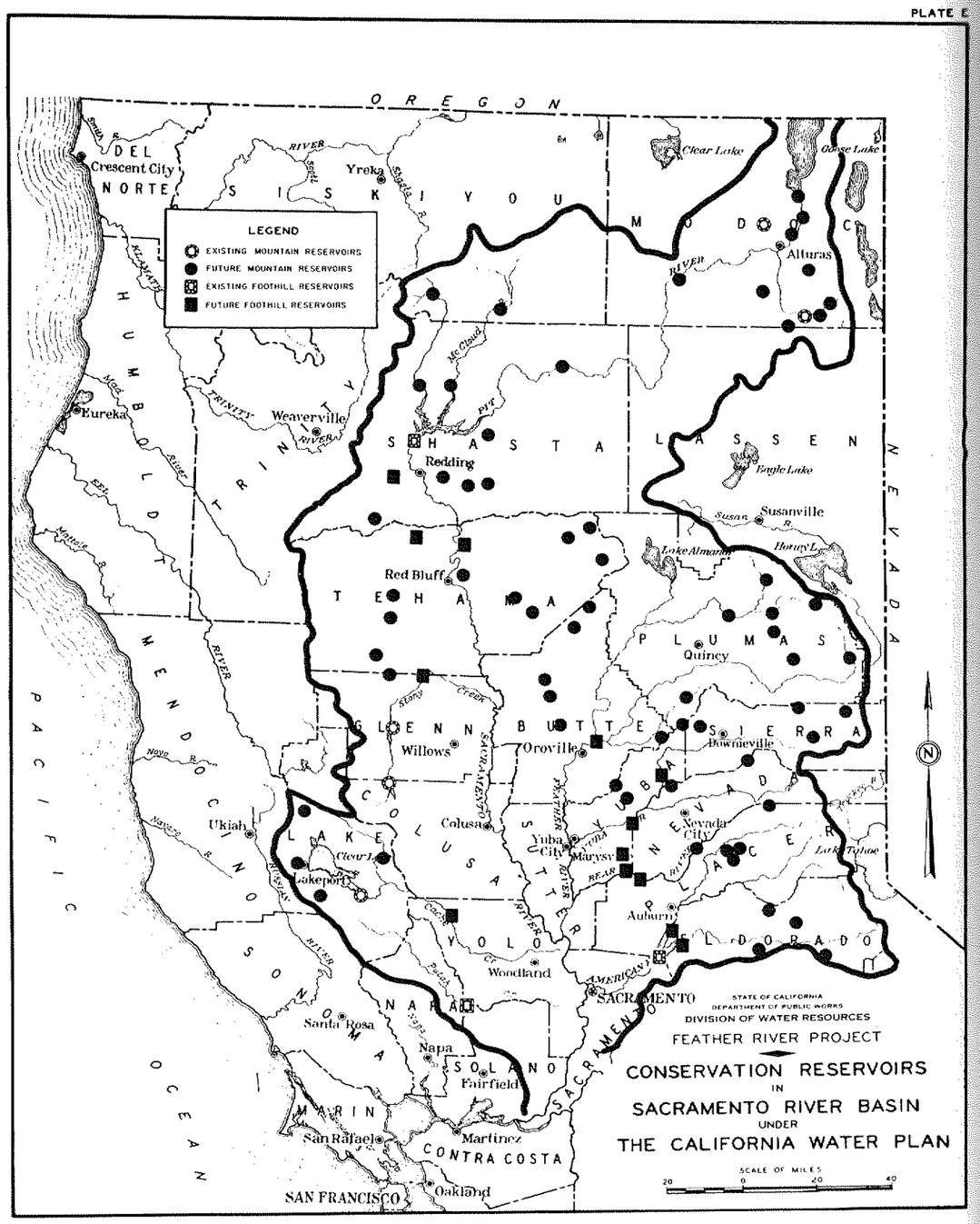
The results presented herein are based upon studies made in connection with the current State-wide Water Resources Investigation being conducted by this Division for the State Water Resources Board. The results of these studies are being published in three bulletins. The first, Bulletin No. 1, "Water Resources of California", was published in 1951. The second, Bulletin No. 2, "Water Utilization and Requirements of California", is currently being published. The studies leading to the publication of third bulletin, Bulletin No. 3, "Plan for Development of Water Resources of California", are well under way, and it is planned to publish this bulletin about July 1, 1956. The results of the studies presented in Bulletin Nos. 1 and 2 were utilized in the preparation of this appendix, as well as those pertaining to Bulletin No. 3 insofar as they have been completed. There is also in progress by this Division another water resources investigation in the 15 northeastern counties of California, most of which lie wholly or in part in the Sacramento River Basin. Since the studies leading to Bulletin No. 3, and those for the Northeastern Counties Water Resources Investigation, are not as yet complete, certain plans proposed for the development of the water resources in the Sacramento River Basin presented herein will be subject to modification upon completion of the indicated studies.

For the purpose of the State-wide Water Resources Investigation the State of California was divided into seven major hydrographic areas, mainly upon topographic lines. The Sacramento River Basin lies in a portion of the Central Valley Area, one of the seven major areas. In addition, for the purpose of making studies of present water utilization and the determination of probable ultimate water requirements, these major areas were further subdivided in Bulletin No. 2 into smaller hydrographic areas. By means of these hydrographic areas, the mountain and foothill areas of the Sacramento River Basin were segregated from those on the Sacramento Valley floor. For each of the hydrographic areas, the present and probable ultimate water requirements for all purposes will be set forth in Bulletin No. 2. These water requirements were utilized for the studies presented herein.

Although actual diversions usually exceed consumptive use, these excess diversions result in return flows which are available for utilization in downstream areas. Therefore, for purposes of the determination of the amount of water available for export from the Sacramento Valley, it is the consumptive use and any irrecoverable losses that must be deducted from available water supplies to determine water available for export. In the mountain areas return flows from diversions in excess of consumptive use and irrecoverable losses are available to reservoirs at the edge of the valley floor for conservation and use to satisfy water requirements in the Sacramento Valley and for export. In the Sacramento Valley areas, return flows not utilized within the valley would become available in the Sacramento-San Joaquin Delta for use therein and for export.

The present irrigated areas in the Sacramento River Basin are found to be 263,000 acres in the mountain areas and 764,000 acres in the Sacramento Valley. It is estimated that these areas will increase under conditions of probable ultimate development to 1,217,000 acres in the mountain areas and to 2,008,000 acres in the valley. Studies indicate that the present consumptive use and irrecoverable losses in the mountain areas are about 420,000 acre-feet per season and that in the Sacramento Valley they are 3,400,000 acre-feet per season. Under conditions of probable ultimate development, it is estimated that these uses will increase to 2,150,000 acre-feet per season in the mountain areas and 5,500,000 acre-feet per season in the valley.

Plans to meet the water requirements in the mountain and foothill areas were formulated on the assumption that it would be necessary to conserve the local runoff by means of surface storage reservoirs to furnish a supply without deficiency to meet the ultimate requirements of these areas. The future reservoirs which have been considered for utilization under The California Water Plan in these areas are shown on Plate E, "Conservation Reservoirs in the Sacramento River Basin Under The California Water Plan".



Studies for furnishing the probable ultimate water requirements of the Sacramento Valley and the 10,500,000 acre-feet of average annual water supply for export were made on a different basis than those for the mountain areas. It was found in the studies of the State-wide Water Resources investigation that sufficient surface storage reservoir capacity was not available to regulate the runoff of the State to a sufficient degree to furnish ultimate local water requirements in the Sacramento River Basin and also water for export to areas of deficiency. The studies showed that to accomplish this it was necessary to use the large ground water storage capacity available in the Central Valley and operate it in conjuction with foothill surface storage reservoirs to furnish the desired supply. The foothill surface storage reservoirs considered for utilization under The California Water Plan are also shown on Plate E.

The foothill reservoirs considered for utilization for the regulation of the impaired mountain runoffs for use in the Sacramento Valley and for export are Shasta and Table Mountain Reservoirs on the Sacramento River, Oroville Reservoir on the Feather River, Narrows and Bullards Bar Reservoirs on the Yuba River, Camp Far West and Garden Bar Reservoirs on the Bear River, Folsom, Auburn, and Salmon Falls Reservoirs on the American River, Black Butte Reservoir on Stony Creek, Guinda Reservoir on Cache Creek, and Monticello Reservoir on Putah Creek. On some of these streams it will be necessary to provide additional surface storage in order to obtain the necessary regulation. This additional storage can be located upstream from the foothill reservoirs and may be used in part for the production of hydroelectric power.

The studies show that in addition to furnishing the probable ultimate water requirements on the Sacramento Valley floor, these reservoirs, together with ground water storage, will make available an average supply of about 10,500,000 acre-feet annually in the Delta for export to areas of deficiency.

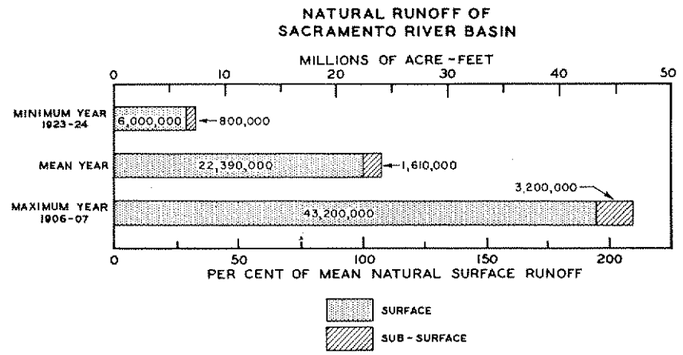
The results of these studies are shown in the accompanying summary tabulation. For the purposes of this tabulation the Sacramento River Basin has been divided into three subareas, that above the gaging station on the Sacramento River near Red Bluff and those of the western and eastern tributaries to the Sacramento River below Red Bluff. This summary tabulation shows the total basin water supply, the upstream water use in mountain and foothill areas, the net downstream water supply, use in the Sacramento Valley floor area, and the conservation storage required to effect the desired degree of regulation of the available supply. This tabulation shows that, in addition to providing for the probable ultimate water requirement of the mountain and foothill and Sacramento Valley areas in the Sacramento River Basin, there would be available for export in the Sacramento Delta an average supply of 10,500,000 acre-feet per season. To accomplish this it would be necessary to provide some 22,000,000 acre-feet of storage capacity in surface reservoirs and also to utilize the 28,000,000 acre-feet of ground water storage capacity in the Sacramento Valley and the 30,000,000 acre-feet in the San Joaquin Valley, with a total effective conservation storage capacity of 80,000,000 acre-feet.

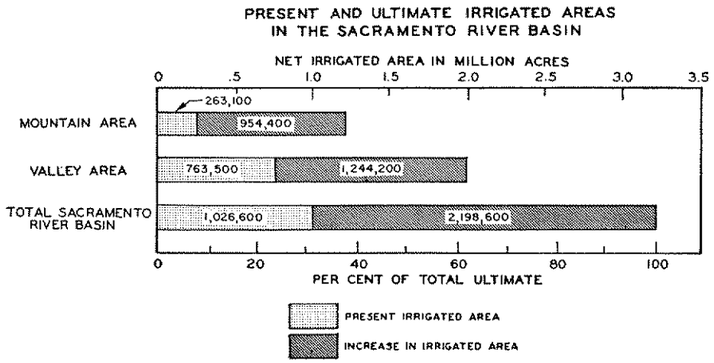
Of the 16,000,000 acre-foot water supply available for Sacramento Valley use and export, 10,200,000 acre-feet would be a firm supply from the surface storage reservoirs of the basin, 2,800,000 acre-feet would be regulated in the ground water of the Sacramento Valley, and 3,000,000 acre-feet would be regulated by ground water storage in the San Joaquin Valley. If storage in the ground water basins was not utilized, 4,700,000 acre-feet annually would be available for export to areas of deficiency. The utilization of the water supply of the Sacramento River Basin is shown on Plate F.

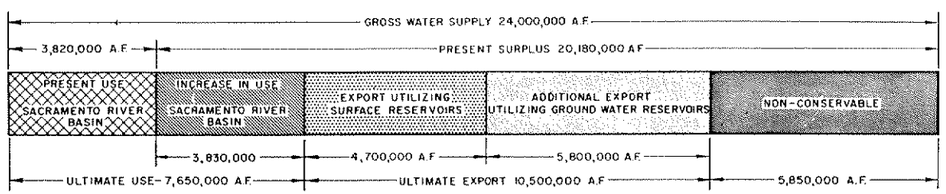
In addition to the 10,500,000 acre-feet of water per season which could be made available for export from the Sacramento River Basin under The California Water Plan, an additional 11,000,000 acre-feet of water per season would be exported from the North Coastal Areas to areas of deficiency in California.

While the amounts of water required to be furnished under the California Water Plan will not all be needed until conditions of ultimate development have been attained, it must be realized that to provide sufficient water supplies to sustain the continued growth of California, it will be necessary to provide orderly additions to the Feather River Project. Plans have progressed sufficiently to indicate that the next unit needed for development to sustain this growth will probably be the complete development of the American River Basin. On that stream upstream reservoirs and Folsom Reservoir would be operated in conjunction with ground water basins in the Sacramento and San Joaquin Valleys. This method of operation of the complete development of the American River Basin would result in an average utilizable supply from that basin of some 2,300,000 acre-feet of water annually. Of this amount, about 1,150,000 acre-feet would be utilized in local areas which it is expected will be dependent on the American River for supplemental supplies, and there would remain 1,150,000 acre-feet per season available for export to areas of deficiency in other parts of California. If Folsom and the other proposed reservoirs were operated to provide a firm supply without utilization of ground water storage, the amount of water available for export would be decreased to 400,000 acre-feet per season.

PLATE F







WATER UTILIZATION IN THE SACRAMENTO RIVER BASIN

DIVISION OF WATER RESOURCES

SUMMARY OF ULTIMATE MEAN SEASONAL SUPPLY, USE AND DISPOSAL OF SACRAMENTO RIVER BASIN WATER

Total Basin Water Supply
(In acre-feet)

Runoff from area above Red Bluff	8,538,000
Runoff from west side tributaries	1,905,000
Runoff from east side tributaries	11,626,000
Total runoff at base of foothills	22,069,000
Runoff from Sacramento Valley floor	321,000
Subtotal (Sacramento River at Sacramento)	22,390,000
Groundwater outflow	1,610,000
Total basin water supply	24,000,000

Upstream Water Use
(In acre-feet)

Item	*Area above Red Bluff*	*West side tributaries*	*East side tributaries*	*Total*
Gross diversions	1,263,000	682,000	1,276,000	3,221,000
Consumptive use	754,000	371,000	677,000	1,802,000
Evaporation and other irrecoverable losses	313,000	109,000	400,000	822,000
Increased runoff due to change in land use	195,000	119,000	160,000	474,000
Net stream flow impairment	872,000	361,000	917,000	2,150,000

Net Downstream Water Supply and Use
(In acre-feet)

Source of supply	*Character and quantity of supply*			
	Firm	*Secondary*	*Unregulated*	*Total*
Foothill Reservoir releases				
From area above Red Bluff	3,700,000	2,000,000	1,966,000	7,666,000
From west side tributaries	700,000	600,000	244,000	1,544,000
From east side tributaries	5,800,000	3,200,000	1,719,000	10,719,000
Subtotals	10,200,000	5,800,000	3,929,000	19,929,000
Precipitation on valley floor				
Deep percolation	- - -	1,610,000	- - -	1,610,000
Surface runoff	- - -	- - -	321,000	321,000
Total water supply	10,200,000	7,410,000	4,250,000	21,860,000
Useable water supply	10,200,000	5,800,000*	0	16,000,000
Water requirements of Sacramento Valley floor				5,500,000
Available for export				10,500,000

* Not all of the secondary water supply is considered to be conservable in the ground water storage basins of the Sacramento and San Joaquin valleys.

Conservation Storage Requirements
(In acre-feet)

Location	*Net effective storage*		
	Above foothill line	*At or near foothill line*	*Total*
Area above Red Bluff	1,700,000	5,300,000	7,000,000
West side of tributaries	1,350,000	1,650,000*	3,000,000*
East side tributaries	2,150,000	9,850,000	12,000,000
Total surface storage	5,200,000	16,800,000	22,000,000
Ground water storage in Sacramento Valley			28,000,000*
Ground water storage in San Joaquin Valley			30,000,000
Total effective conservation storage			80,000,000

* Excludes 1,000,000 acre-feet of storage in Monticello Reservoir on Putah Creek which is overdeveloped in relationship to runoff.

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