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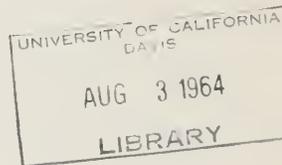
THE RESOURCES AGENCY OF CALIFORNIA  
Department of Water Resources

BULLETIN No. 137-1

SACRAMENTO VALLEY  
EAST SIDE INVESTIGATION

Progress Report

MAY 1964



HUGO FISHER

*Administrator*

The Resources Agency of California

EDMUND G. BROWN

*Governor*

State of California

WILLIAM E. WARNE

*Director*

Department of Water Resources



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PLATE

Plate No.

1	"Possible Plans for Water Development and Potential Service Areas" . . . . .
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THE RESOURCES AGENCY OF CALIFORNIA  
DEPARTMENT OF WATER RESOURCES

1120 N. STREET, SACRAMENTO

March 16, 1964

Honorable Edmund G. Brown, Governor  
and Members of the Legislature  
of the State of California

Gentlemen:

I am pleased to transmit herewith a report entitled "Sacramento Valley East Side Investigation: Progress Report." This investigation was proposed by the department under the California Water Resources Development Program. The Legislature concurred in this selection by the inclusion of study funds in the Budget Act of 1961. The investigation was initiated in July 1961 and is scheduled for completion in June 1966.

This report is submitted at this time to more clearly define the objectives and scope of the investigation, discuss the progress made to date, and outline the course for future studies. The report and available background material will also provide information which may be useful to interested local agencies.

Sincerely yours,

A handwritten signature in cursive script that reads "William E. Warne".

Director

STATE OF CALIFORNIA  
THE RESOURCES AGENCY OF CALIFORNIA  
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor  
HUGO FISHER, Administrator, The Resources Agency of California  
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under the supervision  
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CALIFORNIA WATER COMMISSION

RALPH M. BRODY, Chairman, Fresno

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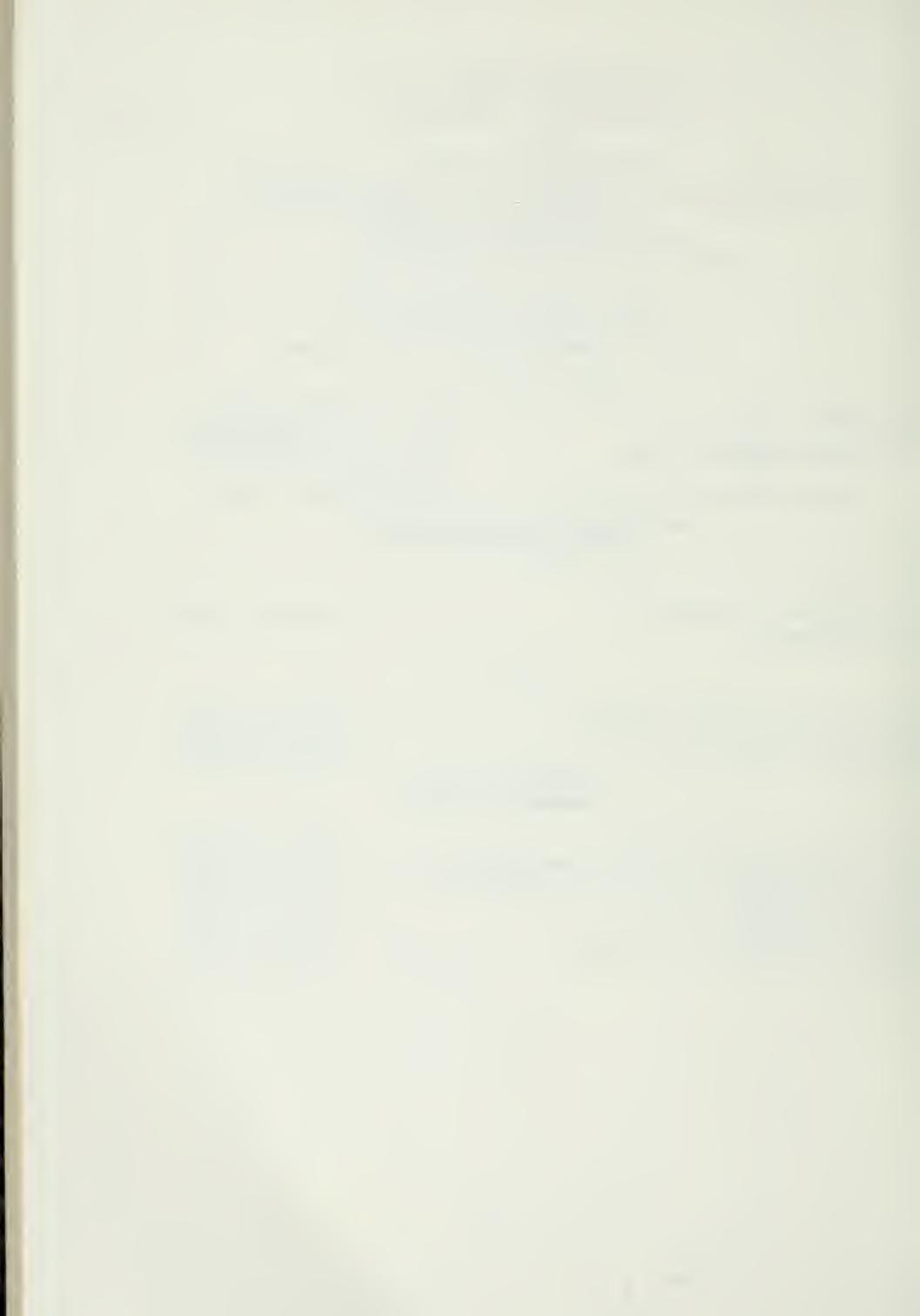
NORRIS POULSON, La Jolla

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WILLIAM M. CARAH  
Executive Secretary

ORVILLE ABBOTT  
Engineer



## CHAPTER I. INTRODUCTION

The Sacramento Valley East Side Investigation study area consists of a 2,000 square-mile area in the northeastern portion of the Central Valley of California. The area includes the watersheds of Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks, and several smaller tributary streams. Runoff from the area, amounting to about 1.2 million acre-feet on a mean annual basis, is almost completely uncontrolled since there are no existing reservoirs having more than a few thousand acre-feet of storage capacity. Due to the relatively large potential for water conservation projects in the east side area, the Department of Water Resources undertook this comprehensive investigation to formulate sound and acceptable water development plans. The investigation, which has been in progress since 1961, is scheduled for completion in 1966.

The purposes of this progress report are to present the historical background for the current studies, to summarize the activities and progress of the investigation to date, and to outline the work program necessary to complete the investigation. The report is divided into four chapters. Chapter I contains a brief discussion of the history which led to authorization of the investigation, the objectives and scope of the investigation, and a description of the area of investigation. Chapter II presents a summary of the work accomplished in the collection, development, and interpretation of basic engineering and related data. Chapter III outlines the plans for water development which are currently being evaluated and discusses some of the more significant problems associated with the evaluation. It also presents a preliminary benefit-cost estimate of possible initial project

features on Deer and Mill Creeks. Chapter IV discusses the work program necessary for completion of the investigation.

### Historical Background

Several prior investigations have been conducted by federal, state, and local agencies to determine the feasibility of certain water resources developments within the investigational area. The possibility of constructing a major storage reservoir on Deer Creek at Deer Creek Meadows, the best topographically suitable site for a large reservoir within the area, has long been considered the major feature of plans for the development of east side streams. The possibility of developing smaller storage reservoirs on Antelope, Mill, Deer, Chico, and Butte Creeks, and off-stream storage sites on the edge of the valley floor, have also been studied.

The dynamic growth of demand for water-oriented recreation, the growing emphasis for preservation and enhancement of anadromous fisheries, and the rapid development of water resources in California have created a need for up-to-date studies in the east side area. Present studies indicate that through multipurpose use of the waters of east side streams, comprehensive plans can be developed which are suitable for near-future construction.

### Authorization for Investigation

The Legislature has long recognized the importance of developing the State's water resources to satisfy the growing demands for water in all areas of the State. Realizing the need for development, yet recognizing that the present and future interests of areas of origin of water must be safeguarded, the Legislature established the California Water Resources Development Program in 1959. The Sacramento Valley East Side Investigation was proposed by the Department of Water Resources under this program, to

bring the previous studies in this area up to date. The Legislature concurred in this selection by the inclusion of \$50,000 in the 1961-62 budget to begin the study. The total cost of the investigation is estimated to be \$500,000.

#### Area of Investigation

The area under investigation is made up of valley and mountainous lands lying east of the Sacramento River on the western slope of the Sierra Nevada and Cascade Range. It consists of the entire drainage basins of Paynes, Antelope, Mill, Deer, Big Chico, and Butte Creeks, and contiguous portions of the Sacramento Valley floor. It is bordered by the Battle Creek Divide on the north, the Feather River Divide on the east, the Sutter Buttes on the south, and the Sacramento River on the west. This area comprises approximately 2,000 square miles, including about 700 square miles of valley floor lands. The elevation of the area varies from 50 feet above sea level near the mouth of Butte Creek to 10,457 feet at Lassen Peak in the Cascade Range. The boundary of the area of investigation is delineated on Plate No. 1 entitled "Possible Plans for Water Development and Potential Service Areas."

Lands within the Sacramento Valley East Side investigational area that are considered to have possibilities for agricultural development in the near future are limited generally to the better lands on the valley floor. These valley floor lands have been divided into three potential service areas: (1) the Los Molinos-Vina Service Area; (2) the Chico Canal Service Area; and (3) the Butte Creek Basin Service Area. These service areas are delineated on Plate No. 1. The Los Molinos-Vina Service Area lies between the Cities of Chico and Red Bluff on the east side of the Sacramento River. It is bounded by Rock Creek on the south; the valley floor

line on the east and north; and a combination of the Southern Pacific Railroad, U. S. Highway 99E, and the Chico Canal Service Area on the west. The area west of U. S. Highway 99E was excluded from the service area because previous studies for the Upper Sacramento River Basin Investigation indicate that ground water development in that area will provide the cheapest and best source of supplemental water. The Chico Canal Service Area consists of lands on the east side of the valley floor in the vicinity of Chico. It is bounded generally by the Los Molinos-Vina Service Area on the north; the 200-foot contour, the City of Chico, and the Durham Mutual Water Company on the east; the Western Canal Company on the south; and the Parrott Investment Company and the Southern Pacific Railroad on the west. The boundaries of this service area were determined by the U. S. Bureau of Reclamation in 1951 during the course of their Sacramento Canals Unit Investigation. The Butte Creek Basin Service Area consists of valley floor lands south of Chico between the Sacramento and Feather Rivers. It is bounded generally by the Chico Canal Service Area and the Oroville-Chico Road on the north; the Feather River on the east; Pennington Road and the Sutter-Buttes on the south; and the Sacramento River on the west.

Higher elevation lands delineated on Plate No. 1 as Eden, Forest Ranch, and Cohasset Ridge, may also have possibilities for near-future water supply development. These areas are expected to develop primarily as home site and recreational developments which could pay more than normal agricultural rates for water.

#### Water Problems in the Investigational Area

Lack of adequate water supplies has hindered residential development in prime mountainous plateau lands in the east side area. Where water is available to these lands, such as at the community of Paradise, extensive

development has occurred. The ridge lands north of Paradise along the east side of Butte Creek and the Cohasset Ridge west of Big Chico Creek are examples of areas where similar developments can be expected if water is made available. The development of summer homes in the Deer Creek Meadows area has been retarded due to downstream irrigators on the valley floor having water rights to essentially the full natural flow of Deer Creek during the summer months of average and below average runoff years.

There are presently many acres of irrigable but unirrigated agricultural lands in the valley floor portion of the investigational area. Irrigation diversions on the valley floor take nearly all of the summer and early fall flows from the major streams in the east side area. Ground water pumping has developed in recent years to supplement these diversions and increase the firm irrigation water supply. This supplemental ground water pumping during the peak summer months allows irrigators to use greater amounts of surface water in the spring and fall and still make beneficial use of the diverted water. This trend will probably continue as more irrigable lands are developed.

Because of increased diversions of surface waters from east side streams anadromous fish populations are being reduced. Although adequate flows exist above the valley floor line, access to these reaches is often cutoff by lack of water in the lower reaches where the diversions occur. During many years this access is cutoff before all the spring-run salmon can get above the valley floor. Consequently many spring-run salmon die without spawning. A similar problem exists for fall-run fish. Sufficient quantities of water are not available early enough in the fall of many years to allow all the fall-run salmon to spawn.

Spring and winter floods cause damages to agricultural lands along streams in the east side area. The frequency and severity of damage

varies from stream to stream, but some flood problems exist along all of the streams in the area.

### Objectives and Scope of Investigation

The objectives of the Sacramento Valley East Side Investigation are: (1) to develop plans that outline the manner in which the water resources of the area can most economically be developed to meet future water requirements; and (2) to evaluate in detail those project units considered likely for near-future construction.

The scope of the Sacramento Valley East Side Investigation is long-range and comprehensive. Detailed consideration is being given to the full development and enhancement of all water and water-associated resources.

The investigation encompasses virtually all aspects of water development, control, and utilization. Studies range from cursory examinations, through reconnaissance evaluations, to detailed estimates and projections. Project units are designed to meet economic demands for local agricultural and industrial water service, provide for enhancement of the recreational and fishery resources, reduce flood flows within and from the area, develop the hydroelectric power potential of the streams if feasible and, to the extent possible, sustain an export supply to the Sacramento-San Joaquin River Delta.

### Related Investigations and Reports

Previous studies by various local, state, and federal agencies have been reviewed during this investigation. The most extensive of these was made by the Division of Water Resources, the predecessor of the Department of Water Resources. Results were presented in "The California Water Plan," published in 1957. Other less extensive investigations include various water supply papers of the United States Geological Survey; published and unpublished

reports by the U. S. Bureau of Reclamation and the Corps of Engineers; other studies by the Department of Water Resources and its predecessors; and reports prepared by local agencies, utilities, and engineering consulting firms.

Reports of related investigations consulted during this investigation are listed below:

U. S. Department of the Interior, Bureau of Reclamation

"Sacramento Canals Unit, Sacramento River Division, Central Valley Project, California." 1951.

An unpublished report on the Chico Canal Service Area.

U. S. Department of the Army, Corps of Engineers

"Master Manual of Reservoir Regulation, Sacramento River Basin, California."

U. S. Department of the Interior, Geological Survey

Geologic Features and Ground Water Storage Capacity of the Sacramento Valley, California, 1961. Water Supply Paper 1497.

Interchange of Surface and Ground Water Along Tributary Streams in the Central Valley, California, 1961.

Water Power Resources of Mill and Deer Creeks, California, 1941.

U. S. Fish and Wildlife Service

An Investigation of Fish-Salvage Problems in Relation to Shasta Dam, Special Scientific Report No. 10, 1940.

Supplementary Report on Investigations of Fish-Salvage Problems in Relation to Shasta Dam, Special Scientific Report No. 26, 1943.

Upper Sacramento River Sport Fishery, Special Scientific Report No. 34, 1950.

Preliminary Report on Fish and Wildlife Resources, Butte Basin, California, 1954.

California State Water Resources Board

Bulletin No. 1, "Water Resources of California." 1951.

Bulletin No. 2, "Water Utilization and Requirements of California." 1955.

California State Department of Water Resources

Bulletin No. 3, "The California Water Plan." 1957.

Bulletin No. 58, "Northeastern Counties Investigation." 1960.

Bulletin No. 98, "Northeastern Counties Ground Water Investigation." 1963.

Bulletin No. 26-1, "Upper Sacramento River Basin Investigation. 1964. (Preliminary edition)

Local Agencies and Engineering Consulting Firms

"Preliminary Reconnaissance Watershed Survey, Antelope Creek, Salt Creek and Tributaries" prepared for the Lassen View Soil Conservation District by Charles S. McCandless and Company, 1963.

## CHAPTER II. INVESTIGATIVE ACTIVITIES

The early phases of the Sacramento Valley East Side Investigation were devoted primarily to the collection and analysis of basic data fundamental to the proper formulation of plans for development of the water resources of the area. These data were divided into the following eight categories; hydrology, topographic mapping, geology, design and cost estimates, fish and wildlife, recreation, land and water use, and economics.

### Hydrology

Both rainfall and snowmelt supply the streams of the East Side stream group. Variations in topography, vegetative cover, and geologic structure of the watersheds effect the pattern and regimen of runoff. Although precipitation occurs principally in the winter months, the carry-over effect of snow packs causes high spring runoff in the basins which have headwaters at high elevations. Precipitation percolates into the volcanic formations of the area and the slow discharge from these formations results in high summer flows for many of the streams in the area, notably Deer and Mill Creeks.

Estimates of natural and impaired runoff in east side streams were made from historical streamflow records, from correlation with the runoff of nearby streams, from area precipitation relationships, and from correlations with precipitation records.

In this investigation, the 40-year period from October 1, 1921, through September 30, 1961, has been selected as the base period for water supply studies. This period has been selected because of availability of data and because it includes the critical dry period of record. The average

runoff for this 40-year period is approximately 98.5 percent of the estimated mean for the 50-year period from October 1, 1911, through September 30, 1961.

Adequate streamflow records were available for evaluating the water supply from most major east side streams. Estimates of natural and present impaired streamflow have been made at all proposed damsites, and on the edge of the Sacramento Valley floor. Plate No. 1, at the end of this report, shows the location of points at which estimated and recorded streamflow data have been compiled.

Although surface runoff comprises the major portion of presently utilized water supply within the Sacramento Valley East Side area, ground water resources are perhaps the most significant source of new water to meet near future municipal, industrial, and agricultural water demands on the valley floor. At the present time ground water resources of the basin are not fully developed, due to the availability of low cost surface water supplies. However, present trends have been toward expanded use of the ground water basin. Consequently, studies are being made to determine the availability and costs of ground water as an alternate or supplement to surface water supplies.

Flood frequency analyses have been made to develop a means of determining flood control benefits and spillway design capacities for Crown and Deer Creek Meadows Reservoirs. These reservoirs are described in Chapter III. The first analysis developed frequency discharge relationships, operational criteria, and other data from which flood control benefits attributable to operation of these reservoirs could be evaluated. The second analysis was made to derive hydrographs of the one-in-twenty-five-year flood,

the standard project flood and the probable maximum flood at these reservoirs. Hydrographs of these flood inflows were prepared and flood routing studies were made at these reservoirs to determine the required spillway capacities.

#### Topographic Mapping

An extensive topographic mapping program of proposed dam and reservoir sites and conduit routes was conducted for design of project features and for determination of reservoir depth-area-capacity relationships. Topographic maps at a scale of 1 inch equals 300 feet, with a 10-foot contour interval, have been prepared for the following reservoirs: Morgan Springs and Savercool on Mill Creek; Deer Creek Meadows and Sugarloaf on Deer Creek; and Web Hollow on Big Chico Creek. These maps, together with mapping already available from other agencies, provided sufficient topographic coverage for the studies so far initiated. Additional topographic mapping is in progress and will be completed before final plans are developed.

#### Geology

Geologic studies for dam and reservoir sites in the Sacramento Valley East Side Investigation include both surface and subsurface exploration. The objective of these geologic investigations is to determine foundation conditions and the availability of construction materials for the proposed structures. At the Deer Creek Meadows site, both geologic mapping and subsurface explorations were used to evaluate foundation conditions and to determine the availability and suitability of borrow materials. Geologic investigations of Crown, Sugarloaf, and Morgan Springs dam and

reservoir sites were limited to reconnaissance geologic mapping. Data obtained from these studies provided a basis for designs and estimates of cost of possible water development facilities. Preliminary reports on the engineering geology of Deer Creek Meadows, Crown, Morgan Springs, and Sugarloaf damsites have been prepared.

Some preliminary geologic mapping and limited subsurface exploration has been done in the area in connection with ground water studies being conducted for the Upper Sacramento River Basin Investigation and for the Coordinated Statewide Planning Program.

Additional geologic mapping in the east side area will be conducted during 1964 and 1965. Further subsurface exploration and borrow exploration of damsites is scheduled in 1964-65. Due to questionable foundation conditions, additional subsurface exploration will be done at Deer Creek Meadows damsite before final designs are completed.

#### Design and Cost Estimates

The preparation of reliable designs and cost estimates is a necessary step in the economic evaluation of water development projects and in the selection of the most favorable alternatives. Preliminary designs and cost estimates have been completed for a water development project in the Mill and Deer Creek Basins. These costs, which are presented in Chapter III, include a factor of about 32 percent of estimated capital costs to provide for the costs of engineering, administration and contingencies. An allowance was also made to cover the cost of interest during construction. Annual costs were computed for a 100-year capital recovery period and a 4 percent interest rate with an appropriate allowance added for operation, maintenance, and replacement.

Future work will include development of designs and cost estimates for features on the other streams in the east side area and for alternative projects on Mill and Deer Creeks.

#### Fish and Wildlife

Fish and wildlife constitute renewable natural resources which are being given full consideration in this investigation. The fish and wildlife phase of the investigation is being conducted by the Department of Fish and Game under contract with the Department of Water Resources. The major objectives of these studies include: (1) inventory of existing fish and wildlife resources; (2) identification of problems confronting these resources; (3) determination of the effects that proposed projects would have on these resources; and (4) formulation of recommendations for the maintenance and enhancement of the fish and wildlife resources.

King salmon, steelhead trout, and resident rainbow and brown trout are the most important species of fish in east side streams. The runs of salmon in these streams range between about 10,000 and 25,000 annually, and are comprised of about half spring-run and half fall-run fish.

In March 1962, a fish-counting station was installed at Stanford-Vina Dam on lower Deer Creek to accurately determine the size of present salmon and steelhead runs, and to provide a means of comparing runs on Deer Creek with those on Mill Creek, where a fish-counting station has been operated by the Department of Fish and Game since 1953.

Extensive water temperature measurements have been made on Mill and Deer Creeks. Six thermographs, three on each stream, were installed during the summer of 1963. These thermographs are being operated for the

following purposes: to determine existing temperature conditions in the lower canyon reaches of these streams; to attempt to define maximum temperatures tolerated by spring-run king salmon; and to aid in evaluating the effect that upstream project features would have on stream temperatures in the lower reaches.

Intensive stream surveys, using large-scale aerial photographs, were made on Mill and Deer Creeks to determine the extent of existing holding pools and spawning gravels for spring-run salmon. The photographs, which covered about 80 miles of stream channel, are also being used in analyzing proposals for the improvement of spawning and holding areas for spring-run salmon. Representative sections have been selected on lower reaches of Mill and Deer Creeks to determine the usable spawning area for fall-run salmon under various streamflow conditions.

Future fisheries work will be directed toward completing studies in progress on Mill and Deer Creeks and extending the studies to include the other major east side streams. This work will include temperature data collection, inventory of anadromous fish populations, salmon spawning gravel studies, and evaluation of possible effects of reservoirs and appurtenant features upon salmon and resident trout. Studies will also be made to determine the potential enhancement that could result from the construction of artificial spawning channels for fall-run salmon.

Wildlife studies to determine the effects of project features on wildlife and to recommend mitigating measures and enhancement possibilities will be conducted during the 1964-65 and 1965-66 fiscal years by a Game Manager on contract from the Department of Fish and Game.

## Recreation

Very few areas in the State can offer more to the outdoor recreationist than would be made available by the construction of Deer Creek Meadows Reservoir on upper Deer Creek. The scenic beauty of the area, the abundance of wildlife, the nearly unlimited availability of excellent recreation lands, and the great potential for enhancement of the trout and salmon populations demand that recreation use be given primary consideration in formulating water projects on upper Deer and Mill Creeks.

Studies to evaluate the recreation potential of the Mill-Deer Project, as described in Chapter III, have been completed to reconnaissance standards. Preliminary estimates of water-associated recreation benefits and costs have been prepared for this project and are included in Chapter III along with other estimated benefits and costs. The recreational potential of the Mill-Deer Project is centered around a large Deer Creek Meadows Reservoir. Surveys of recreation use of existing facilities in the Mill-Deer Project area were completed in 1963. Projections were made from these surveys to determine the expected future recreational use in the area without water resources developments. Estimates were then prepared of the expected future recreational use if the Mill-Deer Project were constructed. The difference in recreational use in visitor-days, with and without the project, is a measure of the estimated recreation benefits to the project. Similar recreation studies will be made on the other east side streams as project plans are developed.

## Land and Water Use

Studies are being conducted for this investigation to update and compile previous land and water use studies in the east side area.

Supplemental information has been developed, where necessary, to give complete data for the investigational area.

Year 1954 land use and estimates of probable ultimate patterns of land use within the investigation area are contained in the Department of Water Resources' Bulletin No. 58, "Northeastern Counties Investigation." Also included are estimates of water requirements associated with these land uses.

Under the direction of the current "Coordinated Statewide Planning Program," a resurvey was made of the Sacramento Valley floor land use in 1961. These new land use data were plotted on USGS 7½' quads and tabulations were prepared. Subsequently, the land classification maps prepared originally for Bulletin No. 58 were updated in line with change in "standards" and improved mapping techniques. Similar land use and classification surveys were conducted in the upstream portions of the investigation area during 1962. These data have also been transferred to USGS 7½' quads and are currently being tabulated.

Estimates of present and future agricultural, municipal and industrial water use will be made from these data.

#### Economics

Preliminary economic evaluations to determine project benefits completed to date include: estimated payment capacity of crops in the investigational area; estimated value of a visitor-day of water-associated recreation; and the value of sport-caught salmon and steelhead, and commercially-caught salmon. These preliminary values have been utilized in formulating the proposed plans for development described in Chapter III.

### CHAPTER III. PLANS FOR WATER DEVELOPMENT

It was stated earlier that the objectives of the Sacramento Valley East Side Investigation are to determine the most logical sequence of water development within the east side area, and to present detailed plans for those projects which have the greatest possibilities for near future construction. All planning activities thus far have been directed toward meeting these objectives. This chapter includes a discussion of several possible water development projects that are being considered. It describes project features, estimates project costs and accomplishments, and presents a summary of results and tentative conclusions.

Plans are being analyzed in accordance with the following economic criteria.<sup>1/</sup>

1. Project units are scaled to provide maximum net benefits; that is, economic returns exceed economic costs by the greatest possible amount.
2. Each project unit, as well as the separable segments thereof, must accomplish a given purpose at least as economically as the most favorable alternative unit.
3. Vendable goods and services created by the project unit have value only to the extent that there will be need and demand for such goods and services.
4. Arrangement of justifiable project units into an optimum sequence as a function of their relative efficiencies in use of economic resources.

<sup>1/</sup> The criteria and methods of economic analysis upon which this section is based are discussed more fully in "Proposed Practices for Economic Analysis of River Basin Projects," Report to the Inter-Agency Committee on Water Resources; U. S. Govt. Printing Office, May 1958.

Project development studies were grouped into two categories; namely, (1) estimates of capital and annual expenditures for potential project units, and (2) analysis of the present and future economic demand for project goods and services.

Tentative plans for the comprehensive development of the Sacramento Valley East Side streams include the following reservoirs: Wing on Inks Creek; Paynes Creek Diversion on Paynes Creek; Salt Creek on Salt Creek; Hogback on Antelope Creek; Dehaven on Little Antelope Creek; Antelope Basin on Salt, Antelope and Little Antelope Creeks; Morgan Springs and Savercool on Mill Creek; Deer Creek Meadows and Sugarloaf on Deer Creek; Crown on Brush and Singer Creeks; Web Hollow on Big Chico Creek; and Jonesville, Forks of Butte, and Barrier on Butte Creek. Although studies of alternative developments are not complete, indications are that the foregoing reservoirs will form the nucleus of the final plans for development of those streams. Additional studies are necessary to determine the merits of developments on Antelope and Paynes Creeks, as proposed in The California Water Plan. Locations of possible future water development features are shown on Plate 1.

Although some time has been spent investigating possible water development projects on all major east side streams, planning studies to date have been concentrated on Deer and Mill Creeks. The various projects are divided into related stream groups and are discussed separately in the following sections.

#### Mill-Deer Project

Mill and Deer Creeks have greater potential for water development projects than the other streams in the east side area. Any plan for the

development of these streams would include construction of a large storage reservoir at Deer Creek Meadows in the upper Deer Creek drainage area. This is topographically the best storage site in the east side area.

Plans have been developed for two possible projects on Mill and Deer Creeks. The first plan considers development of the full water resources potential of Deer Creek, including fish, wildlife, recreation, water supply, flood control, and power. This plan would include two diversion dams (Morgan Springs on upper Mill Creek and Ishi on lower Deer Creek), two large storage reservoirs (Deer Creek Meadows and Sugarloaf) on Deer Creek, a large offstream storage reservoir (Crown) on lower Brush and Singer Creeks, and a series of tunnels, conduits, and powerhouses along the middle and lower reaches of Deer Creek. The second plan would be an initial project which would be similar to the first project, except that it would exclude Sugarloaf Reservoir and all power features. Current studies indicate that power production is not an economically justified purpose for water resource developments in the east side area. Therefore, only the initial project is presented in this report. However, addition of power features to the initial project could be accomplished at any time, if it becomes feasible to do so.

The initial Mill-Deer Project as presently conceived would produce about 30,000 acre-feet per year of new water for local irrigation and domestic requirements and 20,000 acre-feet per year of new yield at the Sacramento-San Joaquin Delta. It would increase salmon and steelhead runs by about 10,000 fish per year, and would ultimately provide for about 2,500,000 visitor-days of fishing and other types of water-associated recreation use per year. It would also reduce the frequency of flooding along Mill and Deer Creeks and along the Sacramento River.

Preliminary estimates show that the Mill-Deer Project would have an initial capital cost of about \$22 million and an average annual equivalent cost, including operation and maintenance, of about \$1.4 million. The total average annual equivalent benefits attributable to the project would be about \$2.5 million. The resultant benefit-cost ratio would be about 1.8:1.

The initial Mill-Deer Project would include the following features (1) Morgan Springs Diversion Dam on Mill Creek near Morgan Springs; (2) Childs Meadows Conduit from this structure to Deer Creek Meadows; (3) Deer Creek Meadows Reservoir on upper Deer Creek; (4) Ishi Diversion Dam on Deer Creek near the foothill-valley floor line; (5) Yahi Conduit from this structure to Brush Creek; (6) Crown Reservoir on Brush and Singer Creeks; (7) Vina Conduit from this reservoir back to Deer Creek; and (8) an irrigation canal and distribution system to local agricultural lands.

The project would be operated in the following manner. Excess winter and spring flows of Mill Creek would be diverted into Gurnsey Creek from the Morgan Springs Diversion Dam, via the Childs Meadow Conduit. These flows, in addition to the natural flows of Deer Creek, would be stored in Deer Creek Meadows Reservoir. Deer Creek Meadows Reservoir would be operated to provide enhancement to recreation at the reservoir, domestic water supplies along upper Deer Creek, fisheries (trout, steelhead, and salmon) enhancement in Deer Creek below the dam, and new irrigation water supplies on the valley floor. Deer Creek Meadows Reservoir, while producing substantial fisheries, recreation, and irrigation benefits, would not fully develop the waters of Deer Creek. Consequently, Crown Reservoir, an offstream storage reservoir on Brush and Singer Creeks on the valley floor, would be constructed to

supplement the water supply developed at Deer Creek Meadows Reservoir and to produce additional water-associated recreation benefits. It would be operated in the following manner. Excess flows of Deer Creek would be diverted into Crown Reservoir from Ishi Diversion Dam, via Yahí Conduit. This water, in addition to natural inflow from Brush and Singer Creeks, would be stored during high runoff periods and released back into Deer Creek during water-deficient months to provide attraction and spawning flows for steelhead and salmon. Stored water would also be released to supply new water to local agricultural lands. All existing water rights would be protected by this project, and supplemental water would be supplied where needed.

Morgan Springs Diversion Dam -- in Section 14, Township 29 North, Range 4 East, Mount Diablo Base and Meridian -- would be 30 feet in height and would be situated such that it would allow gravity diversion from Mill Creek into the upper Deer Creek drainage basin.

Childs Meadow Conduit, with a capacity of 250 cubic feet per second, would carry water from Morgan Springs Diversion Dam into the upper Deer Creek drainage basin. It would terminate at Gurnsey Creek (tributary to Deer Creek) in Section 25, T29N, R4E, Mount Diablo Base and Meridian. The canal would be concrete lined, of trapezoidal cross section, and would be 2.3 miles in length.

Deer Creek Meadows Reservoir, with a capacity of 100,000 acre-feet, would be impounded by a 180-foot high homogeneous earthfill dam on upper Deer Creek in Section 21, T28N, R5E, Mount Diablo Base and Meridian. Fairly extensive geologic investigations have been made at Deer Creek Meadows Dam and Reservoir sites. Foundation exploration at the damsite included three NX (3-inch diameter) diamond drill core holes, one on each abutment and one in the stream channel. In addition, two 6-inch diameter auger holes and

15 backhoe trenches were excavated at the damsite. Subsurface exploration in the reservoir area consisted of 19 auger holes and 27 backhoe trenches in possible borrow material areas. Due to questionable foundation conditions and insufficient information as to available borrow materials, additional subsurface exploration will be done at Deer Creek Meadows before completion of this investigation.

Ishi Diversion Dam -- in Section 23, T25N, RLW, Mount Diablo Base and Meridian -- would be 30 feet in height and would divert water by gravity into Yahí Conduit.

Yahí Conduit, with a capacity of 225 cubic feet per second, would carry water from Ishi Diversion Dam to Brush Creek above Crown Reservoir. The canal would be concrete lined, of trapezoidal cross section, and would be 1.8 miles in length.

Crown Reservoir, with a storage capacity of 40,000 acre-feet, would be impounded by a 4-mile long earth dyke. The dyke would extend from the right abutment in the Northeast  $\frac{1}{4}$  of Section 9, T23N, R1E, Mount Diablo Base and Meridian, a distance of 1 mile south to the Northwest  $\frac{1}{4}$  of Section 16, then southeast a distance of 2 miles to the Northwest  $\frac{1}{4}$  of Section 23, then northeast a distance of 1 mile to left abutment in the Southeast  $\frac{1}{4}$  of Section 14. The dyke would have a maximum height of 65 feet and an average height of about 30 feet. Geologic studies at the site have been limited to surface geologic mapping. Subsurface exploration will be done at this site before completion of this investigation.

Vina Conduit, with a capacity of 350 cubic feet per second, would carry water from Crown Reservoir back to Deer Creek at the existing Stanford-Vina Diversion Dam. It would terminate at Deer Creek in Section 1, T24N, R2W,

Mount Diablo Base and Meridian. The canal would be concrete lined, of trapezoidal cross section, and would be 3.6 miles in length.

The features of the initial Mill-Deer Project are shown in red on Plate 1.

### Big Chico-Butte Project

The major existing water developments in the east side area are located in the Butte Creek drainage basin. Pacific Gas and Electric Company utilizes the natural runoff of Butte Creek, and imported water from West Branch Feather River, for hydroelectric power generation at De Sabla and Centerville Powerhouses on Butte Creek. The Paradise Irrigation District has constructed two storage reservoirs, Magalia and Paradise, on Little Butte Creek to provide domestic and agricultural water supplies to the district. In addition, extensive irrigation developments exist along the valley floor portions of Big Chico and Butte Creeks. Any proposals for water developments on Butte and Big Chico Creeks must consider these existing facilities and their water rights.

Three areas, the flat ridge lands lying north of Paradise (Eden) between Butte and Little Butte Creeks, the Forest Ranch area lying between Big Chico and Butte Creeks, and the Cohasset Ridge area lying between Big Chico and Rock Creeks, show great potential for mountainous homesite developments similar to that which has occurred at the community of Paradise. The only major deterrent to the growth of these areas is lack of an adequate water supply. Project planning on Butte and Big Chico Creeks has not been completed. However, any plans for development on these creeks will give consideration to projects that can supply water to these high value lands.

"The California Water Plan," Bulletin No, 3, presented several possible projects on Butte and Big Chico Creeks which could serve future domestic water requirements to the Forest Ranch and Cohasset Ridge areas, and provide flood control protection and agricultural water requirements to lands on the valley floor. These projects consisted of four headwater and intermediate conservation reservoirs, two low elevation flood control and water conservation reservoirs, and a total of about 75 miles of conveyance conduits. These developments are shown in pink on Plate No. 1.

Final plans for the development of the water resources of Big Chico and Butte Creeks will include pertinent features from The California Water Plan and new plans developed during this investigation. Some features which are presently being considered include Jonesville, Forks of Butte, and Barrier Reservoirs on Butte Creek, and Web Hollow Reservoir on Big Chico Creek.

Studies on these creeks are not sufficiently well advanced at this time to estimate which projects have the greatest possibilities for near future construction.

#### Paynes-Antelope Project

Project formulation has not been initiated on Paynes and Antelope Creeks. However, considerable time has been spent in the collection of basic data, and in the review of plans developed in previous studies. Three projects shown in "The California Water Plan" have been studied. The first consisted of a large flood control reservoir, Antelope Basin Reservoir, on Antelope, Salt, and Little Antelope Creeks, on the valley floor. This project would provide flood protection and some irrigation water to prime agricultural lands lying north and west of Antelope Creek. The second

project, which was studied as an alternative to the first, would consist of three dams in the mountainous areas of Salt, Antelope, and Little Antelope Creeks. The third project would consist of a large Wing Reservoir on Inks Creek, and a diversion dam and conduit diverting water from Paynes Creek into the reservoir.

The directors of the Tehama County Flood Control and Water Conservation District, realizing the need for flood protection on the valley floor in the vicinity of Antelope Creek, recently authorized Charles S. McCandless and Company, consulting engineers, to conduct an investigation to develop plans on Salt, Antelope, and Little Antelope Creeks. Several projects were studied for the district, including those presented in "The California Water Plan." The project recommended for near-future construction would consist of a 6,000 acre-foot offstream storage reservoir on the valley floor just north of Antelope Creek, a diversion into this reservoir from Antelope Creek, and a spillway structure and outlet works which would redirect the waters back into Antelope Creek. This project would not completely eliminate flooding, but would greatly reduce the frequency and severity of flooding.

Future studies for the Sacramento Valley East Side Investigation will include a re-evaluation of the foregoing described plans, and the development of alternative plans which will include consideration of irrigation, flood control, recreation, and fisheries enhancement as possible project purposes.

#### Butte Basin Project

Butte Basin is the most northerly of the natural floodway relief basins flanking the Sacramento River. It lies east of the Sacramento River and extends from the vicinity of Chico on the north to the vicinity of

Meridian on the south. Its eastern boundary is an indefinite line along the gently sloping lands rising from the trough of the basin toward the Sierra Nevada foothills. The basin is about 40 miles long and from 1 to 13 miles wide and encompasses an area of about 270 square miles. During floods as much as 1,000,000 acre-feet of water may collect and be temporarily stored in the basin.<sup>2/</sup>

Many studies have been conducted to determine the feasibility of constructing a levee project for flood protection in Butte Basin. Difficulties in financing, opposition from local landowners, and opposition from sportsmens groups, have prevented the construction of large-scale projects in the area. These studies, however, have all been concerned with the construction of single-purpose flood control projects in the upper basin.

Some time will be spent during the remainder of the Sacramento Valley East Side Investigation in evaluating the possibility of constructing a multipurpose project in the Butte Basin. This project will continue to consider flood control as a primary project purpose, but it will also include recreation, wildfowl management, and fisheries enhancement as possible project purposes.

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<sup>2/</sup> Information in this paragraph taken from: Report on Floods of February - June 1958, by the U. S. Corps of Engineers, November 1958.

## CHAPTER IV. FUTURE WORK PROGRAM

It was demonstrated in the previous chapters that studies completed at the present time have been directed primarily toward collection and compilation of basic hydrologic, recreation, fisheries, economic, and engineering data, and toward the formulation of preliminary plans for development on Mill and Deer Creeks.

Studies remaining to be completed include development of plans on Paynes, Antelope, Big Chico, and Butte Creeks, and completion of plans on Mill and Deer Creeks. These studies will be directed toward development of plans for initial projects on all streams where economically feasible projects exist. Additional plans will be developed to provide the most logical scheduling of projects to meet future water needs within the investigational area. A summary of the work remaining to be completed is presented in the following paragraphs under the headings of Project Service Areas, Ground Water Studies, Project Formulation, and Final Report and Appendixes.

### Project Service Areas

The agricultural service areas described in Chapter I (Los Molinos-Vina, Chico Canal, and Butte Creek Basin) will be studied during 1964 and 1965. Probable locations and types of future developments within the service areas will be determined. Plans will be developed to provide the most feasible methods of satisfying future water requirements in the areas. Present indications are that these service areas can be served new water most economically by combined development of surface and ground water supplies. Possible sources of additional water supply to the Los Molinos-Vina Service Area include diversions from the Mill-Deer Project reservoirs, increased

pumping from ground water, pumping directly from the Sacramento River, and diverting from potential reservoirs in the Upper Sacramento River Basin. The Chico Canal Service Area, like the Los Molinos-Vina Service Area, has several potential sources of water. It could be supplied with surface water from the Mill-Deer Project, from surface developments on Big Chico and Butte Creeks, from the Sacramento River, or from increased ground water pumping. The source which appears to provide the cheapest and best supply to this area would be increased ground water pumping. The Butte Creek Basin Service Area also has many potential sources of new water supply. The best sources appear to be Oroville Reservoir, the Sacramento River, and increased ground water pumping. However, a large multipurpose water development project on Butte Creek might be a feasible source of new water for some of the lands in this area.

The mountainous service areas described in Chapter III (Eden, Forest Ranch, and Cohasset Ridge) will be studied to determine their potential for future residential development. Plans will be developed to determine the most feasible methods of supplying water to these lands.

Some lands lying outside of the area of investigation have been included in the Butte Basin and Eden service areas, since these lands could be conveniently supplied with water from East Side Projects.

#### Ground Water Studies

One of the objectives of the Sacramento Valley East Side Investigation is to determine the costs of ground water development for the aforementioned service areas. These costs will be compared with the least costly alternative surface water supplies that could be developed.

Completed work and work in progress for other planning studies will aid in the east side ground water studies. Geologic surface and subsurface investigations, to delineate aquifers and gather basic data on ground water in the Sacramento Valley, are being conducted by the Coordinated Statewide Planning Program. Basic data, pertinent to determining the cost of ground water development along the east side of the Sacramento Valley between Red Bluff and Chico have been gathered for the Upper Sacramento River Basin Investigation which will be completed in June of 1964. During the period between 1952 and 1958, the United States Geological Survey made extensive hydrology studies of the interchange of surface and ground water in the Central Valley. East side streams included in this study were Antelope, Mill, Deer, Pine, and Big Chico Creeks. Information gathered from the foregoing sources will be used to aid in the development of plans for the Sacramento Valley East Side Area.

#### Project Formulation

As previously mentioned, work to date has been concentrated on Mill and Deer Creeks. Future work will primarily concern other streams in the investigational area. Alternative projects will be studied, designs and cost estimates will be prepared, economic project benefits will be evaluated, and projects will be formulated which allow efficient development of the natural resources of the area. In addition, probable sequences of staging of projects will be studied.

Some additional work will be done on Mill and Deer Creeks. Alternative developments will be studied in more detail. Studies will be made to determine the feasibility of constructing a much larger storage reservoir at the Crown Reservoir site. This alternative to Crown Reservoir is shown

on Plate 1 as Brush Creek Basin Reservoir. The possibility of incorporating artificial spawning channels for fall-run salmon into the Mill-Deer Project will also be studied. Preliminary estimates of project benefits and costs will be refined, and detailed sizing studies will be conducted to insure optimum project formulation.

Completion of project formulation on east side streams will necessitate continued basic data collection and analysis in all of the investigative activities discussed earlier.

#### Final Report and Appendixes

Preparation of the final report on the Sacramento Valley East Side Investigation will constitute a major portion of the work to be accomplished during the remaining two years of this investigation. The report will present results of the investigation in sufficient detail to provide guidance to local water service agencies contemplating a feasibility study of any particular water development project in the investigational area. The final report, due for publication in 1966, will be supported by appendixes covering the subjects of hydrology, geology, fish and wildlife, recreation, and designs and costs of works.





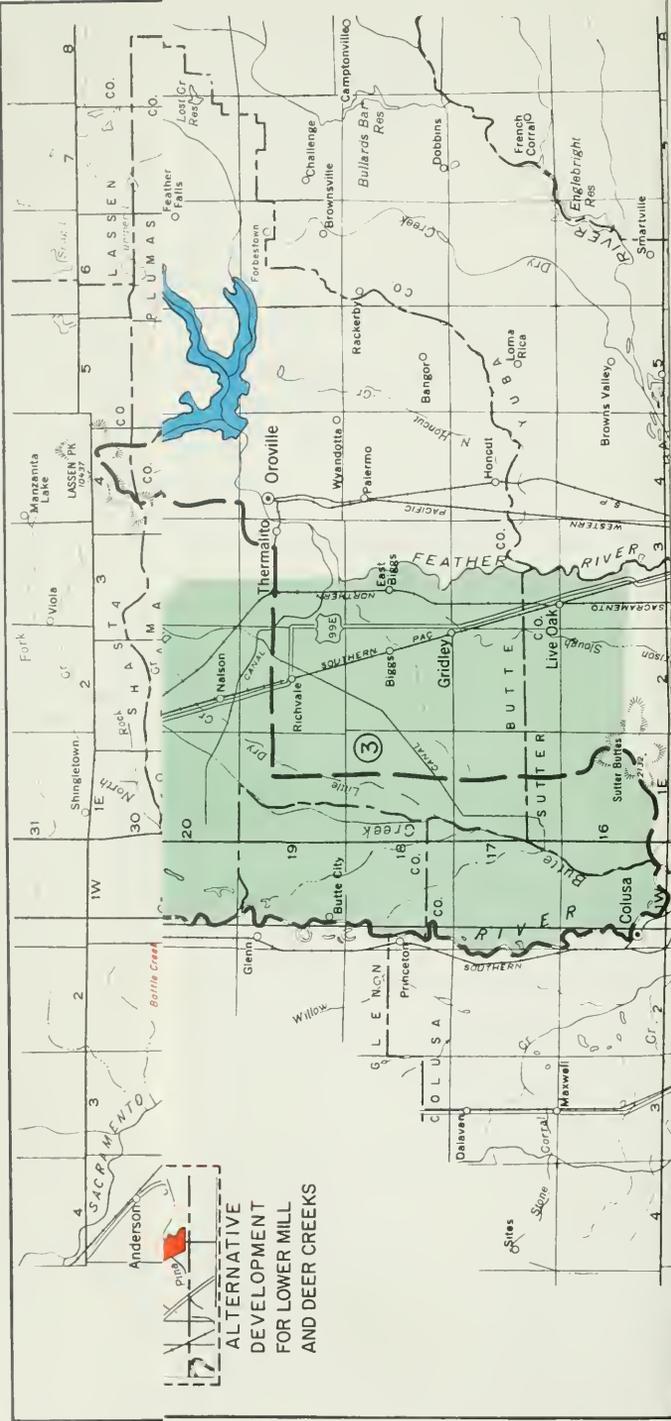








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