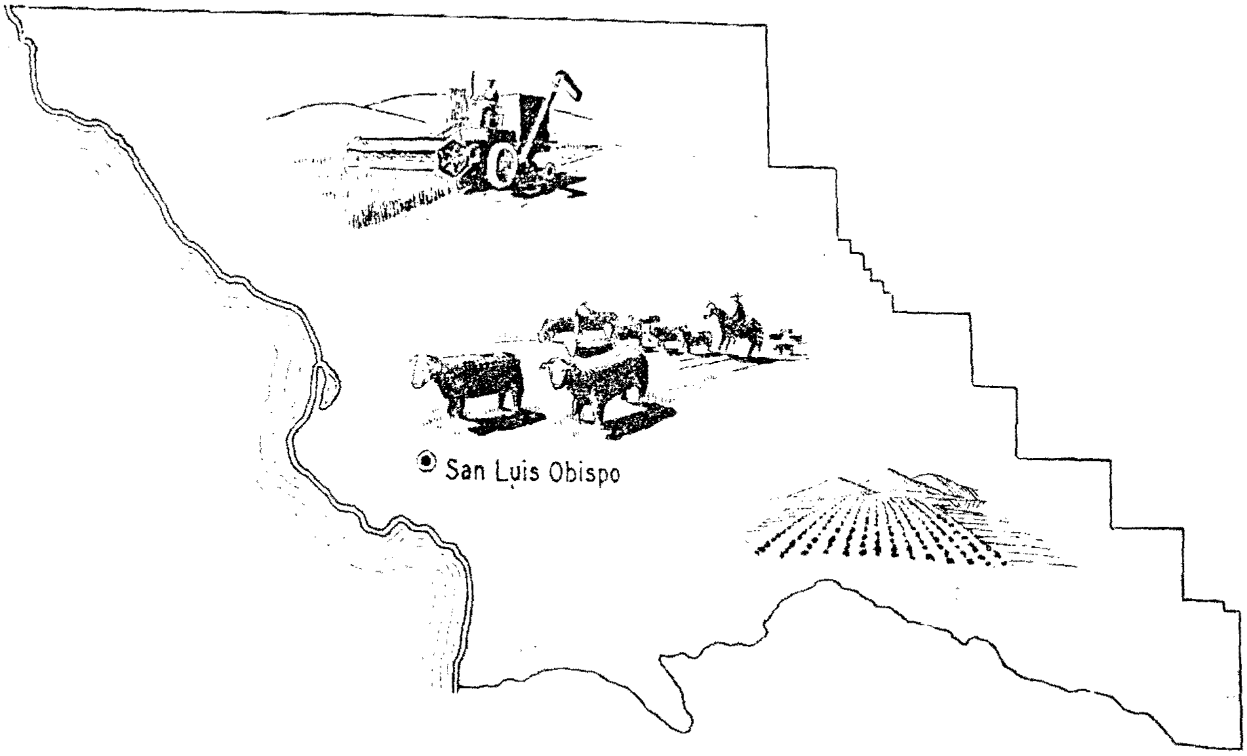
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

STATE WATER RESOURCES BOARD
BULLETIN NO. 18
Volume I
TEXT AND PLATES

SAN LUIS OBISPO COUNTY INVESTIGATION



GOODWIN J. KNIGHT
Governor

HARVEY O. BANKS
Director of Water Resources

May, 1958

STATE OF CALIFORNIA

DEPARTMENT OF WATER RESOURCES

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STATE WATER RESOURCES BOARD

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Volume I

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SAN LUIS OBISPO COUNTY INVESTIGATION

Effective July 5, 1956, the State Water Resources Board was abolished and its functions, duties, and responsibilities assigned to the Department of Water Resources by Chapter 52, Statutes of 1956

GOODWIN J. KNIGHT
Governor

HARVEY O. BANKS
Director of Water Resources

May, 1958

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VEY O. BANKS
DIRECTOR

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STATE OF CALIFORNIA
Department of Water Resources
SACRAMENTO

May 1, 1958

Honorable Goodwin J. Knight, Governor, and
Members of the Legislature of the
State of California

Gentlemen:

I have the honor to transmit herewith the two-volume Bulletin No. 18 of the State Water Resources Board, entitled "San Luis Obispo County Investigation", as authorized by Chapter 3, Statutes of 1952, as amended.

Work on the San Luis Obispo County Investigation and Bulletin No. 18 was initiated by the Division of Water Resources of the Department of Public Works, under the direction of the State Water Resources Board, and subsequently completed and published by the Department of Water Resources, successor to the foregoing agencies.

Volume I of Bulletin No. 18 contains an inventory of the surface and underground water resources of San Luis Obispo County, estimates of present and probable ultimate supplemental water requirements, and preliminary plans and cost estimates for water development works. Volume II consists of 13 appendixes containing statistical and other data pertinent to the Investigation.

Very truly yours,

Harvey O. Banks

HARVEY O. BANKS
Director

ACKNOWLEDGMENT

Valuable assistance and data used in this investigation were contributed by agencies of the Federal Government, cities, counties, public districts, and by private companies and individuals. The Department of Water Resources gratefully acknowledges this splendid cooperation.

Special mention is made of the helpful cooperation of the following:

Board of Supervisors, County of San Luis Obispo
San Luis Obispo County Surveyor and Road Commissioner
San Luis Obispo County Assessor
San Luis Obispo County Farm Advisor
Monterey County Flood Control and Water Conservation District
Board of Directors, Arroyo Grande Soil Conservation District
Board of Directors, Upper Salinas Soil Conservation District
California State Division of Highways
California State Department of Fish and Game
United States Agricultural Research Service
United States Bureau of Reclamation
United States Forest Service
United States Geological Survey, Surface Water Branch
United States Soil Conservation Service
Pacific Gas and Electric Company

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STATE DEPARTMENT OF WATER RESOURCES

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M. J. Shelton . . . . Deputy Director of Water Resources
William L. Berry . . . . Chief, Division of Resources Planning

SOUTHERN CALIFORNIA DISTRICT

Max Bookman . . . . District Engineer

This investigation was conducted and
bulletin prepared under the direction of

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by

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T. W. Matthews . . . . Delineator

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Paul L. Barnes, Chief, Division of Administration

Isabel C. Nessler, Coordinator of Reports

ORGANIZATIONAL CHANGES

This investigation was commenced under the direction of the State Water Resources Board. Members of the Board at the inception of the investigation included Mr. C. A. Griffith*, Chairman, and Messrs. H. F. Cozzens, B. A. Etcheverry*, Clair Hill, R. V. Meikle, Royal Miller, and Phil D. Swing.

At the time this investigation commenced, Mr. A. D. Edmonston was State Engineer and Chief of the Division of Water Resources. On November 1, 1955, Mr. Edmonston retired from State service and was succeeded by Mr. Harvey O. Banks, who served in the capacity as State Engineer until his appointment as Director of Water Resources on July 5, 1956.

The function under which this investigation was conducted was directed by Mr. T. B. Waddell until his retirement from State service on November 1, 1955, at which time he was succeeded by Mr. W. L. Berry. Mr. Berry served as Assistant State Engineer until his appointment as Chief, Division of Resources Planning, on July 5, 1956.

This investigation was under the codirection of Mr. T. M. Stetson, Supervising Hydraulic Engineer, from March 1, 1954, until July 1, 1955, at which time he was succeeded by Mr. I. J. Meyers.

* Deceased.

ORGANIZATION

COUNTY OF SAN LUIS OBISPO

BOARD OF SUPERVISORS

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SAN LUIS OBISPO COUNTY INVESTIGATION

CHAPTER I. INTRODUCTION

During the past decade, San Luis Obispo County, like most other counties in California, has experienced an increase in population concurrently with an expansion and intensification of irrigated agriculture. This growth, however, has not been of equal magnitude with the phenomenal increases of population, industry, and agriculture experienced in other areas of the State such as the Los Angeles, San Francisco, and San Diego metropolitan areas and the Sacramento and San Joaquin Valley agricultural areas. The unprecedented development of these latter areas, with the attendant serious problems of water supply, illustrates the potential problems which will arise in San Luis Obispo County in the future. Recent growth of population and agriculture within the County has resulted in an increased demand on both surface and underground water resources. In some areas of the County, a shortage of irrigation water prevails during the latter part of the irrigation season. Increasing development of urban and domestic use of water within the Cities of San Luis Obispo, Paso Robles, and other communities indicates that, within the near future, available water supply sources may be inadequate to meet the increased demand.

A lesser water problem in San Luis Obispo County is that of flood control. Flood waters have caused damage to lands adjacent to the lower reaches of Arroyo Grande Creek and the Santa Maria River. Recent reclamation of lands adjacent to these streams and intensification of agricultural practices have increased the potential flood damage in these areas.

The growth of population and industry in San Luis Obispo County in the future, together with the anticipated increase in irrigated agriculture, will require an extensive program of local development of both surface and underground water resources; and full satisfaction of the ultimate water-using potential within the County will require importation of substantial amounts of water from sources outside of the County.

Authorization for Investigation

Concern over the adequacy of available water supplies for present and future requirements of San Luis Obispo County prompted the Board of Supervisors of the County, the County Water Resources Committee, and the County's legislative representatives to request the California Legislature to provide funds for a water resources investigation of the County. As a result, the Legislature, in Assembly Bill No. 1, Chapter 3, Statutes of 1952, Item 268.5(b), made an appropriation of the sum of $20,000 for a comprehensive survey of the water resources of the County. The State Water Resources Board, at its meeting of June 6, 1952, directed the State Engineer to submit to the Board a proposed work program to carry out the surveys. On July 18, 1952, the State Water Resources Board approved a recommendation of the State Engineer for a three-year comprehensive survey of the water resources of San Luis Obispo County.

Objectives of the investigation were to include determination of the nature and amount of local water resources, present and probable ultimate water requirements, present and probable ultimate supplemental water requirements, and the development of preliminary plans to meet those supplemental requirements from local or imported sources. It was also considered that the investigation should involve determination of flood control requirements and include preliminary plans for protective works if required. It was proposed that a report covering the investigation would be submitted to the Board on June 30, 1955, or as soon thereafter as possible.

Continuation of the San Luis Obispo County Investigation for the second year was authorized under terms of an agreement dated July 1, 1953, between the State Water Resources Board, the County of San Luis Obispo, and the State Department of Public Works acting through the agency of the State Engineer.

The agreement provided that the sum of $30,000 would be expended during Fiscal Year 1953-54 and that an additional $26,000 would be expended during Fiscal Year 1954-55 to complete the work program of the three-year comprehensive survey. Of the $56,000 so expended, $28,000 was provided by the State Water Resources Board and an equal amount was provided by the County of San Luis Obispo. A supplemental agreement executed by the same parties on July 1, 1954, authorized funds to complete the investigation and report during Fiscal Year 1955. Funds authorized under the latter agreement were exhausted prior to completion of the report and a second supplemental cooperative agreement authorizing the expenditure of $5,000 to complete the report was executed by the afore-mentioned parties effective May 1, 1956. Work on the report subsequent to July 4, 1956, was accomplished by personnel of the State Department of Water Resources, successor to the State Water Resources Board and Division of Water Resources.

The following tabulation presents the cost of the investigation by years, the respective shares of the State of California and the County of San Luis Obispo, and the total cost.

Fiscal year	State of California	County of San Luis Obispo	Annual total
1952-53	$20,000	$ ---	$20,000
1953-54	15,000	15,000	30,000
1954-55	13,000	13,000	26,000
1955-56	2,500	2,500	5,000*
TOTALS	$50,500	$30,500	$81,000

*Funds available for expenditure during Fiscal Year 1956-57.

Additional funds have been expended in San Luis Obispo County by the State Water Resources Board in connection with the State-Wide Water Resources Investigation, authorized by Chapter 1541, Statutes of 1947, and by the State Division of Water Resources for studies of quality of water pursuant to Sections 229 and 230, Division 1, of the California Water Code. Results of these investigations have been used in connection with the San Luis Obispo County Investigation.

Copies of the agreements between the State Water Resources Board, the County of San Luis Obispo, and the Department of Public Works are included as Appendix A.

Related Investigations and Reports

The following reports of prior investigations, concerning various phases of water resources problems of San Luis Obispo County, were reviewed in connection with the current investigation.

Adamson, Paul L., Jenks, Harry N., and Jenks, John H. "Report on Water and Sewage Systems for City of San Luis Obispo". September, 1954.

Arroyo Grande Soil Conservation District and San Luis Obispo County Flood Control and Water Conservation District, in cooperation with U. S. Forest Service and Soil Conservation Service. "Watershed Work Plan, Arroyo Grande Creek Watershed, San Luis Obispo County, California". October, 1955.

California State Department of Public Works, Division of Water Resources. "Salinas Basin Preliminary Investigation". 1933.

California State Department of Public Works, Division of Water Resources. "Salinas Basin Investigation". Bulletin Nos. 52, 52-A, 52-B. July, 1946

California State Department of Public Works, Division of Water Resources. "Salinas Reservoir System in San Luis Obispo County, California". March, 1947.

California State Department of Public Works, Division of Water Resources. "Survey of Petroleum Industry Waste Disposal Practices, Arroyo Grande Oil Field, San Luis Obispo County". August, 1953.

California State Department of Public Works, Division of Water Rights. "Investigation of Lopez Creek as a Source of Water Supply for the City of San Luis Obispo, Applications 348 and 1990". December 1, 1921.

Hamlin, Homer. "Water Resources of the Salinas Valley". United States Geological Survey Water-Supply and Irrigation Paper No. 89. 1904.

Harding, S. T. and Kempkey, A. "Water Supply of the Salinas Valley and Storage Projects for Its Additional Use". January 10, 1955.

Harding, S. T. and Kempkey, A. "Water Supply of the Salinas Valley and Storage Projects for Its Additional Use - Supporting Material". October, 1953.

Macabee, L. Cedric. "Report on Atascadero Water Works, San Luis Obispo County, California". March, 1952.

Marliave, Chester. "Geological Report on El Nacimiento Dam Site Situated Across El Nacimiento Branch of the Salinas River in San Luis Obispo County, California". June 2, 1941.

Ramseier, Roy Edwin. "Additional Water Sources for the City of El Paso de Robles". July 5, 1951.

United States Army, Corps of Engineers. "Interim Flood Control Survey Report, Salinas River, California". 1940.

United States Army, Corps of Engineers. "Survey, Flood Control, Arroyo Grande Creek, San Luis Obispo County, California". March, 1942.

United States Army, Corps of Engineers. "Report on Survey, Flood Control, Santa Maria River and Tributaries, California". June 15, 1953.

United States Army, Corps of Engineers. "Survey Report, Salinas River, California, for Flood Control and Allied Purposes". 1953. Unpublished.

United States Department of Agriculture, Bureau of Chemistry and Soils. "Soil Survey of the Paso Robles Area, California". 1928.

United States Department of Agriculture, Bureau of Chemistry and Soils. "Soil Survey of the San Luis Obispo Area, California". 1928.

United States Department of Agriculture, Bureau of Soils. "Soil Survey of the Santa Maria Area". 1916.

United States Department of Agriculture, Forest Service and Soil Conservation Service. "Reconnaissance Sedimentation Survey, Salinas Reservoir, San Luis Obispo County, California". September, 1953.

United States Department of Interior, Bureau of Reclamation. "Santa Maria Project, Southern Pacific Basin, California". June, 1951.

United States Department of Interior, Geological Survey. "Geology and Ground Water Resources of the Santa Maria Valley Area, California". Water Supply Paper 1000. 1951.

United States Department of Interior, Geological Survey. "Ground Water in the Cuyama Valley, California". Water Supply Paper 1110-B. 1951.

The Division of Water Resources recently completed surveys and studies for the State-Wide Water Resources Investigation, authorized by Chapter 1541, Statutes of 1947. This investigation, under the direction of the State Water Resources Board, had as its objective the formulation of The California Water Plan for full conservation, control, and utilization of the State's water resources to meet present and future water needs for all beneficial purposes and uses in all parts of the State insofar as practicable. The results of this comprehensive investigation are reported on in three publications of the State Water Resources Board.

The first of these publications, Bulletin No. 1, contains an inventory of the available surface water supplies of the State and was published in final form under the title, "Water Resources of California", dated 1951. The second publication, Bulletin No. 2, entitled "Water Utilization and Requirements in California", dated June, 1955, contains estimates of present and probable ultimate land use and water requirements of the State. Data compiled in these two publications, pertaining to San Luis Obispo County, have been used in the preparation of this report. The third in the foregoing series of publications, which sets forth a comprehensive plan for the development and utilization of the water resources of the State, was published in May, 1957, as Bulletin No. 3, entitled "The California Water Plan". Plans for water resource developments presented in this report on the San Luis Obispo Investigation have been developed in conformity with standards and objectives established for the afore-mentioned California Water Plan and have been incorporated into the over-all plan.

By direction of the State Water Resources Board, the Division of Water Resources prepared plans for the Feather River Project as the initial unit of The California Water Plan. A report on this initial unit entitled "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, was submitted by the Water Resources Board to the California Legislature of 1951. The proposed features were authorized by the Legislature for construction by the Water Project Authority of California in Chapter 1441, Statutes of 1951, and subsequently funds in the amount of $2,227,056 were appropriated by the Legislature for additional studies and investigations of the project during Fiscal Years 1953, 1954, and 1955. A report on these additional studies and investigations, entitled "Program for Financing and Constructing the Feather River Project as the Initial Unit of The California Water Plan", dated February, 1955, was completed and transmitted to the Legislature of 1955 by the Water Project Authority.

The Feather River Project features have for their purpose the exportation of surplus waters of the Feather River and of the Sacramento-San Joaquin Drainage Basin to southern portions of the State to provide supplemental water supplies to the west side of the San Joaquin Valley, the South San Francisco Bay area, and the southern California area. Plans for importation of supplemental water supplies to San Luis Obispo County from the Feather River Project were studied and the results of these studies are presented in this bulletin.

Additional funds in the amount of $1,773,000 were appropriated by the Legislature in its Budget Acts of 1956 and 1957 for studies of alternative routes for the Feather River aqueduct. Results of these current studies could not be included in this bulletin as they are scheduled for completion in the spring of 1958.

An investigation of the water resources of the Salinas Basin was completed in 1955 by the Division of Water Resources under a cooperative agreement between the State Water Resources Board, the Monterey County Flood Control and Water Conservation District, and the Department of Public Works acting through the agency of the State Engineer. A report upon the findings of the investigation is being prepared in preliminary form under the title "Bulletin No. 19, Salinas River Basin Investigation". Basic data and plans of development compiled for the Upper Salinas River Basin in connection with the San Luis Obispo County Investigation were utilized in the preparation of the afore-mentioned report on the Salinas River Basin.

Results of the San Luis Obispo County Investigation were published in summary form by the State Water Resources Board in a report entitled "Interim Summary Report on San Luis Obispo County Investigation", dated October, 1955. A summary of conclusions drawn from the current investigation was presented in the afore-mentioned report.

Scope of Investigation and Report

Enabling legislation for the investigation authorized a comprehensive survey of the water resources of San Luis Obispo County. The objectives of the investigation were defined in the work program approved by the State Water Resources Board and an outline of the work required to accomplish those objectives was contained in the initial agreement between the State Water Resources Board, the County of San Luis Obispo, and the Department of Public Works. Achievement of these objectives necessitated evaluation of surface and underground water supplies and the determination of present and probable ultimate land use and water utilization and requirements. Field work and office studies in the investigational area commenced in July, 1952, and continued into June, 1955.

During the course of the field investigation, basic hydrologic data in the form of precipitation and stream flow records, as well as records of ground water levels at wells, were obtained in the field by the Division of Water Resources or were compiled from records of public and private agencies.

Precipitation records were obtained for 46 stations maintained by the U. S. Weather Bureau and 95 stations maintained by local private and public entities.

Stream flow records were obtained from 15 gaging stations maintained by the U. S. Geological Survey. Four additional stream gaging stations equipped with automatic water stage recorders were installed and maintained by the Division of Water Resources. During the course of the investigation, three additional stream gaging stations equipped with automatic water stage recorders were installed. In addition, 17 stations equipped with nonrecording staff gages or datum reference points were established and maintained for varying periods of time on streams throughout the County. Frequent stream flow discharge measurements were made along Salinas River and Arroyo Grande Creek, and their tributaries, for gaging station rating purposes and to determine stream characteristics during periods of influent and effluent flow for underlying ground water basins.

A field survey was made for the purpose of determining the location, type, and characteristics of operating and nonoperating irrigation, municipal, and industrial water wells in the County. During the investigation, approximately 1,300 wells were located in the field in addition to some 70 wells previously located by the U. S. Geological Survey in the Cuyama and Santa Maria Units. Fall and spring measurements were made at about 470 wells chosen to form a comprehensive measuring grid over ground water basins identified within the County. In addition, the U. S. Geological Survey reports measurements made at 11 wells in the Cuyama and Santa Maria areas each fall and spring as part of its continuing investigation. Measurements were made to determine monthly fluctuations of water levels at approximately 70 key wells for varying periods of time throughout the investigational seasons. Water stage recorders were maintained for varying periods of time on a total of 25 nonoperating or abandoned wells throughout the County for the purpose of securing short-term continuous records of ground water level fluctuations.

Geologic features of ground water basins underlying the area were investigated, including occurrence and movement of ground waters and available storage capacities therein. This study included the collection and analysis of approximately 300 water well logs and 150 oil well or shot hole logs. Geologic data collected by the U. S. Geological Survey in connection with the continuing investigation of ground water conditions in Cuyama and Santa Maria Valleys by that agency in cooperation with Santa Barbara County were also utilized. The report on the geologic investigation is presented in Appendix B of this report.

Available historical hydrologic data and geologic information for the ground water basins in the County were found to be inadequate to make preliminary determinations of ultimate safe yields of these basins.

Studies were made of the mineral quality of surface and underground waters in order to evaluate their suitability for beneficial use and to determine the extent and cause of any degradation thereof. To supplement available data of this nature, 114 complete analyses of surface waters and 160 complete analyses of ground waters were made during the course of the investigation. Detailed results of available mineral analyses of surface and underground water supplies of San Luis Obispo County are presented in Appendix F.

The nature and extent of present land use throughout the County were determined from a detailed survey conducted during 1953. Three supplemental surveys of selected truck-cropped areas were conducted during 1954, at three to four-month intervals, following the original survey in order to evaluate the effects of double and triple cropping. Present water requirements were determined by application of appropriate unit values of water use to the areas of irrigated lands. Studies were also made of present use of water for urban and suburban areas within the County.

For the prupose of estimating probable future water requirements, a land classification survey was conducted during 1954. Basic criteria were set up to determine the suitability of all nonurban lands for irrigated agriculture. Consideration was also given to the development of nonirrigable lands to an urban and suburban type of use. Appropriate unit values of water use were applied to the probable ultimate pattern of land use to obtain the estimated ultimate water requirements of the County.

Future requirements for municipal water supplies were estimated from projections of population and per capita water consumption data based upon development of areas of the State with characteristics similar to the investigational area.

In order to develop basic information on consumptive use of water by irrigated and nonirrigated crops in the investigational area, as well as verifying corresponding values estimated for other nearby climatically similar areas, studies were made of soil moisture depletion at representative plots of irrigated and nonirrigated agriculture during the 1953 irrigation season. Consumptive use studies of nonirrigated agriculture and also of native vegetation were continued into 1954. A total of 17 plots of irrigated agriculture and seven plots of nonirrigated agriculture and native vegetation were studied.

In addition to the studies of soil moisture depletion, current irrigation practices in San Luis Obispo County were surveyed in order to determine unit values of water application to important crops on lands having various soil types during the 1954 irrigation season. Records of water well production, acreage served, crops irrigated, number and period of irrigations, and the amounts of water applied were compiled. This information was compiled with the aid of records of power consumption by irrigation pumps and results of pump operation tests furnished by the Pacific Gas and Electric Company. Detailed results of soil moisture depletion and applied water studies are presented in Appendix H.

Hydrologic studies were made for each of the major stream systems. These studies included determination of presently developed safe yield of surface and underground water supplies, present and probable future supplemental water requirements, present waste to the ocean from major streams, and the portion of this waste susceptible of conservation by both surface and underground reservoirs.

The development of possible plans for additional conservation of local surface water supplies included field examination of feasible dam sites, together with geologic investigations thereof. Preliminary designs and estimates of cost were prepared for several heights of dams at many of the sites, and of water conveyance systems and appurtenant works. Preliminary plans and estimates of cost were also prepared for works necessary to import supplemental water from the main aqueduct of the authorized Feather River Project. Consideration was also given to the financial and organizational aspects attendant upon the development of local and imported water supplies. Detailed estimates of runoff at various dam sites, reservoir yield studies, and estimates of cost of various projects considered are presented in Appendixes J, K, and L, respectively. Study was also made of fish, wildlife, and recreational aspects of proposed water supply developments for the County. A report on this study is presented in this Bulletin as Appendix I.

Results of the San Luis Obispo County Investigation are presented in this report in the four ensuing chapters. Chapter II, "Water Supply", contains evaluations of precipitation and stream flow. It also includes results of investigation and study of underground hydrology, and sets forth estimates of presently developed safe yield of surface and underground water supplies. Data regarding the mineral quality of surface and underground water supplies are also presented therein. Chapter III, "Water Utilization and Requirements", includes results of determinations of present and probable ultimate land use and water requirements, and contains estimates of present and probable ultimate supplemental water requirements. It also includes available data on demands for water with respect to rate, time, and place of delivery. Chapter IV, "Plans for Water Development", describes preliminary plans for conservation and utilization of local water supplies, including operation and yield studies, design considerations and criteria, estimates of cost for the construction of works, and analyses of the financial and organizational aspects thereof. Similar consideration is given to the development of rted water supplies. It also includes the results of evaluation of prior reports and investigations on flood control aspects. Chapter V, "Summary of Conclusions and Recommendations", includes conclusions and recommendations resulting from the investigation and studies.

Area Under Investigation

The area under investigation comprises all the lands of San Luis Obispo County. For purposes of analysis of available water supply, it was found necessary in some instances to also investigate portions of adjacent counties containing drainage areas tributary to San Luis Obispo County.

San Luis Obispo County is situated in the Central Coastal Area of California about midway between the Cities of San Francisco and Los Angeles. The County adjoins Santa Barbara County on the south, Kern County on the east, Monterey County on the north, and the Pacific Ocean on the west. San Luis Obispo County has an average dimension of about 60 miles both north and south and east and west, with an area of 3,326 square miles. The location of the County is shown on Plate 1, "Location of San Luis Obispo County".

Drainage Basins

San Luis Obispo County is traversed by five segments of mountain ranges comprising the South Coastal Geomorphic Province. In order of importance, they include the Santa Lucia, Temblor, La Panza, Caliente, and San Luis Ranges. These ranges, which trend generally in a northwest to southeast direction, separate the County into five fairly distinct drainage areas: the Salinas River Basin, which drains in a northwesterly direction to the Pacific Ocean; the Carrizo Plain, which is an enclosed basin; the coastal drainage area, which is tributary to the Pacific Ocean between Monterey County on the north and Santa Maria River Basin on the south; the Santa Maria River Basin comprising portions of the drainage areas of the Santa Maria and Cuyama Rivers; and the San Joaquin Valley drainage area, which is tributary to Tulare Lake Basin in the San Joaquin Valley.

The drainage area of the Salinas River is 4,401 square miles, of which 35 per cent or 1,545 square miles lies within San Luis Obispo County. The headwaters of Salinas River, the largest coastal stream in California south of San Francisco Bay, are located in San Luis Obispo County. About 53 per cent of the area of San Luis Obispo County lies within the Salinas River drainage basin. This portion of the County is characterized by extensive areas of rolling topography with large acreages being suitable for the cultivation and irrigation of a variety of agricultural crops. Elevations range from about 460 feet above sea level in the bed of the Salinas River at the Monterey County line to 4,054 feet at McChesney Mountain in the La Panza Range. Several peaks in the Santa Lucia Range, which separates the Salinas River and coastal drainage areas, attain elevations in excess of 3,000 feet, the highest of which is Pine Mountain with an elevation of 3,594 feet. The Temblor Range, which parallels the San Andreas fault, forms the divide between the upper Salinas River Basin and the San Joaquin Valley.

Principal sources of surface runoff tributary to the Salinas River are streams draining the easterly slopes of the Santa Lucia Range, of which the Nacimiento River is the largest. Estrella Creek and its two principal tributaries, Cholame and San Juan Creeks, drain the easterly portion of the upper Salinas River drainage area.

The Carrizo Plain is a large enclosed basin located in the southeasterly portion of San Luis Obispo County. Small portions of the drainage area tributary to this basin extend into Kern County. The area of the entire

Carrizo Plain watershed is 447 square miles, of which 423 square miles are within San Luis Obispo County. The Carrizo Plain is separated topographically from Salinas River Basin by a low drainage divide between the Temblor and La Panza Ranges. The Caliente Range forms the drainage divide between the southerly portion of Carrizo Plain and Cuyama Valley. The Carrizo Plain drainage area varies in elevation from about 1,900 feet above sea level at Soda Lake near the center of the basin to 5,095 feet at Caliente Mountain. The floor of the basin averages about 2,000 feet above sea level.

The coastal drainage area includes all watersheds tributary to the Pacific Ocean from the northerly extremity of San Luis Obispo County to, but not including, Santa Maria River at the southerly extremity of the County. This coastal drainage area comprises 788 square miles, of which 15 square miles of the San Carpoforo Creek drainage area are located in Monterey County. The major streams included, in addition to San Carpoforo Creek, are Arroyo de la Cruz, San Simeon Creek, Santa Rosa Creek, Old Creek, San Luis Obispo Creek, and Arroyo Grande Creek. These streams drain the westerly slopes of the Santa Lucia Range. The drainage areas of the streams from Morro Bay north produce a large amount of runoff in proportion to their size as compared with drainage areas elsewhere in the County.

Santa Maria River, together with its two major tributaries, the Cuyama and Sisquoc Rivers, drains an area of 1,881 square miles, about 505 square miles of which are within San Luis Obispo County. The La Panza and Caliente Ranges separate the Santa Maria River watershed from the Salinas River watershed and Carrizo Plain, respectively. The floor of Cuyama Valley ranges in elevation between 1,900 feet and 2,900 feet above sea level, averaging about 2,300 feet. The Santa Maria Valley floor varies in elevation from sea level to about 300 feet above sea level.

Climate

San Luis Obispo County exhibits a distinct variation in climate between its coastal and inland sections. The climate in the inland area is characterized by warm, dry summers and relatively cool, wet winters. During the winter season, temperatures below freezing are common but the long, dry summers provide adequate growing season for a wide range of agricultural production. The Carrizo Plain and Cuyama Valley are, to some extent, exceptions in that their high altitudes result in shorter growing seasons limiting the types of agricultural practice. In the inland area, more than 80 per cent of the annual precipitation occurs during the months from December through March. Most of the precipitation falls as rain with small amounts of snow occurring at the high altitudes on infrequent occasions.

The climate in the coastal area of the County is characterized by long, dry, warm summer seasons with frequent ocean fogs, followed by a shorter wet winter period accompanied by cooler temperatures. The distribution of precipitation is similar in the inland region. In the Lower Arroyo Grande and Santa Maria Valleys, killing frosts are rare, making possible the practice of double and triple cropping of lands.

San Luis Obispo County lies in the path of storms originating off the Aleutian Islands which periodically sweep inland along the Pacific Coast during the winter seasons. The mountains of the Santa Lucia Range affect the distribution of precipitation by causing major storms to deposit substantially heavier rainfall in the coastal area and over the westerly portion of the Upper Salinas River Basin than in the easterly portion of the County.

Pertinent climatological data are presented in Table 1 for five selected stations in San Luis Obispo County and vicinity.

TABLE 1

SUMMARY OF CLIMATOLOGICAL DATA FOR SELECTED STATIONS
IN SAN LUIS OBISPO COUNTY AND VICINITY

Station	Elevation, in feet	Recorded temperature in degrees F.			Mean seasonal precipitation in inches	Average number of days between killing frosts
		Maximum	Minimum	Average		
San Luis Obispo	300	110	20	58.7	21.68	315
Point Piedras Blancas	57	85	31	53.4	18.34	354
Santa Maria	217	104	22	57.1	14.24	351
Paso Robles	740	117	0	58.5	15.82	204
Cuyama	2,240	109	8	56.2	5.91	178

Geology

Geologic formations in San Luis Obispo County have been divided, for the purposes of this investigation, into water-bearing and nonwater-bearing groups. Nonwater-bearing rocks include pre-Cretaceous granite rocks, marine, and nonmarine sediments of Jurassic through Pliocene age, and volcanic rocks of Miocene age. Rocks classified as nonwater-bearing generally yield negligible quantities of water to wells and usually contain water of poor quality at depth.

Water-bearing sediments consist of nonmarine sand, gravel, silt, and clay of Pleistocene and Recent ages. The Paso Robles formation and Recent alluvium generally are the most important water-bearing sediments. The Paso Robles formation consists of folded and faulted nonmarine sand, gravel, clay, and minor calcareous beds. While reaching an estimated thickness of 3,000 feet in the higher portions of upper Salinas River drainage area, the

Paso Robles formation is only 200 to 400 feet thick in the San Luis Obispo and Arroyo Grande areas. Alluvium underlies the larger valley floors of the County. In the valley floor of Salinas River, alluvium averages about 30 feet in thickness. In the coastal drainage area, alluvium varies from 60 to 200 feet in thickness and is found only in the larger valleys. Other water-bearing formations are sand dunes and stream deposits of upper Pleistocene age in the Morro Bay and Arroyo Grande areas. Water-bearing formations yield up to 3,000 gallons per minute to wells, with alluvium generally yielding more than older formations.

Soils

Soils of San Luis Obispo County vary in their physical and chemical properties in accordance with difference in parent material, method of formation or deposition, and age or degree of development since their deposition. The soils may be divided into three broad groups: (1) residual soils, (2) older valley filling soils, and (3) Recent alluvial soils.

Residual soils include those which have been developed in place on consolidated bedrock of sedimentary, igneous, and metamorphic origin. Soils in this category are found throughout the County on steeper slopes where drainage is generally good and soils are usually shallow and of medium texture. Rock outcrops are frequently found. Moisture holding capacities are rated as fair to good although, because of unfavorable topography or shallow depths, only a small percentage of soils in this category are suitable for cropping purposes.

Older valley filling soils, which comprise a significant proportion of the Upper Salinas River drainage area and are found to a lesser extent in the San Luis Obispo-Arroyo Grande area, generally occupy intermediate elevations between residual soils and Recent alluvial soils. Since their deposition, soils of this group have been elevated and later eroded in varying degrees by streams cutting through them. As a result, rolling topography characterizes the areas in which these soils occur. Textures vary from light to medium at the surface to heavy at depth. Surface drainage is therefore good, but subsurface drainage is often retarded by the heavier subsoils. The most highly developed profiles in the County exist in soils of this group. Moisture holding capacities are fair to good in the upper zones and poor in the lower zones. Failures of shallow rooted, dry-farmed crops on these soils have been reported in years of deficient rainfall. Soils with the most highly developed profiles are fertilized as standard cropping practice. A wide range of climatically suited crops may be grown on older valley filling soils.

Recent alluvial soils usually occupy flood plains adjacent to stream channels and alluvial fans where accretions and depletions of soil material occur each year. Because this soil is in the process of accumulation, profiles are, at best, in the early stages of development. Soil depths vary considerably, often exceeding six feet. Textures vary from light to medium in the upper Salinas and Carrizo Plain drainage areas with stratified sands and gravels often found beneath the surface. Heavier textures are found in some soils along the coast. Drainage is usually good in the lighter textured soils except during periods of inundation. In the case of heavier soils, perched water is often found, especially above stratified clays. With proper application of water and careful use of commercial fertilizers where required, Recent alluvial soils have a high agricultural value.

Present Development

Development of San Luis Obispo County began with the establishment of its two missions, San Luis Obispo de Tolosa in 1772, around which grew the City of San Luis Obispo and San Miguel Archangel in 1774, at the site of the present community of San Miguel. Early life was centered about the missions where the raising of cattle and grain was the chief occupation. It was not until the latter half of the 19th Century that any appreciable growth in population or agricultural development occurred.

At the time of its formation in 1850 as one of the original 27 counties of the State, the entire population of San Luis Obispo County was listed as 336, exclusive of Indians. By 1890, the first year for which federal census figures were compiled, the population of the County was reported as 16,072, an increase of 400 persons per year. In 1930, the population has increased to 29,613, an average increase of about 300 per year, and in 1950, the population of the County was listed as 51,417, an average increase of more than 1,000 per year. The population of the County was estimated by the State Department of Finance to be 60,800 on July 1, 1955, which represents an increase since the 1950 census of more than 1,800 per year.

The foregoing population growth figures, while relatively small in actual numbers as compared with other parts of the State, indicate a trend of population growth, with attendant general expansion, which may be expected to assume sizable proportions in the future.

For comparative purposes, available federal census figures for incorporated cities in San Luis Obispo County are listed in Table 2 for each census since 1930, and for the most recent special census.

TABLE 2

POPULATION OF INCORPORATED CITIES, SAN LUIS OBISPO COUNTY

City	Population			
	1930	1940	1950	Recent
San Luis Obispo	8,276	8,881	14,180	17,229 (1955)
Paso Robles	2,573	3,045	4,835	6,148 (1952)
Arroyo Grande	892	1,090	1,723	2,061 (1953)
Pismo Beach	No data	1,292	1,425	1,924 (1953)

Agricultural development in San Luis Obispo County began with the first plantings of corn at Mission San Miguel in 1797. Later barley and wheat were planted there as well as at Mission San Luis Obispo. The first irrigation system in California was reported to have been built at Mission San Miguel where irrigation water was diverted by ditch from Santa Ysabel Springs, 15 miles south of the mission. Prior to the 1870's barley was the principal crop grown. In 1868 interest was aroused in the production of wheat and by 1873, approximately 5,000 acres were sown. In 1915, one of the peak years, 353,600 acres of wheat were reported to have been sown. The County Agricultural Commissioner reported 91,700 acres in wheat, 67,300 acres in barley, and 5,100 acres in oats for the year 1955.

The extensive areas of the Upper Salinas Valley and Carrizo Plain within San Luis Obispo County contain about 1,260,000 acres of valley and hill lands. Because of rolling topography which characterizes the area, agricultural development until recent times has been chiefly limited to cattle raising and dry-farmed crop production. The high cost of land leveling and relatively high cost of development of ground water supplies restricted irrigation development to low lying valley lands and terraces adjacent to streams. The introduction of sprinkler irrigation systems on a large scale is believed to be the major factor contributing to irrigation development in Upper Salinas River Basin.

Dry-farmed grain and forage crops, supplemented by increasingly larger acreages of irrigated alfalfa and pasture in the lands adjacent to the Salinas River and its tributaries, are presently utilized in combination with the extensive dry grass mountain and foothill range lands for the production of beef cattle. In 1955, the cattle and dairy industries accounted for 34 per cent of the total county agricultural valuation. In addition, large acreages of dry-farmed wheat are grown on the Carrizo Plain. The wheat produced in this latter area is a high gluten content Baart wheat which brings premium prices from the flour milling industry. Surplus grain and forage crops are exported for use by the dairies in the coastal area and in the Los Angeles area to the south.

In the past, large acreages of dry-farmed almond orchards were cultivated in the vicinity of Paso Robles and Templeton. During the 1920's through the middle 1940's, as many as 16,000 acres of almonds were in production in this area. The cumulative effect of several damaging frosts and increased production costs along with relatively low prices paid for this product have resulted in reduction of acreage to about 7,500 acres.

As previously stated, irrigation was first practiced around Mission San Miguel. Very little data are available on irrigated acreages for the years prior to 1920, the first year in which such data were included in Federal census reports. A total of 5,320 acres was reported to be under irrigation in San Luis Obispo County in 1919, the majority of which was in the Arroyo Grande and Oso Flaco areas.

During state-wide investigations for State Water Resources Board Bulletin No. 2, "Water Utilization in California", it was found that there were approximately 25,000 acres of irrigated land in San Luis Obispo County as of 1950, including truck crops, alfalfa, sugar beets, permanent pasture, and deciduous orchard. This figure was based on field surveys conducted by the

U. S. Bureau of Reclamation and Division of Water Resources. A field survey conducted during 1953 by the Division of Water Resources as a part of the current investigation, showed that irrigated lands totaled 34,140 acres. From the results of the surveys cited, it has been determined that alfalfa and irrigated pasture have become of increasing importance within the County, especially in Upper Salinas Valley. It was also determined that nearly all of the increase in irrigated acreage in San Luis Obispo County since the 1950 survey has occurred in the Upper Salinas Valley. Truck farming has continued to be the major agricultural endeavor in the coastal areas and accounts for about 22 per cent of the total county irrigated acreage.

Urban development has, to a great extent, paralleled growth of agriculture as indicated by previously quoted population figures. Industrial development has been limited generally to that required for the processing and shipping of increasing amounts of agricultural products. Notable exceptions include the recently completed steam-electric power generating plant of the Pacific Gas and Electric Company at Morro Bay and the coking plant of the Union Oil Company on Nipomo Mesa.

The annual harvest of almonds is processed at Paso Robles which also serves as a shipping point for cattle and grain. One of the largest almond packaging plants in the world is located in Paso Robles. Atascadero is a shipping point for poultry products. Oceano is a shipping point for the varied truck and field crops grown in the Arroyo Grande area. Home ports for the County's fishing fleet are located at Morro Bay and Avila. Several major oil company pipe lines cross the county, conveying crude oil from the Bakersfield, Taft, and San Ardo oil fields to offshore loading points at Avila and Cayucos.

U. S. Highways, Sign Routes 101 and 466, traverse the county as also do several State highways. Over 1,200 miles of improved roads are included in the county road system. The coast route of the Southern Pacific Railroad Company provides both freight and passenger service to Los Angeles and San Francisco. Three public airports are located in the County and regularly scheduled air service is provided the County by Southwest Airways.

Two Army training centers, Camp San Luis Obispo and Camp Roberts, occupy large areas within the County. Prior to 1941, Camp San Luis Obispo was a National Guard Camp. In 1941, the camp was leased by the U. S. Army and expanded as a wartime training facility. During the period from June, 1943, until December, 1944, an average of about 15,000 troops were stationed at the camp with a peak population in excess of 23,000 in March, 1944. Except for a period of reactivation during the Korean hostilities as a Signal Corps training center, Camp San Luis Obispo has been on an inactive status since 1947 but has continued to serve as a National Guard and Reserve Officers Training Corps training center. The hospital area of the camp is presently being utilized as quarters for the California Men's Colony, a unit of the State penal system. A permanent facility for the Colony is planned for construction on a 200-acre portion of the Camp property. Camp Roberts was the largest infantry training center in the United States during World War II and although accurate figures are not presently available, it is known that at least 25,000 troops were stationed there during a portion of 1945. Except during the Korean hostilities, Camp Roberts has also been on an inactive status, and is presently being utilized as an Army Reserve training center during the summer months and occasionally by regular Army personnel for maneuvers.

In addition to the facility at Camp San Luis Obispo, the State of California operates three large institutions in San Luis Obispo County. These include a 3,000-acre campus of the California State Polytechnic College at San Luis Obispo, the Atascadero State Hospital at Atascadero operated by the State

Department of Mental Hygiene and the Paso Robles School for Boys near Paso Robles operated by the California Youth Authority.

Abundant recreational attractions are found throughout San Luis Obispo County. A significant portion of the County's income has, for some time, been derived from its tourist trade, and as the population of California increases, it is probable that the recreational facilities of San Luis Obispo County will become one of the State's major attractions. Camping and picnic facilities are located at 20 state and county parks located throughout the County. The most important Pismo clamming area in California is located along the coastal strip from Shell Beach to the Santa Maria River. Ocean swimming is popular south of Morro Bay. Steelhead fishing is a major sport along the entire County coast line. Atascadero Lake, an inland attraction, affords opportunity for swimming, boating, and fishing. Similar facilities will be provided at Salinas Reservoir soon to be opened for public use. Los Padres National Forest, occupying 374 square miles or about 11 per cent of the County area, provides abundant picnic and hunting facilities.

The total assessed valuation of San Luis Obispo County has been doubled over the past decade. The assessed valuation of the County, as reported by the County Auditor for the 1929-30 Fiscal Year, was $33,563,285. In 1939-40, the assessed valuation was $39,515,015, and by 1949-50, it had climbed to $65,603,955. In the 1954-55 Fiscal year, the County's assessed valuation was reported to be $83,627,365.

Hydrologic Units

In order to facilitate analysis of present and probable future water supply problems, San Luis Obispo County and certain tributary areas have been divided into six hydrologic units. These units, the boundaries of which are shown on Plate 2 entitled "Hydrologic Units", have been designated Upper Salinas, Coastal, Carrizo Plain, Cuyama, Santa Maria, and San Joaquin.

Boundaries of the hydrologic units were defined after giving thorough consideration to those factors of water supply and utilization, topography, and geology, which affect hydrologic analyses. The boundaries of each unit are either coincident with the County boundary or else lie along well defined topographic divides. To further facilitate analyses, one hydrologic unit was divided into subunits. Subunit boundaries are also indicated on Plate 2. Areas of hydrologic units and subunits are presented in Table 3.

TABLE 3

AREAS OF HYDROLOGIC UNITS AND SUBUNITS

Name	Area, in acres			
	San Luis Obispo County	Monterey County	Kern County	Total
Upper Salinas Unit	989,000	408,000	1,000	1,398,000
Coastal Unit				
Cambria Subunit	183,000	12,000	0	195,000
San Luis Obispo Subunit	177,000	0	0	177,000
Arroyo Grande Subunit	132,000	0	0	132,000
Subtotals	492,000	12,000	0	504,000
Santa Maria Unit	55,000	0	0	55,000
Cuyama Unit	268,000	0	0	268,000
Carrizo Plain Unit	271,000	0	15,000	286,000
San Joaquin Unit	54,000	0	0	54,000
TOTALS	2,129,000	420,000	16,000	2,565,000

CHAPTER II. WATER SUPPLY

Water supplies of San Luis Obispo County are derived from precipitation occurring almost entirely in the form of rainfall. Ground water is utilized intensively in certain portions of the County, and small amounts of water are utilized through surface storage or direct diversion of stream flow. Historically, there have been no imports or exports of water across the County boundary. Within the County, however, inter-unit exchanges of water have been effected since 1942. The water supply of the County is discussed and evaluated in this chapter under the general headings: "Precipitation", "Runoff", "Underground Hydrology", and "Quality of Water". The following terms are used as defined in connection with the discussion of water supply in this report:

Annual--Pertaining to the 12-month period from January 1st of a given year through December 31st of the same year, sometimes termed the calendar year.

Seasonal--Pertaining to any 12-month period other than the calendar year.

Precipitation Season--The 12-month period from July 1st of a given year through June 30th of the following year.

Runoff Season--The 12-month period from October 1st of a given year through September 30th of the following year.

Investigational Seasons--The three runoff seasons of 1952-53, 1953-54, and 1954-55, during which field and office work on the San Luis Obispo County Investigation was performed.

Mean Period--A period of time chosen to represent conditions of water supply and climate over a long series of years.

Base Period--A period of time shorter than the mean period chosen for detailed hydrologic analysis because prevailing conditions of water supply and climate were approximately equivalent to mean period conditions, and because adequate data for such hydrologic analysis were available.

Mean--An arithmetical average relating to mean periods.

Average--An arithmetical average relating to periods other than mean periods.

In connection with the State-Wide Water Resources Investigation, recently completed, it was determined that the 50 years from 1897-98 to 1946-47, inclusive, constituted the most satisfactory period for estimating mean seasonal precipitation generally throughout California. Similarly, the 53-year period from 1894-95 to 1946-47, inclusive, was selected for determining mean seasonal runoff. In studies for the San Luis Obispo County Investigation, these periods were considered representative of mean conditions of water supply and climate.

Studies were made to select a base period for hydrologic analysis of the several units of the County, during which conditions of water supply and climate would approximate mean conditions, and for which adequate data on water supply, water utilization, and fluctuations of underground storage would be available. For the purpose of surface reservoir operation studies, it was determined that the 16-year period from 1935-36 to 1950-51, inclusive, was the most satisfactory in this respect. Average conditions of water supply during this base period so closely approximated conditions prevailing during the mean period that they were considered to be equivalent. Average temperatures prevailing during the chosen base period also closely approximated mean temperatures.

The latter seven years of the chosen base period, 1944-45 through 1950-51, have been selected as representative of drought conditions throughout the County and consequently have been taken as the critical period for safe yield determinations of surface and underground storage reservoirs. There is evidence that other drought periods, such as the period from 1922-23 through 1935-36, were possibly of slightly greater severity, with regard to accumulated deficiency in water supply for certain reservoir sizes studied, than the period, 1944-45 through 1950-51. Where adequate hydrologic data were available, the earlier drought period was studied. In all cases, it was found that the difference in safe yield determinations resulting from use of the later drought period was well within the limits of accuracy of the studies.

Precipitation

San Luis Obispo County receives nearly all of its precipitation from Pacific storms occurring generally during the months from December through March. Precipitation, the source of all water supplies in the County, is consumed or disposed of in several ways: evaporation and transpiration from plant and ground surfaces soon after occurrence of rain; accumulation in pore spaces of the soil mantle, which source subsequently furnishes water to meet consumptive requirements of vegetal cover; deep percolation to storage in pore spaces of the underground water-bearing materials in absorptive areas; and surface runoff.

Precipitation Stations and Records

As of July 1, 1954, there were 69 active precipitation stations in San Luis Obispo County, of which four were equipped with continuous recorders. Records from these stations, together with those from 81 other active and inactive stations in and adjacent to San Luis Obispo County provided sufficient data to ascertain the pattern of precipitation occurrence over the investigational area. The longest continuous record in the County is that for the station at San Luis Obispo which began in 1869. Records of precipitation are currently being maintained at 64 other stations in San Luis Obispo County having unbroken records extending over at least ten years. Locations of precipitation stations are shown on Plate 3, entitled "Lines of Equal Mean Seasonal Precipitation". Reference numbers correspond to those appearing in State Water Resources Board Bulletin No. 1, "Water Resources of California". Numbers, prefixed by an appropriate county designation; i.e., S. L. O., San Luis Obispo County, or M., Monterey County, etc., have been assigned to those stations not included in Bulletin No. 1. Listed in Table 4 are selected precipitation stations and map reference numbers, together with station elevations, periods of record, maximum, minimum, and mean seasonal precipitation, and sources of record. In those instances where it was necessary, precipitation records were extended to cover the 50-year mean period by correlation of available data with corresponding data from nearby stations having records covering this period. Descriptive data pertaining to all precipitation stations in San Luis Obispo County and vicinity, together with monthly records of precipitation not previously published, are included in Appendix C.

TABLE 4

MAXIMUM, MINIMUM AND MEAN SEASONAL PRECIPITATION
AT SELECTED STATIONS IN SAN LUIS OBISPO COUNTY

Map reference number	Station	Elevation (feet) U.S.G.S. datum	Period of record: From	Period of record: To	Estimated mean seasonal precipitation (Inches of depth)	Maximum and minimum seasonal precipitation: Season	Maximum and minimum seasonal precipitation: Inches of depth	Source of record[b]
SLO-1	Arroyo Grande No. 1	155	1904-05 1908-09 1910-11 1913-14 1916-17 1918-19 1920-21 1924-25 1939-40	 1911-12 1922-23 1936-37 1953-54	15.4	1940-41 1933-34	34.74 8.59	U.S.B.R.
3-048	Atascadero No. 1	835	1915-16 1931-32 1946-47	1928-29 1944-45 1953-54	22.3	1940-41 1952-53	35.51 11.24	U.S.W.B.
3-050	Avila	115	1930-31 1941-42	1939-40 1953-54	17.2	1951-52 1933-34	25.06 9.20	U.S.B.R. & UO Co.
SLO-7	Cambria Highway Maintenance Station	60	1937-38	1953-54	20.7	1940-41 1938-39	38.38 9.53	SDH
SLO-9	Carrizo Plain No. 1	2,000	1938-39	1953-54	8.9	1940-41 1950-51	17.88 5.02	SLO FA (Cavanaugh)
3-54	Cholame Hatch Ranch	1,975	1925-26	1953-54	11.0	1940-41 1933-34	20.73 5.57	U.S.W.B.
3-59	Creston Pump Station	1,099	1924-25	1953-54	13.0	1940-41 1938-39	20.08 6.04	UO Co.
3-58	Ernst Ranch	900	1930-31 1940-41 1943-44	1938-39 1941-42 1953-54	12.7	1940-41 1932-33	25.94 6.15	Private
3-058	Estero	20	1929-30	1953-54	16.8	1940-41 1938-39	31.86 9.56	SO Co.
SLO-15	Gerst Ranch	1,500	1925-26	1953-54	24.3	1940-41 1938-39	48.31 12.06	Private
SLO-18	Hearst Ranch	150	1937-38	1953-54	25.2	1940-41 1938-39	46.79 12.53	Private
3-065	Huasna	770	1929-30 1933-34	1931-32 1953-54	19.9	1940-41 1930-31	37.63 11.18	U.S.W.B. & SLO FA (G. Bair)
3-49	Linn Ranch	800	1925-26	1953-54	16.5	1940-41 1938-39	39.90 7.75	Private
3-68	Nipomo	360	1920-21	1953-54	15.2	1940-41 1923-24	31.09 6.53	Private (A. Mehlschan)

MAXIMUM, MINIMUM AND MEAN SEASONAL PRECIPITATION
AT SELECTED STATIONS IN SAN LUIS OBISPO COUNTY
(continued)

Map reference number	Station	Elevation (feet) U.S.G.S. datum	Period of record		Estimated mean seasonal precipitation (Inches of depth)	Maximum and minimum seasonal precipitation		Source of record[b]
			From	To		Season	Inches of depth	
3-57	Paso Robles No. 1	740	1886-87	1953-54	15.8	1937-38 1897-98	30.69 4.77	U.S.W.B.
3-067	Paso Robles 4NW	830	1938-39	1953-54	---	------[a]		U.S.W.B.
3-069	Point Piedras Blancas	30	1905-06 1939-40	1908-09 1953-54	18.3	1946-47 1940-41	12.49 40.21	U.S.W.B.
SLO-29	Quenzer (Radloff) Ranch	810	1930-31 1937-38 1950-51	1935-36 1946-47 1953-54	12.1	1940-41 1950-51	24.53 5.54	U.S.B.R. & SLO FA
SLO-30	Runitz Ranch (El Pomar)	1,150	1914-15	1953-54	16.4	1940-41 1923-24	28.24 4.50	SLO FA
3-64	San Luis Obispo (Cal Poly)	300	1869-70	1953-54	21.7	1940-41 1897-98	42.92 7.20	U.S.W.B.
3-085	San Luis Obispo Tank Farm	118	1930-31	1953-54	18.7	1940-41 1938-39	37.77 9.91	UO Co.
SLO-53	San Miguel	625	1936-37	1953-54	---	1940-41 1938-39	25.17 6.45	Private (G. Parker)
3-63	Santa Margarita	995	1919-20 1936-37	1930-31 1953-54	25.9	1940-41 1933-34	42.12 7.97	Private (S.P.Depot)
3-076	Santa Margarita (Tank Farm)	974	1931-32	1953-54	24.6	1940-41 1938-39	43.30 10.38	Private (UO Co.)
SLO-35	Seven-X Ranch	1,200	1930-31 1944-45 1951-52	1942-43 --- 1953-54	41.8	1940-41 1938-39	79.63 20.10	Private (Dee Fitzhugh)
SLO-36	Shandon Highway Maintenance Station	1,090	1937-38	1953-54	11.6	1940-41 1947-48	22.89 6.23	U.S.B.R. & SDH
3-078	Shandon Pump Station	1,056	1935-36	1953-54	9.6	1940-41 1950-51	18.99 5.14	U.S.B.R. & Private (SO Co.)
SLO-37	Simmler Highway Maintenance Station	2,047	1937-38	1953-54	8.1	1940-41 1950-51	18.08 4.40	SDH

MAXIMUM, MINIMUM AND MEAN SEASONAL PRECIPITATION
AT SELECTED STATIONS IN SAN LUIS OBISPO COUNTY
(continued)

Map reference number	Station	Elevation (feet) U.S.G.S. datum	Period of record: From	Period of record: To	Estimated mean seasonal precipitation (Inches of depth)	Maximum and minimum seasonal precipitation: Season	Maximum and minimum seasonal precipitation: Inches of depth	Source of record[b]
3-67	Soda Lake	1,975	1925-26 1948-49	1946-47 1953-54	8.7	1940-41 1933-34	18.50 5.39	U.S.B.R. & SLO FA (D. Werling)
SLO-39	Suey Ranch	500	1909-10	1953-54	14.8	1940-41 1912-13	30.02 6.29	Private
3-56	Templeton	800	1925-26 1930-31	1928-29 1953-54	21.3	1940-41 1938-39	38.79 10.79	SLO FA (C. G. Corralt)

a. Broken records.
b. Abbreviation — Name

Abbreviation	Name
U.S.W.B.	United States Weather Bureau
SLO FA	San Luis Obispo County Farm Advisor
U.S.C.E.	United States Corps of Engineers
U.S.B.R.	United States Bureau of Reclamation
SDH	State Division of Highways, San Luis Obispo Office
SDF	State Division of Forestry
SLO RD No. 4	San Luis Obispo County Road District No. 4
PG&E	Pacific Gas and Electric Company
UO Co.	Union Oil Company
SO Co.	Standard Oil Company
AMW Co.	Atascadero Mutual Water Company

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Precipitation Characteristics

As stated previously, precipitation occurs principally in the form of rainfall, although infrequent light snowfalls are recorded in the interior portions of the County at higher altitudes. As shown by lines of equal mean seasonal precipitation depicted on Plate 3, precipitation over San Luis Obispo County occurs in an irregular pattern ranging from a mean seasonal depth of about 42 inches at the higher elevations in the Santa Lucia Range to about eight inches on the Carrizo Plain. Precipitation generally decreases easterly and westerly from the Santa Lucia Range, increasing again slightly over the La Panza Range. Higher elevations in the Caliente and Temblor Ranges have little apparent effect on the over-all pattern of precipitation in the eastern portion of the County where mean seasonal depth of precipitation is relatively low.

Amounts of precipitation occurring from season to season in San Luis Obispo County are subject to wide variation, a characteristic which is typical of the South and Central Coastal Areas in particular and of the State of California in general. Seasonal precipitation at San Luis Obispo has ranged from 33 to 198 per cent of the 50-year seasonal mean. Maximum seasonal precipitation at this station occurred in the 1940-41 season when 42.92 inches were recorded; whereas a minimum of only 7.20 inches fell in the season of 1897-98. The minimum precipitation at this station during the base period was 10.39 inches, occurring during the 1938-39 season.

Long-term trends of precipitation at two typical stations are depicted on Plate 4, "Representative Precipitation Characteristics in San Luis Obispo County", on which relative magnitudes of seasonal precipitation at San Luis Obispo and Paso Robles are graphically illustrated. Recorded and estimated seasonal depths of precipitation and seasonal precipitation indexes for the period of record at four typical stations in various parts of the County are presented in Table 5. The term, "precipitation index", refers to the ratio of the amount of precipitation occurring at a given station during a given season to the mean seasonal precipitation at that station, expressed as a percentage.

TABLE 5

RECORDED AND ESTIMATED SEASONAL PRECIPITATION
AT SELECTED STATIONS IN
SAN LUIS OBISPO COUNTY AND VICINITY

Season	San Luis Obispo		Santa Maria		Paso Robles		San Miguel	
	Precipitation index	Inches depth	Precipitation index	Inches depth	Precipitation index	Inches depth	Precipitation index	Inches depth
1869-70	55	11.83	---	---	---	---	---	---
71	60	12.97	---	---	---	---	---	---
72	124	27.02	---	---	---	---	---	---
73	59	12.79	---	---	---	---	---	---
74	94	20.52	---	---	---	---	---	---
1874-75	91	19.69	---	---	---	---	---	---
76	139	30.12	---	---	---	---	---	---
77	38	8.15	---	---	---	---	---	---
78	141	30.60	---	---	---	---	---	---
79	54	11.66	---	---	---	---	---	---
1879-80	119	25.82	---	---	---	---	---	---
81	109	23.69	---	---	---	---	---	---
82	79	17.03	---	---	---	---	---	---
83	78	17.01	---	---	---	---	---	---
84	195	42.40	---	---	---	---	---	---
1884-85	81	17.59	---	---	---	---	---	---
86	135	29.30	137	19.47	---	---	---	---
87	76	16.54	66	9.36	---	---	---	---
88	85	18.35	83	11.77	90	14.30	---	---
89	90	19.54	113	16.04	100	15.84	---	---
1889-90	178	38.73	195	27.81	193	30.57	---	---
91	90	19.51	85	12.10	104	16.42	---	---
92	75	16.33	69	9.83	76	11.98	---	---
93	140	30.40	124	17.69	143	22.55	112	13.37
94	45	9.81	60	8.52	38	5.94	35	4.20
1894-95	105	22.82	96	13.66	107	16.93	102	12.15
96	82	17.75	81	11.51	83	13.14	86	10.26
97	96	20.75	106	15.14	114	17.96	101	12.02
98	33	7.20	40	5.70	30	4.77	26	3.15
99	80	17.33	88	12.52	73	11.53	66	7.90
1899-1900	79	17.21	65	9.23	74	11.66	70	8.35
01	145	31.40	114	16.28	144	22.80	128	15.30
02	101	21.96	87	12.32	81	12.75	82	9.75
03	85	18.49	90	12.79	71	11.24	62	7.45
04	78	16.99	79	11.18	92	14.51	62	7.45

RECORDED AND ESTIMATED SEASONAL PRECIPITATION
AT SELECTED STATIONS IN
SAN LUIS OBISPO COUNTY AND VICINITY
(continued)

Season	San Luis Obispo		Santa Maria		Paso Robles		San Miguel	
	Precipi- tation index	Inches depth	Precipi- tation index	Inches depth	Precipi- tation index	Inches depth	Precipi- tation index	Inches depth
1904-05	109	23.56	145	20.65	126	19.89	122	14.59
06	130	28.11	125	17.86	96	15.23	106	12.61
07	115	24.89	127	18.02	139	22.00	134	16.00
08	83	18.06	98	13.96	97	15.31	107	12.81
09	145	31.38	160	22.81	153	24.21	150	17.92
1909-10	96	20.85	116	16.58	108	17.09	99	11.80
11	159	34.42	145	20.69	168	26.64	185	22.11
12	79	17.14	68	9.63	78	12.37	106	12.67
13	40	8.58	38	5.46	51	8.06	42	5.01
14	144	31.21	132	18.86	139	22.02	161	19.20
1914-15	130	28.17	133	18.93	158	24.96	178	21.24
16	124	26.93	117	16.66	136	21.54	125	14.89
17	106	23.03	102	14.48	117	18.51	83	9.88
18	83	18.06	114	16.19	91	14.37	98	11.76
19	83	18.09	77	10.99	75	11.91	90	10.78
1919-20	69	14.86	67	9.60	81	12.81	69	8.24
21	89	19.27	78	11.04	87	13.70	96	11.43
22	108	23.36	119	16.88	138	21.81	153	18.27
23	107	23.28	87	12.43	98	15.45	97	11.54
24	38	8.19	44	6.27	40	6.38	45	5.34
1924-25	100	21.63	106	15.07	81	12.74	65	7.76
26	87	18.82	71	10.04	93	14.79	88	10.50
27	114	24.68	110	15.61	138	21.91	112	13.36
28	98	21.33	108	15.36	73	11.49	63	7.55
29	80	17.30	75	10.75	62	9.82	69	8.29
1929-30	69	14.97	64	9.18	69	10.96	62	7.44
31	67	14.63	61	8.72	76	12.10	81	9.69
32	137	29.75	118	16.78	105	16.59	113	13.55
33	73	15.77	80	11.44	61	9.62	56	6.64
34	69	14.97	54	7.67	73	11.62	86	10.27
1934-35	120	25.99	134	19.14	134	21.22	131	15.61
36	111	24.06	97	13.75	115	18.17	98	11.68
37	154	33.29	147	20.98	145	22.87	138	16.51
38	143	30.98	152	21.58	194	30.69	160	19.10
39	48	10.30	75	10.62	55	8.70	54	5.66

RECORDED AND ESTIMATED SEASONAL PRECIPITATION
AT SELECTED STATIONS IN
SAN LUIS OBISPO COUNTY AND VICINITY
(continued)

Season	San Luis Obispo		Santa Maria		Paso Robles		San Miguel	
	Precipitation index	Inches depth	Precipitation index	Inches depth	Precipitation index	Inches depth	Precipitation index	Inches depth
1939-40	115	24.91	113	16.09	98	15.57	106	12.66
41	198	42.92	215	30.64	193	30.48	218	26.08
42	109	23.61	120	17.04	97	15.30	116	13.89
43	120	26.06	121	17.26	109	17.21	111	13.23
44	104	22.47	102	14.56	78	12.30	107	12.81
1944-45	98	21.28	79	11.29	76	12.00	78	9.31
46	83	17.99	78	11.11	71	11.20	77	9.25
47	67	14.27	66	9.36	65	10.27	68	8.16
48	72	15.54	89	12.66	66	10.47	64	7.60
49	68	14.67	64	9.09	67	10.61	67	8.01*
1949-50	87	18.96	69	9.81	71	11.29	71	8.48*
51	72	15.61	65	9.24	66	10.47	66	7.89*
52	135	29.30	126	17.97	114	18.09	---	---
53	78	16.95	76	10.86	69	10.99	---	---
54	91	19.77	85	12.11	71	11.27	---	---
Average for 16-year base period, 1935-36 through 1950-51	103	22.30	103	14.69	98	15.48	100	11.95
Mean for 50-year period, 1897-98 through 1946-47	100	21.68	100	14.24	100	15.82	100	11.93
Average for period of record	97	21.22	97	13.79	98	15.52	98	11.73

* Estimated.

On the average, approximately 90 per cent of the seasonal precipitation at San Luis Obispo occurs during the six-month period from November through April. Illustrative of monthly variation of precipitation in the County is the mean monthly distribution of precipitation as recorded at San Luis Obispo and Paso Robles, presented in Table 6.

TABLE 6

MEAN MONTHLY DISTRIBUTION OF PRECIPITATION
AT PASO ROBLES AND SAN LUIS OBISPO

Month	Paso Robles Precipitation		San Luis Obispo Precipitation	
	In inches of depth	In per cent of seasonal total	In inches of depth	In per cent of seasonal total
July	0.01	0.1	0.01	0.1
August	0.02	0.1	0.04	0.2
September	0.18	1.1	0.23	1.0
October	0.58	3.7	0.81	3.7
November	1.20	7.6	1.67	7.7
December	2.60	16.4	3.80	17.4
January	3.60	22.8	4.94	23.0
February	3.49	22.1	4.52	20.8
March	2.77	17.5	3.60	16.6
April	0.89	5.6	1.34	6.2
May	0.40	2.5	0.58	2.7
June	0.08	0.5	0.14	0.6
TOTALS	15.82	100.0	21.68	100.0

Runoff

The major sources of surface runoff within San Luis Obispo County are the highly productive watersheds of the Santa Lucia Range. A large portion of this runoff in the streams draining the foregoing watersheds is presently wasting to the ocean. Runoff in the streams draining watersheds in the eastern portion of the County is small because of limited precipitation.

Stream Gaging Stations and Records

There are few long-term records of runoff from streams within or tributary to San Luis Obispo County. The longest active unbroken records of stream flow in the County are for Santa Maria River near Santa Maria and Huasna River near Santa Maria, both of which date back to December, 1929. A continuous record of flow of the San Antonio River at Pleyto in Monterey County is also available for a portion of 1922, and continuously since 1929. Earlier records of stream flow are available for 10 stations which are presently inactive. With the exception of the record for Salinas River near Santa Margarita, which is available for a portion of 1922, and continuously from February, 1932, to September, 1949, these earlier records were generally of short duration.

Records of stream flow in San Luis Obispo County are currently being maintained at 14 gaging stations by the U. S. Geological Survey under provisions of federal-state and federal-county cooperative stream gaging programs. These stations are located on Salinas River near Pozo, Salinas River above Pilitas Creek near Santa Margarita, Salinas River at Paso Robles, Toro Creek (Upper Salinas Unit) near Pozo, Jack Creek near Templeton, Estrella Creek near San Miguel, Nacimiento River near Bryson, Nacimiento River near San Miguel, Arroyo de la Cruz near San Simeon, Arroyo Grande Creek at Arroyo Grande, Cuyama River near Santa Maria, Alamo River near Santa Maria, Huasna River near Santa Maria, and Santa Maria River near Guadalupe. In addition, a record of quantity of water in storage in Salinas Reservoir on Salinas River is maintained by the U. S. Geological Survey. The Toro Creek station near Pozo is maintained during the irrigation seasons only. The stations on Estrella Creek and Nacimiento River near Bryson were established by the

U. S. Geological Survey in September, 1954, and October, 1955, respectively, in cooperation with San Luis Obispo County and are being maintained under the cooperative federal-state program.

For the purpose of supplementing available data, the Division of Water Resources installed and maintained four stream flow gaging stations equipped with automatic water stage recorders on Huerhuero Creek near Geneseo School, Estrella Creek near Estrella, Santa Rosa Creek at Cambria, and Arroyo Grande Creek below Santa Manuela School. A station on Nacimiento River near Bryson at the Monterey-San Luis Obispo County line, equipped with a nonrecording staff gage, read at least twice daily, was also maintained by the Division of Water Resources during the 1953-54 and 1954-55 seasons. During the 1952-53 and 1953-54 seasons, a gaging station was established and maintained by Pacific Gas and Electric Company on Toro Creek (Coastal Unit) near State Highway Sign Route No. 1 in the vicinity of Cayucos.

Table 7 contains a list of the stream gaging stations discussed previously along with other stations considered pertinent to the hydrography of San Luis Obispo County, together with their map reference numbers shown on Plate 5, drainage areas, and periods and sources of records. Map reference numbers on Plate 5 correspond to those used in State Water Resources Board Bulletin No. 1, "Water Resources of California". Numbers, prefixed by an appropriate county designation; i.e., S. L. O., San Luis Obispo County, or M., Monterey County, etc., have been assigned to those stations not listed in Bulletin No. 1. Monthly records of stream discharge not previously published are included in Appendix D.

TABLE 7

STREAM GAGING STATIONS IN SAN LUIS OBISPO COUNTY AND VICINITY

TABLE 7

STREAM GAGING STATIONS IN SAN LUIS OBISPO COUNTY AND VICINITY

Index No.	Station	Location: Longitude	Location: Latitude	Drainage area in square miles	Period of record	Source of record
Upper Salinas Unit						
3-21	Salinas River near Pozo	120° 24.0'	35° 18.0'	72.5	July 1942 through Sept. 30, 1954	U.S.G.S.[c]
3-22	Toro Creek near Pozo	120° 25.0'	35° 20.0'	9.5	June 1942 through Sept. 30, 1954[a]	U.S.G.S.
3-23	Salinas Reservoir near Pozo	120° 30.0'	35° 20.0'	111	Dec. 1941 through Sept. 30, 1954	U.S.G.S.
3-24	Salinas River above Pilitas Creek near Santa Margarita	120° 31.0'	35° 21.0'	112	July 1942 through Sept. 30, 1954	U.S.G.S.
3-25	Salinas River near Santa Margarita	120° 34.1'	35° 24.3'	148	Apr. 1922 through Sept. 1922 Feb. 1932 through Sept. 1949	U.S.G.S. U.S.G.S.
3-26	Tassajera Creek near Santa Margarita	120° 39.0'	35° 23.0'	4.4	June 1942 through October 1947[a]	U.S.G.S.
3-27	Santa Margarita Creek near Santa Margarita	120° 39.0'	35° 23.0'	2.4	June 1942 through October 1947[a]	U.S.G.S.
3-28	Salinas River near Atascadero	120° 39.6'	35° 30.4'	216	June 1913 through May 1916	C.H.C.[d]
SLO-4	Jack Creek near Templeton	120° 48.5'	35° 34.1'	25.4	Nov. 1949 through Sept. 30, 1954	U.S.G.S.
SLO-1	Paso Robles Creek near Templeton	120° 42.6'	35° 31.8'	68.0	1941	U.S.C.E.[e]
3-29	Salinas River at Paso Robles	120° 41.1'	35° 37.7'	389	Oct. 1939 through Sept. 30, 1954	U.S.G.S.
SLO-2	Huerhuero Creek near Geneseo School	120° 33.2'	35° 35.0'	101.1	Oct. 1952 through Sept. 1953	D.W.R.[f]
3-30	Estrella Creek near Paso Robles	120° 30.0'	35° 39.0'	782[b]	Dec. 1939 through Sept. 1941	U.S.G.S.
SLO-3	Estrella Creek near Estrella	120° 36.1'	35° 42.1'	882	Oct. 1952 through June 1954	D.W.R.
SLO-5	Estrella Creek near San Miguel	120° 38.4'	35° 43.1'	1,246	Sept. 1954	U.S.G.S.
M-1	Nacimiento River near Bryson	121° 06.4'	35° 47.9'	153	Dec. 1953 through Sept. 30, 1954	D.W.R.
3-31	Nacimiento River near Bryson	121° 05.0'	35° 46.4'	171	Feb. 1901 through Apr. 1901	U.S.G.S.
3-32	Nacimiento River near Bradley	120° 55.4'	35° 44.8'	301	Mar. 1922 through Sept. 1922	U.S.G.S.
3-33	Nacimiento River near San Miguel	120° 47.4'	35° 47.0'	354	Oct. 1939 through Sept. 30, 1954	U.S.G.S.
3-34	San Antonio River near Jolon	121° 11.4'	35° 57.5'	161	1901	U.S.G.S.
3-35	San Antonio River near Pleyto	120° 59.5'	35° 51.9'	282	Apr. 1922 through Sept. 1922 Dec. 1929 through Sept. 30, 1954	U.S.G.S.
M-2	Salinas River near Bradley	120° 52.0'	35° 55.7'	2,522	Dec. 1948 through Sept. 30, 1954	U.S.G.S.
Coastal Unit						
SLO-6	Arroyo de la Cruz near San Simeon	121° 17.0'	35° 43.0'	41.4	Nov. 1950 through Sept. 30, 1954	U.S.G.S.
SLO-7	Santa Rosa Creek at Cambria	121° 04.9'	35° 33.8'	45.5	Oct. 1952 through Sept. 30, 1954	D.W.R.
SLO-8	Toro Creek above State Highway 1	120° 52.0'	35° 25.1'	15.0	Nov. 1952 through Sept. 30, 1954	P.G.&E.[g]
SLO-9	Arroyo Grande Creek below Santa Manuela School	120° 29.8'	35° 11.1'	68.3	Oct. 1952 through Sept. 30, 1954	D.W.R.
3-40	Arroyo Grande Creek at Arroyo Grande	120° 34.3'	35° 07.4'	106	Dec. 1939 through Sept. 30, 1954	U.S.G.S.

STREAM GAGING STATIONS IN SAN LUIS OBISPO COUNTY AND VICINITY
(continued)

Index No.	Station	Location		Drainage area in square miles	Period of record	Source of record
		Longitude	Latitude			
Cuyama Unit						
3-42	Cuyama River near Santa Maria	120° 16.8'	35° 00.8'	912	Dec. 1929 through Sept. 30, 1954	U.S.G.S.
3-43	Alamo Creek near Santa Maria	120° 18.8'	35° 00.7'	87.7	Oct. 1943 through Sept. 30, 1954	U.S.G.S.
3-44	Huasna River near Santa Maria	120° 19.3'	35° 01.3'	119	Dec. 1939 through Sept. 30, 1954	U.S.G.S.
Santa Maria Unit						
3-48	Sisquoc River near Gary	120° 15.8'	34° 51.7'	442	Feb. 1941 through Sept. 30, 1954	U.S.G.S.
SLO-10	Santa Maria River near Santa Maria	120° 26.0'	34° 59.5'	1,710.2	Oct. 1903 through Dec. 1905	U.S.G.S.
3-49	Santa Maria River at Guadalupe	120° 34.3'	34° 58.4'	1,763	Jan. 1941 through Sept. 30, 1954	U.S.G.S.

a. Irrigation seasons only.
b. U.S.G.S. value is 816 square miles.
c. United States Geological Survey.
d. Colony Holding Corporation.
e. U. S. Army Corps of Engineers.
f. Division of Water Resources.
g. Pacific Gas and Electric Company.

In addition to periodic stream flow discharge measurements made for the purpose of rating gaging stations previously described, periodic and intermittent measurements of percolating and rising water were made at 61 stations on streams throughout San Luis Obispo County during the 1952-53 and 1953-54 investigational seasons. Results of these stream flow measurements are included in Appendix D. Included in Appendix J are estimates of monthly runoff occurring during the base period, 1935-36 through 1950-51, at selected dam sites discussed subsequently in Chapter IV.

Runoff Characteristics

Runoff from streams in and tributary to San Luis Obispo County has historically varied within wide limits from month to month and from season to season. Though long-term records of runoff are lacking, available records do indicate characteristic monthly and seasonal variations of runoff found throughout the Central Coastal Area of California. As evidenced by the pattern of precipitation occurrence, available runoff records indicate a relatively high intensity of runoff from streams draining the Santa Lucia Range with greater amounts of runoff occurring in the northwestern portion of the County where precipitation is generally higher. Characteristically, seasonal and monthly variations of runoff follow very closely the seasonal and monthly variations of precipitation. Approximately 85 to 95 per cent of the flow of streams draining the watersheds of San Luis Obispo County occurs during the months of November through April on the average.

One of the most productive watersheds in San Luis Obispo County in terms of total volume of runoff is the Nacimiento River watershed. Unit runoff from this watershed for the 1940-41 season was 1,710 acre-feet per square mile and averaged about 600 acre-feet per square mile during the base period.

Mean seasonal runoff is estimated to be 24,600 acre-feet, and runoff during the base period averaged an estimated 210,270 acre-feet per season.

Approximately 53 per cent of the drainage area above the existing gaging station near San Miguel (Station 3-33) lies within San Luis Obispo County, and approximately 50 per cent of the precipitation falling upon the watershed falls within San Luis Obispo County. However, based on measurements by the Division of Water Resources of the flow of Nacimiento River near Bryson (Station M-1), correlated with longer records of flow downstream, it is estimated that only about 48 per cent of the runoff of the Nacimiento River at the gaging station near San Miguel originates within San Luis Obispo County.

Available records indicate that Arroyo de la Cruz is one of the most productive streams in San Luis Obispo County in terms of runoff per square mile of drainage area. By comparison with other streams in the area having longer records, it is estimated that unit runoff at the gaging station near San Simeon exceeded 3,000 acre-feet per square mile during the 1940-41 season, and averaged 1,080 acre-feet per square mile during the base period, that mean seasonal runoff amounted to 46,400 acre-feet, and that runoff during the base period averaged 44,750 acre-feet per season.

As previously stated, unit runoff is generally greater in the northerly portions of the Santa Lucia Range than in the southerly portions where precipitation is less. Runoff from Arroyo Grande Creek, though draining an area of about two and one-half times that of Arroyo de la Cruz, had an estimated average seasonal undepleted discharge during the base period of 20,730 acre-feet at the U. S. Geological Survey gaging station or slightly less than one-half the value estimated for the same period at the gaging station on Arroyo de la Cruz. Unit runoff during the 1940-41 season at the

Arroyo Grande Creek station was about 420 acre-feet per square mile. Average unit runoff during the base period was about 200 acre-feet per square mile per season.

A comparison of seasonal variations in natural runoff of three typical streams in San Luis Obispo County is depicted on Plate 6, entitled "Runoff Characteristics of Streams in San Luis Obispo County". Long-term trends in natural runoff of two of the streams illustrating the apparent cyclic nature of runoff occurrence are also illustrated on Plate 6. Presented in Table 8 are estimates of the monthly variation in seasonal natural runoff of two selected streams, Nacimiento River and Arroyo Grande Creek.

TABLE 8

AVERAGE MONTHLY DISTRIBUTION OF SEASONAL NATURAL RUNOFF OF NACIMIENTO RIVER AND ARROYO GRANDE CREEK DURING BASE PERIOD, 1935-36 THROUGH 1950-51

Month	Nacimiento River near San Miguel		Arroyo Grande Creek at Arroyo Grande	
	Runoff, in acre-feet	Runoff, in per cent of seasonal total	Runoff, in acre-feet	Runoff, in per cent of seasonal total
October	---	---	370	1.8
November	4,090	1.9	430	2.1
December	18,020	8.6	830	4.0
January	31,450	15.0	1,610	7.8
February	73,000	34.8	5,860	28.3
March	59,170	28.1	5,900	28.5
April	20,370	9.7	2,840	13.7
May	3,340	1.6	1,140	5.5
June	720	0.3	620	3.0
July	80	---	460	2.2
August	20	---	430	1.6
September	10	---	310	1.5
TOTALS	210,270	100.0	20,700	100.0

Quantity of Runoff

As previously stated, few long-term records of runoff in San Luis Obispo County streams are available. With the exception of the Cuyama and Huasna Rivers, no runoff records are available for streams within San Luis Obispo County or tributary areas which extend over the entire chosen base period. From studies of rainfall-runoff relationships and by correlation with longer records from other nearby streams, using a modified form of a method originally described by H. C. Troxell in a report entitled "Hydrology of Western Riverside County, California", sufficient data were obtained to extend existing short-term runoff records. These studies provided bases for estimating surface inflow to proposed surface reservoirs and surface inflow to and outflow from ground water basins selected for hydrologic analysis.

Estimated seasonal natural runoff and seasonal runoff indexes during the 16-year base period, 1935-36 through 1950-51, at stations on four selected streams in San Luis Obispo County are presented in Table 9.

TABLE 9

TABLE 9

ESTIMATED SEASONAL NATURAL RUNOFF
IN SELECTED STREAMS IN SAN LUIS OBISPO COUNTY
DURING BASE PERIOD, 1935-36 THROUGH 1950-51

Season	Arroyo Grande Creek at Arroyo Grande		Arroyo de la Cruz near San Simeon		Salinas River at Paso Robles		Nacimiento River near San Miguel	
	Runoff, in acre-feet	Runoff index	Runoff, in acre-feet	Runoff index	Runoff, in acre-feet	Runoff index	Runoff, in acre-feet	Runoff index
1935-36	22,800	95	43,000	92	109,500	102	203,000	90
37	40,000	167	51,400	110	178,000	166	236,000	105
38	49,000	205	109,900	236	268,100	250	546,000	243
39	5,600	23	6,300	14	12,200	11	32,000	14
1939-40	11,200	47	66,000	142	74,500	69	304,000	135
41	67,400	282	128,900	277	335,700	312	604,000	269
42	23,300	98	56,200	121	101,300	94	253,800	113
43	47,600	199	64,500	138	211,800	197	296,800	132
44	17,400	73	35,600	76	74,500	69	164,300	73
1944-45	13,900	58	36,600	78	57,200	53	169,300	75
46	7,400	31	25,500	55	31,500	29	119,000	53
47	5,400	23	12,100	26	15,500	14	58,000	26
48	3,700	15	9,000	19	12,800	12	44,600	20
49	4,600	19	24,400	52	23,900	22	114,800	51
1949-50	6,800	28	21,800	47	38,500	36	103,200	46
51	5,800	24	24,800	53	31,300	29	115,600	51
16-year average	20,700	87	44,700	96	98,500	92	210,300	94
53-year mean	23,900	100	46,600	100	107,500	100	224,600	100

Major Exchanges of Water

Historically, there has been no exchange of water across the San Luis Obispo County line. For the purpose of hydrologic analyses described in this and ensuing chapters, however, it was necessary to evaluate certain inter-unit and inter-basin exchanges of water. Through the agency of the San Luis Obispo County Flood Control and Water Conservation District, by the terms of a contract providing for operation of the reservoir by the District with the Corps of Engineers, U. S. Army, water service from Salinas Reservoir has been provided to four consumers in the San Luis Obispo Subunit of the Coastal Unit since the Salinas Reservoir distribution system was placed in operation. They are, in order of magnitude of water consumed, City of San Luis Obispo, Southern Pacific Company, Costro Chrome Association, and Granite Construction Company. Water service was provided the latter two organizations for only a brief period of time.

Certain inter-basin exchanges of water are currently effected elsewhere in San Luis Obispo County. These include (1) pumped withdrawals from Arroyo Grande Ground Water Basin by the Water Department of the City of Pismo Beach, (2) pumped withdrawals from Old (Old Creek) Ground Water Basin by the San Luis Obispo County Waterworks District No. 8 (Cayucos) and the Paso Robles Beach Mutual Water Association foruse north and south, respectively, along the coast, and (3) pumped withdrawals from San Luis Obispo (San Luis Obispo Creek) Ground Water Basin by the Avila Water Company for use in the town of Avila.

The diversions and use of the waters of Old Creek by the Paso Robles Beach Water Association are covered by an application to appropriate unappropriated water on file with the State Water Rights Board, for which a license, calling for the diversion of 28,800 gallons per day, has been issued.

Metered and estimated records of diversions from Salinas Reservoir and exports from Arroyo Grande Basin by the County Flood Control and Water Conservation District and City of Pismo Beach, respectively, are presented for the respective periods of record in Table 1C. Records of water production and use by other agencies effecting inter-basin exchanges of water were reported by those agencies to be unavailable.

TABLE 10

MAJOR EXCHANGES OF WATER BETWEEN HYDROLOGIC UNITS
IN SAN LUIS OBISPO COUNTY

In Acre-Feet

Season	Exported from Upper Salinas Unit by San Luis Obispo County Flood Control and Water Conservation District	Exported from Arroyo Grande Basin by Pismo Beach Water Department
1929-30		90[a]
31		100[a]
32		100[a]
33		100[a]
34		100[a]
1934-35		100[a]
36		110[a]
37		110[a]
38		120[a]
39		120[a]
1939-40		130[a]
41		130[a]
42	50[b]	150[a]
43	960	190[a]
44	1,290	220[a]
1944-45	1,510	240[a]
46	1,680	260[a]
47	2,020	280[a]
48	2,320	280[a]
49	2,230	270[a]
1949-50	2,260	290[a]
51	2,550	320
52	2,140	330
53	2,470	360
54	2,410	360

a. Estimated.
b. Diversions commenced in July, 1942.

Underground Hydrology

Contained in this section is a summary discussion of the various factors affecting the occurrence, movement, and utilization of ground water in San Luis Obispo County. Data relating to the extent of present and probable ultimate ground water utilization, in addition to estimates of the safe seasonal ground water yield, are presented.

Except for control provided through operation of Salinas Reservoir, regulation of the water supplies of San Luis Obispo County is accomplished mostly through utilization of storage in ground water reservoirs. Sufficient ground water supplies for all beneficial purposes under present conditions of development are found in valleys and many hill areas throughout the County, except in the Santa Maria Unit, and occur principally in alluvium and other unconsolidated sediments. Ground water reservoirs are replenished by percolation of surface waters in natural channels, by deep penetration of precipitation, by deep penetration of the unconsumed residuum of applied irrigation water, and by subsurface inflow. Disposal of ground water supplies is effected by pumped extractions, by effluent discharge, by consumptive use of water by phreatophytes, and by subsurface outflow.

In connection with the discussion of underground hydrology in this bulletin, the following terms are used as defined:

Key Well--A well chosen for study because it displays ground water characteristics that are considered representative of a given ground water basin or aquifer or a portion thereof.

Free Ground Water--This generally refers to a body of ground water not overlain by impervious materials, and moving under control of the water table slope. Also termed unconfined ground water. In areas of free ground water, the ground water basins provide storage to regulate available water supplies. Changes in ground water storage are indicated by changes in ground water level.

Confined Ground Water Body--A body of ground water overlain by materials sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the difference in head between intake and discharge areas of the confined water body.

Specific Yield--This term, when used in conjunction with ground water, refers to the volume of water a saturated sample of the water-bearing material will yield by gravity divided by the volume of that sample, and is commonly expressed as a percentage. Ground water storage capacity is estimated as the product of the specific yield and the volume of material in the depth intervals considered.

Specific Capacity--The number of gallons per minute per foot of drawdown produced by a pumping well.

Drawdown--The lowering of the water level in a well in the local area around the well caused by pumping, measured in feet.

Safe Yield--Refers to the maximum sustained rate of draft from a surface reservoir which could be maintained throughout a critically deficient water supply period. With reference to utilization of ground water supplies, the term refers to the maximum rate of net extraction from the ground water basin which, if continued over an indefinitely long period of years, would result in the maintenance of certain desirable fixed conditions. Safe ground water yield is normally determined by one or more of the following criteria:

1. Mean seasonal extraction of water from the ground water basin does not exceed mean seasonal replenishment to the basin.

2. Water levels are not so lowered as to cause harmful impairment of the quality of the ground water by intrusion of other water of undesirable quality, or by accumulation and concentration of degradants or pollutants.

3. Water levels are not so lowered as to imperil the economy of ground water users by excessive costs of pumping from the ground water basin or by exclusion of the users from a supply therefrom.

Overdraft--Refers to the use of water in excess of safe yield wherein any one or more of the criteria listed under "Safe Yield" are no longer satisfied.

The maximum safe yield of a ground water basin cannot usually be definitely evaluated until there is evidence of overdraft. As a result of this investigation, it has been determined that the only ground water basin wholly or partially within San Luis Obispo County in which there is evidence of overdraft is the Santa Maria Basin. The portion of the Santa Maria Basin within San Luis Obispo County is contained within the Santa Maria Unit.

With increased use of water from presently underdeveloped basins, ground water levels will be further lowered during drought periods, thereby providing additional space in the basins for storage of percolating surface waters that would otherwise waste to the ocean during wet periods. The net effect thereof would be an increase in yields of the basins.

Since safe ground water yield is not a fixed value but may vary with pumping patterns, the magnitude of ground water basin utilization, the location of principal areas of recharge, and other inter-related factors, a further definition of the term is considered necessary. Therefore, as used in this bulletin with reference to those ground water basins considered to be susceptible of greater utilization, wherein no overdraft presently exists, the term "safe yield of presently developed ground water supplies" refers to the rate of net seasonal extractions therefrom with present patterns of land use under mean conditions of water supply and utilization.

Presented hereinafter are discussions of 19 ground water basins which have been identified in San Luis Obispo County as a result of this investigation. More detailed treatment has been given to two basins because of their relatively large storage capacity, degree of present utilization, or greater abundance of hydrologic data. Not included in the remainder of the group are numerous minor ground water basins scattered throughout the County which, because of their limited storage capacity and minor present water utilization, have not been given detailed consideration in this bulletin. Also not discussed in detail are ground water basins in the Santa Maria and Cuyama Valleys which have been extensively investigated by the U. S. Geological Survey, results of which investigations are published in previously cited reports by that agency. Shown on Plate 9 entitled "Lines of Equal Elevation of Ground Water, Fall 1954", are the locations of the ground water basins, together with water wells employed in analyzing basin characteristics. The wells are numbered by the system utilized by the U. S. Geological Survey, according to the township, range, and section subdivision of the Federal Land Survey. In the portions of San Luis Obispo County not so subdivided, the township, range, and section lines have been projected. Under the system, each section is divided into 40-acre plots which are lettered as follows:

D	C	B	A
E	F	G	H
M	L	K	J
N	P	Q	R

Wells are numbered within each of these 40-acre plots according to the chronological order in which they were located in the field. For example, a well having a number 26S/12E-4N1 would be found in Township 26 South, Range 12 East, and in Section 4. It would be further identified as the first well located in the 40-acre plot designated by the letter "N". Most well numbers in San Luis Obispo County refer to the Mount Diablo Base Line and Meridian except in the southernmost portion of the County where the numbers refer to the San Bernardino Base Line and Meridian.

Studies of underground hydrology included investigation of geologic characteristics of the basins, together with a preliminary quantitative analysis of replenishment and disposal of ground waters in certain basins, and qualitative analysis of ground water hydrology in most of the basins.

Geologic investigations included collection and analysis of prior geologic reports and maps, supplemented by discussion with geologists familiar with various portions of the County. Drillers logs for about 300 water wells and 93 oil wells were collected and analyzed. These data, together with additional information obtained by field surveys were utilized in preparing Plate 7 entitled "Areal Geology", and Plate 8 entitled "Geologic Cross Sections". The locations of the geologic cross sections are shown in plan on

Plate 7. Aquifers of significance to ground water utilization were identified from well data and are shown in the geologic cross sections delineated on Plate 8.

Estimates of specific yield of water-bearing formations and ground water storage capacity were prepared primarily from a knowledge of characteristics of material classified in well logs. A detailed description of methods and procedures utilized in the preparation of these estimates is contained in Appendix B. Where there were sufficient data available on fluctuation of ground water levels, changes in storage occurring in ground water basins were estimated for the base period. Historical fluctuations of ground water levels in various basins are illustrated in Plate 10 entitled "Fluctuation of Water Levels at Selected Wells", on which are presented hydrographs of ground water elevation at 12 wells in three of the 19 identified ground water basins.

Water level measurements utilized in preparing plates relating to the occurrence and movement of ground water and fluctuations of ground water levels were obtained in the field by the Division of Water Resources or from Pacific Gas and Electric Company pumping tests. A summary of all known historical water level measurements at wells in San Luis Obispo County with the exception of those measurements reported by the U. S. Geological Survey for the Santa Maria and Cuyama Units is contained in Appendix E.

Based on the results of the foregoing studies and using stated assumptions and criteria, the safe yield of presently developed ground water supplies in San Luis Obispo County exclusive of the Santa Maria and Cuyama Units is estimated to be about 41,000 acre-feet per season. Under future conditions of development and water utilization, it is estimated that the maximum safe yield of the afore-mentioned area would be on the order of 70,000 acre-feet per season.

Results of studies and pertinent data for each of the ground water basins studied in San Luis Obispo County are discussed in the following paragraphs. Selected characteristics of ground water basins are listed in Table 11. Estimates of the presently developed and maximum safe ground water yield of each basin are presented in Table 12.

TABLE 11

SUMMARY OF CHARACTERISTICS OF
SELECTED GROUND WATER BASINS IN SAN LUIS OBISPO COUNTY

Ground water basin	Surface area in acres	Thickness of water-bearing formations	No. of irrigation wells, 1954	Depth of irrigation wells, in feet: Maximum known	Depth of irrigation wells, in feet: Estimated average	Depth to water in wells, in feet: Maximum known	Depth to water in wells, in feet: Minimum known	Yield of irrigation wells, in gpm: Maximum known	Yield of irrigation wells, in gpm: Estimated average	Specific capacity, in gpm/foot of drawdown: Maximum known	Specific capacity, in gpm/foot of drawdown: Estimated average	Estimated average specific yield in per cent	Estimated usable capacity, in acre-feet
UPPER SALINAS UNIT													
Paso Robles	580,700	0-2,000	220	1,200	400	290	0	3,300	500	111	15	8	3,000,000+
Pozo	3,600	0- 30	17	230	50	110	5	230	100	--	--	15	1,000
COASTAL UNIT													
San Carpoforo	200	0- 60	0	---	--	--	-	---	---	--	--	18	600
Arroyo de la Cruz	750	0- 130+	5	127	100	13	0	---	---	--	--	18	2,200
San Simeon	620	0- 100	6	80	50	50	5	170	100	--	--	18	1,300
Santa Rosa	2,360	0- 130+	9	130	80	30	6	708	400	50	15	17	6,000
Villa	980	0- 130+	3	135	80	90	5	---	---	--	--	15	2,200
Cayucos	530	0- 120+	2	---	--	28	4	166	100	14	10	15	1,300
Old	750	0- 135	3	162	70	34	8	335	200	24	15	15	1,500
Toro	490	0- 80	1	---	--	--	8	500	---	--	--	15	1,000
Morro	1,270	0- 130	12	90	80	52	4	442	300	73	30	12	2,000
Chorro	1,750	0- 80	4	150	70	23	2	700	200	23	15	12	2,500
Los Osos	7,920	0- 100	13	212	60	83	2	396	200	35	15	20	9,000
San Luis Obispo	9,680	0- 160	23	210	90	30	2	600	300	20	15	13	22,000
Pismo	5,140	0- 160	15	110	60	42	0	200	---	--	--	12	10,000
Arroyo Grande	12,460	0- 200±	123	252	100	93	0	1,200	360	500	40	15	40,000
Nipomo Mesa	16,020	0- 900	6	810	400	237	5	1,500	100	29	5	18	------
CARRIZO PLAIN UNIT													
Carrizo Plain	172,000	0-1,000+	8	600	200	58	12	1,000	500	15	5	--	------

TABLE 11

SUMMARY OF CHARACTERISTICS OF
SELECTED GROUND WATER BASINS IN SAN LUIS OBISPO COUNTY

Ground water basin	Surface area in acres	Thickness of water-bearing formations	No. of irrigation wells, 1954	Depth of irrigation wells, in feet: Maximum known	Depth of irrigation wells, in feet: Estimated average	Depth to water in wells, in feet: Maximum known	Depth to water in wells, in feet: Minimum known	Yield of irrigation wells, in gpm: Maximum known	Yield of irrigation wells, in gpm: Estimated average	Specific capacity, in gpm/foot of drawdown: Maximum known	Specific capacity, in gpm/foot of drawdown: Estimated average	Estimated average specific yield in per cent	Estimated usable capacity, in acre-feet
UPPER SALINAS UNIT													
Paso Robles	580,700	0-2,000	220	1,200	400	290	0	3,300	500	111	15	8	3,000,000+
Pozo	3,600	0- 30	17	230	50	110	5	230	100	--	--	15	1,000
COASTAL UNIT													
San Carpoforo	200	0- 60	0	---	--	--	-	---	---	--	--	18	600
Arroyo de la Cruz	750	0- 130+	5	127	100	13	0	---	---	--	--	18	2,200
San Simeon	620	0- 100	6	80	50	50	5	170	100	--	--	18	1,300
Santa Rosa	2,360	0- 130+	9	130	80	30	6	708	400	50	15	17	6,000
Villa	980	0- 130+	3	135	80	90	5	---	---	--	--	15	2,200
Cayucos	530	0- 120+	2	---	--	28	4	166	100	14	10	15	1,300
Old	750	0- 135	3	162	70	34	8	335	200	24	15	15	1,500
Toro	490	0- 80	1	---	--	--	8	500	---	--	--	15	1,000
Morro	1,270	0- 130	12	90	80	52	4	442	300	73	30	12	2,000
Chorro	1,750	0- 80	4	150	70	23	2	700	200	23	15	12	2,500
Los Osos	7,920	0- 100	13	212	60	83	2	396	200	35	15	20	9,000
San Luis Obispo	9,680	0- 160	23	210	90	30	2	600	300	20	15	13	22,000
Pismo	5,140	0- 160	15	110	60	42	0	200	---	--	--	12	10,000
Arroyo Grande	12,460	0- 200±	123	252	100	93	0	1,200	360	500	40	15	40,000
Nipomo Mesa	16,020	0- 900	6	810	400	237	5	1,500	100	29	5	18	------
CARRIZO PLAIN UNIT													
Carrizo Plain	172,000	0-1,000+	8	600	200	58	12	1,000	500	15	5	--	------

TABLE 12

ESTIMATED PRESENTLY DEVELOPED AND MAXIMUM SAFE SEASONAL YIELD OF GROUND WATER SUPPLIES IN PORTIONS OF SAN LUIS OBISPO COUNTY AND VICINITY

In Acre-Feet

Unit, subunit, and ground water basin	Estimated safe seasonal yield	
	Presently developed	Maximum
UPPER SALINAS UNIT		
Paso Robles	25,300	42,700[a]
Pozo	300	1,000
Miscellaneous	1,300	1,300
Subtotals, UPPER SALINAS UNIT	26,900	45,000
COASTAL UNIT		
Cambria Subunit		
San Carpoforo	0	0[b]
Arroyo de la Cruz	200	400[b]
San Simeon	200	300[b]
Santa Rosa	200	600[b]
Villa	100	1,000[b]
Cayucos	100	600
Old	300	300[b]
Toro	100	500
Miscellaneous	200	200
Subtotals, Cambria Subunit	1,400	3,900
San Luis Obispo Subunit		
Morro	600	1,500
Chorro	500	1,500
Los Osos	600	800
San Luis Obispo	1,900	2,000
Pismo	1,000	2,000
Miscellaneous	1,100	1,100
Subtotals, San Luis Obispo Subunit	5,700	8,900
Arroyo Grande Subunit		
Arroyo Grande	6,500	9,500
Nipomo	200	2,500
Subtotals, Arroyo Grande Subunit	6,700	12,000
Subtotals, COASTAL UNIT	13,800	24,800
CARRIZO PLAIN UNIT	600	600
SAN JOAQUIN UNIT	0	0
TOTALS	41,300	70,400

a. Includes yield of Paso Robles Basin within Monterey County.
b. Limited due to construction of proposed water supply developments.

Upper Salinas Unit

Ground water basins which have been identified in the Upper Salinas Unit include the Paso Robles and Pozo Basins. These two basins comprise a total surface area of about 584,000 acres. Approximately 25 per cent of the Paso Robles Basin is located within Monterey County. Ground water basins of the Upper Salinas Unit are replenished primarily from uncontrolled runoff originating in the several major and minor streams tributary to the Salinas River above Wunpost railroad siding, and to a lesser extent from direct infiltration of precipitation.

Water extracted from ground water storage in the Upper Salinas Unit meets over 95 per cent of the water requirement of an estimated present net irrigated area of 11,390 acres, as well as the entire water requirements of the communities of Paso Robles, Atascadero, San Miguel, Santa Margarita, and other smaller urbanized areas. In addition, minor quantities of ground water are extracted from rock fissures, less permeable sedimentary formations, and isolated pockets of alluvium located within the Unit.

Paso Robles Basin. The Paso Robles Basin generally coincides with the portion of the Paso Robles formation located within the Upper Salinas Unit as outlined on Plate 7A, except that the drainage divide at the U. S. Geological Survey gaging station at Wunpost railroad siding is taken as the north boundary. The Paso Robles Basin covers an area of about 581,000 acres and contains some valley floor and terrace areas. Surface topography of the basin consists of hills with relief ranging up to 500 feet. Principal streams draining across the San Luis Obispo County portion of the basin are the Nacimiento River, Estrella Creek, Paso Robles Creek, and the main stem of the Salinas River which leaves the basin at Wunpost.

Ground water storage in the Paso Robles Basin is replenished by percolation of stream flow, precipitation, and return flow from irrigation and other uses. Ground water is disposed of by pumped extractions to meet crop irrigation requirements and municipal and domestic demands, by consumptive use of phreatophytes in areas of high ground water, by effluent discharge, and by subsurface flow to Lower Salinas River Valley.

The Paso Robles formation of upper Pliocene and lower Pleistocene age furnishes water to most wells in the Paso Robles Basin, and consists of nonmarine sand, gravel, and clay up to 2,000 feet in thickness. The alluvium of Recent and upper Pleistocene age yields water to wells on the valley floor of the Salinas River and the Nacimiento River, but most of these wells also obtain water from the Paso Robles formation. The alluvium consists of stream deposited sand, gravel, and clay.

Ground water is essentially unconfined in the Paso Robles Basin although confining clay beds of limited areal extent cause localized artesian pressures to exist with resulting upward movement of ground water. Ground water moves from the periphery of the basin towards the Salinas River and Wunpost as shown by ground water contours on Plate 9A. Details of ground water movement are complex because of the lenticularity of gravels and clays. In topographically high areas, shallow wells generally have higher water levels than deeper wells while the reverse is generally true in topographically low areas. That water is moving upward under the influence of artesian pressures in low areas is also indicated by effluent flow or "rising water" in portions of San Juan, Cholame, Estrella, and Huerhuero Creeks. Irrigation wells generally yield about 500 gallons per minute, but a maximum of 3,300 gallons per minute has been reported. Specific capacity of wells averages about 25 gallons per minute per foot of drawdown with a maximum known value of 111.

Upper Salinas Unit

Ground water basins which have been identified in the Upper Salinas Unit include the Paso Robles and Pozo Basins. These two basins comprise a total surface area of about 584,000 acres. Approximately 25 per cent of the Paso Robles Basin is located within Monterey County. Ground water basins of the Upper Salinas Unit are replenished primarily from uncontrolled runoff originating in the several major and minor streams tributary to the Salinas River above Wunpost railroad siding, and to a lesser extent from direct infiltration of precipitation.

Water extracted from ground water storage in the Upper Salinas Unit meets over 95 per cent of the water requirement of an estimated present net irrigated area of 11,390 acres, as well as the entire water requirements of the communities of Paso Robles, Atascadero, San Miguel, Santa Margarita, and other smaller urbanized areas. In addition, minor quantities of ground water are extracted from rock fissures, less permeable sedimentary formations, and isolated pockets of alluvium located within the Unit.

Paso Robles Basin. The Paso Robles Basin generally coincides with the portion of the Paso Robles formation located within the Upper Salinas Unit as outlined on Plate 7A, except that the drainage divide at the U. S. Geological Survey gaging station at Wunpost railroad siding is taken as the north boundary. The Paso Robles Basin covers an area of about 581,000 acres and contains some valley floor and terrace areas. Surface topography of the basin consists of hills with relief ranging up to 500 feet. Principal streams draining across the San Luis Obispo County portion of the basin are the Nacimiento River, Estrella Creek, Paso Robles Creek, and the main stem of the Salinas River which leaves the basin at Wunpost.

Estimated average specific yield of the sediments of the Paso Robles Basin is about eight per cent. Total estimated storage capacity below present static water levels is estimated to be several millions of acre-feet.

The estimated practical extent of utilization of ground water storage is based primarily upon economic considerations. Irrigators in the west side of the San Joaquin Valley are known to be pumping ground water from depths of up to and exceeding 400 feet, and irrigators in the Upper Salinas Unit are known to be pumping from depths in excess of 200 feet.

Some preliminary analyses of the economics of irrigated agriculture in the Upper Salinas River area indicate that production of alfalfa can yield reasonable farm profits with water costs as high as $30 per acre. If it is assumed that pumping costs, including interest and amortization on pump and well investment, as well as power and maintenance charges, average four cents per acre-foot per foot of lift, and assuming gross application of water of four acre-feet per acre, the resulting economic limit of pumping lift would be about 190 feet. This depth would be approximately 100 feet below present static levels. For more remunerative types of agriculture, as well as for municipal water supplies, this economic limit of pumping lift would be commensurately greater. The storage capacity in the Paso Robles Basin in the 100-foot zone below the present static levels of ground water in that basin may be as much as 3,000,000 acre-feet. The utility of this storage, however, is questionable at this time and cannot be completely evaluated due to the lack of sufficient basic hydrologic and geologic data.

Available historic data on ground water levels in the Paso Robles Basin indicate that, although static ground water levels therein have been subject to monthly and seasonal fluctuations, as well as localized cones of depression resulting from concentrated pumping drafts, there is no evidence of a perennial lowering of the water levels over the past 10 years.

The general long-term stability of ground water levels in the Paso Robles Basin is illustrated by hydrographs of five selected wells presented on Plate 10, entitled "Fluctuation of Water Levels at Selected Wells". The wells from which data were selected for presentation on Plate 10 were chosen because of their relatively longer records of measurements. Adequate records of well measurements in the Paso Robles Basin were not available to properly choose "key" wells in the sense as previously defined.

As there has been no historical indication of overdraft conditions within the basin, the present safe yield of Paso Robles Basin is assumed to be equivalent to the present consumptive use of applied water or about 25,000 acre-feet per season. Because of the extremely large storage capacity, the maximum safe ground water yield of Paso Robles Basin may be expected to be a function of economic pumping lifts and mean seasonal recharge and not of storage capacity or configuration of the basin. It is probable that the yield of the Paso Robles Basin could be increased very nearly to the limit of mean seasonal recharge if not prohibited by economic or water quality considerations. Because of the limited available hydrologic data, estimates of the maximum safe seasonal ground water yield of Paso Robles Basin are subject to considerable error.

Studies by the Division of Water Resources indicate that a substantial portion of the recharge to the Paso Robles Basin is derived from percolation of storm runoff in Salinas River and Estrella and Huerhuero Creeks. Results of these studies indicated that the maximum safe ground water yield of Paso Robles Basin could be on the order of 43,000 acre-feet per season or about 70 per cent greater than the presently derived yield. It is fully recognized that the foregoing figure may be substantially revised in the future as more adequate hydrologic data on which to base estimates are made available.

Pozo Basin and Other Miscellaneous Ground Water Sources. The Pozo Basin is located upstream from Salinas Dam, and comprises a narrow strip of alluvium along the Salinas River and the valley floor of Pozo Creek with an area of about 3,600 acres. The basin lies at an average elevation of about 1,500 feet. The alluvium ranges up to 30 feet in depth. It is replenished by percolation of stream flow, precipitation, and return irrigation flows. It is depleted by pumped extractions, evapo-transpiration, and effluent flow. Total ground water storage capacity in the Pozo Basin is estimated to be about 2,000 acre-feet.

Available evidence indicates that the safe ground water yield of Pozo Basin is at least equal to the present consumptive use of applied water or 300 acre-feet per season on overlying lands, and that further utilization of ground water therein would probably increase the safe ground water yield up to a limit imposed by available storage, as described in Appendix B. Accordingly, the maximum safe ground water yield of Pozo Basin is estimated to be on the order of about 1,000 acre-feet or approximately one-half the total available storage capacity.

The safe yield of relatively nonwater-bearing formations tributary to Paso Robles and Pozo Basins is limited by the ability of the rocks to receive and transmit percolating water through their cracks and fissures. Because of the variable nature of the occurrence of ground water in these formations and the limited geologic data available, the maximum safe yield of these formations cannot be directly evaluated, and can only be inferred from analysis of well measurements and historical production records. For the purposes of this bulletin, the safe ground water yield of sediments and nonwater-bearing formations tributary to the Paso Robles and Pozo Basins has been taken as the present consumptive use of applied water, or about 1,300 acre-feet per season.

It appears that further development of this source to any appreciable magnitude is unlikely.

Coastal Unit

The Coastal Unit has been divided into the Cambria, San Luis Obispo, and Arroyo Grande Subunits. These subunits include several stream systems, each having a ground water basin underlying its lower reaches as shown on Plate 9B, entitled "Lines of Equal Elevation of Ground Water, Fall, 1954, Coastal and Santa Maria Units". Principal sources of water supply in the Coastal Unit include the 15 ground water basins shown on Plate 9B, import of surface supplies from the Upper Salinas Unit, and uncontrolled runoff originating in streams draining the coastal slopes of the Santa Lucia Range. Negligible quantities of ground water are also obtained from rock fissures and isolated pockets of alluvium. Most of the ground water basins in the Coastal Unit have relatively small storage capacities and are filled nearly every winter by percolation of stream flow and precipitation. Several of the ground water basins in the southerly portion of the unit, however, have larger storage capacities and are not completely replenished by stream flow in all years of certain dry periods.

The practical extent of utilization of ground water basins in the Coastal Unit is limited by physical rather than economic considerations. Usable capacity in all cases is limited by either the total storage capacity or the minimum storage required to prevent sea-water intrusion. Hydrologic and geologic data are scant for most of the ground water basins in this unit, and as a result, quantitative hydrologic analyses of many of the basins was not possible.

The total safe yield of presently developed water supply sources in the Coastal Unit is estimated to be about 19,200 acre-feet per season, including 13,600 acre-feet from ground water sources as set forth in Table 12, and 5,600 acre-feet from Salinas Reservoir. Most of the ground water basins in the Coastal Unit are presently underdeveloped and it is estimated that the yields of those basins could be increased through greater utilization and consequent reduction of both effluent flow and excessive consumptive use of water by phreatophytes. However, as described in Chapter IV, it is anticipated that large surface storage developments will be constructed on several of the Coastal Unit streams. These developments would provide water service to downstream lands and other lands in the vicinities of the developments, as well as furnish large quantities of water for export to concentrated areas of demand in the central and southern portions of the Unit. In several instances, ground water basins would be inundated by proposed reservoirs. In those cases the maximum safe ground water yield was taken to be no greater than the ultimate water requirements of overlying lands which would not be inundated.

Hydrologic characteristics of ground water basins in the Coastal Unit are discussed in the following paragraphs under their respective subunit headings.

Cambria Subunit. Ground water basins in the Cambria Subunit include San Carpoforo (or San Carpojo), Arroyo de la Cruz, San Simeon, Santa Rosa, Villa, Cayucos, Old, and Toro Basins, named for the principal streams which traverse them. The eight basins range in size from San Carpoforo Basin, with 200 acres, to Santa Rosa Basin, comprising nearly 2,400 acres. Elevations of the basins range from sea level to over 250 feet.

Ground water storage in the Cambria Unit is replenished largely by percolation of stream flow and to a lesser extent from percolation of precipitation and return irrigation flow. Ground water supplies are disposed of primarily by effluent discharge, by pumped extractions, and by subsurface outflow to the ocean. As previously stated, the town of Cayucos exports water from Old Basin by pumping from wells located near the mouth of Old Creek. Records of historical ground water levels in this Subunit are unavailable except for those collected during the present investigation. Residents contacted have indicated that water levels have been essentially the same for many years. This information along with available records of stream flow indicate that ground water basins have been fully replenished nearly every winter.

Ground water occurs in alluvium of Recent and upper Pleistocene age underlying the lower reaches of the stream valleys. The alluvium consists of stream deposited sand, gravel, and clay up to 130 feet in thickness.

Records of historical water supply and utilization of the Coastal Unit are generally insufficient to permit more than an approximate determination of the maximum safe ground water yield that could be developed. Available measurements of depth to ground water in wells indicate that all of the ground water basins have been recharged completely each winter in recent years by stream percolation, and that even if these basins were essentially completely dewatered during the preceding summer, natural stream flow would be adequate to recharge them in the following winter seasons. This would indicate that safe ground water yield of these basins is greater than the presently imposed net pumping draft. The total presently developed safe yield of ground water in the Cambria Subunit is assumed to be equal to the consumptive use of applied water, and is estimated to be on the order of 1,200 acre-feet per season.

Under ultimate conditions of water utilization, it is felt that the maximum safe ground water yield of these basins, which are all located adjacent to the coast line, would be governed by the total usable storage capacity, or storage capacity above sea level, as well as by percolation rates in the stream channels. In the cases of San Carpoforo, Arroyo de la Cruz, San Simeon, Santa Rosa, and Old Basins, the maximum safe ground water yield was limited to the net water requirements of lands which would not be inundated by proposed reservoirs discussed in Chapter IV. The maximum safe seasonal yield of the eight ground water basins in the Cambria Subunit was, therefore, estimated to be about 3,900 acre-feet. It is assumed that the yield of unregulated surface diversions and pumping from small pockets of alluvium will remain constant at about 200 acre-feet per season.

Separate estimates of the presently developed and maximum safe seasonal ground water yield of each basin comprising the Cambria Subunit, are presented in Table 12.

<u>San Luis Obispo Subunit</u>. Ground water basins in the San Luis Obispo Subunit include Morro, Chorro, Los Osos, San Luis Obispo, and Pismo Basins, named for the principal streams which traverse them. The four ground water basins have an aggregate surface area of about 25,800 acres, ranging from 1,270 acres for Morro Basin to the 9,680 acres comprising San Luis Obispo Basin. The basins range in elevation from sea level to about 350 feet.

The San Luis Obispo and Pismo ground water basins may be conveniently divided into upper and lower areas for descriptive purposes; the upper areas being located in the northwest-southeast trending San Luis Valley, and the lower areas in two north-south trending canyons traversing the San Luis Range.

Storage in the ground water basins of the San Luis Obispo Subunit is replenished by percolation from streams, precipitation, and return flow of excess water applied for irrigation and other uses. Ground water is depleted primarily by pumped extractions, by effluent discharge at times of high water level, and by subsurface flow to the ocean. A small residential area just east of Avila along the coast is supplied from wells located in San Luis Obispo Basin. This supply constitutes an export from San Luis Obispo Basin.

Ground water occurs in alluvium of Recent and upper Pleistocene age, older sand dunes of upper Pleistocene age, and in the Paso Robles formation of lower Pleistocene and upper Pliocene age. Ground water in the basins of the subunit is essentially unconfined, although clay lenses near the ocean may cause local pressure conditions. Ground water generally moves in the direction of surface slope, except in Los Osos Basin where it moves in a northerly direction in the older sand dunes as shown by ground water level contours on Plate 9B.

Yields of irrigation wells in the alluvial fill generally average about 200 gallons per minute with a maximum known yield of over 700 gallons per minute. Specific capacity of wells averages about 15 gallons per minute per foot of drawdown with a maximum known value of 50. Specific yield of the alluvium is estimated to average about 17 per cent.

Records of measurement of ground water levels are virtually non-existent except for those collected during this investigation. Available evidence indicates that water levels fluctuate monthly and seasonally, but there is no indication of perennial lowering. This would indicate that these ground water basins have been replenished historically nearly every winter. A record of available measurements is shown on the hydrograph of well 29S/11E-19P1 on Plate 10, "Fluctuation of Water Levels at Selected Wells".

The presently developed safe yield of the ground water basins comprising the San Luis Obispo Subunit is assumed to be equal to the consumptive use of applied water in those basins or about 5,700 acre-feet per season, of which approximately 1,100 acre-feet are obtained from minor unregulated surface diversions and miscellaneous small ground water bodies.

The maximum safe seasonal yield of ground water in the San Luis Obispo Subunit is not limited by the available storage capacity in all cases. The maximum safe seasonal yields of Morro and Chorro Basins are limited by the usable storage capacity above sea level or about 25 per cent of the total basin capacity as well as by percolation rates in the stream channels. In the case of Los Osos Basin, which has a relatively large ratio of basin storage capacity to average seasonal runoff, the maximum safe seasonal yield will be governed by the amount of percolation from stream flow and precipitation, and present safe yield is assumed to be equal to consumptive use of applied water on overlying lands. Present safe yields of San Luis Obispo and Pismo Basins are assumed equal to the consumptive use of applied water in these basins. In the future, the safe yields could be increased by an amount no greater than the present effluent flow from these basins. The total maximum safe ground water yield of the San Luis Obispo Subunit is therefore estimated to be about 8,900 acre-feet. It is assumed that miscellaneous unregulated surface diversions and uses of ground water from miscellaneous small ground water bodies will remain constant at about 1,100 acre-feet per season.

Separate estimates of the presently developed and maximum safe seasonal ground water yield of each basin comprising the San Luis Obispo Subunit are presented in Table 12.

As stated previously, the City of San Luis Obispo presently derives a major portion of its water supply from Salinas Reservoir. Approximately 2,600 acre-feet were imported from this source in 1954. Because of diversion rights currently being exercised by the U. S. Army and City of San Luis Obispo, the entire net safe seasonal yield of Salinas Reservoir, estimated at 5,600 acre-feet, is treated herein as a portion of presently developed safe yield of the San Luis Obispo Subunit. A discussion of the operation of Salinas Dam and Reservoir, together with pertinent data on existing water rights is presented in Chapter III.

Arroyo Grande Subunit. Ground water basins in the Arroyo Grande Subunit include the Arroyo Grande Basin and Nipomo Mesa. The two basins have a total surface area of about 28,500 acres, of which 12,500 acres comprise Arroyo Grande Basin and 16,000 acres comprise the Nipomo Mesa. The basins range in elevation from sea level to about 460 feet.

Ground water storage in Arroyo Grande Basin is replenished by percolation from streams, precipitation, return flow of applied irrigation water, and some subsurface inflow from Nipomo Mesa. Storage in Nipomo Mesa is replenished primarily from percolation of precipitation. Ground water supplies are depleted in both the Arroyo Grande Basin and Nipomo Mesa by pumping, subsurface outflow, and evapo-transpiration. Ground water has been exported from the Oceano area of Arroyo Grande Basin by the Pismo Beach Water Department continuously since 1929, estimated seasonal quantities of which are listed in Table 10.

Flow of surface water in Arroyo Grande Creek is closely related to subsurface flow in the alluvium. A substantial amount of surface water originating in Arroyo Grande Creek and Lopez Creek, an upstream tributary, percolates into alluvium in the upper portion of the Arroyo Grande Basin. Effluent flow of Arroyo Grande Creek starts about three miles below the confluence of Lopez and Arroyo Grande Creeks. The amount of effluent flow continues to increase downstream, reaching a maximum at the U. S. Geological Survey gaging station at the town of Arroyo Grande. Below Arroyo Grande, surface stream flow percolates to underlying ground water storage in the reach of stream down to the edge of the clay cap which is located a short distance below the bridge at Highway 1. Once surface water reaches the clay cap below Highway 1, very little percolation occurs and nearly all the water wastes to the ocean.

Ground water occurs in alluvium of Recent and Upper Pleistocene age, in Older sand dunes of Upper Pleistocene age, and Paso Robles formation of lower Pleistocene and upper Pliocene age, and in the Careaga sand of Pliocene age. Alluvium occurs only in Arroyo Grande Basin in this subunit and consists mostly of stream deposited sand, gravel, and clay up to about 200 feet thick. Some alluvium near the coast, however, has been deposited in a tidal lagoon or under similar shallow water conditions and consists of relatively impervious silt and clay. This silt and clay forms a confining clay cap in the coastal portion of the Arroyo Grande Basin.

A few wells obtain water from the Older sand dunes in the area between Oceano and Arroyo Grande, but most of the wells in this area obtain water from the underlying Paso Robles formation. Wells in the Nipomo Mesa obtain water from Older sand dunes as well as from the underlying Paso Robles formation. In general, yields of wells from the Older sand dunes are limited because of sanding of wells resulting from heavy drafts, and for this reason most wells which penetrate to the Paso Robles formation yield more water than wells in the Older sand dunes.

Irrigation wells in Arroyo Grande Basin yield up to 1,200 gallons per minute, but probably average about 360 gallons per minute. Specific capacity of wells averages about 40 gallons per minute per foot of drawdown with a maximum known value of 500. Based on an estimated average specific yield of 15 per cent, it is estimated a maximum of 40,000 acre-feet of ground water storage could be utilized without the occurrence of sea-water intrusion. Irrigation wells in the Nipomo Mesa yield up to 1,500 gallons per minute, but probably average closer to 100 gallons per minute. Specific capacity of existing wells averages about five gallons per minute per foot of drawdown although a maximum value of 29 gallons per minute per foot of drawdown was noted. The average specific yield of water-bearing sediments was estimated to be about 18 per cent. No estimate was made of the usable ground water storage capacity of Nipomo Mesa because of insufficient geologic data.

Ground water movement is indicated by contours on Plate 9B. In general, ground water moves down Arroyo Grande Creek following the slope of the ground surface. It will be noted that a large cone of depression exists in the area north of Oceano, and available records indicate that this cone of depression has been present for most of the time since 1945. Well measurements oceanward of this large depression, however, indicate that water levels are above sea level, and it is probable that sea-water intrusion has not occurred. It is probable that the pumping depression is caused by the relatively lower permeability of the Paso Robles formation which underlies the sand dunes and requires a steeper hydraulic gradient to transmit the water to wells in the area from the alluvium. It appears that, in the area to the west of oceanward side of the depression, the impervious clay stratum is sufficiently discontinuous to allow deep percolation of surface water from the old sand dunes into the Paso Robles formation, thus helping maintain a seaward hydraulic gradient. Water level contours on Plate 9B also appear to indicate that ground water is moving from the Nipomo Mesa into Arroyo Grande Basin south of Oceano.

Historical measurements of water levels are more numerous for Arroyo Grande Basin than for any other part of San Luis Obispo County. Long-term hydrographs of six wells, based on available records, are shown on Plate 10, "Fluctuation of Water Levels at Key Wells". These hydrographs and miscellaneous other wells measurements indicate a general decline in water levels during the period from 1933 to 1954. However, water level measurements during the winter periods made during the current investigation and miscellaneous other measurements indicate that Arroyo Grande Basin is essentially filled during most wet seasons. It is, therefore, concluded that, although more extensive utilization of ground water in the basin has resulted in wider fluctuation of ground water levels, the present ground water draft does not exceed the long term recharge of the basin. Available water level measurements in Nipomo Mesa indicate relatively little perennial change in water levels over the past ten years.

Representing the sum of consumptive use of applied water in the free ground water portion, total applied water in the confined ground water portion, and present exports, the present safe seasonal yield of Arroyo Grande Basin is estimated to be about 6,500 acre-feet. With maximum dewatering of ground water storage limited to 40,000 acre-feet in order to prevent sea-water intrusion and dewatering of aquifers in the upper portion of the basin, it was determined that a net draft of an additional 3,000 acre-feet of water could be imposed on Arroyo Grande Basin and still not violate any of the three safe yield criteria previously discussed. Conservation of this additional water would be effected through reduction of surface waste to the ocean and elimination of excessive consumptive use of water by phreatophytes. Surface waste to the ocean would be reduced through greater utilization of the ground water reservoir by allowing more basin capacity to be made available to receive percolating waters.

The safe seasonal ground water yield of the Nipomo Mesa under present conditions of development and utilization is estimated to be 200 acre-feet per season. This basin is recharged solely through percolation of direct precipitation. Through controlled pumping, it is estimated that the safe yield could be increased to a maximum of about 2,500 acre-feet per season. This increase in yield would be effected largely through lowering of the water table and consequent reduction in consumptive use of water by the extensive groves of eucalyptus trees as well as by reducing subsurface outflow.

Santa Maria Unit

The major source of water supply for the Santa Maria Unit is the Santa Maria Ground Water Basin. Small pockets of alluvium along Nipomo Creek also yield negligible amounts of ground water for use in the Nipomo area. Principal sources of recharge to Santa Maria Basin include percolation from the Cuyama and Sisquoc Rivers and deep penetration of rainfall on lands overlying the basin. As has been previously stated, no ground water studies were conducted in the Santa Maria Unit by the Division of Water Resources because of the detailed investigation currently being conducted in that area by the U. S. Geological Survey in cooperation with the County of Santa Barbara. Results of field and office studies conducted by the Geological Survey during the period from 1941 to 1945 are summarized in Water Supply Paper 1000, "Geology and Ground Water Resources of the Santa Maria Valley Area, California". It was estimated in Water Supply Paper 1000 that the safe seasonal yield of water-bearing deposits in the Santa Maria Valley area is in the order of

52,000 acre-feet. It was further estimated that with maximum utilization of the ground water supply in Cuyama Valley, a reduction in subsurface outflow from that valley in the amount of about 2,000 acre-feet would be effected. As outflow from Cuyama Valley constitutes a source of water supply for Santa Maria Basin, the future safe seasonal yield of that basin would thereupon be reduced to about 50,000 acre-feet. The U. S. Geological Survey further estimated net pumpage from Santa Maria Basin to have been about 106,000 acre-feet in 1950, with an average of about 64,000 acre-feet per season during the period, 1929 through 1950.

With completion of Vaquero Dam and Reservoir on the Cuyama River, an additional water supply will be made available for use in Santa Maria Valley. Under the proposed plan of operation, the portion of the reservoir storage capacity allocated to water conservation will be used for temporary detention of flood flows for later release to the Cuyama and Santa Maria Rivers at rates within the percolation capacity of the channel.

Recent studies by the Division of Water Resources in connection with the preparation of State Water Resources Board Bulletins Nos. 2 and 3 show that the present net seasonal draft on Santa Maria Basin is about 91,000 acre-feet and that the safe seasonal yield is about 54,000 acre-feet, indicating an overdraft of about 37,000 acre-feet. Operation of Santa Maria Basin in conjunction with surface storage in Vaquero Reservoir when completed will provide a new yield of about 18,500 acre-feet per season, thus reducing the present average annual overdraft by about 50 per cent.

Cuyama Unit

The major source of water supply for the Cuyama Unit is ground water in the water-bearing sediments of Cuyama Valley herein designated as

Cuyama Basin. The principal source of recharge to Cuyama Basin is the Cuyama River.

Cuyama Valley has also been investigated by the U. S. Geological Survey in connection with its continuing cooperative studies throughout Santa Barbara County. Results of field and office studies in Cuyama Valley during the period 1941 to 1945 are reported in Water Supply Paper 1110-B, "Ground Water in the Cuyama Valley, California". The U. S. Geological Survey estimates the safe seasonal or perennial yield of ground water in Cuyama Valley to be on the order of 9,000 to 13,000 acre-feet, which quantities represent that agency's estimate of the "maximum amount of water that can be practicably salvaged from natural discharge". The quality of ground water in Cuyama Valley is only fair, becoming even less desirable at depth. The Geological Survey points out in its report the possibility of water quality considerations being the limiting factor in safe yield determination. It is suggested that the rate of net ground water extraction may even be less than 9,000 acre-feet in order to avoid overpumping of the basin which could cause a mixing of the poorer with the better quality water.

As in the case of the Santa Maria Unit, the Cuyama Unit, as defined in this bulletin, does not encompass an entire ground water basin, and therefore no determination of safe yield has been made for this unit. Continuing studies by the U. S. Geological Survey in both Santa Maria and Cuyama Valleys should provide an adequate basis for more refined estimates of safe ground water yield for those areas.

Carrizo Plain Unit

Ground water in the Carrizo Plain Basin constitutes the only source of water supply to overlying lands at the present time. The Carrizo

Plain Basin, comprising some 172,000 surface acres, is located in the largest area of internal drainage in the coast ranges. Soda Lake is located at its center.

Carrizo Plain Basin is replenished to some extent around its edges by percolation of precipitation and stream flow resulting from infrequent cloudbursts. Ground water storage in the basin is depleted by evaporation and pumped withdrawals. Small springs in the creeks draining into San Juan Creek on the northwest side of the Carrizo Plain suggest that a small amount of leakage occurs from the Carrizo Plain into the Upper Salinas Unit.

Ground water occurs in alluvium of Recent and Upper Pleistocene age and in the Paso Robles formation of Plio-Pleistocene age consisting of non-marine sand, gravel, and clay up to 1,000 feet in thickness. Only the north-west portion of the ground water basin is presently utilized for irrigation. Here the quality of water in the alluvium is inferior to water in the Paso Robles formation, suggesting that the deeper, fresher water is not replenished by vertical percolation in the area of use. It appears that there is only a limited source of replenishment of the deeper water, and that increased use would probably exceed natural recharge. In other parts of the Carrizo Plain, the water-bearing materials appear to be relatively impervious except near the edges of the basin on apexes of alluvial cones and contain water of poor quality.

Yields of the eight irrigation wells in the Carrizo Plain average about 500 gallons per minute with a maximum known yield at one well of 1,100 gallons per minute. Estimated average specific capacity of irrigation wells is five gallons per minute per foot of drawdown with a maximum known value of 15. No estimate was made of the total usable storage capacity of Carrizo Plain Basin because of insufficient geologic data.

Because of the limited recharge, the safe seasonal yield of Carrizo Plain Basin is believed to be small. Precipitation over the basin averages only about eight inches. Although no runoff from storms was observed during the progress of the field investigation, it is known that percolation from runoff occurs during infrequent cloudbursts which occur in this area. Available measurements of depth to ground water indicated no downward trend in water levels during the investigational seasons. Historical water level measurements prior to the period of this investigation are nonexistent. The safe yield of presently developed ground water supplies of the Carrizo Plain Basin has, therefore, been assumed to be equal to the present consumptive use of applied water or about 600 acre-feet.

Sufficient hydrologic and geologic data are not available on which to base an accurate estimate of the maximum potential safe yield of the Carrizo Plain Basin. Available geologic evidence indicates the total ground water storage capacity of Carrizo Plain Basin could be on the order of several tens of thousands of acre-feet. The practicability of its full utilization is questionable at this time. With further utilization of ground water in the Carrizo Plain Basin and resultant lowering of ground water levels, a mixing of water and consequent degradation of the better quality water is possible. Also, the threat of an unfavorable salt balance, which is likely to be build up through constant re-use of irrigation return flow if lands overlying the basin were extensively irrigated, would tend to limit the yield which could be obtained. For practical purposes, therefore, the maximum safe yield of Carrizo Plain has been assumed equal to the presently developed yield of 600 acre-feet per season.

Because of geologic conditions apparent at this time, it is believed that extensive irrigation of lands in the Carrizo Plain will cause the formation of a body of water at Soda Lake, replenished primarily from return irrigation flows. With full development of the irrigable acreage discussed in Chapter III, the lake would increase in size until a stabilized condition would be reached, at which time the net evaporation from the lake surface would just equal the total return flow from applied irrigation water. Under the foregoing described conditions of development, the lake surface would comprise an estimated 7,800 acres.

San Joaquin Unit

As a result of this investigation, it was determined that water-bearing sediments, including Recent alluvium and a portion of the Paso Robles formation, cover a portion of the San Joaquin Unit. There is virtually no ground water utilization in these areas at the present time, and since there are no records of depth to ground water at the few stock and domestic wells within the Unit, no estimate of safe seasonal ground water yield has been made. Precipitation over the unit averages less than nine inches and the safe ground water yield is probably insignificant.

Quality of Water

Surface and ground water supplies in San Luis Obispo County are generally of fair to good mineral quality and suitable from that standpoint for irrigation and other beneficial uses. However, there are certain areas in the Upper Salinas, Santa Maria, Cuyama, and Carrizo Plain Units where surface waters at low flow stages and some ground waters are considered to be less desirable because of abnormal concentrations of certain minerals.

Terms used in the ensuing discussion of quality of water are defined as follows:

Mineral Analyses--The quantitative determination of inorganic impurities or dissolved mineral constituents in water.

Quality of Water--Those characteristics of water affecting its suitability for beneficial uses.

Contamination--Impairment of the quality of water by sewage or industrial waste to a degree which creates a hazard to public health through poisoning or spread of disease.

Pollution--Impairment of the quality of water by sewage or industrial waste to a degree which does not create a hazard to public health, but which adversely and unreasonably affects such water for beneficial use.

Degradation--Impairment of the quality of water due to causes other than disposal of sewage and industrial waste.

Hardness--A characteristic of water which causes increased consumption of soap, deposition of scale on boilers, injurious effects in some industrial processes, and sometimes objectionable taste, and which is due in large part to the presence of salts of calcium and magnesium.

Complete mineral analyses herein reported include determination of calcium, magnesium, sodium, potassium, bicarbonate, carbonate, chloride, sulfate, nitrate, fluoride, boron, total dissolved solids, electrical conductance (EC x 10^6 at 25° C.) and hydrogen ion concentration, pH. From the analyses, hardness, per cent sodium, and effective salinity are computed.

Concentrations of principal constituents determined in a complete mineral analysis are reported in "parts per million" and "equivalents per million" except for boron, fluoride, and total dissolved solids which are given only in "parts per million".

Standards of Water Quality

Surface and underground waters of San Luis Obispo County are used for irrigation, domestic, municipal, and industrial purposes. Surface waters are also used as stream and lake fisheries as well as for other recreational purposes. Suitability of waters for each of these uses depends in part upon the concentration and character of the dissolved mineral constituents in the waters.

Irrigation Use. Criteria commonly used to judge the suitability of water for irrigation use are: Chloride concentration, conductance (EC x 10^6 at 25° C.), boron concentration, and per cent sodium.

(1) Chlorides are present in nearly all waters. They are not considered essential to plant growth, and may be especially harmful in high concentrations as they cause subnormal growing rates and burning of plant leaves.

(2) Conducance (EC x 10^6 at 25° C.) carries the unit micro mho/cm and is an indicator of total dissolved solids. For most waters, the total dissolved solids content in parts per million can be approximated by multiplying the conductance by 0.7. The presence of excessive amounts of dissolved

salts in irrigation water will result in reduced crop yields.

(3) Boron in small amounts (less than 0.1 ppm) is required for growth by most plants. Conversely plants usually will not tolerate more than 0.5 to 2.0 ppm boron depending on the crop concerned. Citrus trees, particularly lemons, are sensitive to boron in concentrations exceeding 0.5 ppm.

(4) Per cent sodium as shown in water analyses is the proportion of the sodium cation to the sum of all the cations, and is computed by dividing sodium content measured in equivalents per million by the sum of the calcium, magnesium, and sodium contents also measured in equivalents per million, all multiplied by 100. Water containing a high per cent of sodium has an adverse effect on the physical structure of soil by dispersing the soil colloids and making the soil "tight", thus retarding movement of water through the soil. This in turn retards the percolation of the water and makes the soil difficult to work.

The following excerpts from a paper by Dr. L. D. Doneen of the Division of Irrigation of the University of California at Davis, have been used in interpreting water analyses from the standpoint of their suitability for irrigation:

"Because of diverse climatological conditions, crops, and soils in California, it has not been possible to establish rigid limits for all conditions involved. Instead, irrigation waters are divided into three broad classes based upon work done at the University of California, and at the Rubidoux, and Regional Salinity Laboratories of the United States Department of Agriculture.

"Class 1. Excellent to Good--Regarded as safe and suitable for most plants under any condition of soil and climate.

"Class 2. Good to Injurious--Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher ranges of this class.

"Class 3. Injurious to Unsatisfactory--Regarded as probably harmful to most crops and unsatisfactory for all but the most tolerant.

"Tentative standards for irrigation waters have taken into account four factors or constituents, as listed below:

Factor	Class 1 excellent to good	Class 2 good to injurious	Class 3 injurious to unsatisfactory
Conductance ($EC \times 10^6$ at 25° C)	Less than 1,000	1,000-3,000	More than 3,000
Chloride, epm	Less than 5	5-10	More than 10
Per cent sodium	Less than 60	60-75	More than 75
Boron, ppm	Less than 0.5	0.5-2.0	More than 2.0

(End of quotation)

The values shown in the foregoing tabulation are used only as a guide, since permissible limits vary widely with different crops, soils, and climatic conditions.

Actual practice indicates that waters rated as Class 2 and 3 by the foregoing standards particularly in regard to conductance, are successfully used for irrigation in several areas in California. Accordingly, a new procedure for calculating salinity of irrigation water together with revised standards therefor has been suggested by Dr. Doneen as follows:

"This proposed standard for total salts of an irrigation water is based on the premise that the salts will accumulate in the soil due to evaporation from the soil surface and water used by the plants in transpiration. Plants usually remove only a small percentage of the total salts occurring in the irrigation water. As the soil solution becomes concentrated certain salts will precipitate. Because of the low solubility, the first to precipitate will be calcium carbonate, followed by magnesium carbonate and finally by calcium sulfate. These salts will not produce a saline soil. Other salts normally occurring in irrigation water in any significant concentration are extremely soluble and accumulate in the soil solution as salines. These salines are listed as 'effective salinity'. Therefore, calcium and magnesium carbonates and calcium sulfate should not be considered in establishing standards for total salinity as is now the practice in the use of electrical conductance, total parts per million or milliequivalents per liter concentration".

Using this method, Dr. Doneen has tentatively suggested the following criteria of effective salinity for classification of irrigation waters under three soil conditions:

Soil conditions	Class 1 excellent to good	Class 2 good to injurious	Class 3 injurious to unsatisfactory
	Effective salinity, in epm		
Little or no leaching of the soil may be expected.	Less than 3	3-5	More than 5
Some leaching, but restricted. Deep percolation or drainage slow.	Less than 5	5-10	More than 10
Open soils. Deep percolation of water easily accomplished.	Less than 7	7-15	More than 15

Review of various soil surveys in San Luis Obispo County made by the United States Department of Agriculture indicates that most of the irrigable and presently irrigated lands fall within the open soils classification and, for this reason, criteria for soils of this condition will apply throughout this discussion unless otherwise stated.

Domestic and Municipal Use. The "United States Public Health Service Drinking Water Standards, 1946" are probably the most widely used criteria for determining the suitability of water for domestic and municipal use. These standards are divided into two sections; one set of limits is mandatory and the other set is recommended. These standards are shown in the following tabulation:

Limiting Concentrations of Mineral
Constituents in Drinking Water,
U.S.P.H.S. Drinking Water Standards, 1946

Constituent	Should not exceed ppm
Mandatory	
Fluoride (F)	1.5
Lead (Pb)	0.1
Arsenic (As)	0.05
Selenium (Se)	0.05
Hexavalent chromium (Cr)	0.05
Recommended	
Copper (Cu)	3.0
Iron (Fe) and Manganese (Mn) together	0.3
Magnesium (Mg)	125
Zinc (Zn)	15
Chloride (Cl)	250
Sulfate (SO_4)	250
Phenolic compounds (Phenol C_6H_5OH)	0.001
Total dissolved solids	
desirable	500
permitted	1,000

In consideration of the apparent direct relationship between the occurrence of infant methemoglobinemia (blue babies) and the presence of nitrates in drinking water it has been further recommended that limits be prescribed for nitrate concentrations. The California Department of Public Health has recommended a tentative maximum of 10 ppm nitrate nitrogen (44 ppm nitrates) for domestic waters.

Total hardness is an important factor in determining the suitability of a water for domestic and municipal use. Compounds of calcium and magnesium are the principal causes of hardness although other substances such as iron, manganese, aluminum, barium, silica, strontium, and free hydrogen contribute to total hardness. The effect of hardness in water is primarily economic, in that its presence causes increased use of soap, which it coagulates to form an insoluble precipitate. Hard water also will cause formation of scale in water and boiler pipes thus reducing the efficiency of boiler and plumbing systems. With proper treatment, hardness can readily be reduced to acceptable limits. Waters containing 100 ppm or less of hardness (as $CaCO_3$) are considered soft, those containing 101 to 200 ppm, moderately hard, and those containing in excess of 201 ppm as very hard. In this report, hardness is expressed as parts per million of calcium carbonate.

Industrial Use. The foregoing quality standards for domestic and municipal water supplies are considered applicable to most present and anticipated future industrial water uses in San Luis Obispo County. Industrial users usually accept water supplies which are suitable for domestic purposes and provide softening, demineralizing, or other treatment as required.

Data used to determine the quality of water in San Luis Obispo County included 114 complete and 14 partial analyses of surface water, and 160 complete and 36 partial analyses of ground water. A detailed discussion of water quality in various portions of the County, together with results of all available analyses are presented in Appendix F, and are briefly summarized in the following sections under the general headings, "Quality of Surface Water" and "Quality of Ground Water".

Quality of Surface Water

The mineral quality of surface runoff in streams of San Luis Obispo County varies greatly, both areally and with rate of stream flow. The normal relationship of low mineral concentration at high rates of flow and higher mineral concentration at low rates of flow is indicated by many of the surface water analyses hereinafter presented.

As stated previously, surface water supplies in most parts of San Luis Obispo County are generally of good mineral quality and are suitable for all beneficial purposes. Available analyses indicate that most surface waters meet Class 1 or 2 standards for irrigation purposes. Except at low flow stages in some instances, surface waters in San Luis Obispo County also meet United States Public Health Service Drinking Water Standards. Based almost exclusively on analyses of low flow samples, waters of Cholame Creek and Cuyama River appear to be of the poorest quality, being rather high in total dissolved solids. The boron content of Cholame Creek water is also higher than the maximum allowable for certain boron-sensitive crops. Medium and low flow samples from streams draining both the east and west slopes of the Santa Lucia Range exhibit high, yet tolerable, degrees of hardness. It will be noted that much of the data on quality of surface waters presented and discussed herein and in Appendix F are based upon analyses of water samples taken from streams at times of relatively low flow, as the opportunity of obtaining samples at high flow stages from all streams did not generally occur during the investigational seasons. The water supplies developed by construction of surface storage projects described in Chapter IV will, to a large extent, be derived from stored flood flows which, by the nature of their occurrence, tend to be of better quality than some of the low flows sampled during this investigation.

It is therefore expected that water supplies derived from storage projects shown in Chapter IV will be generally of good to excellent quality.

Results of analyses showing mineral quality of selected samples of surface waters in San Luis Obispo County are presented in Table 13. A compilation of the results of all known analyses of surface waters is presented in Appendix F. Locations of surface water sampling stations identified by map reference numbers listed in Table 13 and Appendix F are shown on Plate 5.

TABLE 13

MINERAL ANALYSES OF SURFACE WATERS AT SELECTED STATIONS
IN SAN LUIS OBISPO COUNTY[a]

Stream	Station[b] Map reference number	Date Time	Discharge second-feet	$ECx10^6$ at 25° C	pH	Ca[c]	Mg[c]	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total dissolved solids ppm	Total hardness as $CaCO_3$ ppm	Per cent Na
						Mineral constituents in parts per million / equivalents per million													
UPPER SALINAS UNIT																			
Nacimiento River	At SLO-Monterey Co. Line M-1	6-23-54[d] 1200	2.5	380	8.4	41 / 2.03	16 / 1.33	16 / 0.68	1 / 0.03	2 / 0.08	173 / 2.84	34 / 0.70	12 / 0.34	11 / 0.18	0.0	0.10	215	168	17
Salinas River	At Eureka Bridge near Atascadero 3-28	10-23-53 1015	0.10	617	8.0	60 / 3.0	31 / 2.60	29 / 1.25	2 / 0.05	0 / 0	250 / 4.10	76 / 1.59	32 / 0.9	2 / 0.03	0.3	0.05	388	280	18
Salinas River	At San Miguel Bridge SLO-28	2-14-54 1445	353	435	7.6	50 / 2.5	11 / 0.95	16 / 0.69	3 / 0.08	0 / 0	168 / 2.75	49 / 1.02	27 / 0.75	5 / 0.08	0.2	0.14	300	172	16
COASTAL UNIT																			
Cambria Subunit																			
Arroyo De La Cruz	Near San Simeon SLO-6	3-16-54 1340	Storm runoff	139	7.6	18 / 0.90	10 / 0.80	3 / 0.14	1 / 0.04	0 / 0	110 / 1.8	14 / 0.29	2 / 0.05	5 / 0.09	0.1	0.08	138	85	
San Simeon Creek	At Bridge ¼ mi. upstream from Hwy. #1 SLO-34	7-10-54[d] 1455	1	610	8.1	54 / 2.70	39 / 3.24	19 / 0.82	1 / 0.03	0 / 0	314 / 5.16	41 / 0.83	23 / 0.65	1 / 0.02	0.1	0.15	370	296	12
Old Creek	At State Hwy. #1 Bridge SLO-38	3-22-54 1215	20	648	8.3	67 / 3.35	33 / 2.69	30 / 1.28	1 / 0.04	5 / 0.08	301 / 4.94	80 / 1.66	23 / 0.66	4 / 0.06	0.2	0.05	360	302	17

MINERAL ANALYSES OF SURFACE WATERS AT SELECTED STATIONS
IN SAN LUIS OBISPO COUNTY[a]
(continued)

Station[b] Dis- Mineral constituents in parts per million Total Total

[illegible] ANALYSES OF SURFACE WATERS AT SELECTED STATIONS
IN SAN LUIS OBISPO COUNTY[a]
(continued)

Stream	Station[b] Map reference number	Date Time	Discharge second-feet	ECx10⁶ at 25° C	pH	Ca[c]	Mg[c]	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	Total dissolved solids ppm	Total hardness as $CaCO_3$ ppm	Per cent Na
						Mineral constituents in parts per million / equivalents per million													
San Luis Obispo Subunit																			
Morro Creek	At Cerro Alto Dam Site SLO-40	3-30-54 1400	100	276	8.1	27 / 1.35	14 / 1.15	11 / 0.49	1 / 0.02	0 / 0	134 / 2	28 / 0.59	7 / 0.2	5 / --	0.2	0.05	192	125	16
Pismo Creek	At lower SPRR bridge near Pismo Beach SLO-56	2-13-54[d] 1430	30	787	7.2	50 / 2.5	36 / 3.0	86 / 3.74	9 / 0.23	0 / 0	271 / 4.45	62 / 1.30	113 / 3.2	3 / 0.05	0.4	0.17	586	275	40
Arroyo Grande Subunit																			
Arroyo Grande Creek	At Santa Manuela School SLO-59	2-13-54 1525	5.3	694	7.6	108 / 5.4	25 / 2.1	50 / 2.17	4.5 / 0.11	0 / 0	305 / 5.0	165 / 3.44	35 / 1.0	4 / 0.07	0.4	0.05	607	375	22
SANTA MARIA UNIT																			
Cuyama River	Near Santa Maria 3-42	3-30-53[d] 1030	15	2,750	7.8	239 / 11.93	152 / 12.55	238 / 10.35	6 / 0.17	0 / 0	246 / 4.03	1,295 / 26.95	140 / 3.96	1.2 / 0.02	---	0.2	2,327	1,224	30

a. Analyses by Division of Water Resources unless otherwise noted.
b. Map reference numbers (MR#) for major streams and tributaries, are listed from north to south within the county.
c. These constituents in all analyses by Division of Water Resources and Pacific Chemical Consultants determined by titration.
d. Analyzed by Pacific Chemical Consultants, Van Nuys, California.

Quality of Ground Water

Evaluation of ground water quality in various sections of San Luis Obispo County shows mineral content to be variable, yet generally satisfactory for domestic, municipal, industrial, and irrigation uses. These ground waters are abnormally hard in some cases and require softening for municipal or domestic uses, as well as for certain industrial uses. In some areas, notably Cholame Valley and Cuyama Valley, excessive concentrations of total dissolved solids, sulphates, or boron render the ground water injurious to unsatisfactory for irrigation use. It will be noted that, although some waters exhibit relatively high concentrations of dissolved solids as evidenced by electrical conductivity, these same waters have effective salinities well within reasonable limits for beneficial purposes. No general evidence of sea-water intrusion has been noted in ground water basins bordering on the Pacific Ocean.

Results of analyses showing mineral quality of selected samples of ground waters in San Luis Obispo County are presented in Table 14. A compilation of all known ground water analyses is presented in Appendix F. Locations of wells from which samples listed in Table 14 and Appendix F were obtained are shown on Plate 9.

Quality of Ground Water

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Results of analyses showing mineral quality of selected samples of ground waters in San Luis Obispo County are presented in Table 14. A compilation of all known ground water analyses is presented in Appendix F. Locations of wells from which samples listed in Table 14 and Appendix F were obtained are shown on Plate 9.

TABLE 14

TYPICAL MINERAL ANALYSES OF GROUND WATERS IN SAN LUIS OBISPO COUNTY

Well number M.D.B.&M.	Date sampled	Temperature when sampled	$EC \times 10^6$ at 25°C	pH	Ca	Mg	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F	B	SiO_2	Total dissolved solids	Total hardness	Per cent sodium	Effective salinity

Mineral constituents in parts per million / equivalents per million

TABLE [illegible]

TYPICAL MINERAL ANALYSES OF GROUND WATERS IN SAN LUIS OBISPO COUNTY[a]

Well number M.D.B.&M.	Date sampled	Temperature when sampled °F	ECx10^6 at 25°C	pH	Ca[b]	Mg[b]	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	SiO_2 ppm	Total dissolved solids ppm	Total hardness as $CaCO_3$	Per cent Na	Effective salinity epm
					Mineral constituents in parts per million / equivalents per million															
UPPER SALINAS UNIT																				
23S/14E-26L1	7-15-54[c]	75	1,730	7.7	59 / 2.93	99 / 8.16	166 / 7.25	3 / 0.07	0 / 0	147 / 7.85	269 / 5.48	172 / 4.85	4 / 0.06	0.2	1.70	--	1,126	554	39	10.56
26S/13E-28J1	7-27-54[c]	86	595	8.1	32 / 1.58	17 / 1.42	72 / 3.15	2 / 0.05	0 / 0	262 / 4.28	38 / 0.78	42 / 1.09	3 / 0.05	0.2	0.45	--	326	150	51	3.21
27S/12E-21N1	5-31-54[c]	59	983	7.3	110 / 5.52	48 / 3.91	39 / 1.68	1 / 0.04	0 / 0	341 / 5.59	186 / 3.89	57 / 1.61	2 / 0.04	0.2	0.12	--	664	471	15	5.56
COASTAL UNIT																				
Cambria Subunit																				
27S/9E-28Q1	8- 7-53	--	941	7.4	73 / 3.64	66 / 5.43	43 / 1.87	1 / 0.02	0 / 0	549 / 9.00	11 / 0.22	50 / 1.41	0 / 0	0.6	0.32	--	547	453	17	1.96
San Luis Obispo Subunit																				
31S/13E-19H2	4-30-54	--	1,335	7.9	102 / 5.09	74 / 6.11	36 / 1.58	1 / 0.01	0 / 0	523 / 8.59	74 / 1.54	57 / 1.60	61 / 0.99	0.2	0.20	--	766	---	--	--
Arroyo Grande Subunit																				
32S/13E-29D1	9-29-54[c]	81	934	7.8	97 / 4.85	48 / 3.99	44 / 1.90	3 / 0.03	0 / 0	412 / 6.75	144 / 2.99	31 / 0.87	2 / 0.04	0.1	0.05	--	583	442	17	4.07
SANTA MARIA UNIT																				
11N/35W-18M1[f]	10-19-27[d]	64	--	--	162 / --	56 / --	94 / --	-- / --	0 / -	232 / --	529 / --	51 / --	Tr / --	---	---	10	1,136	635	--	--
CUYAMA UNIT																				
10N/25W-29A2[f]	1942 or 43[e]	--	--	--	211 / --	84 / --	50 / --	-- / --	- / -	168 / --	752 / --	10 / --	-- / --	---	0.36	--	---	872	11	--

TYPICAL MINERAL ANALYSES OF GROUND WATERS
IN SAN LUIS OBISPO COUNTY[a]
(continued)

Well number M.D.B.&M.	Date sampled	Temperature when sampled °F	ECx10⁶ at 25°C	pH	Ca[b]	Mg[b]	Na	K	CO_3	HCO_3	SO_4	Cl	NO_3	F ppm	B ppm	SiO_2 ppm	Total dissolved solids ppm	Total hardness as $CaCO_3$	Per cent Na	Effective salinity epm
					Mineral constituents in parts per million / equivalents per million															
									CARRIZO PLAIN UNIT											
29S/17E-13R1	10-21-53	--	885	8.4	49 / 2.45	15 / 1.24	144 / 6.25	0.4 / 0.01	0 / 0	165 / 2.7	166 / 3.46	74 / 2.1	38 / 0.62	0.85	0.58	--	619	185	63	7.24
29S/19E-31F1	9-21-54[c]	--	2,770	8.1	115 / 5.74	69 / 5.67	405 / 17.60	2.1 / 0.05	0 / 0	187 / 3.06	768 / 16.00	276 / 7.78	116 / 1.87	0.6	1.7	--	1,944	570	60	23.32

a. Analyzed by Division of Water Resources unless otherwise noted.
b. These constituents in all analyses by Division of Water Resources or Pacific Chemical Consultants, determined by titration.
c. Analyzed by Pacific Chemical Consultants, Van Nuys, California.
d. United States Geological Survey, Water Supply Paper 1000, 1951.
e. United States Geological Survey, Water Supply Paper 1110-B, 1951.
f. San Bernardino Base and Meridian.

Sources of Impairment of Water Quality

Sources of impairment to the quality of waters in San Luis Obispo County include natural sources, domestic sewage, irrigation return water, industrial wastes, and sea-water intrusion. A brief discussion of the cause and character of each of these sources is presented in the following paragraphs. Improperly constructed, defective, and abandoned wells are not actually sources of impairment to the ground water quality in themselves but may be important in the transmission of surface wastes, drainage waters, or leachate from cesspools or septic tanks which could be sources of pollution, contamination, or degradation. Such wells may also provide avenues for interchange of waters between aquifers having different quality characteristics, and result in the deterioration of good quality waters.

To maintain the existing ground water quality in a basin, it is necessary to establish a balance between salt input to the waters of a basin and salt output and within any basin this salt balance generally controls the quality of water. If salt input exceeds salt removal, an adverse salt balance exists and water quality will deteriorate due to the accumulation of salt. The sources of salt input to basin waters are many, including: dissolved minerals from soil and rock materials, agricultural fertilizers, industrial wastes, and domestic wastes. Normally, the only major sources of salt removal are surface and subsurface water outflows and water and waste exports.

Natural Sources. San Luis Obispo County has a few areas where poor quality of ground water exists due to natural degradation. In the Salinas Unit, poor quality ground water is found in several areas which are in the vicinity of notable structural features. These areas include: Cholame Valley along the San Andreas fault, San Juan Valley along the San Juan fault, portions of the Salinas River Valley along the Paso Robles fault and between the Bradley anticline and the San Miguel syncline. The poor quality water found adjacent to the faults is probably due to the increased mineralization of ground water exposed to faulted and fractured rock and mineral material, and to contact with gases and mineralized juvenile waters moving up along fault fractures.

The source of poor quality water encountered in the area between the Bradley anticline and the San Miguel syncline is not known; however, several possible sources do exist. The higher mineral content of this water may be due to connate waters retained in this area by the structural folds, to ground water replenishment from poor quality water moving in from Cholame and San Juan Valleys through Estrella Creek system, or to unmapped faults which may traverse the area. The poor quality water in these areas can be a source of degradation to neighboring waters as they move under influence of water table conditions.

Ground water of Cuyama Valley was reported by the United States Geological Survey in Water Supply Paper 110-B, to vary considerably from one part of the valley to another. It was further reported that the ground water was generally rather high in dissolved solids and, in most cases, ranged in hardness from 800 to 1,200 parts per million. Because of the meager data available to the Geological Survey at the time of their study, no explanation could be given for the marked variation in quality which had been observed.

The waters of Cuyama and Santa Maria Valleys show excessive concentrations of sulfate ion and total dissolved solids. The gypsum deposits in the upper reaches of the Cuyama River are largely responsible for this degradation of surface and ground water. Excellent crop yields are obtained, however, using this water, and only continued study will reveal the future results of this degradation.

Domestic Sewage. Domestic sewage returning to ground water through cesspools, septic tanks, and leach lines, or from community treatment plants, is of higher mineral content than source water. In a report entitled "Waste Water Reclamation and Utilization", dated 1954, the California State Water Pollution Control Board listed increases in the mineral content of domestic sewage of 20 to 50 ppm in chlorides, 30 to 60 ppm in sodium, and 20 to 40 ppm in total nitrogen. These increases in mineral content are so small, however, that domestic sewage may be considered a satisfactory source of ground water replenishment in San Luis Obispo County, and from this standpoint susceptible of treatment and conservation. Several ground water basins in San Luis Obispo County, including Paso Robles, San Luis Obispo, and Arroyo Grande Basins, are partially recharged, either directly by sewage treatment plant effluent or by return flow from effluent applied as irrigation water. However, as can be seen from the results of analyses published in this bulletin, many of the ground waters of San Luis Obispo County are rather hard. Concentrated salt wastes resulting from the regeneration of individually owned softening units could eventually render the quality of sewage unsuitable for re-use, and cause localized pollution problems. Similar problems could be created by discharges from central regeneration plants.

Irrigation Return Water. Irrigation of agricultural crops requires application of water in excess of the consumptive requirement for water in order to prevent undue build-up of salts in the root zones. This excess water may contain from two to as many as ten times the salt concentrations found in the original water supply. In areas where irrigation return water can percolate to the ground water, it may constitute an important source of degradation to the water supply.

Industrial Wastes. The development of natural resources and the growth of industry, including agriculture, in San Luis Obispo County will create waste disposal problems. Whenever harmful liquid or water soluble industrial wastes are discharged into stream channels, into the ground, or into unlined sumps, they constitute a threat of pollution to underlying ground water.

Sources of industrial wastes in San Luis Obispo County include the oil industry, an almond processing plant, slaughterhouses, chemical companies, and refuse disposal sites. Wastes derived from the oil industry include connate brines of high salt content pumped from the oil sands, and contaminated "drilling muds". Wastes from the almond packing plant usually contain high concentrations of sodium chloride. Wastes from slaughterhouses are usually of organic nature which, if not suitably treated or handled may produce septicity in water supplies, with accompanying foul odors. Chemical companies can produce wastes of varied types, and in most cases they would be harmful to ground waters if not disposed of properly. Refuse disposed in dumps will, on decomposition, release salts, which, when dissolved by rainfall or applied water, may percolate to ground water.

Sea-Water Intrusion. The ground water basins in San Luis Obispo County, which border the Pacific Ocean, are geologically susceptible to sea-water intrusion. There are no known structural barriers to prevent the landward movement of sea water, and water-bearing materials which form these ground water basins appear to be directly connected with the ocean.

A landward gradient in the ground water surface is necessary for sea-water intrusion to occur. Available well measurements indicate that a seaward gradient has been maintained historically in all coastal ground water basins. Furthermore, except in one instance, available mineral analyses do not indicate that sea-water intrusion of coastal ground waters has taken place. High chloride ion concentrations are reported in historic analyses of the water from a well serving Morro Bay State Park located near the shore of Morro Bay. Excessive withdrawals from that well have apparently lowered the pumping level in that well to a position below sea level.

Although sea-water intrusion has not generally occurred, this does not preclude the possibility of its occurrence in the future. Any increase in ground water utilization or change in pumping pattern in coastal basins which reverses the seaward water table gradient could result in sea-water intrusion, and this should be considered in any plans for future ground water development and utilization. A continuing monitoring program including the measurement of coastal wells and the collection and analyses of water samples therefrom, will be necessary to ascertain the imminence of sea-water intrusion in the future.

CHAPTER III. WATER UTILIZATION AND REQUIREMENTS

Water is beneficially used in San Luis Obispo County at the present time for irrigated agriculture and for municipal and domestic purposes. Irrigated agriculture is the largest user of water, and it is considered that it will remain so in the future. Water supplies are obtained largely by pumped withdrawals from ground water storage, and, to a lesser extent, by direct diversion from surface streams. Salinas Reservoir on the Salinas River is the only major surface storage development supplying water to lands in San Luis Obispo County.

The gross area within San Luis Obispo County has been shown to be about 2,129,000 acres. It was found during this investigation that about 333,000 acres or 16 per cent of this gross area can probably be developed for irrigated agriculture or residential and urban use. The remainder of the area consists of relatively rugged mountain terrain not susceptible of agricultural development. It was also found that, while there has been a substantial increase in irrigated agriculture in San Luis Obispo County in recent years, this development has not been as rapid as the phenomenal increases experienced in certain other portions of the State. Intensively developed areas of irrigated agriculture are found in the Santa Maria Valley, lower Arroyo Grande Valley, and smaller localized areas along the upper Salinas River.

About 38 per cent of the lands found to be potentially irrigable are located on the Carrizo Plain and in the Cuyama Valley lying at relatively high elevations, above which very little tributary runoff originates. Because of their remote location and high elevation, these lands are limited as to crop adaptability and will require expensive works to provide irrigation water service. Large portions of these lands, as well as the lands in the Upper

Salinas Unit, are presently dry-farmed and may be expected to continue to be so used in the future until such time as the pressure for the products of higher types of agriculture makes it feasible to provide water service thereto.

Development of irrigated agriculture is expected to center generally in the Upper Salinas Valley. The rapidity of this development will depend to a great extent upon the capability of the underlying Paso Robles Basin to support increased ground water extractions. Full satisfaction of the water-using potential of this area will require construction of local surface water supply developments and facilities for importation of water from outside sources as described in Chapter IV.

It is anticipated that increases in agricultural activity will result in a proportionate increase in population of urban communities throughout the County. Further, the lands along the coastal portion of the County are especially suited to urban and recreational development such as has occurred in other coastal areas of California. It is expected that increasing numbers of people will be attracted to this area because of its equable climate and scenic attractions.

The nature and extent of water utilization and requirements for supplemental water in San Luis Obispo County, both at the present time and under probable conditions of ultimate urban and agricultural development, are considered in this chapter. In connection with the discussion, the following terms are used as defined:

Water Utilization--Used in a broad sense to include any employments of water by nature or man, either consumptive or nonconsumptive, as well as those irrecoverable losses of water incidental to such employment, and is synonymous with the term "water use".

Demands for Water--Those factors pertaining to specific rates, times, and places of delivery of water, losses of water, quality of water, etc., imposed by the control, development, and use of water for beneficial purposes.

Water Requirement--The amount of water needed to provide for all beneficial uses and for irrecoverable losses incidental to such uses.

Supplemental Water Requirement--The water requirement over and above the sum of safe ground water yield and safe surface water yield under either present or ultimate conditions of development of water use.

Consumptive Use of Water--Water consumed by vegetative growth in transpiration and in building of plant tissue, and water evaporated from adjacent soil, from water surfaces, and from foliage. It also refers to water similarly consumed and evaporated by urban and nonvegetative types of land use.

Applied Water--The water delivered to a farmer's headgate or from a well in the case of irrigation use, or to an individual's meter in the case of urban use, or its equivalent. It does not include direct precipitation.

Ultimate--This refers to conditions estimated to be existent after an unspecified but long period of years in the future when development will be essentially stabilized. It is realized that any present forecasts of the nature and extent of such ultimate development, and resultant water utilization, are inherently subject to possible large errors in detail and appreciable error in the aggregate. However, such forecasts, when based upon best available data and present judgment, are of value in establishing long-range objectives for development of water resources. They are so used herein with full knowledge that their re-evaluation after the experience of a period of years may result in considerable revision.

Water utilization and requirements are discussed and evaluated in this chapter under the general headings: "Present Water Supply Development", "Land Use", "Unit Use of Water", "Present Water Utilization", "Probable Ultimate Water Utilization", "Demands for Water", and "Nonconsumptive Water Demands". Data relating to supplemental water requirements are discussed under the two general headings: "Present Supplemental Water Requirements" and "Ultimate Supplemental Water Requirements".

Present Water Supply Development

Present water supplies within San Luis Obispo County are largely obtained by pumping from ground water storage. As reported in the 1950 federal census, only 3,100 acres or about 11 per cent of the total irrigated area was supplied by surface diversions from streams and springs. Most of the diversion structures serving irrigated lands are temporary in nature and over half of the lands so served receive supplemental water from ground water sources. Salinas Reservoir, on the Salinas River, is presently a source of water supply for Camp San Luis Obispo and the City of San Luis Obispo.

From a canvass of wells conducted during the investigation, it was determined that there are approximately 780 irrigation wells within the County. Approximately 80 per cent of these wells are equipped with pumps of heavy draft having motors of five horsepower or more. In addition, 55 wells, all equipped with pumps of heavy draft, supply water for urban and industrial use. In addition, a large number of wells of small draft supply limited amounts of water for domestic, garden, and stock uses.

Major Water Supply Developments

As stated previously, the only major surface water supply development presently serving lands within San Luis Obispo County is the Salinas Reservoir on the Salinas River with its conveyance system leading to the vicinity of the City of San Luis Obispo. Although Nacimiento Reservoir is located within San Luis Obispo County, the Monterey County Flood Control and Water Conservation District does not presently contemplate serving water to lands within the former county from that source. Nacimiento Dam and Reservoir, located at a point identified in reports of the Division of Water Resources as the "Winchester Ranch Site" on the Nacimiento River, is designed to provide water conservation and flood control benefits to lower Salinas River Valley in Monterey County.

The dam, now substantially completed, consists of an earthfill structure with a height of 210 feet above stream bed, a crest length of about 1,500 feet, and a spillway crest elevation of 800 feet above sea level. The total reservoir storage capacity is about 350,000 acre-feet. It is understood from statements of officials of the Monterey County Flood Control and Water Conservation District that a portion of this storage capacity will be used for flood control purposes. Nacimiento Dam and Reservoir, if operated entirely for water conservation purposes, would have an estimated net safe seasonal yield of about 73,000 acre-feet.

Construction of Vaquero Dam, as a major feature of the authorized Santa Maria Project, was begun on July 1, 1956, and is scheduled for completion in 1958. Although the Santa Maria Unit will receive substantial flood control and water conservation benefits from this project, the major portion of benefits will accrue to the Santa Barbara County portion of the Santa Maria Valley. A more detailed description of the Santa Maria Project is contained in Chapter IV.

Salinas Dam and Reservoir were constructed in 1941 by the U. S. Army to provide a water supply for Camp San Luis Obispo. Pertinent data relating to Salinas Dam and Reservoir are included in the following tabulation:

Type of dam: Concrete arch.

Height above stream bed: 135 feet.

Crest length: 460 feet.

Spillway crest elevation: 1,301 feet.

Spillway discharge capacity: 42,000 second-feet.

Initial reservoir storage capacity: 26,045 acre-feet.

Net safe seasonal yield: 5,600 acre-feet.

Capital cost: $1,714,600.

Water is conveyed from Salinas Dam through 48,700 feet of 24-inch diameter reinforced concrete pipe to a 3,000,000 gallon regulating reservoir at Santa Margarita booster pumping station. The pipe line has a rated capacity of 12.4 second-feet under gravity flow from Salinas Reservoir when the reservoir water surface is at an elevation of 1,267 feet. A booster pumping station at the dam, consisting of two diesel-driven horizontal centrifugal pumps, is capable of maintaining the rated flow of 12.4 second-feet when the water surface elevation falls below 1,267 feet. Three electrically driven horizontal centrifugal pumps are provided at Santa Margarita booster station which pump water through an additional 6,810 feet of 24-inch diameter reinforced concrete pipe to the entrance portal of Cuesta Tunnel, a 5,327-foot, partially lined tunnel through the Santa Lucia Range. From the outlet portal of the tunnel, water is conveyed through an 18-inch diameter steel pipe line a distance of 5,700 feet to a bifurcation structure. A pipe line from one branch of the bifurcation structure conveys water to the City of San Luis Obispo filtration plant located at elevation 550 feet. Approximately 3,480 feet of 18- and 12-inch diameter steel pipe can convey water from the other branch of the bifurcation structure to Chorro Creek Reservoir and the filtration plant at

Camp San Luis Obispo. Pertinent features of Chorro Creek Dam and Reservoir are presented in the following tabulation:

Type of dam: Earthfill.

Height above stream bed: 80 feet.

Crest length: 500 feet.

Spillway crest elevation: 610 feet.

Initial storage capacity: 220 acre-feet.

Net safe seasonal yield: 50 acre-feet.

Approximate capital cost: $200,000.

The tributary drainage area above Salinas Reservoir is 111 square miles, and the mean seasonal inflow to the reservoir is estimated to be about 25,000 acre-feet. Based on reservoir operation studies conducted by the Division of Water Resources, the gross safe yield of the reservoir is estimated to be about 5,800 acre-feet per season. However, under the terms of the water right permit under which the project is operated, and which will be further discussed, stream flow entering the reservoir during the months from July through October must be released down the Salinas River to satisfy vested rights. On the basis of this latter requirement, the net safe seasonal yield of the reservoir is estimated to be 5,600 acre-feet.

An agreement, dated January 1, 1944, was entered into by the U. S. Army and the City of San Luis Obispo providing for sale of a specified amount of water at a specified price for delivery at the bifurcation structure on the Salinas Reservoir conveyance conduit. The agreement specified a term of one year with the further provision that the agreement will continue in effect for as long a time as no action is taken by the Secretary of the Army or the City to cancel it. The contract has been renewed from year to year with revisions of water rates and amounts of water delivered. The most recent version of the agreement provides for delivery at a maximum of 3,000 acre-feet per year at an average cost to the City of $72 per million gallons or about $22 per acre-foot.

An agreement, dated May 1, 1952, was entered into by the U. S. Army and the San Luis Obispo County Flood Control and Water Conservation District, providing for the operation and maintenance of the Salinas Reservoir and conveyance system by the District. The agreement also provided that the Army would reimburse the District for expenses incurred in the operation and maintenance of the project and directed the District to deliver water to any water service customers designated by the Army.

In compliance with specific requests by the City of Paso Robles and the towns of Santa Margarita and Templeton, the Army has on several occasions directed the San Luis Obispo County Flood Control and Water Conservation District to make releases from Salinas Reservoir. It is reported that releases were made down the channel of Salinas River during the dry-weather portion of each year from 1942 to 1945, with a live stream being maintained as far as Camp Roberts. Records of all of these releases, however, are not available. Set forth in Table 15 are the quantities of water diverted from Salinas Reservoir through its conveyance conduit to the Coastal Unit as well as quantities released down the Salinas River, to the extent of available information. Quantities listed in Table 15 as releases are those in addition to the normal low flow summer releases required between July 1 and October 31 of each year under terms of existing water right permits. Quantities listed as diversions in Table 15 are measured at Salinas Dam.

TABLE 15

HISTORIC DIVERSIONS AND RELEASES FROM SALINAS RESERVOIR

In Acre-Feet

Season October 1 - Sept. 30	Diversions	Releases	Total
1941-42	50	1,460	1,510
43	960	-----	960
44	1,290	-----	1,290
1944-45	1,510	-----	1,510
46	1,680	4,580	6,260
47	2,020	2,830	4,850
48	2,320	-----	2,320
49	2,230	-----	2,230
1949-50	2,260	-----	2,260
51	2,550	-----	2,550
52	2,140	4,030	6,170
53	2,190	2,210	4,400
54	2,690	2,400	5,090

Water Service Agencies

Water for urban and irrigation purposes in San Luis Obispo County is presently furnished by 24 water service agencies, 19 of which obtain their entire water supplies by pumping from ground water sources. Two agencies supplement their ground water supplies by surface diversions, and three agencies derive their entire supply from surface diversions.

The largest water service agency in San Luis Obispo County in terms of developed supply is the San Luis Obispo County Flood Control and Water Conservation District, which was formed by a special act of the State Legislature in 1945.

In addition to the San Luis Obispo County Flood Control and Water Conservation District, there are 25 organized water agencies within San Luis Obispo County including four municipal water departments, three private water companies, eight mutual water companies, seven county water works districts, two county water districts, and one water conservation district.

Available data concerning the various agencies are summarized in Table 16, including their approximate number of service connections and source of water supply.

TABLE 16

ORGANIZED WATER AGENCIES
IN SAN LUIS OBISPO COUNTY, 1954

	Approximate number of service connections, 1954	Source of water supply
Upper Salinas Unit		
Paso Robles Water Department	1,670	10 wells
Atascadero Mutual Water Company	1,700	4 wells, one spring
Garden Farms Mutual Water Company	50	1 well
Green River Mutual Water Company	50	2 wells
Atascadero County Water District	none	none
San Luis Obispo County Water Works District No. 1 - San Miguel	475	3 wells
San Luis Obispo County Water Works District No. 5 - Templeton	189	3 wells
San Luis Obispo County Water Works District No. 6 - Santa Margarita	170	3 wells
San Luis Obispo County Flood Control and Water Conservation District	3	Salinas River
Coastal Unit		
Arroyo Grande Water Department	1,200	3 wells
Pismo Beach Water Department	1,080	3 wells
San Luis Obispo Water Department	5,600	Salinas River, Reservoir Canyon, 2 wells
Avila Water Company	150	1 well
Oceano Water Company	39	2 wells
Los Osos Highlands Water Company	40	1 well
Branch's Mill Water Company	none	Arroyo Grande Creek
Cambria Pines Service Corporation	500	4 wells
McNeill Pump Company	none	Arroyo Grande Creek
Morro Rock View Mutual Water Company	180	1 well
Paso Robles Beach Mutual Water Association	360	3 wells
Grover City County Water District	1,030	2 wells
San Luis Obispo County Water Works District No. 2 - Morro Bay	1,200	3 wells
San Luis Obispo County Water Works District No. 4 - Morro Bay	510	2 wells
San Luis Obispo County Water Works District No. 8 - Cayucos	180	2 wells

ORGANIZED WATER AGENCIES
IN SAN LUIS OBISPO COUNTY, 1954
(continued)

	Approximate number of service connections, 1954	Source of water supply
Coastal Unit (continued)		
San Luis Obispo County Water Works District No. 9 - Baywood Park	200	3 wells
Santa Maria Unit		
Santa Maria Valley Water Conservation District	none	300 wells

Appropriation of Water

Since the effective date of the Water Commission Act of December 19, 1914, 77 applications to appropriate water of streams in San Luis Obispo County have been filed with the Division of Water Resources or its predecessors. Applications filed through June 30, 1956, are listed in Appendix G together with pertinent data on the proposed diversions and uses of water and present status of the applications.

The applications listed in Appendix G should not be construed as comprising a complete or even a partial statement of water rights in the San Luis Obispo County area. They do not include appropriative rights initiated prior to December 19, 1914, riparian rights, correlative rights of overlying owners in ground water basins, nor prescriptive rights which may have been established on either surface streams or underground basins, none of which are currently on record with the State Water Rights Board. In general, water rights may only be firmly established by court decree.

Water right permits covering storage and diversion of unappropriated waters of the Salinas River stored in Salinas Reservoir were issued to five agencies by the State Division of Water Resources as follows:

Agency	Storage (acre-feet)	Diversion (cfs)	Date of filing
United States Army	45,000	12.4	5-27-41
City of San Luis Obispo	45,000	12.4	6- 4-41
City of Paso Robles	2,400	----	10-10-41
County Water Works District No. 6 (Santa Margarita)	200	1.5	2-26-47
County Water Works District No. 5 (Templeton)	200	1.5	5-28-48

It should be noted that the Army's permit is prior in time and right to all others listed in the foregoing tabulation. Downstream releases from Salinas Reservoir listed in Table 15 have been authorized by the Army when,

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in their opinion, sufficient water was available in the reservoir to meet prior rights.

Dams Under State Supervision

The Department of Water Resources supervises the construction, enlargement, alteration, repair, maintenance, operation, and removal of dams, for the protection of life and property within California. All dams in the State, excepting those under federal jurisdiction, are under the the jurisdiction of the Department. As defined in the Water Code, "dam" means any artificial barrier, together with appurtenant works, if any, across a stream, watercourse, or natural drainage area, which does or may impound or divert water, and which either (a) is or will be 25 or more feet in height from natural stream bed to crest of spillway, or (b) has or will have an impounding capacity of 50 or more acre-feet. Any such barrier, which is or will be not in excess of six feet in height, regardless of storage capacity, or which has or will have a storage capacity not in excess of 15 acre-feet, regardless of height, is not considered a dam.

The only completed dam currently under State supervision in San Luis Obispo County, other than the previously described Nacimiento Dam, is Atascadero Park Dam which impounds the waters of Atascadero Lake. As stated previously, Salinas and Chorro Dams are owned by the U. S. Army and are, therefore, not subject to State jurisdiction. Atascadero Park Dam and Lake are owned by the County of San Luis Obispo and are operated as a recreational facility. The dam is an earthfill structure located on a small unnamed tributary of Atascadero Creek. The dam is 17 feet in height and impounds some 150 acre-feet of water. In order to maintain the water surface of Atascadero Lake at the desired elevation for recreational purposes, supplemental water is diverted to the lake from Atascadero Creek at a diversion point located about three miles upstream from Atascadero.

Land Use

For the purpose of estimating present water requirements in San Luis Obispo County, field surveys were made of the nature and extent of land use prevailing during the investigational seasons. Also, in order to determine the probable ultimate water requirements of the County, field surveys were made to classify all lands in the County with regard to their suitability for various types of agriculture as well as for urban and suburban use. Field surveys of land use and land classification were commenced in July, 1953, and continued into August of 1954.

Present Land Use

As indicated previously, the only historical land use surveys within San Luis Obispo County for which maps and other supporting data are known to be available are those conducted by the U. S. Bureau of Reclamation and Division of Water Resources in 1946 and 1950, respectively. Utilizing aerial photographs taken of the investigational area in 1949 and 1950 by the U. S. Production and Marketing Administration, a comprehensive land use survey was made in the field during the 1953-54 season as part of the current investigation. All lands supporting irrigated agriculture and all urban lands were mapped during the survey. In addition, on those lands overlying ground water bodies, all areas of phreatophytes and open water surfaces were mapped, as well as fallow and idle lands equipped with irrigation facilities but not irrigated at the time of the survey. All classes of nonirrigated agriculture and all areas of native vegetation on lands overlying ground water bodies were also mapped.

To ascertain the extent of double and triple cropping in truck-cropped areas, four separate surveys of selected truck-cropped lands were conducted over a period of one year at three to four-month intervals. From the results of these special surveys, it was possible to determine the average acreage of truck-cropped lands actually under production in a given year as well as lands normally truck-cropped which are idle or lying fallow.

Results of the 1953-54 land use survey showed a total of about 28,600 acres under irrigation in San Luis Obispo County and about 5,600 acres devoted to urban and military cantonment purposes. In order of total acreages, irrigated crops include alfalfa, truck crops, permanent pasture, sugar beets, field corn, hay and grain, beans, cotton, and deciduous orchard.

Field reconnaissance from time to time during the investigational seasons failed to disclose significant changes in the total acreage under irrigation or changes in the pattern of land use. Land use prevailing during the 1953-54 season is, therefore, taken as representative of "present" conditions of development throughout the County and investigational area and is so referred to in subsequent discussion.

Presented in Table 17 is a summary of present land use in San Luis Obispo County. Included under the heading, "Miscellaneous Field Crops", are sugar beets, field corn, beans and cotton. Irrigated parks and golf courses are listed under the heading, "Urban and Military". Military acreages listed under that heading include only the cantonment areas. All acreages presented are net water-using areas and do not include streets and roads. Farm lot inclusions in irrigated areas which were found to be largely nonirrigated were so classified. Irrigated farm lots, comprising less than one per cent of the total irrigated acreage are not presented in Table 17 as a separate category but rather are included in the acreages presented for the various crops.

TABLE 17

PRESENT WATER SERVICE AREAS
IN SAN LUIS OBISPO COUNTY, 1953

Net Areas in Acres

Hydrologic unit and subunit	Irrigated agriculture							Urban, sub-urban, and military	Total water service area
	Alfalfa	Pasture	Orchard	Truck crops	Misc. field crops	Hay and grain	Subtotal		
UPPER SALINAS UNIT	6,870	2,660	20	370	90	490	10,500	1,340	11,840
COASTAL UNIT									
Cambria Subunit	110	370	50	---	120	430	1,080	160	1,240
San Luis Obispo Subunit	630	860	70	700	200	200	2,660	3,280	5,940
Arroyo Grande Subunit	150	210	350	2,820	70	140	3,740	880	4,620
Subtotals, Coastal Unit	890	1,440	470	3,520	390	770	7,480	4,320	11,800
SANTA MARIA UNIT	530	880	---	3,690	960	---	6,060	60	6,120
CUYAMA UNIT	1,550	140	---	---	2,280	80	4,050	---	4,050
CARRIZO PLAIN UNIT	30	110	---	---	50	130	320	10	330
SAN JOAQUIN UNIT	---	---	---	---	---	---	---	---	---
TOTALS	9,870	5,230	490	7,580	3,770	1,470	28,410	5,730	34,140

Plates 11A, 11B, and 11C, entitled "Present and Probable Ultimate Land Use", show the areal extent of lands presently receiving water service in San Luis Obispo County. Irrigated lands are shown in green, and urban and suburban lands are shown in red.

A comparison of results of the land use survey made for this investigation with results of the 1950 survey show significant increases in the total acreage devoted to irrigated pasture and alfalfa. An over-all increase in irrigated area of nearly 5,000 acres or 16 per cent was noted between 1950 and 1953. Much of this increase has been due to the introduction of deep well turbine pumps enabling farmers to tap deeper aquifers of the Paso Robles Basin of the Upper Salinas Unit. Irrigation development was previously limited generally to the relatively flat terraces and flood plains adjacent to streams. However, development of sprinkler irrigation systems has enabled farmers to irrigate large acreages of rolling hill lands not heretofore considered susceptible of irrigation without costly leveling. These rolling hill lands are being devoted principally to pasture and alfalfa.

Truck farming has continued to be a major factor in the economy of San Luis Obispo County. Approximately 9,500 acres, or nearly 33 per cent of the total County irrigated area, are devoted to truck farming. These truck cropped areas are located principally in the Santa Maria Unit and in the Arroyo Grande area in the southern portion of the Coastal Unit. An average of 7,600 acres of land were truck cropped during the 1953-54 season. Although most of the truck crop acreage reported for 1953 has developed on previously dry-farmed or native land, a portion of it has replaced previously irrigated deciduous orchards. New plantings of sugar beets in the Upper Salinas Unit, are meeting with general success. Cotton appears to be most successful in Cuyama Valley where prevailing temperatures are warmer at night and more favorable for its growth. The County Farm Advisor and agricultural officials at California Polytechnic College report that unfavorable climatic conditions are the primary reason for the lack of commercial plantings of citrus orchards in San Luis Obispo County.

As previously stated, there are presently about 180,000 acres of land under dry-farmed crop production in San Luis Obispo County, including over 7,000 acres of almonds in the Upper Salinas Unit. The bulk of dry-farmed grains are grown in the Upper Salinas and Carrizo Plain Units. Dry-farmed grain lands are usually fallowed and cropped in alternate years.

Probable Ultimate Pattern of Land Use

The economy of San Luis Obispo County is and always has been based primarily on its agricultural development, including extensive dry-farmed crop and beef production. Except for growth resulting from the establishment of military reservations, urban growth as indicated by population figures has apparently paralleled that of agriculture. Under ultimate conditions of development, it is reasonable to assume that this relationship will continue to prevail in most areas of the County. It is anticipated, however, that irrigation development will be of greater importance under future economic conditions. Along the coastal strip north of Arroyo Grande Valley, favorable climatic conditions and a natural scenic beauty have encouraged the "resort" type of urban and suburban development. Increased growth of this type is anticipated in the future.

Because of the direct relationship between land use and water requirements, particular attention was given to the classification of lands within San Luis Obispo County suitable for irrigation and urban and suburban development and to the forecast of probable ultimate crop and urban land use patterns. A detailed land classification survey was conducted throughout the investigational area in the summer and fall of 1954 for the purpose of determining the location and extent of lands suitable for irrigation development. To assist in forecasting the ultimate crop pattern that would result from such development, lands were mapped in the field according to various crop adaptability classes. In so doing, consideration was given to such physical characteristics as topography, soil depth, soil texture, saline or alkaline conditions, moisture holding capacity, high water table conditions, and the presence of rock. The projection of probable crop patterns on the various adaptability classes required consideration of climatic conditions, ease of irrigation, and current agricultural practices. No consideration was given to economic factors pertaining to the production and marketing of crops such as cost of water, cost of labor, available markets, and market prices, etc., as these factors are subject to wide variation over a period of years, and their relation to crop values may be considerably changed under conditions of ultimate development. Presented in Table 18 are descriptions of the various crop adaptability classes and standards used in the survey.

TABLE 18

LAND CLASSIFICATION STANDARDS

Class	Characteristics
V	Smooth lying valley lands with slopes up to six per cent in general gradient in reasonably large-sized bodies sloping in the same plane; or slightly undulating lands which are less than four per cent in general gradient. The soils have medium to deep effective root zones, are permeable throughout, and free of salinity, alkalinity, rock, or other conditions which would limit the crop adaptability of the land. These lands would be suitable for all climatically adapted crops.
Vp	Similar in all respects to Class V, except for the depth of the effective root zone which limits its use only to shallow-rooted crops, such as grain and pasture.
Vr	Similar in all respects to Class V, except for the presence of rock on the surface or within the plow zone in sufficient quantity to prevent the use of the land for cultivated crops. These lands are suitable for the production of irrigated pasture crops.
Vl	Similar in all respects to Class V, except for having fairly coarse textures and low moisture holding capacities, which, in general, make these lands unsuited for the production of shallow-rooted crops because of the frequency of irrigations required to supply the water needs of such crops.
Vw	Similar in all respects to Class V, except for the present existing condition of a high water table which, in effect, limits the crop adaptability of those lands to pasture crops. Project drainage and a change in irrigation practices would be required to affect the crop adaptability of these lands. For the purpose of this investigation, it is assumed that there will be no change in the use of these lands.
Vs	Similar in all respects to Class V, except for the presence of saline and alkali salts which limit the present adaptability of these lands to crops tolerant of those conditions. The presence of salts within the soil indicate poor drainage and a medium to high water table. The reclamation of these lands will require drainage and the application of additional water over and above crop requirements in order to leach out the harmful salts.
Vm	This class covers marshlands which under present conditions are non-irrigable, being under water a large part of the year. The present vegetation is mostly tules and water-loving types of plants. These lands would require extensive drainage before they could be utilized for agricultural crops. It is assumed that there will be no change, and that their water use will continue to be the same as the present. If this type of land were developed, the probable result would be a decrease in its water requirement.

LAND CLASSIFICATION STANDARDS
(continued)

Class	Characteristics
Va	Land at present considered nonirrigable due to the presence of saline and alkali salts in excess of agricultural crop tolerance. The feasibility of reclamation of this type of land is presently unknown. It is, therefore, assumed for this bulletin that the ultimate land use of these lands will remain unchanged.
H	Undulating and rolling lands up to 20 per cent maximum slope for large-sized bodies sloping in the same plane, grading down to less than 12 per cent for undulating lands. The soils are permeable, with medium to deep effective root zones, and are suitable for the production of all climatically adapted crops. The only limitation is that imposed by topographic conditions which affect the ease of irrigation and the amount of land that might ultimately be developed.
Hp	Similar in all respects to Class H, except for the depth of the effective root zone,which limits the use of this land to shallow-rooted crops.
Hr	Similar in all respects to Class H, except for the presence of rock on the surface or within the plow zone in sufficient quantity to restrict the use of the land to noncultivated crops.
Hl	Similar in all respects to Class H, except for having fairly coarse textures and low moisture holding capacities which in general makes these lands unsuited for the production of shallow-rooted crops because of the frequency of irrigations required to supply the water needs of such crops.
Hpr	Similar in all respects to Class H, except for the depth of the effective root zone and presence of rock on the surface or within the root zone in sufficient quantity to restrict the use of the land to noncultivated crops.
Ht	Similar in all respects to Class H, except for topographic limitations. These lands have smooth slopes up to 30 per cent in general gradient for large-sized bodies sloping in the same plane, and up to 12 per cent slopes for rougher and more undulating topography. This class of land will not be as highly developed as other "H" classes of land and is considered as best suited only for irrigated pasture land.
Htp	Similar in all respects to Class Ht, except for the depth of the effective root zone, which limits the use of this land to shallow-rooted crops.

LAND CLASSIFICATION STANDARDS
(continued)

Class	Characteristics
Htr	Similar in all respects to Class Ht, except for the presence of rock on the surface or within the plow zone in sufficient quantity to restrict the use of land to noncultivated crops.
Htl	Similar in all respects to Class Ht, except for having fairly coarse textures and low moisture holding capacities, which, in general, makes these lands unsuited for the production of shallow-rooted crops because of the frequency of irrigations required to supply the water needs of such crops.
Htpr	Similar in all respects to Class Ht, except for the depth of the effective root zone and the presence of rock on the surface or within the root zone, which limits the use of these lands to noncultivated shallow-rooted crops.
N	Includes all lands which fail to meet the minimum requirements of the foregoing classes.

In addition to those lands considered to be potentially irrigable, as defined by the foregoing standards, certain lands, by virtue of their topographic characteristics and proximity to either existing urban centers or probable future urban areas, were considered susceptible to urban and suburban development. These lands, though in some cases possessing all of the necessary characteristics of irrigable lands, were not so classified and are termed herein as "habitable areas". Results of the county-wide survey show there are about 31,000 acres of land considered to be habitable under this definition. Approximately four per cent, or 1,100 acres of lands classed as habitable, are presently irrigated.

Results of the land classification survey show that there are about 411,000 acres of irrigable lands within San Luis Obispo County. About 38 per cent or 155,000 acres of irrigable lands within the County are relatively flat "valley lands" comprising flood plains and terraces. Over 30 per cent of these lands are found within the Carrizo Plain Unit with large acreages also in the Salinas, Cholame, and Estrella Valleys of the Upper Salinas Unit. About 116,000 acres of irrigable valley lands have adequate soil depths and are suitable for the production of all climatically suited crops with most types of irrigation practice. The remainder of irrigable valley lands, because of limiting soil depths, are generally suitable for the production of irrigated grain or pasture.

About 256,000 acres of hill lands are classified as irrigable. These lands, comprising 62 per cent of the gross irrigable area within the County, and typified by relatively steep or rolling topography, generally will require special irrigation practice. Approximately 102,000 acres of these lands in the County, classified as Class "H", have fairly deep and well developed soil profiles and are suitable for all climatically adapted crops. Large acreages of irrigated pasture are currently being developed on these lands. Nearly 38 per cent of the gross irrigable area, or about 154,000 acres, comprise the remainder of irrigable hill lands in the County which, because of excessive slopes, shallow soil depths, or presence of rock, are suitable for the development of irrigated pasture only. These lands are found scattered throughout all hydrologic units. Results of the land classification survey of San Luis Obispo County are summarized by units and subunits in Table 19.

TABLE 19

CLASSIFICATION OF IRRIGABLE LANDS IN SAN LUIS OBISPO COUNTY, 1954

TABLE 19

CLASSIFICATION OF IRRIGABLE LANDS IN SAN LUIS OBISPO COUNTY, 1954

Gross Areas in Acres

Hydrologic unit and subunit	Irrigable valley lands	Irrigable hill lands	Subtotals	Nonirrigable lands	Totals
UPPER SALINAS UNIT	39,260	119,280	158,540	830,460	989,000
COASTAL UNIT					
Cambria Subunit	3,390	10,680	14,070	168,930	183,000
San Luis Obispo Subunit	6,380	25,090	31,470	145,530	177,000
Arroyo Grande Subunit	5,440	21,640	27,080	104,920	132,000
Subtotals, Coastal Unit	15,210	57,410	72,620	419,380	492,000
SANTA MARIA UNIT	10,310	8,420	18,730	36,270	55,000
CUYAMA UNIT	16,880	19,630	36,510	231,490	268,000
CARRIZO PLAIN UNIT	72,580	49,350	121,930	149,070	271,000
SAN JOAQUIN UNIT	680	2,180	2,860	51,140	54,000
TOTALS	154,920	256,270	411,190	1,717,810	2,129,000

Based on the results of the land use survey, land classification survey, and information gathered from other available sources, a probable ultimate pattern of land use as related to water requirements, was developed for the investigational area. Estimates of water requirements for irrigated agriculture are based, in part, on the net number of acres of land which will be irrigated during any one season. Net acreages were computed by the application of appropriate percentage factors to gross acreages as derived from the land classification survey. The foregoing factors accounted for the effects of the size and shape of the parcels of irrigable lands, inclusion of small areas of nonirrigable lands among those classified generally as irrigable, productive capacity of the lands and probable crop rotation, ease of irrigation development, and inclusion of roads, railroad rights of way, and other non-agricultural land uses. The factors were largely based upon experience and judgment of the classifiers, supplemented by consultation with residents and agricultural officials of the investigational area, and knowledge of the characteristics of the lands under consideration.

The probable ultimate pattern of land use was projected utilizing the net irrigable acreages derived from the land classification survey and by consideration of climatic conditions, present land use pattern, and present trends in the development of irrigated land.

It has been estimated that the predominant irrigated crops under ultimate conditions of development will be pasture, alfalfa, and truck. It is anticipated that the local cattle industry will increase in valuation with a greater proportion of the animals being raised on permanent pasture. Demand will increase for supplemental feed, and proportional increases have been projected for irrigated hay and grain.

It is assumed that irrigation will eventually be applied to presently dry-farmed deciduous orchards and vineyards. New acreages of these crops will be developed on presently native or dry-farmed lands. It is expected that new markets for truck and field crops will develop as the State and local population increases, and appropriate allowance has been made for these crops in the ultimate crop pattern.

Recent increased urban and suburban development in lower Arroyo Grande Valley and along the coast from Morro Bay north, represents a trend of development which, it is estimated, will ultimately encompass about one-third of the habitable lands within the Coastal Unit. Improvement of State Highway No. 1 and construction of its proposed extension south of Morro Bay along the coast will also provide impetus to urban and suburban development along the entire coast line.

From analyses of historical population records and miscellaneous agricultural records, it has been assumed that future urban growth will be proportional to future growth of irrigated agriculture in the Upper Salinas Unit. As discussed hereinbefore, it appears that urban and suburban development will be proportionally larger in the Coastal Unit. This assumption appears valid in view of the extent of lands presently zoned for residential, commercial, and industrial activity and is supported by future zoning plans currently being developed by the staff of the County Planning Commission. In the Santa Maria and Cuyama Units, it is not expected that urban and suburban growth will parallel agricultural growth, as urban centers supporting those units are and probably will continue to be located in Santa Barbara County. Under ultimate conditions of development in the Carrizo Plain Unit, it is assumed that lands will remain in relatively large holdings as at present, and that most of the urban and suburban development serving that Unit will continue to be located outside of the Unit. For the foregoing cited reasons, urban and suburban development in the Santa Maria, Cuyama, and Carrizo Plain Units has been expanded to a much less extent, percentagewise, than in the Upper Salinas Unit. Because of its remote location, no urban development appears likely in the San Joaquin Unit.

Based on the foregoing assumptions, it is estimated that about 297,000 acres of land will be irrigated under ultimate conditions of development and water use. It is further estimated that about 36,000 acres of urban and suburban lands will ultimately require water service. Presented in Table 20 is a tabulation of estimated probable ultimate water service areas in San Luis Obispo County summarized by units and subunits. Irrigable and habitable lands, as determined by the land classification and habitable area surveys, are shown on Plate 11, where, for illustrative purposes, differentiation has been made between valley and hill lands as tabulated in Table 19. Although no differentiation has been made between irrigable and habitable lands shown on Plate 11, it is probable that future urban and suburban development will occur in the vicinity of present urban areas with development of present vacant inclusions and peripheral lands taking place first. For the purpose of this bulletin, it is assumed that no further increase or decrease will take place in military cantonment areas.

TABLE 20
PROBABLE ULTIMATE WATER SERVICE AREAS

TABLE 20

PROBABLE ULTIMATE WATER SERVICE AREAS
IN SAN LUIS OBISPO COUNTY

Net Areas in Acres

Hydrologic unit and subunit	Irrigated Agriculture								Urban, sub-urban, and military	Total water service area
	Alfalfa	Pasture	Orchard	Vineyard	Truck crops	Misc. field crops	Hay and grain	Subtotal		
UPPER SALINAS UNIT	20,600	41,300	8,500	3,500	9,000	12,100	11,800	106,800	10,200	117,000
COASTAL UNIT										
Cambria Subunit	2,000	3,480	100	---	1,400	1,800	200	8,980	2,290	11,270
San Luis Obispo Subunit	4,100	8,400	200	---	3,700	3,600	400	20,400	13,270	33,670
Arroyo Grande Subunit	4,000	6,030	200	---	6,000	1,400	500	18,130	7,870	26,000
Subtotals, Coastal Unit	10,100	17,910	500	---	11,100	6,800	1,100	47,510	23,430	70,940
SANTA MARIA UNIT	2,100	4,040	200	---	5,000	3,000	200	14,540	1,000	15,540
CUYAMA UNIT	6,100	10,810	300	500	2,100	6,000	400	26,210	500	26,710
CARRIZO PLAIN UNIT	20,000	19,000	---	---	2,000	4,700	53,800	99,500	1,000	100,500
SAN JOAQUIN UNIT	1,000	1,310	---	---	---	---	---	2,310	---	2,310
TOTALS	59,900	94,370	9,500	4,000	29,200	32,600	67,300	296,870	36,130	333,000

Unit Use of Water

The second step in evaluation of present and probable ultimate water requirements of San Luis Obispo County involved the determination of appropriate unit values of water use for each class of land requiring water service. Use of water was also determined for certain classes of native vegetation and dry-farmed crops, as required, for purposes of hydrologic analysis.

Unit Values of Consumptive Use

For the purpose of supplementing available consumptive use data and to provide additional data in support of estimates of water requirements, a program of soil moisture depletion studies was conducted at representative irrigated, dry-farmed, and native vegetation plots during the 1953-54 growing season. Soil moisture depletion studies consisted of both field and laboratory work and involved (1) the collection of soil samples from representative plots at specified intervals of time prior to and following irrigations, (2) determination of both field and oven-dry weights of the soil samples, (3) reduction of resultant values of contained moisture to equivalent inches depth of water, and (3) determination of rates of consumptive use of water during intervals of time between successive samplings. Detailed results of all soil moisture depletion studies, including methods and procedures utilized therein, are presented in Appendix K. Descriptions of investigational test plots are included in the appendix, and their locations are indicated on Plate 11.

Unit values of consumptive use for various crops were computed for each of the units and subunits of the investigational area using a procedure suggested by Harry F. Blaney and Wayne D. Criddle, of the Soil Conservation

Service, United States Department of Agriculture, in their reports entitled "A Method of Estimating Water Requirements in Irrigated Areas from Climatological Data" dated December, 1947, and "Determining Water Requirements in Irrigated Areas from Climatological and Irrigation Data", dated August, 1950. The method as described in the latter report is as follows:

> "Briefly, the procedure is to correlate existing consumptive use data with monthly temperature, monthly percentages of yearly daytime hours, precipitation, and growing or irrigation season use. Coefficients have been developed from existing measured consumptive use and temperature data and monthly percents of yearly daytime hours. Thus if only monthly temperature records are available and latitude is known, the consumptive use can be computed from the formula U=KF; where U = consumptive use of water in inches for any period, K = empirical consumptive use coefficient, and F = sum of the monthly consumptive use factors for the period (sum of the products of mean monthly temperature and monthly percent of annual daytime hours)."

As can be seen from the foregoing description, no direct consideration is given to the effect of wind movement, fog, and humidity on the rate of water consumption. These factors are generally unmeasured and the few available records thereof are usually of relatively short length in comparison to other available climatological data. Effects of the foregoing variables are believed to be largely responsible for the differences in the quantity of water consumptively used by certain crops grown under otherwise identical climatological and other environmental conditions. As shown in Appendix H, "K" factors derived from soil moisture depletion studies conducted in San Luis Obispo County varied by as much as 20 per cent, depending upon the crop and hydrographic unit.

The following is an outline of the procedure utilized in estimating unit values of consumptive use for San Luis Obispo County:

1. Measured growing season units of consumptive use of water as derived from soil moisture depletion studies were employed in the cited

formula for the purpose of computing appropriate consumptive use coefficients for the particular investigational season. The coefficient (K) was derived as the quotient of the measured growing period consumptive use of water (U), and the consumptive use factor (F). The available heat or consumptive use factor in this step was taken as the sum of the products of the average monthly temperatures prevailing during the 1953 growing season and the monthly percent of annual daytime hours at the location of the plot.

2. Average consumptive use coefficients were then computed for each crop studied. For those crops included in the present and probable ultimate pattern of land use which are not grown presently or for which suitable study plots could not be found, results of similar studies in other areas were utilized by correlation with local climatological conditions.

3. In a given subunit, the unit value of consumptive use of water for each irrigated crop during its growing season was taken as the product of the weighted 16-year base period average consumptive use factor for the subunit and the appropriate coefficient of consumption, derived as in (1) above.

4. Unit values of consumptive use of water for each crop during the nongrowing season were taken as the amount of precipitation available, up to but not exceeding one or two inches of depth per month, depending on the crop.

5. The total seasonal unit value of consumptive use of water for each irrigated crop was then taken as the summation of values derived under items (3) and (4).

6. That portion of the unit seasonal value of consumptive use of water supplied by precipitation, termed "effective precipitation", was taken as equal to the sum of water consumed during the nongrowing season, consumptive use of direct precipitation occurring during the growing season, and

consumptive use of moisture stored in the soil during the nongrowing season but utilized during the growing season.

7. Unit values of consumptive use of applied water for each irrigated crop were taken to be the difference between total seasonal consumptive use of water and effective precipitation.

8. Unit seasonal values of consumptive use of water for grain and other dry-farmed crops were based on rates of consumptive use observed at study plots in connection with the soil moisture depletion study and on data gathered in connection with similar studies elsewhere.

9. Unit seasonal values for native annual grasses were taken as the summation of available precipitation up to, but not exceeding, two inches in depth per month.

10. Unit seasonal values for native vegetation other than native annual grasses were estimated from available data modified so as to apply to local conditions of water supply and climate.

11. Unit seasonal values for free water surfaces were estimated from records of evaporation at Salinas Reservoir and available temperature records.

12. Unit seasonal values of consumptive use of water by various ategories of urban land use were estimated from comprehensive data gathered n a previous study by the Division of Water Resources in the Los Angeles tropolitan Area. The reasonableness of these units as applied to local con- tions was checked by application of the units to selected water service eas for which water production and land use data were available.

Estimated unit mean seasonal values of consumptive use of applied ter, effective precipitation, and total seasonal consumptive use of water irrigated and urban lands in the investigational area under both present and ultimate conditions of development are presented in Table 21. Unit values contained in Table 21 are also considered representative of average values prevailing during the base period. For illustrative purposes, the monthly distribution of mean seasonal consumptive use of water by alfalfa and truck crops in the San Luis Obispo and Shandon areas is depicted on Plate 12, entitled "Monthly Distribution of Mean Seasonal Consumptive Use of Water by Representative Crops, San Luis Obispo County".

ESTIMATED UNIT VALUES OF MEAN SEASONAL
CONSUMPTIVE USE OF WATER IN SAN LUIS OBISPO COUNTY

ESTIMATED UNIT VALUES OF MEAN SEASONAL CONSUMPTIVE USE OF WATER IN SAN LUIS OBISPO COUNTY

In Feet of Depth

Class of land use	Upper Salinas Unit			Coastal Unit: Cambria Subunit			Coastal Unit: San Luis Obispo Subunit			Coastal Unit: Arroyo Grande Subunit		
	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use
Irrigated Agriculture												
Alfalfa	2.6	1.0	3.6	1.6	1.5	3.1	1.9	1.5	3.4	2.1	1.3	3.4
Pasture	2.7	1.0	3.7	2.0	1.2	3.2	2.3	1.2	3.5	2.3	1.1	3.4
Orchard	1.3	1.1	2.4	0.6	1.2	1.8	0.7	1.2	1.9	0.8	1.2	2.0
Vineyard	0.7	1.0	1.7	--	--	--	--	--	--	--	--	--
Truck crops	1.4	1.0	2.4	1.2	1.0	2.2	1.5	1.0	2.5	1.5	1.0	2.5
Miscellaneous field	1.3	1.0	2.3	0.5	1.5	2.0	0.8	1.4	2.2	1.0	1.0	2.0
Hay and grain	0.5	0.6	1.1	0.1	1.0	1.1	0.1	0.9	1.0	0.2	0.8	1.0
Urban and Military												
Weighted average												
Present	0.6	0.7	1.3	0.9	0.7	1.6	0.8	0.7	1.5	1.1	0.7	1.8
Ultimate	0.8	0.7	1.5	1.7	0.7	2.4	1.6	0.7	2.3	1.7	0.7	2.4

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Class of land use	Santa Maria Unit			Cuyama Unit			Carrizo Plain Unit			San Joaquin Unit		
	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use	Applied water	Precipitation	Total seasonal consumptive use
Irrigated Agriculture												
Alfalfa	2.2	1.1	3.3	2.8	0.7	3.5	3.2	0.7	3.9	3.1	0.7	3.8
Pasture	2.2	1.1	3.3	2.8	0.7	3.5	3.2	0.7	3.9	3.1	0.7	3.8
Orchard	0.7	1.1	1.8	1.6	0.7	2.3	1.8	0.7	2.5	--	--	--
Vineyard	--	--	--	0.9	0.7	1.6	--	--	--	--	--	--
Truck crops	1.5	0.9	2.4	1.7	0.7	2.4	1.8	0.7	2.5	--	--	--
Miscellaneous field	1.0	1.1	2.1	1.5	0.7	2.2	1.6	0.7	2.3	--	--	--
Hay and grain	0.3	0.7	1.0	0.5	0.7	1.2	0.7	0.7	1.4	--	--	--
Urban and Military												
Weighted average												
Present	0.6	0.7	1.3	0.6	0.7	1.3	0.6	0.7	1.3	--	--	--
Ultimate	0.8	0.7	1.5	0.8	0.7	1.5	0.8	0.7	1.5	--	--	--

Units of Applied Water

Studies were made of the amounts of water applied to typical irrigated crops in San Luis Obispo County during the 1953 and 1954 irrigation seasons. Results of these studies, supplemented by the results of previously described water use studies, provided sufficient bases for the estimation of mean seasonal units of applied water for irrigated and urban lands under both present and ultimate conditions of development.

During the course of the field investigation, measurements were made of the amount of water applied to 27 test plots of representative crops, including alfalfa, pasture, walnuts, sugar beets, artichokes, celery, and lettuce. Test plots were selected so as to include typical soil types mapped in the land classification survey. For each plot, data were recorded as to the area irrigated, frequency of irrigation, and the amount of water applied. Applied water was computed from records of power consumption maintained by cooperators and Division of Water Resources personnel, and from pump test reports provided by Pacific Gas and Electric Company.

Results of applied water studies indicate a wide variation in irrigation practice with respect to both frequency and quantity of water application. Major factors contributing to these differences include differences in crops, climate, soil types, method of irrigation, and the skill of the irrigator. Climatic variations were found to be the major cause for seasonal differences in applied water at individual plots. All of these variations are typical of most irrigated areas and can be expected to occur in the future. Similar variations can be expected in urban and suburban areas, although not to such a marked degree.

A summary of the results of applied irrigation water studies in San Luis Obispo County is presented in Table 22. Detailed results of those studies are presented in Appendix H.

TABLE 22

MEASURED AVERAGE SEASONAL APPLICATION
OF IRRIGATION WATER ON REPRESENTATIVE CROPS
IN SAN LUIS OBISPO COUNTY

Unit	Number of plots			Applied water in feet of depth		
	1953	1954	Total	1953	1954	Weighted average for two seasons
UPPER SALINAS UNIT						
Alfalfa	4	2	6	4.0	2.6	3.5
Pasture	4	4	8	4.7	3.5	4.1
Field corn	-	1	1	---	1.9	1.9
COASTAL UNIT						
Alfalfa	-	1	1	---	2.5	2.5
Pasture	-	1	1	---	2.4	2.4
Walnuts	-	1	1	---	1.5	1.5
Sugar beets	1	1	2	1.0	1.1	1.1
Artichokes[a]	1	2	3	1.1	0.7	0.8
Celery[a]	3	-	3	4.0	---	4.0
Lettuce[b]	-	1	1	---	0.7	0.7

a Single crops, three and four month irrigation seasons.
b Single crop, three month irrigation season.

Irrigation efficiencies derived from data presented in Table 22 and from the results of soil moisture depletion studies were used as bases for the computation of mean seasonal units of applied water under both present and ultimate conditions of development and water use. Defined as the ratio of consumptive use of applied water to the total applied water, irrigation efficiency is commonly expressed as a percentage.

Results of studies in San Luis Obispo County indicate a variation in irrigation efficiency under present conditions ranging from 34 to 90 per cent. Although irrigation efficiencies vary widely between crops and among plots devoted to the same crop, it is felt that irrigation efficiencies currently being achieved in San Luis Obispo County are somewhat lower than those being achieved in other areas wherein irrigation has been practiced longer. With the exception of truck and field crop irrigation in the Coastal and Santa Maria Units, the vast majority of lands presently under irrigation in San Luis Obispo County have been developed since the end of World War II. As would be expected, considerable variation in irrigation technique exists and will continue to exist as farmers refine their procedures and develop more efficient systems. In a report by the United States Soil Conservation Service entitled "Ground Water Replenishment by Penetration of Rainfall, Irrigation, and Water Spreading in Zone 3, Ventura County Flood Control District, California", dated April, 1953, it was indicated that for the area studied, efficiencies of 74 to 77 per cent prevailed for alfalfa and irrigated pasture, 58 to 64 per cent for beans, and 70 to 75 per cent for summer truck crops. High efficiencies are difficult to achieve in all instances because of differences in root depth, soil type, topography, method of irrigation, drainage characteristics, and in the practices of the individual irrigators, but it is believed that over a period of time, as techniques are developed and refined, irrigation efficiencies within San Luis Obispo County will generally improve. Records of irrigation efficiencies in Ventura County, where irrigation has been practiced for a relatively greater number of years, are considered indicative of efficiencies which could be achieved in San Luis Obispo County.

Presented in Table 23, are irrigation efficiencies considered to be applicable to San Luis Obispo County for both present and probable ultimate conditions of development.

TABLE 23

ESTIMATED IRRIGATION EFFICIENCIES
UNDER PRESENT AND PROBABLE
ULTIMATE CONDITIONS OF DEVELOPMENT
IN SAN LUIS OBISPO COUNTY

Crop	Irrigation efficiency	
	Present	Ultimate
Alfalfa	50	65
Pasture	50	65
Orchard	75	80
Truck	75	80
Miscellaneous	75	80
Hay and grain	75	80
Vineyard	--	65

For illustrative purposes, there are presented in Table 24 estimated mean seasonal units of applied water for each of the units and subunits in San Luis Obispo County applicable to present conditions of development. Modified versions of present irrigation efficiencies, reflecting anticipated future changes in irrigation practice, were used to derive units of applied water for ultimate conditions of water use. Variations in weighted units of use for urban, suburban, and military lands appearing in Table 24 reflect differences in prevailing patterns of development rather than actual differences in estimated unit use of water.

TABLE 24

ESTIMATED MEAN SEASONAL UNITS OF APPLIED WATER
IN SAN LUIS OBISPO COUNTY
UNDER PRESENT CONDITIONS OF DEVELOPMENT

In Feet of Depth

Hydrologic unit and subunit	Irrigated agriculture						Urban, suburban, and military, weighted average
	Alfalfa	Pasture	Orchard	Truck crops	Misc. field crops	Hay and grain	
UPPER SALINAS UNIT	5.2	5.4	1.7	1.9	1.7	0.7	3.2
COASTAL UNIT							
Cambria Subunit	3.2	4.0	0.8	---	0.7	0.1	3.1
San Luis Obispo Subunit	3.8	4.6	0.9	2.0	1.1	0.1	3.0
Arroyo Grande Subunit	4.2	4.6	1.1	2.0	1.3	0.3	2.8
SANTA MARIA UNIT	4.4	4.4	---	2.3	2.0	---	3.0
CUYAMA UNIT	5.6	5.6	---	---	2.0	0.7	---
CARRIZO PLAIN UNIT	6.4	6.4	---	---	2.1	0.9	---
SAN JOAQUIN UNIT	---	---	---	---	---	---	---

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Unit values of applied water for ultimate conditions of development corresponding to those presented in Table 24 were derived similarly. The ultimate values, reflecting higher irrigation efficiencies, varied from 77 to 94 per cent of the values presented in Table 24. No change was forecast for urban and suburban units of applied water as it is believed that any such change will be negligible.

Water Requirements

Water requirements in San Luis Obispo County under present and probable ultimate conditions of development were estimated by multiplying the acreage of each category of land use under present and probable ultimate conditions of development by appropriate units of water use with due consideration given to geologic conditions affecting the use and re-use of water. In portions of the County wherein water applied to lands in excess of consumptive use will either return to ground water storage and be available for re-use, or will drain from the area under consideration and be available for re-use downstream, the measure of water requirement was taken as the amount of consumptive use of applied water. For lands overlying confined ground water bodies, wherein it was assumed that water applied in excess of consumptive use is prevented from returning to ground water storage for subsequent re-use, or in those areas wherein the unconsumed residuum drains directly to the ocean or is otherwise unavailable for re-use, the measure of water requirement was taken as the amount of applied water.

Both present and ultimate seasonal water requirements for irrigated lands were evaluated for conditions of water supply and climate that would prevail with a repetition of climatic conditions which occurred during the base period. Requirements so estimated were taken as equivalent to mean seasonal water requirements under the two conditions of development.

Present Water Requirements

Based on the foregoing criteria, the present mean seasonal water requirement of San Luis Obispo County was estimated to be about 69,000 acre-feet. Except for portions of the Coastal and Santa Maria Units wherein excess applied water drains directly to the ocean or is discharged thereto as sewage effluent, present water requirements for all other areas of San Luis Obispo County were estimated utilizing unit values of consumptive use of applied water. Urbanized areas of the Coastal Unit, wherein total applied water is considered the measure of demand under present conditions of development, include the Cayucos-Morro Bay, Avila, Shell Beach, and Pismo Beach areas.

The determination of water requirements within military reservations for any particular period is inherently difficult because of changing international conditions affecting their position in the military preparedness program. Past history of the operation of the two military reservations within San Luis Obispo County have indicated a widely fluctuating water demand. In addition to their use during World War II, when their demand for water was perhaps at a peak, both reservations have been or are being used periodically for U. S. Army Reserve or National Guard training purposes during the summer months. The hospital area of Camp San Luis Obispo is presently being utilized as a medical facility of the State of California, Department of Corrections. For the purposes of this report, estimates of present water requirements for the cantonment areas in military reservations have been based upon the assumption of maximum utilization of the area for military purposes. In the absence of complete records of water use at the two camps during World War II, an attempt was made to estimate such use by the application of appropriate units of water use to the various prevailing categories of land use. Water requirements for irrigation purposes in national forest areas or military reservations outside of cantonment areas are included in total water requirements hereinafter presented.

Presented in Table 25, are estimated present mean seasonal water requirements for San Luis Obispo County by units and subunits derived on the basis of the afore-mentioned methods and assumptions.

TABLE 25

ESTIMATED PRESENT MEAN SEASONAL WATER REQUIREMENTS IN SAN LUIS OBISPO COUNTY

In Acre-Feet

Hydrologic unit and subunit	Irrigated agriculture	Urban, suburban, and military	Total
UPPER SALINAS UNIT	26,000	900	26,900
COASTAL UNIT			
Cambria Subunit	1,100	100	1,200
San Luis Obispo Subunit	4,500	3,800	8,300
Arroyo Grande Subunit	5,800	900	6,700
Subtotals, Coastal Unit	11,400	4,800	16,200
SANTA MARIA UNIT	16,600	------	16,600
CUYAMA UNIT	8,200	------	8,200
CARRIZO PLAIN UNIT	600	------	600
SAN JOAQUIN UNIT	------	------	------
TOTALS	62,800	5,700	68,500

Probable Ultimate Water Requirements

Water requirements in San Luis Obispo County, under probable ultimate conditions of development, were determined by multiplying the estimated acreage of each type of land use by appropriate unit values of seasonal water use with proper consideration given to anticipated future conditions affecting the use and re-use of water. Accordingly, the probable ultimate water requirement of San Luis Obispo County is estimated to be approximately 721,000 acre-feet per season.

As in the case of present water requirements, estimated ultimate water requirements for Upper Salinas, Cuyama, and San Joaquin Units were derived from units of consumptive use of applied water. Under ultimate conditions of development, it was assumed that urban and military development in the Coastal Unit would be served by sewerage works discharging their effluent directly to the ocean. The measure of demand for areas so served was, therefore, assumed to be the total applied water as was the case for irrigable lands which drain directly to the ocean or which overlie a confined ground water basin.

In the Santa Maria Unit, total applied water was taken as the measure of demand for irrigable and potential urban lands overlying the confined ground water body in the western part of the Basin. For all other irrigable and potentially urban lands within the Unit, estimates of ultimate water requirements were based upon unit values of consumptive use of applied water.

As discussed previously, geologic and topographic evidence indicate that little if any re-use of return irrigation flow will be effected in the Carrizo Plain Unit under ultimate conditions of development. Furthermore, it appears that a large body of water would form at Soda Lake from pondage of return irrigation flow, unless suitable artificial drainage facilities are provided. Without such measures, it was estimated that evaporation from the lake would approximate 15,000 acre-feet per season, with conditions of development and water use proposed herein, before the lake would become stabilized. A stabilized condition would be reached when net evaporation from the lake would be just equal to the total return irrigation flow. It is therefore believed that total applied water will be the measure of demand in the Carrizo Plain Unit under ultimate conditions of development. This assumption would be valid regardless of the crop pattern or any measures which would be undertaken to alleviate the drainage problem.

Estimates of probable ultimate water requirements for lands on military reservations were based on the assumption that present cantonment areas would undergo no further expansion and that irrigable lands would be irrigated to the maximum practicable extent. Ultimate water requirements for cantonment areas were derived by the same method as were the present water requirements.

A summary of estimated probable ultimate mean seasonal water requirements for the various units and subunits within San Luis Obispo County, derived in accordance with the afore-mentioned methods and assumptions, is contained in Table 26.

TABLE 26

ESTIMATED PROBABLE ULTIMATE MEAN SEASONAL
WATER REQUIREMENTS IN SAN LUIS OBISPO COUNTY

In Acre-Feet

Hydrologic unit and subunit	Irrigated agriculture	Urban, suburban, and military	Total
UPPER SALINAS UNIT	212,800	8,200	221,000
COASTAL UNIT			
Cambria Subunit	15,300	6,900	22,200
San Luis Obispo Subunit	37,400	39,800	77,200
Arroyo Grande Subunit	33,200	23,600	56,800
Subtotals, Coastal Unit	85,900	70,300	156,200
SANTA MARIA UNIT	26,700	800	27,500
CUYAMA UNIT	62,800	400	63,200
CARRIZO PLAIN UNIT	242,800	3,200	246,000
SAN JOAQUIN UNIT	7,200	------	7,200
TOTALS	638,200	82,900	721,100

Future Water Requirements of the City of San Luis Obispo

As will be discussed in detail in Chapter IV, the most pressing water resource problem presently facing San Luis Obispo County is considered to be the development of an additional water supply for the City of San Luis Obispo. Estimates of the City's future water requirements, prepared during the San Luis Obispo County Investigation, formed a partial basis for various water supply plans considered.

Future water requirements were estimated by the application of projected per capita water consumption rates to projected population increases. Historical population figures for the City were projected into the future by use of both the graphical comparison and the arithmetic progression methods. By use of the former method, the slope of the projected population curve is influenced largely by the past experience of larger neighboring cities. By use of the latter method, the historical rate of population increase of the City being studied determines the slope of the population projection line for future years. Identical results were obtained from both of the foregoing methods.

From an analysis of water consumption and population data available for most years since 1933, it was determined that the trend in daily per capita water consumption has remained fairly constant, averaging 172.5 gallons per day.

Results of the foregoing studies indicate the future rate of population increase in the City will be about 690 per year, and that the resulting increase in annual water use will be about 134 acre-feet per year. Total demands on the City's water supply system resulting from the foregoing increases were estimated to be about 4,100 acre-feet in 1960, 5,400 acre-feet in 1970, and 6,700 acre-feet in 1980. The indicated requirement of 4,100 acre-feet in 1960 would be nearly equal to the total amount of water presently available to the City, including 3,000 acre-feet from Salinas Reservoir.

Estimated rates of growth of population and water requirements for the City of San Luis Obispo are depicted on Plate 13, "Projection of Population and Water Requirement of City of San Luis Obispo".

Monthly Demands for Water

In the preliminary design of works to meet supplemental water requirements, consideration must be given to current practice in San Luis Obispo County as regards monthly distribution of seasonal water demand for irrigation and urban use. Demands for water for irrigation and urban purposes in San Luis Obispo County vary from month to month depending upon the type of land use and prevailing climatic conditions. Generally speaking, irrigation water is applied during the months from April through October for most crops. Multiple truck cropping practices in the Coastal and Santa Maria Units impose demands on irrigation water supplies throughout the year subject to the occurrence of precipitation. Irrigated hay and grain receive application of supplemental water during the winter months when deficiencies in precipitation occur. To achieve the desired soil moisture content for germination of seed, hay, grain, and bean lands are often preirrigated prior to planting.

From analysis of measurements of application of water for irrigation purposes during the 1952-53 and 1953-54 seasons, it has been found that for certain crops, the monthly demand for water varies from zero to as high as 18.4 per cent of the seasonal demand in Upper Salinas Unit. In the Coastal Unit, the extremes were found to be much less pronounced. Analyses of records of water consumption obtained from the Cities of Paso Robles and San Luis

Obispo reveal a more uniform monthly distribution than is the case with irrigation.

Estimates of average monthly distribution of seasonal demands for irrigation and urban water are presented in Table 27. The estimates of monthly demands for irrigation water, showed in Table 27, for the Upper Salinas, Cuyama, Carrizo Plain, and San Joaquin Units are based upon applied water studies made in the Upper Salinas Unit. Figures for the Coastal and Santa Maria Units are based on studies made in the Coastal Unit.

TABLE 27

ESTIMATED AVERAGE MONTHLY DISTRIBUTION OF
SEASONAL DEMAND FOR WATER IN SAN LUIS OBISPO COUNTY

(In Per Cent of Season Total)

Month	Upper Salinas, Cuyama, Carrizo Plain, and San Joaquin Units		Coastal and Santa Maria Units	
	Irrigation	Urban and suburban	Irrigation	Urban and suburban
October	14.9	8.0	10.6	8.4
November	0.0	5.4	3.9	7.3
December	0.0	4.3	0.0	6.8
January	0.0	4.3	0.0	6.7
February	0.0	4.1	0.0	5.7
March	0.0	5.0	0.0	6.3
April	8.5	7.0	7.5	7.3
May	10.7	10.5	14.0	9.5
June	14.2	12.0	15.9	9.8
July	17.8	14.2	17.4	10.7
August	18.1	13.5	16.2	11.5
September	15.8	11.7	14.5	10.0
TOTALS	100.0	100.0	100.0	100.0

Supplemental Water Requirements

Supplemental water requirements have been previously defined as the difference between the water requirements and the sum of safe ground water yield and safe surface water yield. In the case of a ground water basin, the safe yield cannot ordinarily be determined with any great accuracy until there are indications of an overdraft as previously defined. If an overdraft does exist, the present supplemental water requirement would be equal to the present overdraft. Under ultimate conditions of development, the supplemental water requirement would be equal to the present overdraft plus the difference between present and ultimate water requirements.

The existence of a supplemental water requirement does not necessarily imply that further local water conservation development is infeasible. On the contrary, a large portion if not all of the supplemental requirement may be met by additional local surface water development. Estimated present and probable ultimate requirements for supplemental water in San Luis Obispo County are discussed and evaluated in the following sections. Physical conditions in adjacent counties affecting supplemental water requirements in portions of San Luis Obispo County are also discussed.

Present Supplemental Water Requirements

As shown previously, presently available data indicate that none of the ground water basins in the Upper Salinas, Coastal, Cuyama, Carrizo Plain, and San Joaquin Units are overdrawn. The present mean seasonal water requirement of 68,500 acre-feet in those units is apparently being satisfied by the safe yield of the developed water supply and supplemental water is, therefore, presently not required.

Throughout the County, irrigation development has been restricted to a large extent because of limited water supply development. In some local areas, temporary deficiencies have been reported. These deficiencies have been primarily the result of poor well spacing or improper well construction and development as discussed in Chapter II. These deficiencies are, therefore, considered to be negligible and have not been included in present computations.

More extensive utilization of ground water supplies will eventually be manifested by overdraft conditions unless supplemental water is made available. The continuance of a ground water level monitoring program would provide data required to ascertain the imminence of such overdraft conditions.

The prevailing overdraft on ground water supplies in Santa Maria Valley is evidenced by perennial lowering of ground water levels, in all portions of the valley including the Santa Maria Unit. Evaluation of present supplemental water requirements for the Santa Maria Unit apart from the rest of Santa Maria Valley would be meaningless as the present supplemental requirement for water in the entire valley would have to be met in order to eliminate the overdraft in the Santa Maria Unit. Accordingly, both present and probable ultimate supplemental water requirements have not been evaluated for that Unit.

Probable Ultimate Supplemental Water Requirements

For reasons discussed hereinbefore, maximum safe ground water yield determinations have been made for only the Upper Salinas, Coastal, Carrizo Plain, and San Joaquin Units. The probable ultimate supplemental water requirement of the foregoing units is estimated to be approximately 583,000 acre-feet as shown in the following tabulation:

	Acre-feet
Ultimate water requirement	630,000
Presently developed water supply	47,000
Probable ultimate supplemental water requirement	583,000

Approximately 155,000 acre-feet, or 26 per cent of the probable ultimate supplemental water requirement of the four hydrologic units, can be met by further development of local water supplies, including about 29,000 acre-feet from increased ground water development, as discussed in Chapter II, and 126,000 acre-feet from surface water developments, as discussed in Chapter IV. The remaining 428,000 acre-feet of water would have to be imported from sources outside the County.

CHAPTER IV. PLANS FOR WATER SUPPLY DEVELOPMENT

The water supplies of San Luis Obispo County are generally adequate to meet present water requirements except for deficiencies presently existing in Santa Maria Valley and in other smaller areas wherein temporary local problems have arisen. With full development of the County's water resources, however, large quantities of water will have to be imported from sources outside the County. Although attainment of ultimate conditions of development and water use will undoubtedly not occur until the distant future, the need for development of an additional source of water for the growing requirements of the City of San Luis Obispo is immediate.

In consideration of the ultimate water-using potential of the County and of the immediate problem facing the City of San Luis Obispo, it is desirable that a sound plan of water resource development be available for San Luis Obispo County at this time, and that it be prosecuted under a program of staged construction as the growth and attendant water needs of the County dictate. As a result of this investigation, such a plan has been developed which conforms to and is consistent with objectives of The California Water Plan. In formulation of the plan for San Luis Obispo County, the following factors were considered:

1. Provision for the water needs of the City of San Luis Obispo for the immediate future.

2. Conservation of local waters now wasting to the ocean in order to provide to the maximum practicable extent for the anticipated future water needs of irrigated agriculture and urban and suburban lands throughout the County.

3. Importation of water from sources outside San Luis Obispo County to satisfy the probable future water needs of the County in excess of new water yields of considered local water resource developments.

As was stated in Chapter I, the Division of Water Resources for several years conducted state-wide surveys and studies for the State Water Resources Board. These studies led to the formulation of The California Water Plan for full conservation, control, and utilization of the State's water resources to meet present and future water needs for all beneficial purposes and uses in all parts of the State insofar as practicable. As stated previously, Bulletin No. 3 of the State Water Resources Board entitled "The California Water Plan", was published in May, 1957. In addition to plans for development of the water resources of this investigation, plans are also presented therein to satisfy the ultimate water requirements of the County in excess of water made available by maximum practicable development of local water supplies.

In general, major features of The California Water Plan are large multipurpose projects requiring relatively large capital expenditures. Plans presented in this report for the further development of local supplies would be such that the works could be integrated into the major features of The California Water Plan.

Descriptions of plans considered for the conservation and utilization of local water supplies in San Luis Obispo County, and plans for importation of water from available sources outside the County, are presented in this chapter under the sections designated: "Plans for Local Conservation Development", "Alternative Plans for Water Supply Development", "Plans for Importation of Water", and "Flood Control".

Included herein are estimates of costs of the various plans, estimates of amounts of supplemental water that would be made available by their adoption and construction, and an economic comparison of the relative merits of the several plans.

Design of features of plans presented herein was necessarily of a preliminary nature and primarily for cost estimating purposes. More detailed investigation, which would be required in order to prepare construction plans and specifications, might result in designs differing in detail from those presented in this bulletin. The resulting estimates of cost must also be considered of a preliminary nature and for the purpose of comparing the relative merits of the considered projects. Further consideration of a given project would require procurement of additional topography and other design data, as foundation drilling and materials analyses. Such work was beyond the scope of this investigation.

The capital costs of dams, reservoirs, diversion works, conduits, pumping plants and appurtenances for water conservation and conveyance systems studied were estimated from preliminary designs based largely on data from surveys made during the current investigation, both by the Division of Water Resources and other cooperating agencies. Estimates of construction quantities were made from these preliminary designs. Unit prices of construction items were determined from recent contract bid cost data for projects similar to those under consideration or from manufacturers list prices and are considered representative of prices prevailing in 1954. Estimates of capital cost included costs of rights of way and construction, 10 per cent of construction costs for engineering, 15 per cent of the construction costs for contingencies, and interest during construction computed at the rate of four per cent per annum for one-half the construction period. Estimates of annual costs included interest on the capital investment at 3.5 per cent per annum, amortization over a 40-year period on a 3.5 per cent sinking fund basis, replacement costs, operation and maintenance costs, and cost of electrical energy required for pumping. Replacement costs were estimated as the annual costs of accumulation of a sinking fund, bearing three and one-half per cent interest, equal to the estimated costs of those items of dam construction such as gates, valves, and other metal work, and pipe line and pumping plant equipment which, it is estimated, would require replacement during the assumed repayment period. Operation and maintenance costs were estimated for dams and reservoirs on the basis of the costs shown in the following tabulation:

$0.20 per acre-foot for first 25,000 acre-feet of storage capacity

$0.10 per acre-foot for next 75,000 acre-feet of storage capacity

$0.06 per acre-foot for next 900,000 acre-feet of storage capacity

Plans for Local Conservation Development

The erratic occurrence of runoff in San Luis Obispo County severely limits the extent to which local water supplies can be utilized without regulatory storage capacity to equalize stream flow from winter to summer months and from wet periods to ensuing periods of drought. At the present time, this required regulatory storage capacity has largely been developed in the underground storage basins. Studies by the Division of Water Resources indicate that a maximum of approximately 200,000 acre-feet of water per season presently wasting to the ocean can be economically conserved for beneficial use in San Luis Obispo County through further regulation by surface and underground reservoirs.

The two primary methods by which a portion of the presently wasted water might be captured, including increased development of ground water supplies and storage of runoff in surface reservoirs, are discussed in the following paragraphs. As at present, it is anticipated that direct diversions of surface runoff will continue to comprise a minor portion of the total developed water supply.

Further Development of Ground Water Storage

It is estimated that in excess of 200,000 acre-feet of underground storage capacity has been utilized to date in the County, most of which has been in the Paso Robles Basin of the Upper Salinas Unit. Future growth and economic development in the County will necessarily be reflected in further utilization of the underground reservoirs. Correspondingly, ground water levels will be further lowered during drought periods, thus providing storage space for percolation of stream flow and precipitation during subsequent wet periods.

As set forth in Chapter II, it is estimated that ground water basins in San Luis Obispo County, with increased utilization as will occur by the additional development of overlying lands, could provide an additional yield of about 33,000 acre-feet per season. To attain this increased yield it would be necessary to dewater in excess of 400,000 acre-feet of additional ground water storage capacity. Such additional utilization would not, however, result in the creation of excessive pumping lifts nor would withdrawals from the basins under such conditions exceed average annual recharge thereto. The Paso Robles and Arroyo Grande Basins are the most important in the County with respect to possibilities for increased ground water development.

Planned operation of ground water basins would result in increased yield not only through salvage of a portion of the runoff presently wasting to the ocean, but also, in certain areas, through reduction or elimination of nonbeneficial consumptive use of water by phreatophytes. It is estimated that up to 12,000 acre-feet of water per season may be conserved by elimination of phreatophytic growth in ground water basins of San Luis Obispo County.

For purposes of review, there is presented in Table 28 a summary of estimated present and anticipated maximum practicable safe seasonal yield of ground water supplies in San Luis Obispo County exclusive of the Santa Maria and Cuyama Units.

TABLE 28

ESTIMATED PRESENTLY DEVELOPED
AND MAXIMUM PRACTICABLE SAFE YIELD
OF GROUND WATER SUPPLIES IN
PORTIONS OF SAN LUIS OBISPO COUNTY AND VICINITY

In Acre-Feet

Hydrologic unit	Estimated safe seasonal yield	
	Presently developed	Maximum
UPPER SALINAS UNIT	26,900	45,000[a]
COASTAL UNIT	13,800	24,800
CARRIZO PLAIN UNIT	600	600
SAN JOAQUIN UNIT	0	0
TOTALS	41,300	70,400

a. Includes yield of Paso Robles Basin within Monterey County.

As set forth in Chapter II, the maximum safe seasonal yields of certain ground water basins were limited for the purposes of this bulletin to the estimated mean seasonal water requirements of overlying lands not affected by proposed surface water supply developments. Therefore, these estimated mean seasonal water requirements of overlying lands were deducted from estimated gross yields of proposed reservoirs to obtain net safe seasonal yields thereof.

Potential Surface Storage Developments

Investigation of potential surface storage developments in San Luis Obispo County included studies to determine the amounts of supplemental water that could be developed by constructing reservoirs of various storage capacities at the sites considered, geologic investigations to determine suitability of dam sites in regard to types and heights of dams, and estimates of capital and annual costs for purposes of establishing economic relationships between the various storage capacities considered at the several sites.

Preliminary reconnaissance was made of 58 potential dam and reservoir sites in San Luis Obispo County and vicinity, after which efforts were concentrated on more detailed investigation of 17 of the sites considered more favorable for development. The sites given reconnaissance examination and subsequently eliminated on the basis of poor geologic conditions, limited water supply, high capital costs, or excessive unit costs of water are listed in the following tabulation and shown on Plate 14:

Dam and reservoir	Stream	Dam and reservoir	Stream
	Upper Salinas Unit		
American Canyon	Salinas River	Middle Mountain	Cholame Creek
Pozo	Salinas River	Upper Cholame	Cholame Creek
Salinas No. 2	Salinas River	Lower Cholame	Cholame Creek
Salinas No. 1	Salinas River	White Canyon	White Canyon Creek
Upper Atascadero	Atascadero Creek		
Rocky Gorge	Graves Creek	Palo Prieto Canyon	Palo Prieto Canyon Creek
Upper Jack	Jack Creek		
Middle Jack	Jack Creek	La Panza	San Juan Creek
Upper Paso Robles	Paso Robles Creek	Shedd Canyon	Shedd Canyon Creek
Lower Paso Robles	Paso Robles Creek		
Mustang	Tributary to Cholame Creek	Huerhuero	Huerhuero Creek
	Carrizo Plain Unit		
Elkhorn	Unnamed tributary to Carrizo Plain		

am and reservoir	Stream	Dam and reservoir	Stream
		Coastal Unit	
pper Burnett	Burnett Creek	Dark Range	Toro Creek
ower Burnett	Burnett Creek	Estero	Toro Creek
one Tree	Arroyo de la Cruz	Cerro Alto	Morro Creek
hileno	Arroyo de la Cruz	Los Osos	Los Osos Creek
rows Nest	Steiner Creek	Laguna Lake	San Luis Obispo Creek
ed Mountain	San Simeon Creek		
ypress Mountain	Santa Rosa Creek	See Canyon	See Canyon Creek
ammoth Rock	Santa Rosa Creek	Pismo	Pismo Creek
an Geronimo	Villa Creek	Stone Cabin	Lopez Creek
ayucos	Cayucos Creek	Lopez No. 2	Lopez Creek
isty Peak	Old Creek	Basquez	Basquez Creek
an Luisito	San Luisito Creek*	San Bernardo	San Bernardo Creek*

* Not shown on Plate 14; see description below.

Reconnaissance investigation of potential dam and reservoir sites the Carrizo Plain and San Joaquin Units, as well as eastern portions of the per Salinas Unit, together with hydrologic studies, indicated that there are feasible sites, and that present waste of water from those areas is either existent or insignificant in comparison with present and probable future plemental water requirements. Some sites in the foregoing tabulation, ever, were studied for possible development as regulating reservoirs for orted supplies.

A number of sites suitable for smaller development, such as San onimo, Cayucos, Estero, Cerro Alto, and Rocky Gorge, also San Luisito and Bernardo, which are located on minor tributaries of Chorro Creek east of o Bay, were reconnoitered and found to have possibilities for providing r supplies for smaller communities. Because of their limited storage city or yield, further study of these sites was considered beyond the of this investigation. Subsequent investigations, however, may prove sites to be highly desirable for construction by individual farmers some of the smaller communities.

Preliminary designs and cost estimates were made for the remaining 17 dams and reservoirs investigated. In most cases, estimates of cost and of reservoir yield were made for several capacities at each site. All sites examined are shown on Plate 14, entitled "Existing and Potential Water Supply Developments". Those sites at which preliminary designs and cost estimates were prepared are listed in the following tabulation:

Dam and reservoir	Stream	Dam and reservoir	Stream
	Upper Salinas Unit		
Rinconada	Salinas River	Lower Jack	Jack Creek
Cantera	Salinas River	Santa Rita	Santa Rita Creek
Lower Atascadero	Atascadero Creek	San Miguelito	Nacimiento River
Dover	Dover Creek	Jarrett Shut-In	Nacimiento River
	Coastal Unit		
Bald Top	San Carpoforo Creek	Santa Rosa	Santa Rosa Creek
Ragged Point	San Carpoforo Creek	Whale Rock	Old Creek
Yellow Hill	Arroyo de la Cruz	Wittenberg	Arroyo Grande Creek
Palmer Flats	San Simeon Creek		
San Simeon	San Simeon Creek	Lopez	Arroyo Grande Creek

It will be noted in the foregoing tabulation and on Plate 14 that a number of alternative sites were considered for the construction of dams on several of the streams in the County. Final decision as to the site or sites considered most feasible of development on a particular stream or stream system was reached after consideration of the various engineering and economic factors involved. In some cases, the limited water supply precluded more than a single development on a given stream. In other instances, sites were eliminated from further consideration due to apparent limitations as to geologic conditions or after preliminary design and cost estimates revealed excessive capital or unit costs of water.

Prior to completion of this bulletin, the Monterey County Flood Control and Water Conservation District initiated and essentially completed construction of Nacimiento Dam and Reservoir. Further study of the El Nacimiento, Winchester Ranch, and Pebblestone Shut-In on the Nacimiento River as possible sites for the development of supplemental water supplies for San Luis Obispo County would serve no practical purpose, and they were therefore eliminated from further consideration in this bulletin.

Although several alternative storage capacities were investigated at the final chosen sites, detailed discussions of the proposed developments are presented following for only one capacity at each site. Detailed cost estimates for all structures considered are presented in Appendix L of this bulletin.

Estimates of monthly runoff throughout the base period were made for each of the chosen sites, using the previously described method developed by Troxell wherein consideration is given to available runoff records for the area as well as precipitation, slope, vegetative cover, and absorptive character of the respective watersheds. Monthly distribution of estimated seasonal runoff was estimated by correlation with long-term records for nearby streams. At the Lower Jack and YellowHill sites, actual records of measured runoff were available for a portion of the base period. The resulting recorded or estimated monthly runoff occurring during the base period at Salinas and Nacimiento Dams, in addition to the 11 sites chosen for study, is presented in Appendix J. Annual summaries of the runoff values at proposed dam sites are presented in Table 29.

TABLE 29

RECORDED AND ESTIMATED SEASONAL RUNOFF
DURING BASE PERIOD AT SELECTED DAM SITES IN SAN LUIS OBISPO COUNTY AND VICINITY

In Acre-Feet

Season	Upper Salinas Unit				Coastal Unit						
	Lower Jack	Santa Rita	San Miguelito	Jarrett Shut-In	Bald Top	Upper Ragged Point	Yellow Hill	San Simeon	Santa Rosa	Whale Rock	Lopez
1935-36	10,700	9,500	50,600	94,600	17,800	35,000	43,000	23,800	16,800	14,000	19,500
37	12,400	11,000	57,500	107,700	20,500	41,600	51,400	28,100	20,400	18,500	34,300
38	30,600	26,300	124,300	234,500	37,800	77,300	109,900	52,400	36,000	31,400	40,300
39	2,000	1,900	8,900	16,600	3,300	6,500	6,300	4,300	3,800	2,700	6,400
40	15,700	13,900	73,500	137,800	25,700	51,800	66,000	35,000	24,400	16,500	13,400
1940-41	32,000	27,400	136,400	257,600	45,700	94,000	128,900	63,800	39,000	37,500	53,700
42	12,600	11,200	61,800	115,600	24,300	49,000	56,200	33,100	22,900	18,000	16,700
43	15,700	13,900	71,400	133,700	25,200	50,800	64,500	34,400	18,600	20,400	36,400
44	8,520	7,700	41,000	76,500	15,500	30,500	35,600	20,600	13,000	11,300	13,900
45	8,960	8,100	42,500	79,300	15,700	30,800	36,600	20,800	15,000	11,000	11,300
1945-46	6,240	5,600	30,600	57,100	11,800	23,000	25,500	15,500	11,700	7,400	9,300
47	3,350	3,100	15,500	28,800	6,400	12,100	12,100	8,200	5,100	3,600	6,600
48	2,400	2,100	12,100	22,100	4,800	9,100	9,000	6,100	3,600	2,500	6,100
49	6,080	5,500	29,500	55,100	11,000	21,500	24,400	14,500	8,200	5,400	7,000
50	4,480	4,100	27,000	50,200	10,400	20,300	21,800	13,600	7,400	5,700	9,000
1950-51	5,730	5,200	30,000	55,700	12,100	23,500	24,800	15,900	13,100	7,400	8,700
AVERAGES	11,100	9,800	50,800	95,200	18,000	36,100	44,800	24,400	16,200	13,300	18,300

Monthly net evaporation rates throughout the base period were estimated for each reservoir, based primarily upon records of evaporation at Salinas Reservoir adjusted for differences in precipitation and temperature occurring at each of the individual reservoirs. Values of net evaporation were computed as the difference between gross evaporation and the consumptive use of water by native vegetation in the reservoir area. The resulting average values of estimated monthly unit net evaporation at the various reservoir sites are presented in Table 30.

TABLE 30

ESTIMATED AVERAGE MONTHLY NET EVAPORATION
DURING BASE PERIOD AT SELECTED RESERVOIR SITES
IN SAN LUIS OBISPO COUNTY AND VICINITY

In Feet of Depth

Month	Upper Salinas Unit		Coastal Unit				
	Lower Jack and Santa Rita	San Miguelito and Jarrett Shut-In	Bald Top, Upper Ragged Point, and Yellow Hill	San Simeon	Santa Rosa	Whale Rock	Lopez
October	0.31	0.33	0.21	0.20	0.19	0.29	0.26
November	0.05	0.08	0.09	0.05	0.06	0.12	0.09
December	-0.37	-0.28	-0.21	-0.19	-0.14	-0.04	-0.09
January	-0.27	-0.19	-0.16	-0.17	-0.09	-0.03	-0.08
February	-0.50	-0.36	-0.20	-0.21	-0.12	-0.03	-0.11
March	-0.23	-0.14	-0.13	-0.10	-0.02	0.06	-0.03
April	0.19	0.22	0.12	0.12	0.14	0.22	0.16
May	0.51	0.51	0.30	0.30	0.29	0.41	0.37
June	0.63	0.63	0.38	0.38	0.38	0.50	0.45
July	0.75	0.75	0.41	0.42	0.41	0.57	0.50
August	0.71	0.71	0.40	0.40	0.40	0.55	0.48
September	0.56	0.56	0.33	0.33	0.33	0.46	0.40
TOTALS	2.34	2.82	1.54	1.53	1.83	2.96	2.40

Sedimentation in proposed reservoirs was estimated from records of sediment accumulation at existing reservoirs in central and southern California, including those available for Salinas Reservoir. Use was also made of the basic sedimentation equation presented in the report entitled "Flood Frequencies and Sedimentation from Forest Watersheds", by Henry W. Anderson, U. S. Forest Service, dated August, 1949. Reservoir operation studies were based on the effective storage capacity that would remain after 20 years of sedimentation, which period represents one-half of the amortization period assumed for dam and reservoir costs. The constructed capacity of the reservoirs is hereinafter referred to as the "gross reservoir storage capacity", and the effective capacity remaining after 20 years of operation as the "net reservoir storage capacity". Values of sedimentation utilized for the various reservoirs are shown in the following tabulation:

Reservoir	Sedimentation allowance, in acre-feet
Upper Salinas Unit	
Lower Jack	500
Santa Rita	500
San Miguelito	1,000
Jarrett Shut-In	2,000
Coastal Unit	
Bald Top	500
Ragged Point	500
Yellow Hill	1,000
San Simeon	500
Santa Rosa	500
Whale Rock	500
Lopez	1,000

It is possible that more conservation storage in the foregoing reservoirs could be preserved by keeping burned areas to a minimum and maintaining good vegetative cover in the tributary watersheds.

Yields of new water for various assumed capacities at each of the sites receiving detailed consideration were determined from monthly operation studies conducted over the chosen base period, 1935-36 through 1950-51. Reservoirs were first operated on a "gross" safe yield basis in which it was assumed that all runoff at each dam site was susceptible of regulation by the reservoir. Gross yields thus obtained were then reduced to net yields, assumed to be equal to the estimated amounts of water available for storage and utilization which would not otherwise be put to beneficial use downstream under anticipated ultimate conditions of development by increased utilization of the ground water basins. Therefore, proposed reservoirs were not credited with presently undeveloped ground water yield which could ultimately be put to beneficial use on lands overlying ground water basins. Estimated maximum safe ground water yields for each of the ground water basins identified during this investigation were presented previously in Table 12.

The monthly distribution of yields from reservoirs in the Upper Salinas Unit was based upon an irrigation demand schedule. For the Coastal Unit, the monthly distribution of demand was assumed to reflect a 75 per cent irrigation demand schedule and 25 per cent urban demand schedule. Following is a tabulation showing monthly demand schedules used for reservoir operation studies in the two foregoing units.

Month	Monthly demand in per cent of annual total	
	Upper Salinas Unit	Coastal Unit
October	14.9	10.0
November	0.0	4.7
December	0.0	1.7
January	0.0	1.7
February	0.0	1.4
March	0.0	1.6
April	8.5	7.4
May	10.7	12.9
June	14.2	14.4
July	17.8	15.8
August	18.1	15.0
September	15.8	13.4
TOTALS	100.0	100.0

Spillways for proposed dams in San Luis Obispo County were designed to pass the probable peak discharge from a flood having an estimated frequency of once in one thousand years occurring at a time when the reservoir would be full. Consideration was given to the effect of surcharge reservoir storage on reducing peak discharges over spillways at all reservoirs except Lower Jack and Santa Rita. Effective reductions in estimated peak flows were estimated to vary from 7 to 65 per cent, based on routing studies. For the Lower Jack and Santa Rita Reservoirs, the effect of surcharge storage was found to be negligible, and no reduction in peak flow was considered for spillway design purposes. In all cases, spillway designs are considered to be conservative.

The valuations of lands and improvements required for the construction of proposed dams and reservoirs were based upon data obtained from the San Luis Obispo and Monterey County Assessors. Estimates of the costs of necessary highway relocations were furnished by the Monterey County Flood Control and Water Conservation District, the San Luis Obispo County Road Commissioner and the State Division of Highways.

Presented following are brief discussions of the 11 dam and reservoir sites considered most favorable of development in San Luis Obispo County and vicinity. The results of investigation of these sites are depicted graphically on Plate 21, entitled "Relationship Between Storage Capacity of Reservoirs and Capital Costs"; Plate 22, entitled "Relationship Between Storage Capacity of Reservoirs and Net Safe Seasonal Yield"; and Plate 23, entitled "Relationship Between Net Safe Seasonal Yield of Reservoirs and Annual Unit Cost".

Lower Jack Dam and Reservoir. The Lower Jack dam site is located on the lower reach of Jack Creek in the Paso de Robles land grant, about six miles west of the twon of Templeton. The site has been variously called Lower Jacreek and Lower Jack Creek in the past. Consideration was given to construction of a dam and reservoir at the Lower Jack site for storage of surplus waters of Jack Creek, and utilization of the waters so conserved in the Upper Salinas Unit.

The Lower Jack dam site was mapped at a scale of one inch equals 100 feet, with a contour interval of five feet, and the reservoir area was mapped at a scale of one inch equals 400 feet, with a contour interval of 10 feet, by the U. S. Bureau of Reclamation in 1946. Reservoir areas and storage capacities, computed from the reservoir area map, are presented in Table 31.

TABLE 31

AREAS AND CAPACITIES OF
LOWER JACK RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	990	0	0
10	1,000	4	10
20	1,010	18	120
30	1,020	39	410
40	1,030	60	900
50	1,040	98	1,700
60	1,050	130	2,840
70	1,060	160	4,290
80	1,070	190	6,040
90	1,080	220	8,090
100	1,090	260	10,500
110	1,100	310	13,300
115	1,105	330	15,000
120	1,110	350	16,600
130	1,120	410	20,400
140	1,130	470	25,000
150	1,140	560	30,000
160	1,150	660	36,100
170	1,160	750	43,100
180	1,170	850	51,100

Based upon preliminary geologic reconnaissance, the Lower Jack dam site is considered suitable for either an earthfill or masonry type of dam. Geology of the site was investigated by the U. S. Bureau of Reclamation in 1947, and by the Division of Water Resources in 1953. No exploratory drilling or trenching of the foundation has been done at this site, nor of the borrow areas.

Bedrock at the dam site consists of massive, fairly well-bedded, Cretaceous sandstones, and some conglomerates. The beds strike nearly east-west across the southeast trending channel, and have a 40 to 50 degree dip downstream. About 200 feet upstream from the axis, a fault crosses the channel, bringing shales of the reservoir area in contact with the sandstones at the dam site. The sandstones are fractured and would probably require moderate grouting. There is considerable soil creep on the right abutment, and possibly some small slides.

In the channel section of the dam, it is estimated that a depth of two feet of gravel would have to be stripped, and the bedrock shaped under the impervious core. It is further estimated that about six feet of surface soil and six feet of weathered rock would have to be removed from the left and right abutments for the impervious section.

Yield studies were made for reservoir storage capacities of 15,000 and 25,000 acre-feet at the Lower Jack site and are summarized in Appendix K. The estimates of safe seasonal yield obtained from these studies are as follows:

Height of dam, in feet	Gross reservoir storage capacity, in acre-feet	Safe seasonal yield, in acre-feet	
		Gross	Net
135	15,000	5,600	3,400
160	25,000	6,800	4,600

Differences between gross and net yields presented in the foregoing tabulation represent releases required to maintain water levels in downstream ground water basins at elevations which would prevail without operation of the reservoir under present conditions of development. The relationship between reservoir storage capacity and net safe seasonal yield for Lower Jack reservoir is shown graphically on Plate 22.

After consideration of results of the yield studies, geologic reconnaissance, and topography of the site, detailed estimates of cost were prepared for an earthfill dam and reservoir of both the foregoing sizes, which estimates are presented in Appendix L. General features of both sizes of dam and reservoir are listed in Table 32.

Santa Rita Dam and Reservoir. The Santa Rita dam site is located on Santa Rita Creek about three miles upstream from its confluence with Paso Robles Creek in the Asuncion Land Grant. Consideration was given to construction of a dam and reservoir at the Santa Rita site for storage of floodwaters in Santa Rita Creek and utilization of water so conserved in the Upper Salinas Unit.

The Santa Rita dam site was mapped at a scale of one inch to 50 feet, with a contour interval of five feet, by the U. S. Bureau of Reclamation in 1946. Reservoir areas and storage capacities for various stages of water surface elevation were computed from U. S. Geological Survey quadrangles at a scale of 1:24,000, with a contour interval of 20 feet, and are shown in Table 33.

TABLE 33

AREAS AND CAPACITIES OF
SANTA RITA RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,005	0	0
5	1,010	1	2
15	1,020	4	30
25	1,030	10	100
35	1,040	19	240
45	1,050	34	510
55	1,060	51	930
65	1,070	66	1,520
75	1,080	82	2,260
85	1,090	120	3,270
95	1,100	150	4,620
105	1,110	190	6,320
115	1,120	220	8,370
124	1,129	260	10,500
125	1,130	270	10,800
135	1,140	320	13,800
138	1,143	340	14,800
145	1,150	390	17,300
155	1,160	460	21,600

A spillway saddle is located on the ridge northeast of the left abutment. The geology of the site was investigated by the U. S. Bureau of Reclamation in 1947 and by the Division of Water Resources in 1953. No exploratory drilling or trenching of the foundation has been done at this site, nor of the borrow areas. Based upon preliminary geologic reconnaissance, the Santa Rita dam site is considered suitable for an earthfill dam.

Bedrock at the dam site consists of sandstone, siltstone, and shale of Cretaceous age. Outcrops are found only in deep gullies and in roadcuts. All exposures exhibit fairly tight fractures and joints, and light to moderate grouting would be required. The rocks strike directly across the stream bed at the axis and dip 40 to 50 degrees upstream. About 100 yards downstream the beds dip downstream, suggesting the presence of major geologic structure in the area.

It is estimated that an average depth of 16 feet of sand, gravel, and weathered rock would have to be stripped in the channel section under the impervious section of the dam. An estimated six feet of soil and eight feet of weathered rock would have to be stripped from both abutments for the impervious section. Stripping depths to sound rock for the spillway would be the same as on the abutments.

Yield studies were made for reservoir storage capacities of 10,000 and 15,000 acre-feet at the Santa Rita site, results of which are summarized in Appendix K. The estimates of safe seasonal yield obtained from these studies are as follows:

Height of dam in feet	Gross reservoir storage capacity in acre-feet	Safe seasonal yield in acre-feet	
		Gross	Net
124	10,000	4,500	2,700
138	15,000	5,200	3,200

Differences between gross and net yields presented in the foregoing tabulation represent releases required to maintain water levels in downstream ground water basins at elevations which would prevail without operation of the reservoir under present conditions of development. The relationship between reservoir storage capacity and net safe seasonal yield for Santa Rita Reservoir is shown graphically on Plate 22.

After consideration of results of the yield studies, geologic reconnaissance, and topography of the site, detailed estimates of cost were prepared for an earthfill dam and reservoir of both the foregoing sizes, which estimates are presented in Appendix L. General features of both sizes of dam and reservoir are listed in Table 34.

TABLE 34

GENERAL FEATURES OF TWO SIZES OF DAM AND RESERVOIR AT THE SANTA RITA SITE ON SANTA RITA CREEK

Characteristics of Site

Drainage area--18.6 square miles

Estimated average seasonal runoff--9,800 acre-feet per year

Estimated average net seasonal depth of evaporation--2.34 feet

Estimated sedimentation--500 acre-feet

Elevation of stream bed, U.S.G.S. Datum--1,005 feet

	Gross reservoir storage capacity, in acre-feet	
	10,000	15,000
Earthfill Dam		
Crest elevation, in feet, U.S.G.S. datum	1,144	1,158
Crest length, in feet	447	520
Crest width, in feet	25	25
Height, spillway lip above stream bed, in feet	124	138
Side slopes, upstream and downstream	2.25:1	2.5:1
Freeboard, above spillway lip, in feet	15	15
Volume of fill, in cubic yards	422,600	666,430
Reservoir		
Surface area at spillway lip, in acres	264	341
Net storage capacity at spillway lip, in acre-feet	9,500	14,500
Type of spillway	Ogee weir with concrete chute	
Spillway discharge capacity, in second feet	20,000	20,000
Type of outlet	Pipe encased in concrete	Pipe encased in concrete
Estimated net safe seasonal yield, in acre-feet	2,700	3,200
Capital Costs		
Dam and reservoir	$1,107,000	$1,404,000
Per acre-foot of storage	111	94
Per acre-foot of net safe yield	410	439
Annual Costs		
Dam and reservoir	$56,800	$70,700
Per acre-foot of net safe yield	21.00	22.10
Per acre-foot of incremental net safe yield	----	27.80

For each height of dam, the earthfill structure would comprise an impervious core of select earth material, and upstream and downstream sections of free-draining material. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. It is estimated that sufficient material, both pervious and impervious, and riprap, could be obtained within one and one-half miles of the dam site in the reservoir area.

The spillway for either height of dam would cut through the saddle northeast of the left abutment discharging into a ravine downstream from the toe of the dam, and would have a discharge capacity of 20,000 second-feet. The spillway would be designed as a concrete-lined overpour chute with an ogee weir control section.

The outlet works for either height of dam would consist of a 36-inch diameter steel pipe encased in concrete, placed in a trench excavated to sound rock beneath the dam. Releases from the reservoir would be controlled at the upstream end of the outlet by means of hydraulically operated slide gates in an inclined intake structure on the slope of the right abutment upstream from the dam. Releases would be further regulated by a Howell-Bunger valve at the downstream end of the outlet.

It was estimated that either height of dam could be constructed within one year and that summer flow of Santa Rita Creek could be diverted through the outlet conduit.

For illustrative purposes, a plan, profile, and section of a dam, creating a reservoir with a storage capacity of 15,000 acre-feet at the Santa Rita site, are shown on Plate 17.

San Miguelito Dam and Reservoir. The San Miguelito dam site is located in Monterey County on the upper reaches of the Nacimiento River, about two miles upstream from the mouth of Gabilan Creek and about nine miles upstream from Jarrett Shut-In dam site. The reservoir area lies within Hunter-Liggett Military Reservation. Consideration was given to the construction of a dam and reservoir at the San Miguelito site for storage of floodwaters of Nacimiento River and utilization of water so conserved in the Upper Salinas Unit.

The San Miguelito dam site and two saddle dam sites were mapped at a scale of one inch equals 100 feet, with contour intervals of ten feet, by the Division of Water Resources in 1954. Reservoir areas and storage capacities for various stages of water surface elevation were computed from U. S. Geological Survey quadrangles at a scale of 1:24,000, with contour intervals of 20 feet, and are shown in Table 35.

TABLE 35

AREAS AND CAPACITIES OF
SAN MIGUELITO RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	1,110	0	0
10	1,120	2	6
20	1,130	6	50
30	1,140	13	140
40	1,150	30	360
50	1,160	55	780
60	1,170	90	1,510
70	1,180	180	2,860
80	1,190	340	5,460
90	1,200	540	9,860
100	1,210	820	16,700
110	1,220	1,150	26,500
120	1,230	1,570	40,100
126	1,236	1,800	50,200
130	1,240	1,980	57,900
140	1,250	2,400	79,800
150	1,260	2,800	106,000
158	1,268	3,060	129,400
160	1,270	3,120	136,000
170	1,280	3,440	168,000
180	1,290	3,770	204,000
190	1,300	4,210	244,000

TABLE 36

GENERAL FEATURES OF TWO SIZES OF DAM AND
RESERVOIR AT THE SAN MIGUELITO SITE ON NACIMIENTO RIVER

Characteristics of Site
Drainage area--68.4 square miles
Estimated average seasonal runoff--50,800 acre-feet
Estimated average net seasonal depth of evaporation--2.82 feet
Estimated sedimentation--1,000 acre-feet
Elevation of stream bed, U.S.G.S. datum--1,110 feet

	Gross reservoir storage capacity, in acre-feet	
	50,000	130,000
Earthfill Dam		
Crest elevation, in feet, U.S.G.S. datum	1,250	1,285
Crest length, in feet	480	630
Crest width, in feet	30	30
Height, spillway lip above stream bed, in feet	126	158
Side slopes, upstream and downstream	2.5:1	3:1
Freeboard, above spillway lip, in feet	14	17
Volume of fill, in cubic yards	638,200	1,300,000
Auxiliary Saddle Dams		
Number of dams	0	2
Aggregate crest length, in feet	---	2,740
Height, in feet	---	50
Crest width, in feet	---	30
Side slopes	---	2.5:1
Total volume of fill, in cubic yards	---	403,800
Reservoir		
Surface area at spillway lip, in acres	1,820	3,060
Net storage capacity at spillway lip, in acre-feet	49,000	129,000
Type of spillway	Ogee weir located in saddle	
Spillway discharge capacity, in second feet	49,000	38,600
Type of outlet	30-inch diameter steel pipe	36-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	6,000	13,000

GENERAL FEATURES OF TWO SIZES OF DAM AND
RESERVOIR AT THE SAN MIGUELITO SITE ON NACIMIENTO RIVER
(continued)

	Gross reservoir storage capacity, in acre-feet	
	50,000	130,000
Capital Costs		
Dam and reservoir	$1,734,000	$3,017,000
Per acre-foot of storage	35	23
Per acre-foot of net safe yield	289	232
Annual Costs		
Dam and reservoir	$ 88,700	$ 155,600
Per acre-foot of net safe yield	14.80	12.00
Per acre-foot of incremental net safe yield	---	9.60

The Jarrett Shut-In dam and saddle dam sites were mapped at a scale of one inch equals 100 feet, with contour interval of 10 feet, by the Division of Water Resources in 1954. Reservoir areas and storage capacities for various stages of water surface elevation were computed from U. S. Geological Survey quadrangles at a scale of 1:24,000, with contour interval of 20 feet, and are shown in Table 37.

TABLE 37

AREAS AND CAPACITIES OF
JARRETT SHUT-IN RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	900	0	0
10	910	3	20
20	920	10	80
30	930	28	270
40	940	54	680
50	950	79	1,350
60	960	110	2,290
70	970	140	3,540
80	980	190	5,190
90	990	250	7,390
100	1,000	320	10,200
110	1,010	380	13,700
120	1,020	430	17,800
130	1,030	510	22,500
140	1,040	580	27,900
144	1,044	610	30,000
150	1,050	660	34,100
160	1,060	760	41,200
170	1,070	880	49,400
180	1,080	1,040	59,000
190	1,090	1,270	70,600
193	1,093	1,350	75,000
200	1,100	1,570	84,800
210	1,110	1,850	102,000
214	1,114	1,960	110,000
220	1,120	2,130	122,000
230	1,130	2,610	145,500
240	1,140	3,090	174,000
250	1,150	3,620	207,500
260	1,160	4,170	246,500
270	1,170	4,720	291,000
280	1,180	5,270	341,000
290	1,190	5,940	397,000
300	1,200	6,730	460,000

Preliminary geologic reconnaissance by the Division of Water Resources in 1953 indicated that the Jarrett Shut-In dam site is suitable for either a gravity or arch type of dam. The maximum feasible height of dam is limited by a broad saddle occurring within the reservoir area approximately 1.5 miles northwest of the dam site. The abutment slopes at the dam site vary from nearly vertical to 1.25 to 1, with the average slope about 0.75 to 1. Shaping of the abutments would be required for construction of an earthfill dam.

The foundation rock at the dam site consists of a massively bedded, weather-resistant cobble conglomerate of Cretaceous age. The individual cobbles of the mass are invariably sheared and recemented. The rock is hard and well cemented, and the ground mass consists of medium to coarse-grained, poorly sorted sandstone. A few very blocky joints divide the bedrock mass. No major faults or shears were observed on the abutments, but there is evidence of possible major faulting passing through the gorge in the channel section. No exploratory drilling is known to have been done at the site, and a drilling program should be accomplished prior to any final consideration for construction of a dam.

Yield studies were made for reservoir storage capacities of 30,000 acre-feet, 75,000 acre-feet, and 110,000 acre-feet at the Jarrett Shut-In site, and are summarized in Appendix K. The estimates of safe seasonal yield obtained from these studies, with Jarrett Shut-In Reservoir operated as a secondary development coordinately with existing Nacimiento Reservoir, were as follows:

Height of main dam, in feet	Gross reservoir storage capacity, in acre-feet	Safe seasonal yield, in acre-feet	
		Gross	Net
163	30,000	7,700	6,000
213	75,000	13,500	10,500
233	110,000	17,600	13,800

Differences between gross and net yields presented in the foregoing tabulation represent releases required to maintain water levels in the downstream ground water basins at elevations which would prevail with reservoir operation. The relationship between reservoir storage capacity and net safe seasonal yield for Jarrett Shut-In Reservoir is shown graphically on Plate 22.

After consideration of results of the yield studies, geologic reconnaissance, and topography of the site, detailed estimates of cost were prepared for a main concrete arch dam, auxiliary earthfill saddle dams, and reservoir of each of the foregoing three sizes, which estimates are presented in Appendix L. General features of the three sizes of dam and reservoir are listed in Table 38.

TABLE 38

GENERAL FEATURES OF THREE SIZES OF DAM AND
RESERVOIR AT THE JARRETT SHUT-IN SITE ON NACIMIENTO RIVER

Characteristics of Site
Drainage area--130 square miles
Estimated average seasonal runoff--95,200 acre-feet
Estimated average net seasonal depth of evaporation--2.82 feet
Estimated sedimentation--2,000 acre-feet
Elevation of stream bed, U.S.G.S. datum--900 feet

	Gross reservoir storage capacity, in acre-feet		
	30,000	75,000	110,000
Arch Dam			
Crest elevation, in feet, U.S.G.S. datum	1,063	1,113	1,133
Crest length, in feet	402	467	522
Crest width, in feet	6	6.5	7
Height, spillway lip above stream bed, in feet	144	193	214
Freeboard, above spillway lip, in feet	19	20	19
Volume of concrete, in cubic yards	17,800	45,000	54,000
Auxiliary Saddle Dams			
Number of saddle dams	0	1	2
Aggregate crest length, in feet	---	1,910	2,350
Height, in feet	---	85	105
Crest width, in feet	---	20	20
Side slopes	---	2.5:1	2.5:1
Total volume of fill, in cubic yards	---	576,000	1,102,000
Reservoir			
Surface area at spillway lip, in acres	610	1,350	1,960
Net storage capacity at spillway lip, in acre-feet	28,000	73,000	108,000
Type of spillway	Ogee weir with concrete chute		
Spillway discharge capacity, in second feet	75,000	71,600	70,000
Type of outlet	36-inch diameter steel pipe	Two 30-inch diameter steel pipes	30- and 36-inch diameter steel pipes
Estimated net safe seasonal yield, in acre-feet	6,000	10,500	13,800

GENERAL FEATURES OF THREE SIZES OF DAM AND
RESERVOIR AT THE JARRETT SHUT-IN SITE ON NACIMIENTO RIVER
(continued)

	Gross reservoir storage capacity, in acre-feet		
	30,000	75,000	110,000
Capital Cost			
Dam and reservoir	$1,736,000	$3,743,000	$4,691,000
Per acre-foot of storage	58	50	43
Per acre-foot of net safe yield	289	356	340
Annual Cost			
Dam and reservoir	$ 86,800	$ 185,300	$ 232,700
Per acre-foot of net safe yield	14.50	17.60	16.90
Per acre-foot of incremental net safe yield	---	21.90	14.40

The main dam was designed as a concrete arch of the variable radius and variable angle type, in order to best fit the topography of the site. A dam more than 220 feet in height would probably require a thrust block at the left abutment. In view of the lack of data concerning foundation conditions, a depth of 15 feet normal to the surface was assumed for stripping at the main dam. Subsurface exploration by slant core drilling would be necessary to determine the nature and structure of the underlying bedrock with regard to its suitability as foundation for an arch dam, and to determine the depth of debris in the channel section.

For cost estimating purposes a unit cost of $20 per cubic yard for concrete in the arch dam was assumed, on the premise that local aggregates would be used with low alkali cement. Aggregates downstream along the Nacimiento River have been used by the State Division of Highways for concrete structures, and appear to meet their specifications in regard to sodium sulfate soundness and Los Angeles Rattler tests. Further testing of the aggregates for reactiveness and soundness would be necessary before their use in construction of an arch dam at this site. In the event local aggregates should prove to be not suitable for an arch dam, it might be more economical to construct an earthfill dam rather than import more expensive aggregates from a proven source. A preliminary estimate indicated that the cost of an earthfill dam creating a reservoir storage capacity of 75,000 acre-feet would be comparable to the cost of an arch dam at this site.

Auxiliary earthfill dams would be required in the saddle to the northwest of the main dam site for the 75,000 and 110,000 acre-foot capacity reservoirs. Although an auxiliary dam would not be required for the 30,000 acre-foot reservoir, small slab and buttress dams were designed to close the saddle on both sides of the spillway. In the design of the two auxiliary dams required for the 110,000 acre-foot reservoir, the earthfill would abut on either side of the reinforced-concrete spillway training walls. The upstream faces of the dams would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Under the impervious section of the auxiliary dams, an average depth of stripping of 10 feet was assumed.

The capacity of the reservoir is considered limited to 110,000 acre-feet at the Jarrett Shut-In site since (1) sufficient earthfill materials are not available within a reasonable haul distance for construction of large saddle dams, (2) thrust blocks would be necessary at the abutments to accommodate a higher arch dam, and (3) there is no saddle suitable for a spillway for a higher dam.

The spillway was designed as a concrete-lined overpour chute with an ogee weir control section placed through the saddle northwest of the main dam site and discharging into El Piojo Creek. No provision was made for overpour at the arch, due to the height of the dam and the character of the foundation rock.

The estimated construction time for heights of dam with reservoir storage capacities of 30,000 acre-feet, 75,000 acre-feet, and 110,000 acre-feet, would be one, two, and three years, respectively. Diversion of the stream during construction would be accomplished through the outlet works during summer months, and through a depressed section of the arch dam during winter months.

Outlet works in each instance would consist of a steel pipe placed through the main dam. Releases would be controlled by high-pressure slide gates located on the upstream face of the dam and protected by trash rack structures. The releases would be further controlled by Howell-Bunger valves located on the downstream face of the dam. If the releases from the reservoir were to be used for domestic purposes, an intake tower could be constructed on the upstream face of the dam.

As has been stated, the Jarrett Shut-In reservoir area is in the Los Padres National Forest and the Hunter Liggett Military Reservation. The only improvements which would probably require relocation are a few miles of military roads and telephone lines of temporary type of construction. It was assumed that the road over the ridge to State Highway No. 1 at San Simeon would not require relocation because it is not a through road for public travel. Considerable clearing of the reservoir lands would be required. A new all-weather road from the paved "Sam Jones" military road would have to be constructed for a distance of about 3.5 miles to furnish access to the dam sites.

For illustrative purposes, the plans, profiles, and sections for the arch dam and saddle dam creating a reservoir with storage capacity of 110,000 acre-feet at the Jarrett Shut-In site are shown on Plate 15.

Bald Top Dam and Reservoir. The Bald Top dam site is located on San Carpoforo (San Carpojo) Creek about six miles upstream from its mouth and about four miles upstream from the Upper Ragged Point site, in the southwest quarter of Section 36, Township 24 South, Range 6 East, M. D. B. & M. The San Luis Obispo-Monterey county line passes through the site. Consideration was given to construction of a dam and reservoir at the Bald Top site for storage of flood waters in San Carpoforo Creek and utilization of the waters so conserved in the Coastal Unit.

The Bald Top dam site and reservoir area are shown on a U. S. Geological Survey quadrangle at a scale of 1:24,000, with a contour interval of 20 feet. The quadrangle was enlarged photographically to a scale of one inch equals 500 feet for dam layout and cost estimating purposes. Reservoir areas and storage capacities for various stages of water surface elevation were computed from this map and are presented in Table 39.

TABLE 39

AREAS AND CAPACITIES OF
BALD TOP RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	670	0	0
10	680	2	10
20	690	8	60
30	700	19	200
40	710	29	440
50	720	42	790
60	730	58	1,290
70	740	76	1,960
80	750	99	2,840
90	760	120	3,930
100	770	140	5,230
110	780	150	6,680
120	790	170	8,280
130	800	180	10,000
140	810	200	11,900
150	820	210	14,000
160	830	230	16,200
170	840	240	18,500
175	845	250	19,700
180	850	260	21,000
190	860	270	23,700
200	870	290	26,500
210	880	300	29,400
220	890	320	32,500
230	900	330	35,800

Based upon preliminary geologic reconnaissance, the Bald Top dam site is considered suitable for an earthfill dam of moderate height. Geology of the site was investigated by the Division of Water Resources in 1954. No exploratory drilling or trenching of the foundation areas has been done at this site nor of the borrow areas.

Bedrock consists of siltstone, shale, and sandstone. Although rocks are poorly exposed at the site, they appear to dip upstream. Exposures show that the sediments have been highly fractured and both quartz and calcite veins were noted. Near the upstream toe of the dam, shales have formed small slides near the stream bed, but no large slides were found. The rocks would probably take moderate grouting.

Stripping under the impervious section of the dam on both abutments is estimated to be about three feet of soil and 10 feet of loose rock. In the channel section of the dam, it is estimated that an average of 20 feet of gravel and boulders and five feet of loose rock would have to be stripped under the impervious core. A nominal depth of stripping of two feet may be required under the random fill sections.

A yield study was made for a reservoir storage capacity of 20,000 acre-feet at the Bald Top site. Results of that study, which are presented in Appendix K, show that a dam 175 feet high, impounding 20,000 acre-feet of water, would produce both a gross and net safe seasonal yield of 10,400 acre-feet when operated as a primary development on San Carpoforo Creek. Gross and net yields were assumed to be equal since it is believed that storage of flood flows at the Bald Top site would have no appreciable effect on recharge of San Carpoforo Basin. Furthermore, it will be shown subsequently that soils comprising the irrigable lands overlying the San Carpoforo Basin will either be inundated or be required for construction of the Upper

Ragged Point Dam and Reservoir.

The relationship between reservoir storage capacity and net safe seasonal yield for Bald Top Reservoir is shown on Plate 22.

After consideration of results of yield studies, geologic reconnaissance, and availability of materials, a detailed estimate of cost was prepared for an earthfill dam and reservoir having a storage capacity of 20,000 acre-feet, which estimate is presented in Appendix L. General features of the dam and reservoir are presented in Table 40.

Character
Drainage
Estimated
Estimated
Estimated
Elevation

Earthfill
Crest ele
Crest len
Crest wid
Height, s
in feet
Side slop
Freeboard
Volume of

Reservoir
Surface a
Net stora
in acre
Type of s
Spillway
Type of o
Estimated
in acre

Capital C
Dam and r
Per acre-
Per acre-

Annual Cos
Dam and r
Per acre-

TABLE 40

GENERAL FEATURES OF A DAM AND
RESERVOIR AT THE BALD TOP SITE ON SAN CARPOFORO CREEK

Characteristics of Site

Drainage area--15.6 square miles
Estimated average seasonal runoff--18,500 acre-feet
Estimated average net seasonal depth of evaporation--1.54 feet
Estimated sedimentation--500 acre-feet
Elevation of stream bed, U.S.G.S. datum--670 feet

	Gross reservoir storage capacity, in acre-feet
	20,000
Earthfill Dam	
Crest elevation, in feet, U.S.G.S. datum	860
Crest length, in feet	960
Crest width, in feet	30
Height, spillway lip above stream bed, in feet	175
Side slopes, upstream and downstream	3:1
Freeboard, above spillway lip, in feet	15
Volume of fill, in cubic yards	1,528,900
Reservoir	
Surface area at spillway lip, in acres	250
Net storage capacity at spillway lip, in acre-feet	19,500
Type of spillway	Chute
Spillway discharge capacity, in second-feet	7,600
Type of outlet	30-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	10,400
Capital Costs	
Dam and reservoir	$2,249,000
Per acre-foot of storage	112
Per acre-foot of net safe yield	216
Annual Costs	
Dam and reservoir	$111,300
Per acre-foot of net safe yield	10.70

The earthfill structure would comprise an impervious core of select material, and upstream and downstream sections of random fill material. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Boulders in the stream bed and massive sandstones near the dam site may furnish sufficient material for this purpose. It was estimated that there are possibly 500,000 cubic yards of impervious material in the reservoir area. Random fill material could be obtained from the reservoir area and from salvage of excavated materials. Employment of semipervious random fill would necessitate installation of a gravel blanket and drains along the downstream face of the impervious section to carry away any water seeping through the impervious core.

The concrete-lined spillway would be located on the left abutment and was designed as the chute type with an ogee weir control section. The spillway would have a discharge capacity of 7,600 second-feet and would discharge into San Carpoforo Creek about 150 feet downstream from the toe of the dam.

The concrete intake structure for the outlet works would be located at the upstream toe of the dam near the right abutment with a steel trash rack at its entrance. A concrete pressure conduit beneath the dam would extend from the intake to a gate chamber located slightly upstream of the dam axis, wherein a high pressure slide gate would be installed. A reinforced-concrete pipe, founded on bedrock, would extend beneath the dam from the gate chamber to the valve house, and would contain an access passageway to the gate chamber as well as a steel outlet pipe. The outlet pipe would have a diameter of 30 inches.

It was estimated that the dam could be constructed within one year, and that summer flow of San Carpoforo Creek could be diverted through the outlet conduit during construction.

Construction of an access road would be required for a distance of about 5.1 miles. The only improvement in the reservoir area is a small summer cabin.

<u>Upper Ragged Point Dam and Reservoir</u>. The Upper Ragged Point dam site is located on San Carpoforo (San Carpojo) Creek, about 1.8 miles from its mouth, and on the line between Sections 14 and 15, Township 25 south, Range 6 east, M. D. B. & M. Stream bed elevation at the site is about 70 feet, U.S.G.S. datum. Consideration was given to construction of a dam and reservoir at the Upper Ragged Point site for storage of surplus waters of San Carpoforo Creek, and utilization of the waters so conserved in the Cambria and San Luis Obispo Subunits of the Coastal Unit.

The Upper Ragged Point dam site and reservoir area are shown on a U. S. Geological Survey quadrangle at a scale of 1:24,000, with a contour interval of 20 feet. Since the dam site has not been mapped, the quadrangle was enlarged photographically to a scale of one inch equals 500 feet for dam layout and cost estimating purposes. Reservoir areas and storage capacities for various stages of water surface elevation were computed from this map and are presented in Table 41.

TABLE 41

AREAS AND CAPACITIES OF
UPPER RAGGED POINT RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	70	0	0
10	80	8	30
20	90	28	210
30	100	50	600
40	110	62	1,160
50	120	70	1,820
60	130	78	2,560
70	140	86	3,380
80	150	94	4,280
90	160	100	5,250
100	170	110	6,300
110	180	120	7,450
120	190	135	8,720
130	200	150	10,200
140	210	160	11,700
150	220	170	13,400
160	230	175	15,100
170	240	180	16,800
180	250	195	18,700
190	260	210	20,800
200	270	220	22,900
210	280	230	25,200
220	290	240	27,500
230	300	255	30,000
240	310	270	32,600
250	320	280	35,400
260	330	290	38,200
270	340	305	41,200
280	350	320	44,300
290	360	330	47,600
300	370	345	50,900
310	380	360	54,400
320	390	380	58,200
330	400	400	62,000

Based upon preliminary geologic reconnaissance, the Upper Ragged Point dam site is considered suitable for an earthfill dam of moderate height. Geology of the site was investigated by the Division of Water Resources in 1955. No exploratory drilling or trenching of the foundation has been done at this site, nor of the borrow areas.

Bedrock at the site consists of well cemented sandstone and siltstone, sheared shale, and some metavolcanics. It is highly fractured and jointed, and heavy grouting would be required. The State Geologic Map shows a large fault about three-fourths mile southwest of the site. There is a small rubble slide on the left abutment and some talus near the base of the right abutment.

In the channel section of the dam, an average estimated depth of 25 feet of gravel and three feet of loose bedrock would have to be stripped under the impervious core. On the left and right abutments, an estimated two feet of soil and five feet of loose rock would have to be removed under the impervious section for the first 200 feet of dam height. Above 200 feet of dam height, about four feet of soil, and five feet of loose rock would have to be removed. Removal of the slide and talus material would also be necessary. For the pervious fill sections, a nominal depth of stripping of two feet may be required throughout the contact area.

A yield study was made for a reservoir storage capacity of 30,000 acre-feet at the Upper Ragged Point site. Results of that study are presented in Appendix K and show that a dam 230 feet high, impounding 30,000 acre-feet of water, would produce gross and net safe seasonal yields of 17,500 acre-feet when operated as a primary development on San Carpoforo Creek. The foregoing gross and net yields were assumed to be equal since all of the irrigable valley lands overlying the San Carpoforo Basin shown on Plate 11B would either be inundated by the reservoir or would be used as construction materials for Upper Ragged Point Dam.

A conjunctive operation study was also made for reservoirs at both the Bald Top and Upper Ragged Point sites. Results of the latter study show that a reservoir with 20,000 acre-feet of storage at the Bald Top site operated coordinately with a reservoir with 30,000 acre-feet of storage at the Upper Ragged Point site would produce a gross and net safe system yield of 22,500 acre-feet per season.

The relationship between storage capacity and net safe seasonal yield for Upper Ragged Point Reservoir and also for the combined Upper Ragged Point and Bald Top Reservoirs is shown on Plate 22.

After consideration of the results of yield studies, geologic reconnaissance, and topography of the site, preliminary estimates of cost were prepared for an earthfill dam and reservoir having a storage capacity of 30,000 acre-feet, which estimate is presented in Appendix L. General features of the dam and reservoir are presented in Table 42.

TABLE 42

GENERAL FEATURES OF A DAM AND RESERVOIR
AT THE UPPER RAGGED POINT SITE ON SAN CARPOFORO CREEK

Characteristics of Site

Drainage area--34.3 square miles
Estimated average seasonal runoff--36,600 acre-feet
Estimated average net seasonal depth of evaporation--1.54 feet
Estimated sedimentation--500 acre-feet
Elevation of stream bed, U.S.G.S. datum--70 feet

	Gross reservoir storage capacity, in acre-feet
	30,000
Earthfill Dam	
Crest elevation, in feet, U.S.G.S. datum	320
Crest length, in feet	1,010
Crest width, in feet	30
Height, spillway lip above stream bed, in feet	230
Side slopes, upstream and downstream	3:1
Freeboard, above spillway lip, in feet	20
Volume of fill, in cubic yards	4,006,500
Reservoir	
Surface area at spillway lip, in acres	255
Net storage capacity at spillway lip, in acre-feet	29,500
Type of spillway	Chute
Spillway discharge capacity, in second-feet	15,000
Type of outlet	42-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	17,500
Capital Costs	
Dam and reservoir	$5,420,000
Per acre-foot of storage	181
Per acre-foot of net safe yield	310
Annual Costs	
Dam and reservoir	$259,800
Per acre-foot of net safe yield	14.80

The earthfill structure would comprise an impervious core of select material, and upstream and downstream sections of pervious free draining material. Adequate quantities of fill material are not available in the proposed reservoir area. It is estimated that additional material suitable for use in the impervious section of the dam could be obtained from terraces to the southwest of the site within about 1.8 miles of haul distance. Additional pervious fill material could be obtained from the stream channel downstream from the dam site. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Riprap could be quarried from hard outcrops located about three miles upstream from the site.

The concrete-lined spillway would be located on the right abutment and was designed as the chute-type with an ogee-weir control section. The spillway would have a discharge capacity of 15,000 second-feet and would discharge into San Carpoforo Creek about 500 feet downstream from the toe of the dam. A pilot channel or other special treatment would be required at the approach to the spillway to prevent the flood discharge of a large ravine from eroding the upstream face of the dam.

The outlet works would have a concrete intake structure located at the upstream toe of the dam near the left abutment and a steel trash rack at its entrance. A concrete pressure conduit beneath the dam would extend from the intake to a gate chamber located slightly upstream of the axis of the dam, wherein a high pressure slide gate would be installed. A reinforced-concrete culvert, founded on bedrock, would extend beneath the dam from the gate chamber to the valve house. It would contain an access passageway to the gate chamber as well as a steel outlet pipe, 42 inches in diameter, supported on cradles.

It was estimated that the dam could be constructed in two years and diversion of the summer flows of San Carpoforo Creek during construction could be effected through the outlet conduit. Diversion of winter flows would be effected through a closure section. As the channel is rather narrow at the site, a large amount of fill would need to be placed the second year.

Included in the reservoir area are an abandoned ranch house and two barns. There is also an access road to an abandoned quicksilver mine which would be relocated.

Yellow Hill Dam and Reservoir. The Yellow Hill dam site is located on Arroyo de la Cruz about 1.5 miles upstream from its mouth in the Piedra Blanca Land Grant. A site suitable for a small dam and reservoir is located about 0.5 mile upstream and is called Upper Yellow Hill dam site. Consideration was given to the construction of dams and reservoirs at both of the two sites described for storage of flood waters of Arroyo de la Cruz and utilization of waters so conserved in the Cambria and San Luis Obispo Subunits of the Coastal Hydrologic Unit.

The Yellow Hill reservoir area was mapped in 1955 utilizing photogrammetric methods by the Division of Water Resources at a scale of one inch equals 500 feet with a 25-foot contour interval. Topography was carried up to a minimum elevation of 200 feet. Reservoir areas and storage capacities computed from this map for the Upper Yellow Hill and Yellow Hill sites are presented in Tables 43 and 44, respectively. The dam sites were mapped photogrammetrically at a scale of one inch equals 500 feet with a contour interval of 20 feet to an elevation of 300 feet.

TABLE 43

AREAS AND CAPACITIES OF
YELLOW HILL RESERVOIR

Upper Site

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	40	0	0
10	50	51	170
20	60	88	860
30	70	130	1,960
40	80	170	3,450
50	90	220	5,400
60	100	280	7,900
70	110	320	10,900
80	120	360	14,300
90	130	400	18,100
95	135	410	20,100
100	140	420	22,200
110	150	450	26,600

TABLE 44

AREAS AND CAPACITIES OF
YELLOW HILL RESERVOIR

Lower Site

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	30	0	0
10	40	49	160
20	50	97	890
30	60	140	2,080
40	70	180	3,680
50	80	230	5,730
60	90	280	8,280
70	100	340	11,400
80	110	400	15,100
90	120	440	19,300
100	130	480	23,900
110	140	510	28,800
120	150	540	34,100
130	160	570	39,600
140	170	600	45,500
147	177	620	49,800
150	180	640	51,700
160	190	680	58,300
170	200	710	65,200
180	210	750	72,500
190	220	790	80,200
200	230	830	88,300
210	240	870	96,800
220	250	910	105,700

A geologic investigation of the Yellow Hill dam site was made in 1954 by the geologists of the Division of Water Resources. No prior geologic work at this site is known, nor have the foundation and borrow areas been explored by drilling. The site appears to be suitable for a moderately high earthfill dam.

Bedrock consists of altered volcanic rock which weathers to a red soil. The volcanics have been locally serpentinized and very highly fractured. A large fault zone crosses the stream bed about 600 feet above the axis of the dam and dips about 60 degrees toward the ocean. Although the impervious section of the dam would not reach this fault zone, suitable design precautions would be necessary to insure the stability of the dam. The bedrock at the site would probably require moderate to heavy grouting.

Stripping on both abutments under the impervious section of an earthfill dam at this site was estimated to average about five feet of soil and 20 feet of loose rock. In the channel section an estimated average depth of about 40 feet, with a possible maximum of 60 feet, of gravel would have to be stripped under the impervious core of a dam.

Yield studies were made for reservoir storage capacities of 20,000, 50,000, and 80,000 acre-feet at the Yellow Hill sites. Detailed results of these studies are presented in Appendix K. Estimates of safe seasonal yield obtained from the studies are as follows:

Height of dam, in feet	Gross reservoir storage capacity, in acre-feet	Safe seasonal yield, in acre-feet	
		Gross	Net
95	20,000	13,500	13,100
147	50,000	23,300	22,900
190	80,000	27,700	27,300

The difference of 400 acre-feet between gross and net yields presented in the foregoing tabulation represents the probable ultimate mean seasonal water requirement of lands overlying Arroyo de la Cruz Basin which would not be affected by the construction of the dam and reservoir. The relationship between reservoir storage capacity and net safe seasonal yield for Yellow Hill reservoir is shown graphically on Plate 22.

As a result of the geological investigation and the reservoir yield studies, estimates of cost were prepared for dams at the Yellow Hill site with heights of 147 and 190 feet from stream bed to spillway lip, creating reservoir capacities of 50,000 and 80,000 acre-feet, respectively. An estimate of cost was also prepared for a dam at the Upper Yellow Hill site with a height of 95 feet from stream bed to spillway lip and creating a reservoir storage capacity of 20,000 acre-feet. Detailed estimates of cost for the three foregoing reservoir capacities are presented in Appendix L, and general features of the three dams and reservoirs are listed in Table 45.

TABLE 45

GENERAL FEATURES OF THREE SIZES OF DAM AND
RESERVOIR AT THE YELLOW HILL SITE ON ARROYO DE LA CRUZ

Characteristics of Site
Drainage area--41.4 square miles
Estimated average seasonal runoff--44,800 acre-feet
Estimated average net seasonal depth of evaporation--1.54 feet
Estimated sedimentation--1,000 acre-feet
Elevation of stream bed, U.S.G.S. datum--40 and 30 feet

	Gross reservoir storage capacity, in acre-feet		
	20,000	50,000	80,000
Earthfill Dam			
Crest elevation, in feet, U.S.G.S. datum	150	192	234
Crest length, in feet	980	1,030	1,130
Crest width, in feet	30	30	30
Height, spillway lip above stream bed, in feet	95	147	190
Side slopes, upstream and downstream	2.5:1	2.5:1	3:1
Freeboard, above spillway lip, in feet	15	15	14
Volume of fill, in cubic yards	869,900	2,142,500	4,228,100
Reservoir			
Surface area at spillway lip, in acres	410	620	790
Net storage capacity at spillway lip, in acre-feet	19,000	49,000	79,000
Type of spillway	Ogee weir with concrete-lined chute		
Spillway discharge capacity, in second-feet	16,200	13,900	11,900
Type of outlet	30-inch diameter steel pipe	48-inch diameter steel pipe	60-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	13,100	22,900	27,300
Capital Costs			
Dam and reservoir	$1,420,000	$3,599,000	$6,401,000
Per acre-foot of storage	71	72	80
Per acre-foot of net safe yield	108	157	234
Annual Costs			
Dam and reservoir	$71,500	$176,100	$310,200
Per acre-foot of net safe yield	5.50	7.70	11.40
Per acre-foot of incremental net safe yield	---	10.70	30.50

For all heights of dam, earthfill structures were contemplated comprising an impervious core of select earth material with upstream and downstream sections of random semipervious material. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Employment of semipervious random fill in the outer sections would necessitate the installation of gravel blankets and drains along the downstream face of the impervious core as a precautionary measure to carry away possible leakage that might occur through the impervious section and at the abutments.

It was assumed that 75 per cent of the material excavated from channel and abutments could be used in the random fill section of the dam. Stream gravels and bedrock could also be used as random fill. Rock for riprap could be obtained from a quarry about six miles upstream. Impervious material does not appear to be available in adequate quantities in the alluvium of the reservoir area. The alluvial flats downstream from the proposed dam contain only a foot or two of soil and this would probably not be workable. The weathered volcanic rock may furnish adequate impervious material but testing would be required to determine its suitability. For cost estimating purposes, it was assumed that additional impervious material would be obtained from terrace deposits along the edge of the ocean westerly, and to the north and south of the site along State Highway No. 1. At present these terraces are used mostly for grazing and a cost for acquisition of this land for borrow material was taken into account in cost estimates. However, it should be noted that if development occurs along this coastal area, the value of the land may be substantially increased.

The spillway was designed as a concrete-lined chute with ogee weir control sections. The spillway would be excavated through the right abutment and discharge into a small ravine discharging into Arroyo de la Cruz just downstream from the dam. Riprap protection was provided on the downstream toe of the dam near where the ravine discharges into Arroyo de la Cruz. At the site for the smaller dam upstream, a spillway could be excavated through a ridge on the left abutment, and a small saddle dam would be required to the left of this spillway. The spillway for the 80,000 acre-foot reservoir would have a discharge capacity of 11,900 second-feet.

The outlet works would be located on the left abutment. The intake structure would consist of a short concrete tower with a steel trash rack at its entrance. A concrete pressure conduit would be installed beneath the dam and would extend from the intake to a gate chamber located slightly upstream from the axis of the dam, wherein a high pressure slide gate would be installed. A reinforced-concrete culvert, founded on bedrock, would extend beneath the dam from the gate chamber to a valve house located at the downstream toe of the dam. This culvert would house an access passageway to the gate chamber as well as a steel outlet pipe supported on cradles. This pipe would have a diameter of 60 inches. Releases would be regulated by a Howell-Bunger and a needle valve.

It was estimated that the dam for the largest size of reservoir could be constructed in two years, and summer flow of Arroyo de la Cruz could be diverted through the outlet conduit. This dam could be so constructed as to allow a closure section of the earthfill embankment to accommodate winter flows during the first winter.

There are no county roads in the reservoir area. Improvements include a few irrigation wells and an abandoned ranch.

For illustrative purposes, the plan, profile, and section for the dam creating a reservoir with storage capacity of 80,000 acre-feet at the

Yellow Hill site are shown on Plate 18.

San Simeon Dam and Reservoir. The San Simeon dam site is located in the San Simeon Land Grant on San Simeon Creek about two miles upstream from its mouth. Consideration was given to the construction of a dam and reservoir at the San Simeon site for storage of floodwaters in San Simeon Creek and utilization of waters so conserved in the Cambria and San Luis Obispo Subunits of the Coastal Unit.

The San Simeon dam site and reservoir area was mapped at a scale of one inch equals 500 feet with a contour interval of 25 feet by the Division of Water Resources in 1955 using photogrammetric methods. Reservoir areas and storage capacities for various water surface elevations computed from this reservoir map are presented in Table 46.

TABLE 46

AREAS AND CAPACITIES OF
SAN SIMEON RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	55	0	0
5	60	20	33
15	70	61	440
25	80	110	1,290
35	90	150	2,590
45	100	190	4,290
55	110	230	6,390
65	120	270	8,890
75	130	300	11,700
85	140	340	14,900
95	150	380	18,500
105	160	430	22,600
115	170	480	27,100
125	180	530	32,200
135	190	580	37,700
145	200	630	43,800
155	210	670	50,300
165	220	720	57,200
169	224	740	60,100
175	230	770	64,700
185	240	830	72,700
195	250	890	81,300

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A geologic investigation of the San Simeon dam site was made in 1955 by geologists of the Division of Water Resources. No prior geologic work at the site is known, nor has exploratory drilling of the foundation or borrow areas been done. Available information indicates that the site is suitable for construction of an earthfill dam up to a maximum height of about 200 feet.

Rocks at the site consist of well consolidated sandstone, shale, and some chert and metamorphosed volcanics, all of which are a portion of the Franciscan series. Outcrops in the vicinity are scattered and indicate complex geologic structure which is typical of the Franciscan series. All outcrops show jointing, and shears are abundant in the softer rocks. The rocks should take moderate to heavy grouting.

In the channel section, an estimated average depth of about 40 feet of gravel and three feet of loose rock would be stripped under the impervious core of the dam. Stripping on the left abutment is estimated to be about three feet of soil and ten feet of loose rock. Stripping on the right abutment is estimated to be an average of 15 feet of loose rock with only about five feet necessary on the steep slope. For the pervious section, a nominal depth of stripping of two feet was assumed throughout the contact area.

A yield study was made for a reservoir storage capacity of 60,000 acre-feet at the San Simeon site. Results of that study, which are presented in Appendix K, show that a dam 175 feet high, impounding 60,000 acre-feet of water, would produce gross and net safe seasonal yields of 18,500 and 18,200 acre-feet, respectively. The 300 acre-foot difference between the gross and net yield of the reservoir represents the probable ultimate mean seasonal water requirement of lands overlying San Simeon Basin not affected by construction of San Simeon Dam and Reservoir. The relationship between reservoir storage capacity and net safe seasonal yield for San Simeon

Reservoir is shown on Plate 22.

After consideration of results of yield studies and geologic reconnaissance, a detailed estimate of cost was prepared for an earthfill dam and reservoir having a storage capacity of 60,000 acre-feet, which estimate is presented in Appendix L. General features of the dam and reservoir are given in Table 47.

TABLE 47

GENERAL FEATURES OF A DAM AND RESERVOIR AT THE SAN SIMEON SITE ON SAN SIMEON CREEK

Characteristics of Site

Drainage area--24.8 square miles
Estimated average seasonal runoff--24,400 acre-feet
Estimated average net seasonal depth of evaporation--1.53 feet
Estimated sedimentation--500 acre-feet
Elevation of stream bed, U.S.G.S. datum--55 feet

	Gross reservoir storage capacity, in acre-feet 60,000
Earthfill Dam	
Crest elevation, in feet, U.S.G.S. datum	237
Crest length, in feet	2,230
Crest width, in feet	30
Height, spillway lip above stream bed, in feet	169
Side slopes, upstream and downstream	2.5:1 & 3:1
Freeboard, above spillway lip, in feet	13
Volume of fill, in cubic yards	4,211,700
Reservoir	
Surface area at spillway lip, in acres	740
Net storage capacity at spillway lip, in acre-feet	59,500
Type of spillway	Chute
Spillway discharge capacity, in second-feet	6,900
Type of outlet	48-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	18,200
Capital Costs	
Dam and reservoir	$6,314,000
Per acre-foot of storage	105
Per acre-foot of net safe yield	347
Annual Costs	
Dam and reservoir	$ 304,200
Per acre-foot of net safe yield	16.70

Only one capacity of reservoir was studied for this site due to the fact that several sizes of dams and reservoirs were studied for the so-called Palmer Flats site about 0.8 mile upstream. These studies were abandoned due to the discovery of a large slide on the right abutment of the Palmer Flats site. However, the studies established that smaller sizes of reservoirs on San Simeon Creek would give lower unit costs of reservoir yield, but that a development of about 60,000 acre-foot capacity would supply water at costs which are believed to be within the upper limit of economic feasibility in the area.

An earthfill structure was contemplated at the San Simeon site, comprising an impervious core of select earth material with upstream and downstream sections of semipervious random fill material. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Adequate impervious material is available within a mile of the site. Alluvial gravels appear to be abundant in the channel and reservoir area for semipervious random fill. Material stripped from the foundation of the dam should be suitable for use as random fill. Riprap would be selectively quarried from the volcanic rocks outcropping near the site. Employment of semipervious random fill in the outer sections would necessitate the installation of gravel blankets and drains at the downstream face of the impervious section as a precautionary measure to carry away possible leakage that might occur through the impervious section and at the abutments.

The spillway would have a discharge capacity of 6,900 second-feet, and was designed as a concrete-lined chute with an ogee weir control section. The spillway would be excavated through the left abutment around the end of the dam.

The outlet works would be located on the left abutment. The intake structure would be a short concrete tower with a steel trash rack at its entrance. A concrete pressure conduit would be installed beneath the dam and would extend from the intake to a gate chamber located slightly upstream from the axis of the dam. Within the gate chamber, an emergency high pressure slide gate would be installed. A reinforced concrete culvert, founded on bedrock, would extend from the gate chamber to the valve house at the downstream toe of the dam and would house an access passageway to the gate chamber as well as a 48-inch steel outlet pipe supported on cradles. Releases would be regulated by a Howell-Bunger valve and a needle valve located at the downstream end of the outlet pipe.

It was estimated that the dam would require an estimated two years for construction, and, therefore, it was assumed that a closure section of the earthfill embankment to accommodate diversion of the stream during construction would be kept open the first year.

Construction of a dam at the San Simeon site would require the relocation of about 4.5 miles of county road. Several ranches and power and telephone lines are included in the reservoir area.

Santa Rosa Dam and Reservoir. The Santa Rosa dam site is located on Santa Rosa Creek about seven miles upstream from its mouth and in the south half of Section 16, Township 27 south, Range 9 east, M. D. B. & M. Consideration was given to the construction of a dam and a reservoir at the Santa Rosa site for storage of flood waters in Santa Rosa Creek and utilization of water so conserved in the Cambria and San Luis Obispo Subunits of the Coastal Hydrologic Unit.

A topographic map of the Santa Rosa dam site at a scale of one inch equals 100 feet, with 10-foot contour intervals, was prepared in the field by the Division of Water Resources in 1955. Reservoir areas and storage capacities for various heights of dams were computed from U. S. Geological Survey quadrangles at scales of 1:24,000 and 1:62,500, with contour intervals of 20 feet and 50 feet, respectively, and are presented in Table 48.

TABLE 48

AREAS AND CAPACITIES OF
SANTA ROSA RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	240	0	0
10	250	1	3
20	260	20	110
30	270	36	390
40	280	55	840
50	290	71	1,470
60	300	86	2,250
70	310	110	3,230
80	320	130	4,430
90	330	150	5,830
100	340	160	7,380
110	350	190	9,130
120	360	210	11,100
130	370	230	13,300
138	378	240	15,200
140	380	250	15,700
150	390	270	18,300
160	400	300	21,200
170	410	330	24,300
172	412	340	25,000
180	420	370	27,800
190	430	400	31,700
198	438	420	35,000
200	440	430	35,800
210	450	460	40,300
220	460	490	45,000
230	470	520	50,100
240	480	550	55,400
250	490	580	61,100
260	500	620	67,100

Based upon preliminary geologic reconnaissance, the Santa Rosa dam site is considered suitable for an earthfill or concrete dam. A geologic investigation of the Santa Rosa dam site was made in 1954 by geologists of the Division of Water Resources. No prior geologic work at the site is known, nor have the foundation or borrow areas been explored by drilling.

Bedrock at the site consists of slightly altered basaltic rock and some agglomerate, both of the Franciscan series. The structure is unknown, but the volcanic rock underlies the ridge of the left abutment and extends well into the hill of the right abutment. The rocks are very highly fractured and faulted, and slickenside surfaces are found throughout the outcrops. Along some of the fractures the rock has a cherty appearance, and along other fractures resembles serpentine. Quartz veins up to two inches wide were noted as well as a few calcite stringers. In many places, the rock has been highly brecciated. No open fractures were noted, and very little grout should be required unless open fractures are encountered at depth. In spite of the high degree of fracturing, the rock appears to be quite strong and should be adequate for an earthfill or concrete dam. The left abutment consists of a long narrow ridge which may pass an excessive amount of seepage and may, therefore, require blanketing with impervious material.

In the channel section, it is estimated that a depth of about 20 feet of fractured rock would have to be stripped under the impervious section of an earthfill dam. Stripping on the right abutment beneath the impervious section would probably include five feet of soil and about 15 feet of loose and overhanging rock. On the left abutments, stripping is estimated to consist of one foot of soil and eight feet of loose rock. For the random fill sections of the dam, a nominal depth of stripping of two feet may be required throughout the contact area.

Yield studies were made for reservoir storage capacities of 15,000, 25,000, and 35,000 acre-feet at the Santa Rosa site and are summarized in Appendix K. The estimates of safe seasonal yield obtained from these studies were as follows:

Height of dam, in feet	Gross reservoir storage capacity, in acre-feet	Safe seasonal yield, in acre-feet	
		Gross	Net
138	15,000	7,900	7,300
172	25,000	7,800	9,200
198	35,000	11,700	11,100

The 600 acre-foot difference between the gross and net reservoir yields presented in the foregoing tabulation, represents the probable ultimate mean seasonal water requirement of lands overlying Santa Rosa Basin not affected by construction of Santa Rosa Dam and Reservoir. The relationship between reservoir storage capacity and net safe seasonal yield for Santa Rosa Reservoir is shown graphically on Plate 22.

After consideration of the results of yield studies, geologic reconnaissance,and topography of the site, detailed estimates of cost were prepared for an earthfill dam and reservoir of each of the foregoing three sizes, which estimates are presented in Appendix L. General features of the three sizes of dam and reservoir are listed in Table 49.

TABLE 49

GENERAL FEATURES OF THREE SIZES OF DAM AND RESERVOIR AT THE SANTA ROSA SITE ON SANTA ROSA CREEK

Characteristics of Site
Drainage area--14.9 square miles
Estimated average seasonal runoff--16,200 acre-feet
Estimated average net seasonal depth of evaporation--1.83 feet
Estimated sedimentation--500 acre-feet
Elevation of stream bed, U.S.G.S. datum--240 feet

	Gross reservoir storage capacity, in acre-feet		
	15,000	25,000	35,000
Earthfill Dam			
Crest elevation, in feet, U.S.G.S. datum	393	425	450
Crest length, in feet	570	800	965
Crest width, in feet	30	30	30
Height, spillway lip above stream bed, in feet	138	172	198
Side slopes, upstream and downstream	2.5:1	3:1	3:1
Freeboard, above spillway lip, in feet	15	13	12
Volume of fill, in cubic yards	658,800	1,378,100	2,081,400
Reservoir			
Surface area at spillway lip, in acres	250	340	430
Net storage capacity at spillway lip, in acre-feet	14,500	24,500	34,500
Type of spillway	Side channel with concrete-lined chute		
Spillway discharge capacity, in second-feet	7,400	6,900	3,800
Type of outlet	30-inch diameter steel pipe	36-inch diameter steel pipe	42-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	7,300	9,200	11,100
Capital Costs			
Dam and reservoir	$2,068,000	$3,080,000	$4,121,000
Per acre-foot of storage	138	123	118
Per acre-foot of net safe yield	283	335	371
Annual Costs			
Dam and reservoir	$101,900	$149,200	$198,800
Per acre-foot of net safe yield	14.00	16.20	17.90
Per acre-foot of incremental net safe yield	----	24.90	26.10

For all heights of dams an earthfill structure was contemplated, comprising an impervious core of select earth material with upstream and downstream sections of semipervious random fill material.

Employment of semipervious random fill in the outer sections would necessitate the installation of a gravel blanket and drains as a precautionary measure to carry away possible leakage that might occur through the impervious section and at the abutments. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope.

Areas of impervious material occurring in the reservoir area are not large. There may be about 200,000 cubic yards of impervious material on the valley floor, on terraces, and on hillsides in the reservoir area within two miles of the dam site. Additional impervious fill could be obtained from the flats downstream from the site. Part of this land would necessarily have to be acquired because it may be adversely affected by spillway discharge. Bedrock and possibly stream deposits are available for random fill locally. Satisfactory riprap was not noted in the immediate vicinity of the site, but suitable rock could be selectively quarried from the volcanic rock outcrops in the reservoir area.

The spillway was designed as a concrete-lined chute with ogee weir control sections and would have a discharge capacity of about 3,800 second-feet. The spillway would be excavated through a saddle on the left abutment and discharge into Santa Rosa Creek about 1,000 feet downstream from the toe of the dam.

The intake structure for the outlet works would be located on the left abutment. This structure would be a short concrete tower with a steel trash rack at its entrance. A concrete pressure conduit would be installed beneath the dam and would extend from the intake to a gate chamber located slightly upstream from the axis of the dam. Within the gate chamber, an emergency high pressure slide gate would be installed. A reinforced concrete culvert would extend from the gate chamber to the valve house at the downstream toe of the dam. This culvert would house an access passageway to the gate chamber as well as a steel outlet pipe supported on cradles. The outlet pipe would have a diameter of 42 inches, and releases would be regulated by a combination of a Howell-Bunger and needle valve.

It was estimated that the dam could be constructed within one year and summer flow of Santa Rosa Creek could be diverted through the outlet conduit. However, the total construction time was estimated to be two years due to the required relocation of about 3.7 miles of State Highway 41. The first year of construction could be devoted to relocation of the state highway and spillway construction.

Five fairly large ranches are located in the reservoir area and another lies just downstream from the dam and spillway sites. Several local power and telephone lines are also located in the reservoir area. Estimated costs of acquisition of lands required for the reservoir do not include a cost for the mineral rights at Oceanic Mine which would be inundated by the reservoir because the mine appeared to be abandoned.

Whale Rock Dam and Reservoir. The Whale Rock dam site is located on Old Creek in the Morro y Cayucos land grant, approximately 1.1 miles upstream from the mouth of the stream and about one-half mile east of Cayucos. Consideration was given to construction of a dam and reservoir at the Whale Rock site for storage of surplus waters of Old Creek, and utilization of the waters so conserved in the Cambria and San Luis Obispo Subunits of the Coastal Hydrologic Unit.

The Whale Rock reservoir area was mapped by photogrammetric methods at a scale of one inch equals 500 feet, with a contour interval of 25 feet, by the Division of Water Resources in 1955. The dam site was mapped from similar data at a similar scale but with contour interval of 20 feet. Reservoir areas and storage capacities computed from the reservoir map are presented in Table 50.

TABLE 50

AREAS AND CAPACITIES OF
WHALE ROCK RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	40	0	0
10	50	1	3
20	60	10	58
30	70	20	210
40	80	50	560
50	90	90	1,260
60	100	130	2,360
70	110	180	3,910
80	120	220	5,910
90	130	260	8,310
100	140	310	11,200
110	150	360	14,500
120	160	400	18,300
124	164	420	20,000
130	170	450	22,600
140	180	500	27,300
150	190	550	32,500
160	200	600	38,200
163	203	610	40,000
170	210	650	44,400
180	220	690	51,100
190	230	750	58,300
200	240	810	66,100
210	250	900	74,600

Based upon preliminary geologic reconnaissance, the Whale Rock dam site is considered suitable for an earthfill dam of moderate height. Geology of the site was investigated by the Division of Water Resources in 1954. No exploratory drilling or trenching of the foundation has been done at this site. Results of tests conducted on a single sample of the borrow material indicate the borrow material has relatively low shear strength and density. Further detailed exploration and testing of the foundation and borrow areas would be required in order to adequately determine necessary design precautions.

Bedrock at the site consists of slightly metamorphose basaltic rock of the Franciscan series. Serpentine is exposed on the right abutment about 200 feet above the stream bed and near the downstream toe of the proposed dam. The serpentine-basalt contact dips about 30 degrees downstream. However, the main portion of either of the two heights of dam considered would abut the basaltic rock. If higher dams were to be considered, excess leakage may occur at the contact. The basalt is soft, highly weathered, and appears to be highly fractured. The fractures seem tight, however, and it is likely that only moderate grouting will be required, except at larger fracture zones and in the serpentine.

In the channel section of the dam, it was estimated that a depth of 30 feet of gravel and three feet of loose bedrock would have to be stripped under the impervious core. On the left and right abutments, it was further estimated that about three feet of soil and seven feet of loose rock would have to be removed for the impervious section. For the random fill sections, a nominal depth of stripping of two feet may be required throughout the contact area.

Yield studies were made for reservoir storage capacities of 20,000 and 40,000 acre-feet at the Whale Rock site and are summarized in Appendix K.

The estimates of safe seasonal yield obtained from these studies were as follows:

Height of dam, in feet	Gross reservoir storage capacity, in acre-feet	Safe seasonal yield, in acre-feet	
		Gross	Net
124	20,000	6,600	6,300
163	40,000	9,200	8,900

The difference between gross and net yields presented in the foregoing tabulation, in the amount of 300 acre-feet, represents the sum of estimated present exports from lower Old Basin and probable ultimate mean seasonal water requirements of lands overlying Old Basin which would not be affected by construction of Whale Rock Dam and Reservoir. The relationship between reservoir storage capacity and net safe seasonal yield for Whale Rock Reservoir is shown graphically on Plate 22.

After consideration of results of the yield studies, preliminary geologic reconnaissance, and topography of the site, detailed estimates of cost were prepared for earthfill dams and reservoirs having storage capacities of 20,000 and 40,000 acre-feet, which estimates are presented in Appendix L. General features of the two sizes of dam and reservoir are listed in Table 51.

TABLE 51

GENERAL FEATURES OF TWO SIZES OF DAM AND RESERVOIR AT THE WHALE ROCK SITE ON OLD CREEK

Characteristics of Site

Drainage area--20.3 square miles
Estimated average seasonal runoff--13,320 acre-feet
Estimated average net seasonal depth of evaporation--2.96 feet
Estimated sedimentation--500 acre-feet
Elevation of stream bed, U.S.G.S. datum--40 feet

	Gross reservoir storage capacity, in acre-feet	
	20,000	40,000
Earthfill Dam		
Crest elevation, in feet, U.S.G.S. datum	177	215
Crest length, in feet	575	720
Crest width, in feet	30	30
Height, spillway lip above stream bed, in feet	124	163
Side slopes, upstream and downstream	2.5:1	2.5:1
Freeboard, above spillway lip, in feet	13	12
Volume of fill, in cubic yards	630,300	1,313,200
Reservoir		
Surface area at spillway lip, in acres	420	620
Net storage capacity at spillway lip, in acre-feet	19,500	39,500
Type of spillway	Side channel with concrete-lined chute	
Spillway discharge capacity, in second-feet	8,600	7,100
Type of outlet	30-inch diameter steel pipe	42-inch diameter steel pipe
Estimated net safe seasonal yield, in acre-feet	6,300	8,900
Capital Costs		
Dam and reservoir	$1,943,000	$2,884,000
Per acre-foot of storage	97	72
Per acre-foot of net safe yield	308	324
Annual Costs		
Dam and reservoir	96,000	141,600
Per acre-foot of net safe yield	15.20	15.90
Per acre-foot of incremental net safe yield	----	17.50

The 40,000 acre-foot reservoir would require an earthfill dam comprising an impervious core of select earth material, and upstream and downstream sections of semipervious random fill material. Based on preliminary reconnaissance, it is estimated that ample earthfill material, suitable for the impervious section of the dam, occurs within two miles upstream of the site. Random fill material could probably be obtained from the reservoir area and salvage of excavated materials. Employment of semipervious random fill in the outer sections would necessitate installation of a gravel blanket and drains along the downstream face of the impervious section to carry away any water seeping through the impervious core. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope. Riprap rock could be imported from a source outside the reservoir area or salvaged from the spillway excavation.

The concrete-lined spillway for the dam would be located on the left abutment and was designed as a chute type with a side-channel control section. The spillway would have a discharge capacity of 7,100 second-feet and would discharge into Old Creek about 150 feet downstream from the toe of the dam.

The alternative spillway location was considered through a saddle located about one mile east of the dam site and which would spill into Willow Creek. Although the spillway structure at this location would be cheaper than on the left abutment, the costs of acquiring necessary rights of way and replacement of existing bridges along Willow Creek were estimated on a preliminary basis to be greater than the savings in cost of the structure. However, the possibility of utilizing this saddle should be explored further if design of a dam is undertaken at this site.

The outlet works for the dam would have a concrete intake structure at the upstream toe near the right abutment, with a steel trash rack at its entrance. A concrete pressure conduit beneath the dam would extend from the intake to a gate chamber located slightly upstream from the axis of the dam, wherein a high pressure slide gate would be installed. A reinforced-concrete culvert, founded on bedrock, would extend beneath the dam from the gate chamber to the valve house, and would contain an access passageway to the gate chamber as well as a steel outlet pipe supported on cradles. The outlet pipe would have a diameter of 42 inches. It was estimated that the dam could be constructed within one year, and that summer flow of Old Creek could be diverted through the outlet conduit during construction.

Included in the reservoir area are four partially irrigated ranches, a recently installed substation of Pacific Gas and Electric Company, a power transmission line, a telephone line, and a county road. The cost of these lands and improvements and relocations form a substantial portion of the total cost of the project. The length of required road relocation and improvement would be 3.9 miles.

Subsequent to the preparation of the original cost estimate for the Whale Rock Dam and Reservoir in 1954, a service agreement was executed in the fall of 1956 between the Department of Water Resources, and the Division of Architecture, providing for further investigation of Whale Rock Project as a possible source of supplemental water for California State Polytechnic College and the California Men's Colony. It was anticipated that construction of the Whale Rock Project might be undertaken by the two foregoing State agencies as a joint venture with the City of San Luis Obispo.

Work under the agreement involved additional exploration of the foundation and borrow areas and the preparation of a revised cost estimate of the Whale Rock Project, including costs of the dam, reservoir, and conveyance conduit from the dam to the proposed service area. The additional exploration work included the drilling of three diamond drill holes along the axis of the dam and a number of holes in proposed borrow areas. Strength and compaction test were conducted on samples obtained from the drill holes.

Results of the foregoing additional exploration work indicate that the cost of the Whale Rock Dam and Reservoir would be greater than that shown in Table 51. Factors which indicate this greater cost include: (1) diamond drilling logs demonstrate the need for about 50 per cent more stripping in the channel section and on both abutments than was originally contemplated, (2) tests of borrow material showed it to have low strength necessitating the use of flatter slopes for the dam section than were originally assumed, resulting in the need for a substantially greater amount of embankment material in the dam cross-section, and (3) the value of lands in the reservoir area has increased rapidly during recent years. It is not considered that the conclusion as to the desirability of construction of the Whale Rock Project would be affected by the indicated increase in cost.

<u>Lopez Dam and Reservoir</u>. The Lopez dam site is located on Arroyo Grande Creek about 0.2 of a mile below the confluence with Lopez Creek and on the line between Sections 32 and 33, Township 31 south, Range 14 east, M. D. B. & M. Consideration was given to construction of a dam and reservoir at the Lopez site for control of floods on Arroyo Grande Creek and utilization of the flood waters conserved in the Arroyo Grande Subunit of the Coastal Unit.

The Lopez dam site was mapped up to an elevation of 550 feet in 1946 by the U. S. Bureau of Reclamation at a scale of one inch equals 50 feet, with a five-foot contour interval. The reservoir area was mapped by the Bureau in 1947 to an elevation of 500 feet at a scale of one inch equals 500 feet with 10-foot contour intervals. This was supplemented by interpolation up to an elevation of 550 feet from a U. S. Geological Survey quadrangle, at a scale of 1:62,500 and with a contour interval of 50 feet. Reservoir areas and storage capacities at various stages of water surface elevation, computed from the foregoing maps, are given in Table 52.

TABLE 52

AREAS AND CAPACITIES OF
LOPEZ RESERVOIR

Depth of water at dam, in feet	Water surface elevation, U.S.G.S. datum, in feet	Water surface area, in acres	Storage capacity, in acre-feet
0	375	0	0
5	380	2	5
15	390	14	85
25	400	53	420
35	410	100	1,190
45	420	160	2,490
55	430	240	4,490
65	440	280	7,090
75	450	330	10,100
85	460	380	13,700
95	470	440	17,800
105	480	520	22,600
110	485	570	25,000
115	490	620	28,300
125	500	730	35,000
135	510	840	42,800
143	518	940	50,000
145	520	960	51,800
155	530	1,090	62,100
165	540	1,230	73,700
175	550	1,370	86,700

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A geologic investigation of the Lopez dam site was made in 1954 by geologists of the Division of Water Resources. The geology of this site had been previously mapped and reported upon by the U. S. Bureau of Reclamation, but no exploratory drilling or trenching of the foundation has been done. Based upon preliminary geologic reconnaissance, Lopez dam site is considered to be suitable for a moderate to large sized earthfill dam with the spillway on the right abutment.

Geology of the bedrock is rather complex and outcrops are poor except in the road cuts on the left abutment. The region for about 1,000 to 1,500 feet both upstream and downstream from the axis appears to be part of a fault sliver with the Franciscan formation to the west and the Monterey formation to the east. The intrusive member of the bedrock at the site was called gabbro by U. S. Bureau of Reclamation geologists. In the road cut on the left abutment, rock types include interbedded tuffaceous or rhyolitic rocks, volcanic breccias, and some shales and siltstones, all intruded by gabbroic or basaltic rocks. The gabbroic intrusives vary in width from two feet to 30 feet and generally dip upstream. All of these rocks are highly fractured and would require heavy grouting. Exposures on the right abutment are poor, but the bedrock is about the same as that described above. The bedrock generally is strong. The rhyolitic and tuffaceous materials are of low density and should be tested for strength and density before being salvaged for use as fill. All rocks are weathered on the outcrop but the intrusive rock is generally the least weathered.

Stripping on both abutments under the impervious section of the dam would include an estimated five feet of soil and 15 feet of loose rock. Stripping the channel section would require removal of an estimated average of 50 feet of gravel with a probable maximum of 100 feet.

For all heights of dam a rolled fill structure was contemplated comprising an impervious core of select earth material and upstream and downstream sections of semipervious random fill material. Employment of semipervious random fill in the outer sections would necessitate the installation of gravel blankets and drains at the downstream face of the impervious section as a precautionary measure to carry away possible leakage that might occur through the impervious section and at the abutments. The upstream face of the dam would be protected against wave action by rock riprap placed to a depth of three feet normal to the slope.

There are an estimated 1,000,000 cubic yards of impervious material in the reservoir area within two miles of the site. The stream gravels appear suitable for use as random fill, but they should be thoroughly tested for strength and density. The Division of Water Resources tested a sample of the proposed impervious borrow material and classified it as a silty sand. A maximum density of 104 pounds per cubic foot was obtained in the compaction test of this nonplastic material. Results of this test, though of a preliminary nature, were incorporated into designs adopted for cost estimating purposes. Riprap may be selectively quarried near the site from the gabbroic intrusives.

The spillway would have a discharge capacity of 13,800 second-feet. The spillway was designed as a concrete-lined chute with an ogee weir control section and would be located on the right abutment.

The outlet works would consist of a concrete intake structure located at the upstream toe of the dam near the left abutment with a steel trash rack at its entrance. A concrete pressure conduit beneath the dam would extend from the intake to a gate chamber located slightly upstream from the axis of the dam wherein a high pressure slide gate would be installed. A reinforced concrete culvert, founded on bedrock, would extend beneath the dam from the gate chamber to the valve house at the downstream toe of the dam. This culvert would house an access passageway to the gate chamber as well as a steel outlet pipe supported on cradles. The outlet pipe would have a diameter of 48 inches. Releases would be regulated by a Howell-Bunger valve and a needle valve located in the valve house.

It was estimated that the dam could be constructed within one year and summer flow of Arroyo Grande Creek could be diverted through the outlet conduit during construction.

Construction of a dam at the Lopez site would require the relocation of about 13.1 miles of county roads. Improvements in the reservoir area include a one-room school house, a county park, a small gravel plant, a private camp ground, seven ranches including some irrigated and nonirrigated farm land, and telephone and power lines.

Alternative Plans for Water Supply Development

This section contains a discussion of the various possible alternative plans for water supply development in San Luis Obispo County, with particular regard to their relative capability of meeting future supplemental water requirements of various parts of the County. Economic factors pertinent to the selection of feasible water projects for eventual future construction are discussed as are some organizational and financial aspects involved in water resources developement in San Luis Obispo County.

The selection of a plan for the development of the water resources of San Luis Obispo County and subdivisions thereof, was based on consideration of the following principal factors: (1) present and estimated future supplemental water requirements of potential service areas, (2) the net safe seasonal yield or amount of new water that would be developed by a particular project compared to that which would be developed by an alternative project, (3) the capital cost of a given project compared to that of alternative projects, (4) the annual cost of net safe yield that would be developed by a given project compared to that by alternative projects, (5) the annual cost of incremental net safe yield that would be developed from various sizes of structures comprising a given project, and (6) the estimated cost of imported water.

Possible plans for the importation of water, which are discussed subsequently, could made a considerable amount of supplemental water available to San Luis Obispo County. Although it should not be considered as substitute for supplies available from potential local conservation works, the estimated cost of imported water delivered into the County from outside sources was used in this bulletin as a general guide in establishing the upper limit of practicable development of the local water resources of San Luis Obispo.

In selecting the capacities of reservoirs hereinafter recommended for incorporation into the overall plan of development, where no physical limitations of the sites were apparant, the sizes of surface storage developments were increased to the point where the incremental costs of new water yields produced thereby would be generally equivalent to the estimated cost of imported water. It was found that this procedure would, while having a reasonably sound economic basis, result in a relatively high degree of conservation of surface runoff and leave only some very infrequent flood flows to waste to the ocean. It is hereinafter estimated that imported water from northern California could be delivered to the Upper Salinas Unit in Cholame Creek, at a cost of from $20 to $30 per acre-feet, depending on the amount served and based upon certain assumptions as described later. Approximate cost of conveyance of this water to strategic locations in San Luis Obispo County were given consideration in the foregoing comparison of cost of unimported water with incremental costs of local storage and conveyance developments.

It is recognized that several of the water supply developments discussed previously will require relatively large capital expenditures for construction. The question of whether they will ever be built, or the order in which they will be built, will be a matter for local decision. Major factors affecting that decision will be the extent of need for supplemental water, the availability of an imported supply, and the unit cost thereof as compared to the unit cost of yield which could be obtained from a local water supply development. Construction of the more expensive local developments will therefore probably be deferred if increasing demands for supplemental water do not force their construction prior to the arrival of imported water supplies in San Luis Obispo County.

For comparative purposes, there is presented in Table 54 a recapitulation of yields of water that could be developed by construction of the several storage capacities considered at each of the eleven dam and reservoir sites given detailed study in San Luis Obispo County. Presented also in Table 54 are comparisons of certain economic factors pertaining to each reservoir. Unit costs of water presented are indicative of such costs at the reservoirs and do not include costs of conveyance or distribution. Graphical interpretations of certain data presented in Table 54 are shown on Plates 21, 22, and 23. Discussions of various water supply plans are presented in the following paragraphs.

TABLE 54

COMPARISON OF WATER YIELDS AND CAPITAL AND
ANNUAL COSTS OF SURFACE STORAGE DEVELOPMENTS
IN SAN LUIS OBISPO COUNTY AND VICINITY

Stream and reservoir	Gross storage capacity, in acre-feet	Safe seasonal yield, in acre-feet		Capital costs			Average annual costs		
		Gross	Net	Total	Per acre-foot of gross storage capacity	Per acre-foot of net safe yield	Total	Per acre-foot of net safe yield	Per acre-foot of incremental net safe yield
UPPER SALINAS UNIT									
Jack Creek									
Lower Jack	15,000	5,600	3,400	$1,304,000	$ 87	$384	$ 66,100	$19.40	-----
	25,000	6,800	4,600	1,751,000	70	381	87,000	18.90	$17.50
Santa Rita Creek									
Santa Rita	10,000	4,500	2,700	1,107,000	111	410	56,800	21.00	-----
	15,000	5,200	3,200	1,404,000	94	439	70,700	22.10	27.80
Nacimiento River									
San Miguelito*	50,000	7,700	6,000	1,734,000	35	289	88,700	14.80	-----
	130,000	17,000	13,000	3,017,000	23	232	155,600	12.00	9.60
Jarrett Shut-In*	30,000	7,700	6,000	1,736,000	58	289	86,800	14.50	-----
	75,000	13,500	10,500	3,743,000	50	356	185,300	17.60	21.90
	110,000	17,600	13,800	4,691,000	43	340	232,700	16.90	14.40
San Miguelito and)* Jarrett Shut-In)	130,000 110,000	29,200	24,100	7,708,000	32	320	388,300	16.10	-----
COASTAL UNIT									
San Carpoforo Creek									
Bald Top	20,000	10,400	10,400	2,249,000	112	216	111,300	10.70	-----
Upper Ragged Point	30,000	17,500	17,500	5,420,000	181	310	259,800	14.80	-----
Bald Top and Upper Ragged Point	50,000	22,500	22,500	7,669,000	153	340	371,100	16.50	-----
Arroyo de la Cruz									
Upper Yellow Hill	20,000	13,500	13,100	1,420,000	71	108	71,500	5.50	-----
Yellow Hill	50,000	23,300	22,900	3,599,000	72	157	176,100	7.70	10.70
	80,000	27,700	27,300	6,401,000	80	234	310,200	11.40	30.40
San Simeon Creek									
San Simeon	60,000	18,500	18,200	6,314,000	105	347	304,200	16.70	-----

COMPARISON OF WATER YIELDS AND CAPITAL AND
ANNUAL COSTS OF SURFACE STORAGE DEVELOPMENTS
IN SAN LUIS OBISPO COUNTY AND VICINITY
(continued)

COMPARISON OF WATER YIELDS AND CAPITAL AND
ANNUAL COSTS OF SURFACE STORAGE DEVELOPMENTS
IN SAN LUIS OBISPO COUNTY AND VICINITY
(continued)

Stream and reservoir	Gross storage capacity, in acre-feet	Safe seasonal yield, in acre-feet		Capital costs			Average annual costs		
		Gross	Net	Total	Per acre-foot of gross storage capacity	Per acre-foot of net safe yield	Total	Per acre-foot of net safe yield	Per acre-foot of incremental net safe yield
COASTAL UNIT (continued)									
Santa Rosa Creek									
Santa Rosa	15,000	7,900	7,300	$2,068,000	$138	$283	$101,900	$14.00	-----
	25,000	9,800	9,200	3,080,000	123	335	149,200	16.20	$24.90
	35,000	11,700	11,100	4,121,000	118	371	198,800	17.90	26.10
Old Creek									
Whale Rock	20,000	6,600	6,300	1,943,000	97	308	96,000	15.20	-----
	40,000	9,200	8,900	2,884,000	72	324	141,600	15.90	17.50
Arroyo Grande Creek									
Lopez	25,000	9,800	3,800	3,070,000	123	808	148,700	39.10	-----
	50,000	12,500	6,500	4,228,000	85	650	205,500	31.60	21.00

* Operated as secondary developments coordinately with existing Nacimiento Reservoir.

Jack Creek and Santa Rita Projects

Based on criteria discussed previously in this chapter, it is indicated that construction of a reservoir on Jack Creek at the Lower Jack site offers one of the cheapest sources of supplemental water in the Upper Salinas Unit, in terms of unit cost. The average annual cost per acre-foot of net safe seasonal yield from Lower Jack Reservoir is estimated to be $18.90 for the 25,000 acre-foot storage capacity. This is somewhat less expensive than the yield of the smaller reservoir considered at the same site. Larger sizes were not considered since a reservoir with a storage capacity of 25,000 acre-feet would develop about 70 per cent of the estimated runoff of Jack Creek and incremental costs of new yield were found to be very near to the costs of imported water. Water from this reservoir could be conveyed by conduit to nearby areas of use, or it could be released to the natural stream channel for percolation into the downstream ground water basin, from which it could be pumped by wells. Lower Jack Reservoir appears to be one of the most desirable local developments from which supplemental water could be made available to the Paso Robles-Atascadero area and its relatively low capital cost would make the project attractive for construction by a local entity.

It was found that a 15,000 acre-feet dam and reservoir at the Santa Rita site on Santa Rita Creek would produce a net safe seasonal yield of about 3,200 acre-feet with an average annual unit cost per acre-foot of yield of about $22. This cost per acre-foot of yield is nearly as low as Lower Jack site just described, and is also competitive with the cost of water imported from the Feather River Project. Of the local water supply developments for the Upper Salinas Unit shown in Table 54, the Santa Rita development had the lowest estimated capital cost. A 15,000 acre-foot reservoir at the Santa Rita site could be constructed at a capital cost of about $1,400,000. Larger sizes were not considered since their average annual cost per acre-foot of incremental net safe yield would increase substantially beyond the assumed unit cost of imported water. It is therefore concluded that the Santa Rita Dam and Reservoir should be given consideration in future plans for water development in the Upper Salinas Unit. Water service could be provided to the Paso Robles-Atascadero area in a manner similar to that proposed for operation of the Lower Jack development.

Nacimiento Projects

Results of detailed studies on the Nacimiento River above the existing Nacimiento Reservoir indicate that the San Miguelito and Jarrett Shut-In sites are feasible for the development of a water supply for the northern portion of the Upper Salinas Unit.

Of the two reservoir storage capacities studied at the San Miguelito site, the 130,000 acre-foot capacity appeared to be the most favorable for eventual construction. Construction of a 130,000 acre-foot reservoir at the San Miguelito site as a secondary development to Nacimiento Reservoir would produce 13,000 acre-feet per season of new water at a cost per acre-foot of about $12.

Three storage capacities were studied at the Jarrett Shut-In site. The largest reservoir capacity of 110,000 acre-feet would probably be the most desirable, in view of the indicated need for maximum development of the storage potential at this site, and the estimated relatively low cost of the new water developed. Because of the structural requirements at the main axis, and the scarcity of materials for construction of a larger auxiliary dam, larger reservoir storage capacities were not studied.

Results of studies of San Miguelito and Jarrett Shut-In Reservoirs, operated coordinately with Nacimiento Reservoir, show that the two reservoirs would yield 24,100 acre-feet of new water per season. The total capital cost of the two upstream projects would be $7,708,000. The two developments would provide newwater at a unit cost of $16.10 per acre-foot.

The yields developed by the San Miguelito and Jarrett Shut-In Reservoirs could be conveyed to potential service areas in the Upper Salinas Unit by a conduit system such as the Nacimiento-Shandon Conduit and Creston Lateral, shown on Plate 14. Under the proposed plan, the foregoing yields would be released down the Nacimiento River, passed through the Nacimiento Reservoir, and diverted from the river into the Nacimiento-Shandon Conduit.

The Nacimiento-Shandon Conduit would take water from the Nacimiento River immediately downstream from Nacimiento Dam at an elevation of about 920 feet. The water would be pumped into a pressure conduit which would extend easterly from the dam and would divide at a bifurcation structure southeast of San Miguel. The main conduit would continue easterly therefrom to Shandon terminal reservoir, located about one mile southeast of the town of Shandon. This portion of the conduit would include two booster pumping plants in addition to the one located at Nacimiento Dam. The Creston Lateral would extend in a general southeasterly direction from the bifurcation structure and would terminate in the Creston terminal reservoir about one mile south of Creston. This lateral would also include two booster pumping plants. The over-all length of the Nacimiento-Shandon Conduit would be about 31 miles.

Based exclusively on reconnaissance data, it was estimated that the combined Nacimiento-Shandon Conduit and Creston Lateral could be constructed at a capital cost of $6,462,000 and would convey the yields of San Miguelito and Jarrett Shut-In Reservoirs to the Creston-Shandon area at a total average annual cost, including costs of the two storage reservoirs, of about $38 per operated coordinately with Nacimiento Reservoir, show that the two reservoirs would yield 24,100 acre-feet of new water per season. The total capital cost of the two upstream projects would be $7,708,000. The two developments would provide newwater at a unit cost of $16.10 per acre-foot.

The yields developed by the San Miguelito and Jarrett Shut-In Reservoirs could be conveyed to potential service areas in the Upper Salinas Unit by a conduit system such as the Nacimiento-Shandon Conduit and Creston Lateral, shown on Plate 14. Under the proposed plan, the foregoing yields would be released down the Nacimiento River, passed through the Nacimiento Reservoir, and diverted from the river into the Nacimiento-Shandon Conduit.

The Nacimiento-Shandon Conduit would take water from the Nacimiento River immediately downstream from Nacimiento Dam at an elevation of about 920 feet. The water would be pumped into a pressure conduit which would extend easterly from the dam and would divide at a bifurcation structure southeast of San Miguel. The main conduit would continue easterly therefrom to Shandon terminal reservoir, located about one mile southeast of the town of Shandon. This portion of the conduit would include two booster pumping plants in addition to the one located at Nacimiento Dam. The Creston Lateral would extend in a general southeasterly direction from the bifurcation structure and would terminate in the Creston terminal reservoir about one mile south of Creston. This lateral would also include two booster pumping plants. The over-all length of the Nacimiento-Shandon Conduit would be about 31 miles.

Based exclusively on reconnaissance data, it was estimated that the combined Nacimiento-Shandon Conduit and Creston Lateral could be constructed at a capital cost of $6,462,000 and would convey the yields of San Miguelito and Jarrett Shut-In Reservoirs to the Creston-Shandon area at a total average annual cost, including costs of the two storage reservoirs, of about $38 per acre-foot. The indicated cost of water exceeds the costs which farmers are generally encountering in developing local ground water resources in the Upper Salinas Unit under present conditions. As in the case of all local water supply developments, the timing of need for supplemental water and availability of an imported supply, together with the financial capacity of the area served, will, to a large degree, determine which units of a conveyance system such as the foregoing would ever be constructed, and the order of that construction.

Coastal Projects

Two sites on San Carpoforo Creek were given detailed study, including the Upper Ragged Point and the Bald Top sites. One size of reservoir was studied at each site. Although hydrologic studies indicated that more yield could be developed at each of the sites considered, the scarcity of construction materials precluded the consideration of larger dams than those studied. More detailed investigation of available materials of construction may result in construction of larger developments at these sites.

Coordinated operation studies indicated that storage capacities of 20,000 and 30,000 acre-feet at the Bald Top and Upper Ragged Point sites, respectively, would develop a combined net safe seasonal yield of 22,500 acre-feet at a total capital cost of $7,669,000, and an average annual unit cost of $16.50 per acre-foot. Comparative studies indicated that the Bald Top site, as a primary development, would be the cheaper of the two sites with regard to both capital cost and unit cost per acre-foot of yield. The two developments could serve supplemental water to the coastal area north of San Simeon, as well as potentially water deficient areas to the south, through suitable conveyance facilities hereinafter described.

Results of water development studies indicate that the Yellow Hill site on Arroyo de la Cruz is one of the most promising undeveloped sites in the County. Three reservoir capacities were studied at the Yellow Hill site. Plate 21 illustrates that, within the range of capacities studied, the capital cost of Yellow Hill Reservoir varies uniformly with reservoir capacity. It can also be seen from Plates 22 and 23 that the Yellow Hill Reservoir produces the greatest yield per acre-foot of storage capacity at the least unit cost for all reservoirs studied. An 80,000 acre-foot reservoir would produce a net safe seasonal yield of 27,300 at a unit cost of $11.40 per acre-foot. Studies indicated that reservoirs with storage capacities exceeding 80,000 acre-feet would have incremental unit costs in excess of the estimated unit cost of delivery of imported water to San Luis Obispo County. For the foregoing reason, and because of the scarcity of embankment construction materials within reasonable haul distances, larger capacities were not considered at this site. Yellow Hill Reservoir could provide water service to lands in the vicinity of San Simeon and could also be connected to conveyance facilities providing water service to the San Luis Obispo Subunit.

The San Simeon site is considered to be the most feasible of four sites studied on San Simeon Creek. Only a 60,000 acre-foot capacity reservoir was considered at the San Simeon site as prior studies at the Palmer Flats site, which was subsequently discarded because of poor geologic conditions, indicated that the 60,000 acre-foot capacity would supply water at costs which are believed to be within the upper limit of economic feasibility for the area. A larger capacity at the San Simeon site was not planned since the foregoing capacity would control approximately 70 per cent of the runoff of San Simeon Creek. A reservoir constructed at the San Simeon site could provide water service to the San Simeon-Cambria area and could also be connected to a conveyance system providing a supplemental water supply to the San Luis Obispo Subunit.

Reservoirs of three capacities, including one of 35,000 acre-foot capacity, were studied at the Santa Rosa site on Santa Rosa Creek. Topographic limitations of the site and the fact that this capacity would control in excess of 70 per cent of the runoff of Santa Rosa Creek precluded the study of larger capacities. Santa Rosa Reservoir could provide supplemental water to irrigated and urban lands in the Cambria-Cayucos area and could also provide water service to potentially water deficient areas in the San Luis Obispo Subunit to the south.

The Whale Rock Dam and Reservoir is considered to be the most feasible water supply development on Old Creek. Studies indicated that a 40,000 acre-foot reservoir at the Whale Rock site would yield about 8,900 acre-feet of new water per season. Preliminary cost estimates based on reconnaissance surveys indicated that such a development would have a capital cost of about $2,884,000 and deliver water at the dam at a unit cost of slightly less than $16 per acre-foot. Larger capacities were not studied because of a reservoir of 40,000 acre-feet capacity would control in excess of 70 per cent of the mean annual runoff of Old Creek. Recent revision of the capital cost of this project previously referred to does not indicate the need for revision of the foregoing selected size of reservoir. Supplemental water could be furnished to the San Luis Obispo Subunit from Whale Rock Reservoir. Details of such a plan are presented in a subsequent section designated "Whale Rock Project".

The Lopez site of Arroyo Grande Creek is considered the most economical for development of the several sites studied in the Arroyo Grande Creek watershed. This site would also control the greatest amount of runoff of all sites considered on this stream system. Two capacities were studied at the Lopez site, including one of 50,000 acre-feet. The unit cost per acre-foot of yield for this capacity would be about $32. The practicability of constructing a dam with such a relatively high unit cost of water would depend to a large degree on the timing of availability of imported water and the unit cost thereof.

As stated previously, future increased urbanization of lower Arroyo Grande Valley may dictate the need for flood control storage at the Lopez site as well as downstream channel improvements. A 50,000 acre-foot reservoir at the Lopez site, operated entirely for water conservation purposes, would still provide appreciable downstream flood control.

It can be seen on Plates 11B and 14 that most of the feasible water supply developments in the Coastal Unit are located in the Cambria Subunit while the major portion of present and potential water service areas are in the San Luis Obispo and Arroyo Grande Subunits to the south. Plans for the satisfaction of future supplemental water requirements in the Coastal Unit included conveyance of water through a coastal pipe line, designated the Cambria Conduit, which would be constructed from Upper Ragged Point Reservoir on the north to Indian Knob Terminal Reservoir in the vicinity of San Luis Obispo. The approximate alignment of the Cambria Conduit is shown on Plate 14.

At the present time it appears that the proposed Cambria Conduit would lend itself ideally to multibarrel pipe line construction. It is recognized, however, that major modifications in design may be necessary before such a conduit would be built. Certain design factors, such as the conduit location, type of construction, and location of areas to be served, depend upon many physical and economic factors extant in the future which are not susceptible of evaluation at the present time. As in the case of the Nacimiento-Shandon Conduit and Creston Lateral, the timing of need for supplemental water and the availability of an imported supply and the unit cost thereof, together with the financial capability of the area to be served, will determine which units of the Cambria Conduit, if any, will eventually be constructed, and the order of that construction.

The proposed Cambria Conduit would begin at the outlet works of Upper Ragged Point Dam at an elevation of about 110 feet. The conduit would then extend southerly along the coast on an alignment roughly paralleling State Highway 1, collecting waters from Yellow Hill, San Simeon, Santa Rosa, and Whale Rock Reservoirs. At a point near the town of Morro Bay, the conduit would leave the coast and proceed inland through Los Osos Valley over a low divide into San Luis Valley, and finally terminate at Indian Knob Terminal Reservoir located about five miles south of the City of San Luis Obispo at an elevation of 320 feet. The total length of conduit would be about 59 miles. Booster pumping plants would be required at Arroyo de la Cruz, San Simeon Creek, Old Creek, and at the low divide between Los Osos and San Luis Obispo Valleys.

Although detailed estimates of cost of the Cambria Conduit were not prepared, reconnaissance estimates of the cost thereof indicate that the unit cost of water delivered to service areas in the Cambria and San Luis Obispo Subunits would be competitive with the cost of imported water.

Whale Rock Project

It is believed that the solution to the immediate water supply problem facing the City of San Luis Obispo lies in the construction of Whale Rock Dam and Reservoir on Old Creek together with suitable conveyance facilities from the dam to a connection with the City's existing distribution system.

The Whale Rock Project and the other developments herein presented for the coastal streams north of Old Creek have the important advantage that they are located in an area of potential water surplus. Therefore, these developments can be constructed and water exported therefrom to the San Luis Obispo and Arroyo Grande Subunits with adequate allowance for the water needs of the local areas adjacent to these streams. It was found that the Whale Rock Project would have a lower cost for new water yield delivered near the City of San Luis Obispo than would projects on Arroyo Grande Creek, the coastal streams north of Old Creek, or Jack Creek in the Upper Salinas Unit. It should be noted that projects on Arroyo Grande Creek or Jack Creek would be located in local areas of potential water deficiency. It should be further pointed out that, although it appears that the cost of the Whale Rock Project will be higher than that shown herein, this project would provide the best solution to the immediate water supply problem for the City of San Luis Obispo.

Conveyance of water from Whale Rock Reservoir to the City's distribution system could best be accomplished by construction of a conduit leading from the dam to the City's filtration plant located in Stenner Canyon at an elevation of 576 feet. The proposed conduit is designated herein and is shown on Plate 14 as the "Whale Rock Conduit". For study purposes, a branch lateral, designated the Los Osos Lateral, was also considered which could facilitate the eventual provision of water service to possible future urban areas associated with expansion of the City to the west and south. The Los Osos Lateral would extend from a proposed bifurcation structure located at the town of Morro Bay to a small terminal regulating reservoir in Los Osos Valley. A small filtration plant would be required to treat water conveyed through the Los Osos Lateral.

All units of the Whale Rock Conduit could be incorporated into the ambria Conduit and would constitute portions of the first barrel of that ystem.

The cost of the Whale Rock Conduit as proposed herein, is estimated o be about $2,031,000. The average annual cost per acre-foot of water elivered to San Luis Obispo would be about $33, of which $17 would represent he cost of conveyance. Detailed cost estimates of the Whale Rock Dam, eservoir, and Conduit are presented in Appendix G.

It might be desirable to effect construction of the Whale Rock roject in staged development. As an initial project to provide assurance of additional water for San Luis Obispo in the immediate future, a small liversion dam with a reservoir storage capacity of 2,000 acre-feet could be onstructed at the Whale Rock site, together with a conveyance conduit to the ity with a capacity of about 11.5 second-feet. This initial dam would also e a zoned earthfill structure, and would be so constructed that it could be ater incorporated into the larger dam at the same site. It is estimated that his initial project would provide a firm supply of water to the City of about ,200 acre-feet per season. The capital cost of the works would be about 2,150,000, with an average annual cost of the developed water supply delivered o the filtration plant of the City of San Luis Obispo of about $60 per acre-oot. It should be recognized that with subsequent full development of Whale ock Reservoir, the unit cost of the water delivered to San Luis Obispo would e reduced to the afore-mentioned value of about $33 per acre-foot.

rganizational and Financial Aspects of Water Resources Development

It is believed that proper implementation of the several water evelopment plans for future construction in San Luis Obispo County, as set orth in this bulletin, will eventually require the formation of a county-wide water agency whose principal functions would be to finance, construct, and operate major water development projects, and to execute water service contracts with subordinate districts. It is further considered that such an agency is necessary not only to undertake the development of local water resources, but also to obtain imported water from the Feather River Project or some other unit of The California Water Plan.

In order to carry out the foregoing objectives, it is believed that either a new agency would have to be created or else additional powers would have to be granted the present San Luis Obispo County Flood Control and Water Conservation District, authorized by Act of the State Legislature in 1945. These additional powers would include permission for the county-wide agency to sell water and to issue bonds, proceeds from the sale of which could be used for construction of water development projects. In some instances, it would be desirable that these bonds would constitute a lien upon all of the taxable property in the entire County, even though the proceeds thereof might be used to directly benefit a smaller area. However, concurrently with such financing and construction, the county-wide agency would execute contracts with member units who would be benefited by the project in which the member units would provide sufficient sums to pay off debt service charges on the bonds issued by the county-wide agency, together with operation, maintenance, and replacement costs incurred by the project.

With an agency such as San Luis Obispo County Flood Control and Water Conservation District, as modified, in charge of master county water resources development planning and implementation, including financing and construction, the particular local area of a member unit using project water would not be required to raise large funds in advance and would not necessarily require a large staff of qualified personnel to operate and maintain the project or projects. The county-wide agency would also probably have less difficulty in marketing bonds because of the broadened tax base and resulting increased financial capacity. Thus, the county-wide district might be able to obtain more favorable interest rates and other more favorable bond issuance features than could any of the member units.

A county-wide water agency would be logically charged with the continuation and expansion of the basic data collection program initiated as part of this investigation. The collection, compilation and evaluation of basic hydrologic data is absolutely necessary to plan future developments required to maintain adequate water supplies.

Plans for Importation of Water

It has been shown earlier in this bulletin that the water requirements of potential agricultural lands and urban areas in San Luis Obispo County exceed the presently developed yields of local sources of water supply. It has been further shown that the yields of all possible local developments considered hereinbefore would fail to meet the estimated ultimate supplemental water requirement of the County by a substantial amount. As discussed in the introductory chapter of this bulletin, work has been completed on state-wide studies leading to the development of The California Water Plan, which is a comprehensive plan for the provision of supplemental water supplies to all of the irrigable and habitable areas of the State of California. The initial unit of The California Water Plan, the authorized Feather River Project, and other features of that plan are described in the ensuing sections.

Feather River Project

The purposes of the Feather River Project are (1) flood control and irrigation in the Sacramento Valley, (2) electric power generation, and (3) to furnish Feather River water for firming surplus waters existing, in most years, in the Sacramento-San Joaquin Delta. This surplus could be used to provide a supplemental water supply to areas of water deficiency on the west side of the San Joaquin Valley in Fresno, Kings, and Kern Counties; the south San Francisco Bay areas in Alameda, Santa Clara, and San Benito Counties, and the South Coastal Area of California.

Major units of the Feather River Project, as authorized by the State Legislature in 1951, by Chapter 1441, Statutes of 1951, included a multipurpose dam and reservoir on the Feather River near Oroville, a power plant at the dam, an afterbay dam and power plant, a Delta Cross Channel, an electric power transmission system, a conduit to transport water from the Sacramento-San Joaquin Delta to Santa Clara and Alameda Counties, and a conduit to transport water from the Sacramento-San Joaquin Delta to the San Joaquin Valley and to southern California. It was estimated that about 4,000,000 acre-feet of water per season would be provided to areas served by the Feather River Project Aqueduct.

Further studies, culminating in the previously described report of the Division of Water Resources entitled "Program for Financing and Constructing the Feather River Project as the Initial Unit of The California Water Plan", dated February, 1955, indicated the desirability of certain modifications in the original plan. Among these modifications was the addition of San Luis Reservoir as a major feature of the Feather River Project Aqueduct.

Several possible routes for the conveyance of water to southern California were discussed in the February, 1955, report. It was concluded that so-called "High Line Route" would provide the greatest flexibility of all routes studied, as it would serve the greatest water deficient area. As stated in the introduction of this bulletin, the Legislatures of 1956 and 1957 appropriated funds in the amount of $1,777,000 for studies of alternative routes for the Feather River Project Aqueduct leading from the San Joaquin Valley to southern California, of which $500,000 were designated for studies of a coastal route.

Feather River Project water could be delivered to San Luis Obispo County by at least two possible methods, depending upon the alignment finally adopted for the main conduit serving southern California. In the event of adoption of the Coastal Line, San Luis Obispo County could be served by direct diversion from various points along the aqueduct as it would traverse the County. Although a possible alignment for the Coastal Line was presented in the February, 1955, report, final decision as to the most feasible route must necessarily be deferred pending completion of studies currently under way by the Department.

In the event of adoption of the High Line Route, San Luis Obispo County could be served by a pumped diversion from that route at a point near Avenal Gap. Since such a diversion was not incorporated in the authorized features of the project, and since firm costs of delivery of water from the project have not yet been determined, the scheme must be considered only as preliminary in nature. However, for the purpose of evaluating the economic feasibility of local water supply developments as previously discussed, a preliminary cost estimate of such a diversion was prepared in connection with the current investigation.

Under this proposed plan, water would be diverted by a canal side pumping plant located about 10 miles south of Kettleman City. The water would be lifted from elevation 370 feet, through five pumping plants and connecting canals, to an elevation of 1,200 feet at the portal of a tunnel through the Diablo Range. This tunnel would be 5.4 miles in length and would discharge into a tributary of Cholame Creek a few miles east of Cholame.

Estimates of cost of the foregoing conduit were prepared for continuous diversions of 50, 100, and 200 second-feet into San Luis Obispo County. A summary of these estimated capital and annual costs is presented in Table 55. The annual costs were based on an interest rate of three per cent, with a repayment period of 50 years. Estimates presented in Table 55 refer to costs of the water delivered to the Cholame area and do not include costs of terminal reservoir storage or distribution works within the County.

TABLE 55

ESTIMATED CAPITAL AND ANNUAL COSTS
OF FEATHER RIVER PROJECT WATER DELIVERED
IN CHOLAME CREEK IN SAN LUIS OBISPO COUNTY

Item	Capacity of diversion conduit, in second-feet, and delivered water supply, in acre-feet per season		
	50	100	200
	36,500	73,000	146,000
CAPITAL COSTS	$8,685,000	$9,545,000	$11,180,000
ANNUAL COSTS			
Debt service (50 years at 3 per cent)	$ 337,600	$ 371,000	$ 434,600
Replacements	8,000	11,200	18,400
Operation and maintenance	173,700	190,900	223,600
Electrical energy	292,000	584,000	1,168,000
TOTALS	$ 811,300	$1,157,100	$ 1,844,600
Annual costs, per acre-foot	$ 22.20	$ 15.80	$ 12.60
Annual costs, per acre-foot in Feather River Project Aqueduct at point of diversion	8.00	8.00	8.00
TOTALS	$ 30.20	$ 23.80	$ 20.60

Other Units of the California Aqueduct System

The authorized Feather River Project is proposed as the initial unit of The California Water Plan and would eventually become the key feature of the California Aqueduct System, a complex combination of works extending from the Oregon line to the Mexican Border. It is proposed that more than

1,000,000 acre-feet of regulated water would be transported each season through he California Aqueduct System. The California Water Plan, including features f the California Aqueduct System, are reported on in detail in previously escribed State Water Resources Board Bulletin No. 3, entitled "The California ater Plan" dated May, 1957.

Of particular interest to San Luis Obispo County are two features of he California Aqueduct System, namely, the Central Coastal and Carrizo-Cuyama queducts. These two aqueducts would consist of facilities necessary to supply he probable ultimate water requirements of Monterey, San Luis Obispo, and anta Barbara Counties. The Central Coastal Aqueduct would deliver a seasonal mount of 760,000 acre-feet to the foregoing counties. The Carrizo-Cuyama queduct was designed to serve only the Carrizo Plain and Cuyama Valley areas and ould be capable of delivering a seasonal amount of 330,000 acre-feet of water.

The Central Coastal Aqueduct would begin at a diversion from the San oaquin West Side conduit near Avenal Gap. Water would be pumped from the conduit nd conveyed westerly to Avenal Gap Forebay, from which it would be lifted through series of pumping plants and short canals up the easterly slope of the Cholame ills to a 5.5-mile tunnel passing westerly through the hills into the Upper alinas Unit at an elevation of about 1,180 feet. From the westerly portal of the unnel the aqueduct, in canal, would pass south of the communities of Shandon and holame and would discharge into Shedd Canyon Reservoir on Indian Creek. An rrigation supply of 60,000 acre-feet per season would be released for use on ands near the community of Cholame. The capacity of this initial reach of the queduct would be 2,200 second-feet, or twice the average flow rate, in order to ilize off-peak power, with resultant reduction in costs of electric energy.

Shedd Canyon Reservoir would provide regulation for delivery of 160,000 re-feet per season for irrigation of lands along the easterly slope of upper

Salinas Valley. The aqueduct would continue westerly from Shedd Canyon Reservoir to a crossing of Huerhuero Creek where a release of 115,000 acre-feet would be made to Huerhuero Reservoir, which would regulate the supply to a suitable demand schedule for delivery to lands along the upper Salinas River.

The Central Coastal Aqueduct would then continue from Huerhuero Creek westerly and southerly, passing east of Templeton, Atascadero, and Santa Margarita. An extended series of tunnels, totaling about 16 miles in length, would convey the water from the vicinity of Santa Margarita through the Santa Lucia Range to Tar Springs Reservoir, located on a tributary to Arroyo Grande Creek, about 8 miles east of Arroyo Grande. Tar Springs Reservoir would provide regulation for delivery of 30,000 acre-feet per season to the Arroyo Grande Valley and Nipomo Mesa on a monthly demand schedule. The aqueduct would then continue southerly, releasing 35,000 acre-feet per season for delivery to lands in the Nipomo Valley. After crossing the Cuyama River about 8 miles southeast of Nipomo, the aqueduct would convey water southeasterly along the edge of Sisquoc Valley to the Sisquoc River. Here 105,000 acre-feet per season would be released into Round Corral Reservoir for regulation and delivery to the Santa Maria Valley. As distinguished from the aforementioned Coastal Line of the Feather River Project Aqueduct, however, the Central Coastal Aqueduct would terminate at existing Cachuma Reservoir in Santa Barbara County, and would not be designed to serve areas south of Santa Barbara County.

The locations of features of the Carrizo-Cuyama Aqueduct within San Luis Obispo County are shown on Plate 14. The aqueduct would originate at a canal-side pumping plant on the California Aqueduct in the southwestern corner of the San Joaquin Valley. Water would be lifted up the easterly slope of the Temblor Range to an elevation of 2,500 feet by a series of four pumping plants. The final pumping plant would discharge water into two separate pipe lines. One line, the Carrizo Lateral, would continue westward and would discharge into a channel leading through the Elkhorn Plain to Elkhorn Reservoir. The other line, the Cuyama ateral, would turn southward to Bitterwater Afterbay on Bitterwater Creek. From his afterbay a 4-mile tunnel would pass southwesterly through the ridge to the uyama Valley. The pumping plants and aqueduct would be designed so that they ould convey the required amounts of water with operation only during periods of f-peak power demand, and would have a capacity of 910 second-feet or twice the verage diversion rate of 455 second-feet.

Water supplies in the amount of 76,000 acre-feet per season for Cuyama lley would be discharged on an off-peak basis from the last pumping plant to tterwater Afterbay which would reregulate them to a continuous flow. All of the mainder of the discharge from the last pumping plant would be discharged into e line leading to Elkhorn Reservoir which would provide daily and monthly reregu-tion to make the delivered water supplies conform to the irrigation demand schedule r the Carrizo Plain. The amount so delivered would be 254,000 acre-feet per season.

Implementation of plans for water development described in this and pre-ding sections would provide sufficient water supplies to meet all of the present d probable ultimate water requirements of San Luis Obispo County insofar as can determined at this time.

It has been pointed out that it is probably not practicable to serve water certain irrigable lands in San Luis Obispo County under present economic condi-ns because of their elevation or geographic location. The lands in this category ld probably not require water for a considerable period of time in the future. is assumed, however, that all of these lands which cannot be feasibly served local water development works, would eventually be served from an imported ly.

For summary purposes, there is presented in Table 56 a derivation of the mated requirements for imported water supplies in Upper Salinas, Coastal, rizo Plain, and San Joaquin Hydrologic Units under ultimate conditions of devel-t. It will be noted in the table that in excess of 400,000 acre-feet of water eventually have to be imported to satisfy the ultimate water requirements of four hydrologic units.

TABLE 56

ESTIMATED REQUIREMENTS FOR IMPORTED WATER SUPPLIES
IN UPPER SALINAS, COASTAL, CARRIZO PLAIN, AND SAN JOAQUIN HYDROLOGIC UNITS
UNDER ULTIMATE CONDITIONS OF DEVELOPMENT

In Acre-Feet

Hydrologic unit	Maximum practicable net safe seasonal yield			Water requirement	Requirement for imported water
	Ground water	Surface	Total		
Upper Salinas	45,000*	31,900	76,900	221,000	144,100
Coastal	24,800	100,100	124,900	156,200	31,300
Carrizo Plain	600	0	600	246,000	245,400
San Joaquin	0	0	0	7,200	7,200
TOTALS	70,400	132,000	202,400	630,400	428,000

* Includes estimated yield of portion of Paso Robles Basin within Monterey County.

Flood Control

Objectives of the current investigation included a study of flood control problems in San Luis Obispo County. Although the scope of the current investigation did not permit a comprehensive study of the problem, sufficient data were available to ascertain that flood control is not presently a major problem in the County, except in the Arroyo Grande and Santa Maria Valleys. Throughout the rest of the County, flood hazards consist of minor flooding and drainage problems. During periods of heavy runoff, damage in the latter areas is generally limited to erosion of highway fills and bridge abutments. State funds were provided by the Legislature in 1938 and again in 1952 to a number of counties, including San Luis Obispo County, for the emergency repair of various highway fills, bridges, and culverts damaged or washed out by floods occurring in those years.

Historical flood damage of major proportions in San Luis Obispo County was generally confined to lands comprising flood plains of the upper Salinas River, Arroyo Grande Creek, and the Santa Maria River, and consisted of channel bank erosion and extensive damage to agricultural property, railroads, highways, residences, businesses, industries, public property, and utilities.

Because of relatively short records of stream flow in San Luis Obispo County, peak discharges resulting from most floods can only be estimated from high-water marks, newspaper accounts, and other available sources. Available data indicate that at least eight floods of major proportions occurred in San Luis Obispo County since the flood of 1861-62, the earliest known major flood of recent history. At least 12 other floods of lesser magnitude than the foregoing caused considerable damage to both public and private property. It is anticipated that the extent of damage resulting from a repetition of floods of magnitudes comparable with the foregoing, will increase as more intensive urban, industrial, and agricultural de-velopment occurs on flood plains adjacent to stream channels.

Presented in the following paragraphs, under their respective section headings, are discussions of flood control problems and existing improvements in the three major flood hazard areas of San Luis Obispo County.

Upper Salinas River Valley

In terms of peak discharge, the flood of 1938 was the largest of record the upper Salinas River. A peak flow of 11,000 second-feet was recorded at the S. Geological Survey gaging station near Santa Margarita in February of that r. Although the flood of 1862 may have been one of greater magnitude, suffi-ent data are not available to evaluate its peak discharge. Other floods, includ- those of 1881, 1889, 1890, 1911, and 1937, are reported to have been especially ge. A peak flow of 7,260 second-feet was recorded at the Salinas River gaging tion near Santa Margarita in February, 1937.

The major portion of damage from the foregoing floods in the Upper Salinas River Valley was generally limited to bank erosion and consequent loss of agricultural lands. The Salinas River channel near Paso Robles was eroded and considerably widened in places as a result of the 1862 flood. Damage to public property occurred during the 1913-14 flood when the highway bridge at Paso Robles and a railroad bridge near the Monterey County line were washed out.

There are no flood control works at the present time in the Upper Salinas River Valley. Some degree of protection for downstream lands and property is afforded by Salinas Reservoir which provides incidental regulation of peak discharges of the upper Salinas River. Since construction of the dam and reservoir in 1941, damage to lands adjacent to the river has been negligible and limited generally to minor bank erosion.

Based on the foregoing data, it is not believed that construction of flood control works would be justified at this time. The presence of brush and trees in the channel which, it is reported, have increased in areal extent since the construction of Salinas Dam, may pose a minor flood hazard. The feasibility of clearing the channel is questionable, since the cost of clearing could be considerably greater than the flood control benefits which would be derived therefrom. Such a project would result in a saving in water, however, through reduction of nonbeneficial consumptive use of water by phreatophytes.

Arroyo Grande Valley

The floods of 1909 and 1911 are reported to be the largest known to have occurred on Arroyo Grande Creek. These floods produced estimated peak discharges of 28,000 and 30,000 second-feet, respectively, at the town of Arroyo Grande, based on high-water marks. These floods caused substantial damage to public and private property and resulted in the loss of three lives. Other floods, including those of 1862, 1884, 1890, 1914, 1937, and 1943, though of lesser magnitude than the 1911 flood, caused extensive damage to both public and private property. It is interesting to note that the storm of February and March, 1938, which caused such extensive damage throughout the rest of central and southern California, caused only negligible damage in Arroyo Grande Valley.

The most recent flood of consequence on Arroyo Grande Creek was that which occurred during the 1951-52 season. This flood produced a peak flow of 5,370 second-feet at the U. S. Geological Survey gaging station at Arroyo Grande, and caused minor damage to the channel banks. Approximately 300 acres of agricultural lands were inundated and one bridge was damaged.

The greatest potential flood hazard in Arroyo Grande Valley appears to be to those lands comprising the rich flood plain of the lower valley below the city of Arroyo Grande. Lands above Arroyo Grande are also subject to flooding, although to a lesser degree than the lower valley lands. Efforts have been made to control flood flows in lower Arroyo Grande Creek by the construction of levees along both sides of the channel. These levees extend from a point a few hundred feet above State Highway 1 to the mouth of the creek channel, just west of the town of Oceano. Certain critical sections of the levees have been reinforced with post and wire revetment. Unfortunately, these levees were constructed of highly erodable, low-density, sand and gravel, and are frequently breached during flood flows.

The extent of flood hazard in lower Arroyo Grande Valley is difficult to evaluate because of limited available data and changing channel conditions. For the two foregoing reasons and because of the lack of good correlation between peak discharge estimates and resulting flood damage, the evaluation of potential flood damage is subject to considerable error. The problem can best be illustrated by a comparison of flooded areas resulting from two recent floods. The 1952 flood, with peak flow of 5,370 second-feet, as stated previously, flooded approximately 330 acres of land. By contrast, the 1943 flood, with a peak flow of only 2,800 second-feet, flooded nearly 400 acres in the same area.

Maximum nondamaging discharges of Arroyo Grande Creek have been estimated by both the U. S. Corps of Engineers and the Arroyo Grande Soil Conservation District in connection with the preparation of previously discussed reports. In their 1941 report, the Corps of Engineers estimated that the maximum nondamaging flows in Arroyo Grande Creek for the upper and lower valley reaches were 9,000 and 3,000 second-feet, respectively. Based on data contained in the 1955 report of the Arroyo Grande Soil Conservation District, it was estimated that the maximum nondamaging flood flow in lower Arroyo Grande Creek would be only slightly greater than 1,300 second-feet.

Possible plans for the control of floods in Arroyo Grande Valley investigated by the U. S. Corps of Engineers included: (1) a dam for flood control only at the Lopez site, and levees in the lower valley along lower Arroyo Grande Creek and its principal lower tributary, Los Berros Creek, (2) a dam for flood control and water conservation at the same site, and levees in the lower valley identical with those in the first plan, and (3) levees in the lower valley. The first of the three foregoing plans was considered by the Corps of Engineers to be the most advantageous and was estimated to have a total capital cost of $4,345,000 and an annual cost of $189,000. At the time of completion of their report, the Corps of Engineers found that there was not presently economic justification for any of the three plans studied since the estimated annual cost of each of the plans would have been approximately four times the average annual tangible benefits, and because intangible benefits would not have been sufficient to outweigh the lack of economic justification.

Because of continued local concern over the existing threat of damage from floods, Zone 1 of the San Luis Obispo County Flood Control and Water Conservation District was formed in lower Arroyo Grande Valley in 1945. In 1951, residents of Zone 1 successfully voted a bond issue in the amount of $40,000. It was intended that the $40,000 would be used for the construction of flood control works in lower Arroyo Grande Valley, although no construction work has been started.

An investigation of a plan for works of improvement in the Arroyo Grande watershed was completed in 1955 by the U. S. Soil Conservation Service, under the direction of and in cooperation with the Arroyo Grande Soil Conservation District and the San Luis Obispo County Flood Control and Water Conservation District, as authorized by the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat., 666). Results of the investigation were reported on in the previously cited report of October, 1955, of the two afore-mentioned districts. The report proposed a plan for a combination of land treatment and structural measures at an estimated total cost of $475,315, of which it was proposed that $349,895 would be borne by the Federal Government, and $125,420 would be borne by local interests. Structural measures, designed to prevent overflow of Arroyo Grande Creek and its principal lower valley tributary, Los Berros Creek, included channel realignment and enlargement, in addition to embankment stabilization. Based on the engineering and economic analyses presented in the report, it was concluded that the project as proposed, would have an over-all favorable benefit-cost ratio of 1.24 to 1. Construction of a portion of this project was completed in 1957.

Although it was not possible to make an independent analysis of all flood control aspects in Arroyo Grande Valley in connection with the San Luis Obispo County Investigation, certain flood control aspects of a dam and reservoir located at the Lopez site were studied. Results of these studies indicate that a flood peak regulated by the surcharge storage in a 50,000 acre-foot capacity reservoir, assuming the reservoir full at the beginning of the flood flow, would reach the lower valley considerably later than the peak flow from the tributary area below the dam. It was further found that the resulting peak outflow from Lopez Reservoir would be essentially equivalent to the peak discharge from the lower tributary area and that the two peak flows entering the lower valley would be from two to four and one-half times the carrying capacity of the channel. It will be noted that even with greater control of the peak flows at Lopez dam site, which a flood control reservation would provide, the peak flow from the tributary area downstream from the reservoir, if no regulatory storage were constructed on the streams draining therefrom, would exceed the downstream channel capacity. Therefore, it appears that consideration of a flood control reservation in the reservoir would not be justified. It further appears that the most effective means of providing flood control on Arroyo Grande Creek would be by channel improvements at such time as they would be economically justified.

Santa Maria River Valley

The largest peak discharge of record on the Santa Maria River and its tributaries occurred as a result of the March, 1938, flood. A peak flow of 17,300 second-feet was recorded at the U. S. Geological Survey gaging station on the Santa Maria River near Santa Maria during that flood. Although exact comparisons cannot be made, it is believed that the flood of 1862 was probably of the greatest magnitude in recent history. Other floods causing extensive age in Santa Maria Valley included those of 1878, 1884, 1890, 1909, 1910, 1911, 4, 1924, and 1937. All of the foregoing floods caused extensive damage to or s of agricultural lands and would cause even greater damage if they were eated under present conditions of development. The City of Santa Maria was ensively flooded during several of the foregoing peak flows.

The most critical flood hazard in San Luis Obispo County, as well as acent Santa Barbara County, is believed to be that which presently exists in Santa Maria Valley. A repetition of any of the previously cited floods would age or destroy lands and property throughout the valley. Flood control works ng the Santa Maria River consist primarily of low training dikes constructed at ategic points. A rail and wire revetment was constructed along the north bank the river by the County of San Luis Obispo in 1953 at a total cost of $7,000. se measures offer a moderate degree of protection from small floods, but, at t, can offer only temporary protection from most of the damaging floods which caused such havoc in recent years.

It is believed that adequate flood control measures for the Santa Maria ley are incorporated in the authorized Santa Maria Project currently under struction. The Santa Maria Project is a water conservation and flood control ject which was jointly developed by the U. S. Bureau of Reclamation and Corps ngineers, and consists of a dam at the Vaquero site on the Cuyama River about miles upstream from the confluence of the Cuyama and Sisquoc Rivers, together levees along the Santa Maria River and a portion of a tributary stream, ley Canyon. The location of Vaquero Reservoir is shown on Plate 14.

The Santa Maria Project is presently being constructed jointly by the Bureau of Reclamation and Corps of Engineers, and is scheduled for completion 959.

The proposed dam is designed as a zoned earthfill. It would have a height 4 feet above stream bed and would have a crest length of 1,775 feet. The reservoir would cover an area of 3,400 acres and would impound 214,000 acre-feet of water to the top of the spillway gates. The Vaquero Dam and Reservoir is a multiple-purpose development having storage allocations as follows:

Silt storage	45,000 acre-feet
Flood control reservation	89,000 acre-feet
Conservation storage	80,000 acre-feet

The Santa Maria Valley Levee and Channel Improvements are described in Appendix 3 to the report of the District Engineer, Corps of Engineers, Los Angeles District, dated June 15, 1951, as follows:

> "17. Location and function.--The Santa Maria Valley levee and channel improvements consist of the following: (1) Levee and channel improvements along Santa Maria River and (2) levees and an excavated channel extending from the canyon mouth of Bradley Canyon to a point on Santa Maria River about 3.3 miles downstream from Fugler's point.
>
> "18. The levee and channel improvements along Santa Maria River would consist of the following: (1) A single levee extending along the left bank of Santa Maria River for about 17 miles from Fugler's Point to a point about 600 feet downstream from the highway bridge at Guadalupe, (2) a single levee extending along the right bank of Santa Maria River for about 5 miles from a point about 1-1/4 miles downstream from the Highway US 101 bridge to a point about 1-1/2 miles upstream from the railroad bridge at Guadalupe, and (3) channel clearing from Fugler's Point to the Pacific Ocean. Upstream from the upper end of the right-bank levee, the channel would be cleared between the levee on the left bank and the edge of the right bank. Between the upper end of the right-bank levee and Bonita Road, the channel would be cleared between the levees. Below Bonita Road, clearing would be limited, in general, to a 1,500-foot wide channel.
>
> "19. The Bradley Canyon levee and channel would consist of 2,600 feet of double levees along the lower end of the work and 7,500 feet of single levee. In addition, a 1,500-foot dike would be constructed along the right bank at the mouth of the canyon to prevent the inundation of high-valued agricultural and residential property."

These levees would have an 18-foot crown and vary in height from 10 to 14 feet above stream bed.

As described in the Corps of Engineers' report on the Santa Maria Project, the proposed project would control to nondamaging intensity a design flood peak of 230,000 second-feet in the Santa Maria River. Operation of Vaquero Reservoir would ɔe the design peak to 150,000 second-feet at Fugler's Point. Below Fugler's t the proposed channel improvements are designed to safely pass 150,000 second-.

In the report of the U. S. Bureau of Reclamation entitled, "Santa Maria ɩect, Southern Pacific Basin, California", dated November 30, 1951, the total ; of the project was estimated to be $24,575,000, based on October, 1950, price ɜls. A summary of project costs is as follows:

Vaquero Dam and Reservoir	$14,300,000
Santa Maria River levees	9,540,000
Bradley Canyon levees	735,000
TOTAL	$24,575,000

In addition to the cost of the flood control levees, the estimated allo- ion to flood control of the cost of Vaquero Dam is $3,530,000, making a total od control allocation for the project of $13,805,000. Of this amount, the fed- l agencies recommended that local interests contribute $990,000 toward the cost levees and channel improvements in the Santa Maria Valley, which cost represents uisition of lands, easements, rights of way, and relocation of utilities neces- y for construction of channel improvements. The remainder, or $12,815,000, was ommended to be nonreimbursable. An amount of $10,770,000 was allocated to water servation and would be repaid to the Federal Government by local water users.

Pursuant to Chapter 13, Statutes of 1957, approved by the Governor on ɔruary 1, 1957, the Santa Maria Project, as recommended by the Chief of ʒineers in House Document Numbered 400, Eighty-Third Congress, Second Session, ɜ adopted by the State Legislature as an approved water development project. ls approval by the State Legislature authorizes appropriations to be made by e State to pay for that portion of the cost of local cooperation which includes rchase of lands, easements, and rights of way, and replacement of existing ldges and utilities.

CHAPTER V. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

As a result of field investigation and analyses of available data on the water resources and water problems of San Luis Obispo County, the following conclusions and recommendations are made.

Summary of Conclusions

1. Recent growth of population and irrigated agriculture within San Luis Obispo County has resulted in increased demands on both surface and underground water resources.

2. Anticipated future growth of population and irrigated agriculture will require an extensive program of development of local water resources, and full satisfaction of the ultimate water using potential of the County will require importation of substantial amounts of water from sources outside of the County.

3. The present primary source of water supply of San Luis Obispo County is direct precipitation. The occurrence of precipitation in the County varies markedly both areally and with time, mean seasonal depth of precipitation varies from a maximum of about 42 inches in the Santa Lucia Range to about eight inches on the Carrizo Plain. Approximately 90 per cent of the seasonal precipitation generally occurs during the six-month period from November through April. Precipitation from season to season varies generally from as low as about 25 per cent to as much as about 220 per cent of the mean seasonal amount.

4. Surface runoff of streams draining San Luis Obispo County follows closely the pattern of occurrence of precipitation both monthly and seasonally.

5. With the exception of the regulation of the Salinas River afforded by operation of Salinas Reservoir, regulation of the water supplies of San Luis Obispo County has, to date, been accomplished almost entirely through utilization of storage in underground reservoirs. The recently completed Nacimiento Reservoir will serve to regulate the flow of Nacimiento River and will provide supplemental water for beneficial use in Monterey County. Vaquero Reservoir, presently under construction, will regulate flood flows of the Cuyama River and make possible increased recharge of the Santa Maria ground water basin, thereby reducing the present overdraft in that basin.

6. Salinas Reservoir, the property of the United States Army, with a gross storage capacity of 26,000 acre-feet and an estimated net safe seasonal yield of 5,600 acre-feet, presently provides seasonal water supplies of up to 3,000 acre-feet to the City of San Luis Obispo. In addition, intermittent releases have been made from the reservoir to the Salinas River at the request of downstream water users.

7. A total of 19 ground water basins varying in economic importance have been identified in San Luis Obispo County, excluding the Santa Maria and Cuyama Basins, and it is estimated that in excess of 200,000 acre-feet of underground storage capacity has been utilized to date in those basins. The safe yield of the presently developed ground water supply, excluding the Santa Maria and Cuyama Basins, is about 41,100 acre-feet per season, distributed by hydrologic units as follows: Upper Salinas Unit, 26,900 acre-feet; Coastal Unit, 13,600 acre-feet; Carrizo Plain Unit, 600 acre-feet; and San Joaquin Unit, none.

8. Surface and ground water supplies of San Luis Obispo County are generally of fair to good mineral quality and suitable for irrigation and

other beneficial uses. Surface and ground water supplies from certain localized areas are relatively hard and also exhibit relatively high concentrations of total dissolved solids, sulphates, and boron.

9. The urban and agricultural areas presently receiving water service in San Luis Obispo County comprise about 34,000 acres, distributed by hydrologic units as follows: Upper Salinas Unit, 12,000 acres; Coastal Unit, 12,000 acres; Santa Maria Unit, 6,000 acres; Cuyama Unit, 4,000 acres; Carrizo Plain Unit, 300 acres; and San Joaquin Unit, none.

10. It is estimated that, under probable ultimate conditions of development and water use in San Luis Obispo County, there would be about 333,000 acres requiring water service, distributed by hydrologic units approximately as follows: Upper Salinas Unit, 117,000 acres; Coastal Unit, 71,000 acres; Santa Maria Unit, 16,000 acres; Cuyama Unit, 27,000 acres; Carrizo Plain Unit, 100,000 acres; and San Joaquin Unit, 2,000 acres.

11. The present mean seasonal water requirement of San Luis Obispo County is about 69,000 acre-feet, distributed by hydrologic units as follows: Upper Salinas Unit, 27,000 acre-feet; Coastal Unit, 16,000 acre-feet; Santa Maria Unit, 17,000 acre-feet; Cuyama Unit, 8,000 acre-feet; Carrizo Plain Unit, 600 acre-feet; and San Joaquin Unit, none.

12. The probable ultimate mean seasonal water requirement of San Luis Obispo County will be about 721,000 acre-feet, distributed by hydrologic units as follows: Upper Salinas Unit, 221,000 acre-feet; Coastal Unit, 156,000 acre-feet; Santa Maria Unit, 28,000 acre-feet; Cuyama Unit, 63,000 acre-feet; Carrizo Plain Unit, 246,000 acre-feet; and San Joaquin Unit, 7,000 acre-feet.

13. There is no present requirement for supplemental water in San Luis Obispo County except in the Santa Maria Unit, wherein an overdraft on the underlying Santa Maria Ground Water Basin exists. Present and ultimate

supplemental water requirements were not derived for the Santa Maria and Cuyama Units since the U. S. Geological Survey is presently engaged in detailed hydrologic studies of the Santa Maria and Cuyama Ground Water Basins. Results of these studies will provide valuable data for the future re-evaluation of the safe yields of the foregoing ground water basins.

14. It is considered that of the remainder of San Luis Obispo County, excluding the Santa Maria and Cuyama Units, future urban and agricultural and development will first result in water deficiencies in the Upper Salinas Unit and the San Luis Obispo and Arroyo Grande Subunits of the Coastal Unit.

15. Under probable ultimate conditions of development and water use in the portion of San Luis Obispo County which excludes the Santa Maria and Cuyama Units the mean seasonal requirement for supplemental water will be about 583,000 acre-feet.

16. Approximately 155,000 acre-feet of supplemental water can be developed seasonally from local water supply sources in San Luis Obispo County, including about 29,000 acre-feet from ground water sources and 126,000 acre-feet from surface water developments. The portion of the ultimate supplemental water requirements of San Luis Obispo County which cannot be met through further development of local water supply developments could be supplied through importation facilities of the California Aqueduct System, a major feature of The California Water Plan.

17. In order to accomplish maximum practicable development of local surface water supplies of San Luis Obispo County the undeveloped dam and reservoir sites considered to be most favorable for development, with respect to both cost and yield of water, include the following:

Site	Stream
Lower Jack	Jack Creek
Santa Rita	Santa Rita Creek
San Miguelito	Nacimiento River
Jarrett Shut-In	Nacimiento River
Bald Top	San Carpoforo Creek
Upper Ragged Point	San Carpoforo Creek
Yellow Hill	Arroyo de la Cruz
San Simeon	San Simeon Creek
Santa Rosa	Santa Rosa Creek
Whale Rock	Old Creek
Lopez	Arroyo Grande Creek

18. The Lower Jack, Santa Rita, San Miguelito and Jarrett Shut-In Dams and Reservoirs could provide supplemental water supplies to lands in the Upper Salinas Unit. It is feasible from an engineering standpoint to convey water conserved by the San Miguelito and Jarrett Shut-In Reservoirs by means of a pressure conduit to potential water service areas in the Upper Salinas Unit.

19. The Bald Top, Upper Ragged Point, Yellow Hill, San Simeon, Santa Rosa, Whale Rock, and Lopez Dams and Reservoirs could provide supplemental water supplies to lands in the Coastal Unit. It is feasible from an engineering standpoint to convey water conserved by Bald Top, Upper Ragged Point, Yellow Hill, San Simeon, Santa Rosa, and Whale Rock Reservoirs by means of a pressure conduit to potential water service areas in the Cambria and San Luis Obispo Subunits.

20. The most pressing water resource problem facing San Luis Obispo County is considered to be the development of an additional water supply for the City of San Luis Obispo. Existing sources of supply will be inadequate to meet the City's increasing demands for water by about 1960.

21. The Whale Rock Project on Old Creek, including a conveyance conduit leading to the City of San Luis Obispo's existing filtration plant could be constructed as the initial feature of the plan presented in this

bulletin for conservation of local surface water supplies of San Luis Obispo County.

22. If constructed, the Whale Rock Project would provide sufficient water for the City of San Luis Obispo until 1990, and in addition could serve water to intermediate areas between the reservoir and the City, provided the City maintains its present supply in Salinas Reservoir. This project would have a capital cost of about $4,915,000, including the dam and reservoir and conveyance conduit to the City of San Luis Obispo, and would deliver water to the City at a cost of about $33 per acre-foot.

23. A staged construction of the Whale Rock Project may be desirable, whereby a diversion dam and conduit would be constructed initially, at a capital cost of about $2,150,000. This initial project would provide a firm water supply of about 2,200 acre-feet per season at a unit cost of about $60 per acre-foot.

24. Water required to meet anticipated future water needs of San Luis Obispo County, in excess of that which can be conserved by full practicable development of local waters, can be made available through facilities of The California Water Plan. The authorized Feather River Project is the initial unit of that plan.

25. Flood hazards presently exist in the Santa Maria and Arroyo Grande Valleys, but flood control is not a major problem in the remainder of San Luis Obispo County. The Santa Maria Project, presently being constructed by the U. S. Bureau of Reclamation and the Corps of Engineers, U. S. Army, will provide flood control in the Santa Maria Valley as well as alleviate ground water overdraft in the Santa Maria Ground Water Basin. Studies of flood control works for protection of Arroyo Grande Valley have been conducted by the Corps of Engineers and the U. S. Soil Conservation Service.

26. The prosecution of a sound, comprehensive program of water resources development in San Luis Obispo County will require formation of a single county-wide water agency, organized with appropriate powers. Such an agency will be necessary to properly undertake the development of both local and imported water supplies.

Recommendations

It is recommended:

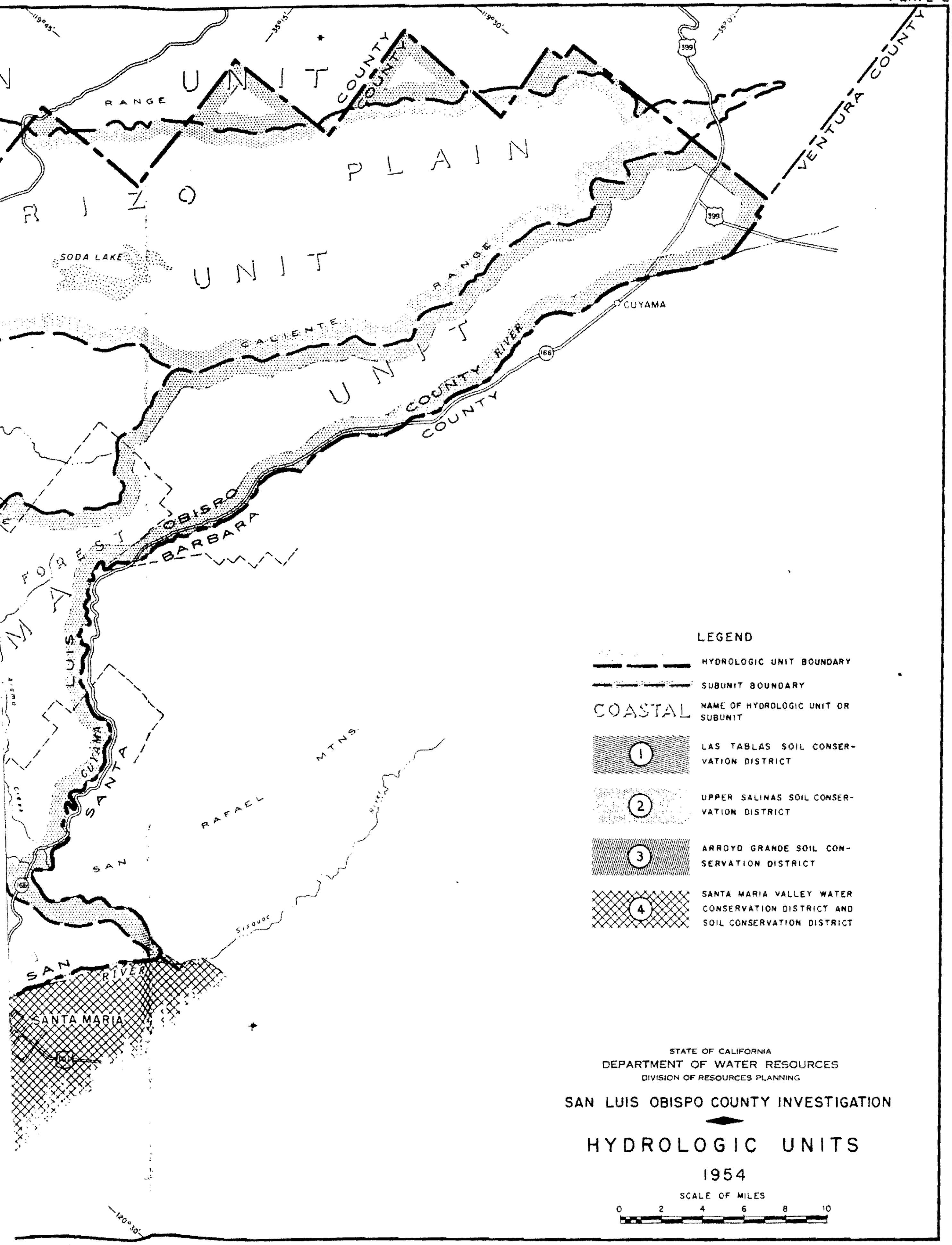
1. That the existing San Luis Obispo County Flood Control and Water Conservation District be granted additional authority or that a new county-wide agency endowed with appropriate powers, as set forth hereinbefore, be created for the purposes of planning, coordinating, financing, constructing, and operating feasible water supply developments.

2. That plans for the development of the local water resources of San Luis Obispo County be executed in conformity with the conclusions set forth herein.

3. That a program be initiated for the acquisition of lands, easements, and rights of way necessary for construction of feasible water supply developments in San Luis Obispo County described hereinbefore.

4. That a program involving the collection, compilation, and evaluation of basic hydrologic data throughout San Luis Obispo County be continued and expanded for the purpose of more adequately evaluating the water problems and solutions thereto under continuing growth and development of the County.

5. That continuing support be given to the study of major multipurpose water resources developments under The California Water Plan, including those relating to importation of supplemental water to central and southern California.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HYDROLOGIC UNIT BOUNDARY
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COASTAL
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1
LAS TABLAS SOIL CONSERVATION DISTRICT
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UPPER SALINAS SOIL CONSERVATION DISTRICT
3
ARROYO GRANDE SOIL CONSERVATION DISTRICT
4
SANTA MARIA VALLEY WATER CONSERVATION DISTRICT AND SOIL CONSERVATION DISTRICT
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING
SAN LUIS OBISPO COUNTY INVESTIGATION
HYDROLOGIC UNITS
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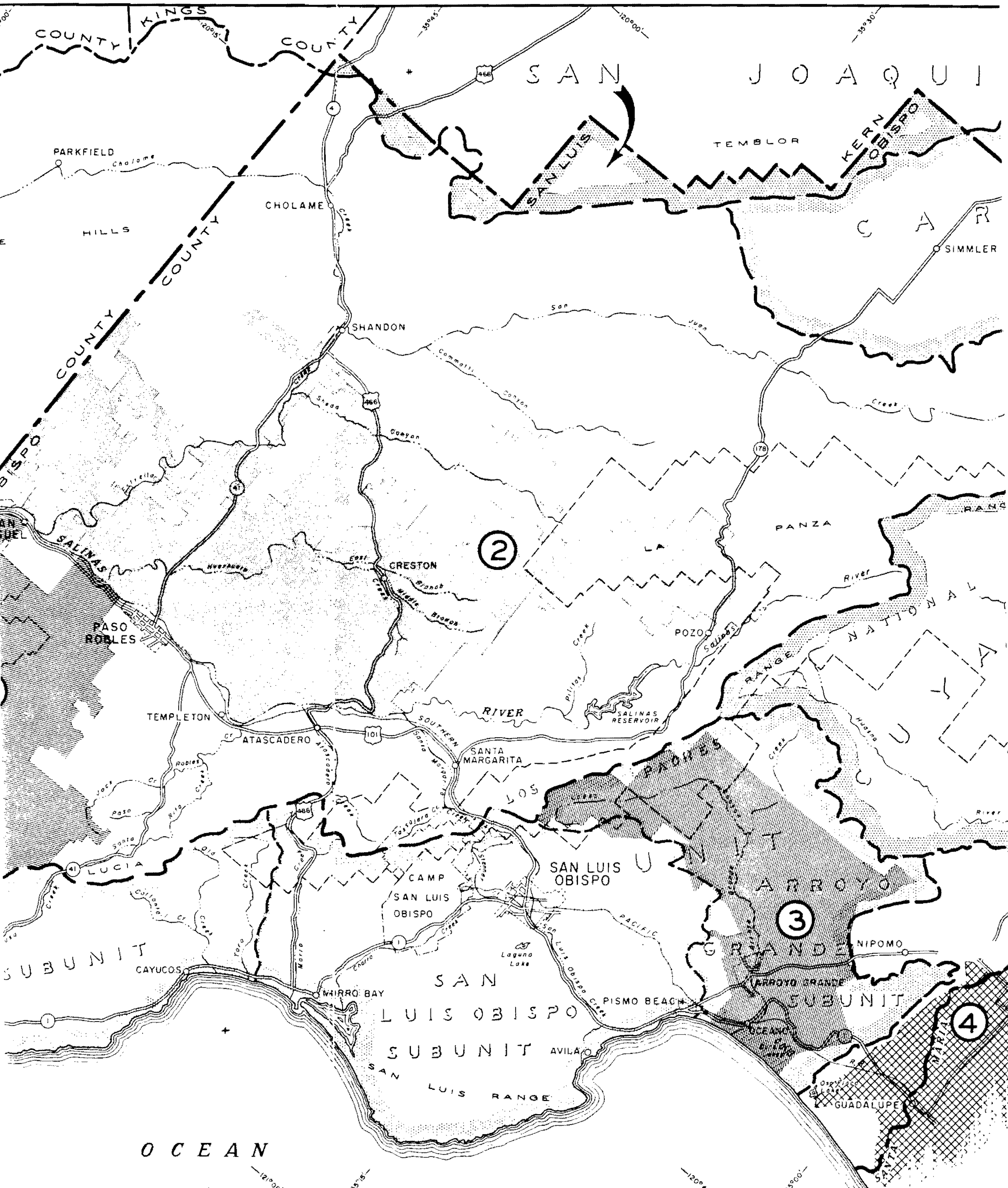
KINGS COUNTY
COUNTY
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CAR
PARKFIELD
CHOLAME
HILLS
SIMMLER
SHANDON
San Juan Creek
CRESTON
LA PANZA
PASO ROBLES
SALINAS
TEMPLETON
ATASCADERO
RIVER
SALINAS RESERVOIR
POZO
SANTA MARGARITA
SOUTHERN PACIFIC
LOS PADRES NATIONAL
RANGE
CUYA
LUCIA
SAN LUIS OBISPO
CAMP SAN LUIS OBISPO
ARROYO GRANDE
NIPOMO
SUBUNIT
CAYUCOS
MORRO BAY
SAN LUIS OBISPO SUBUNIT
PISMO BEACH
ARROYO GRANDE SUBUNIT
AVILA
SAN LUIS RANGE
GUADALUPE
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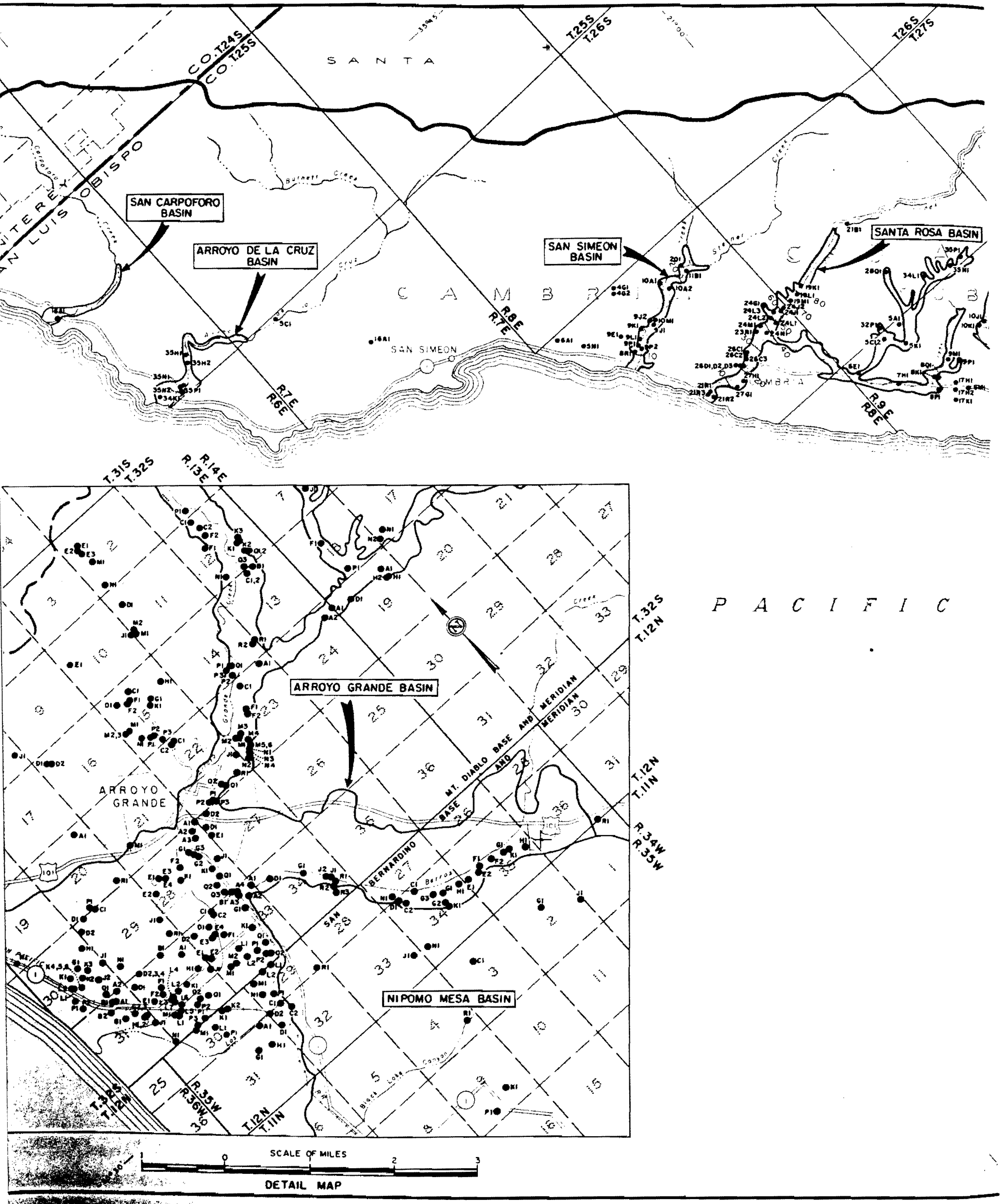

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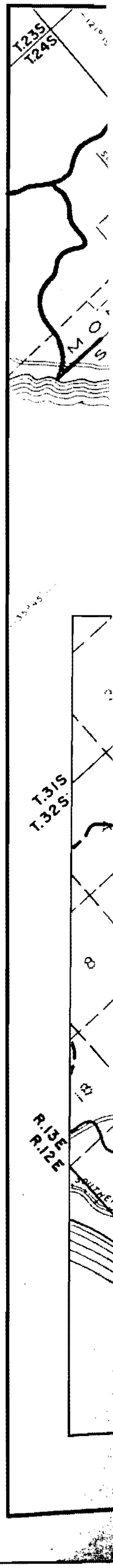
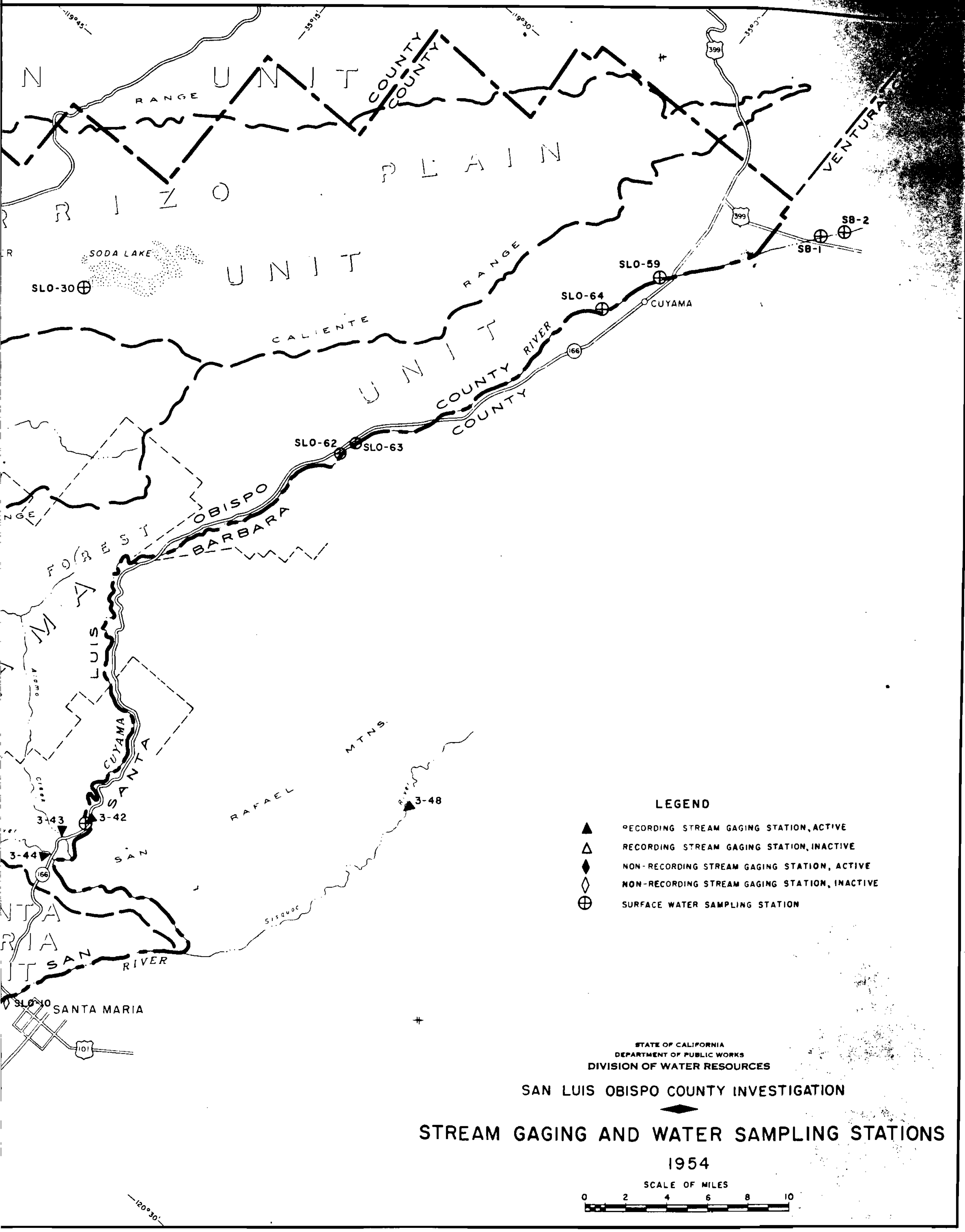
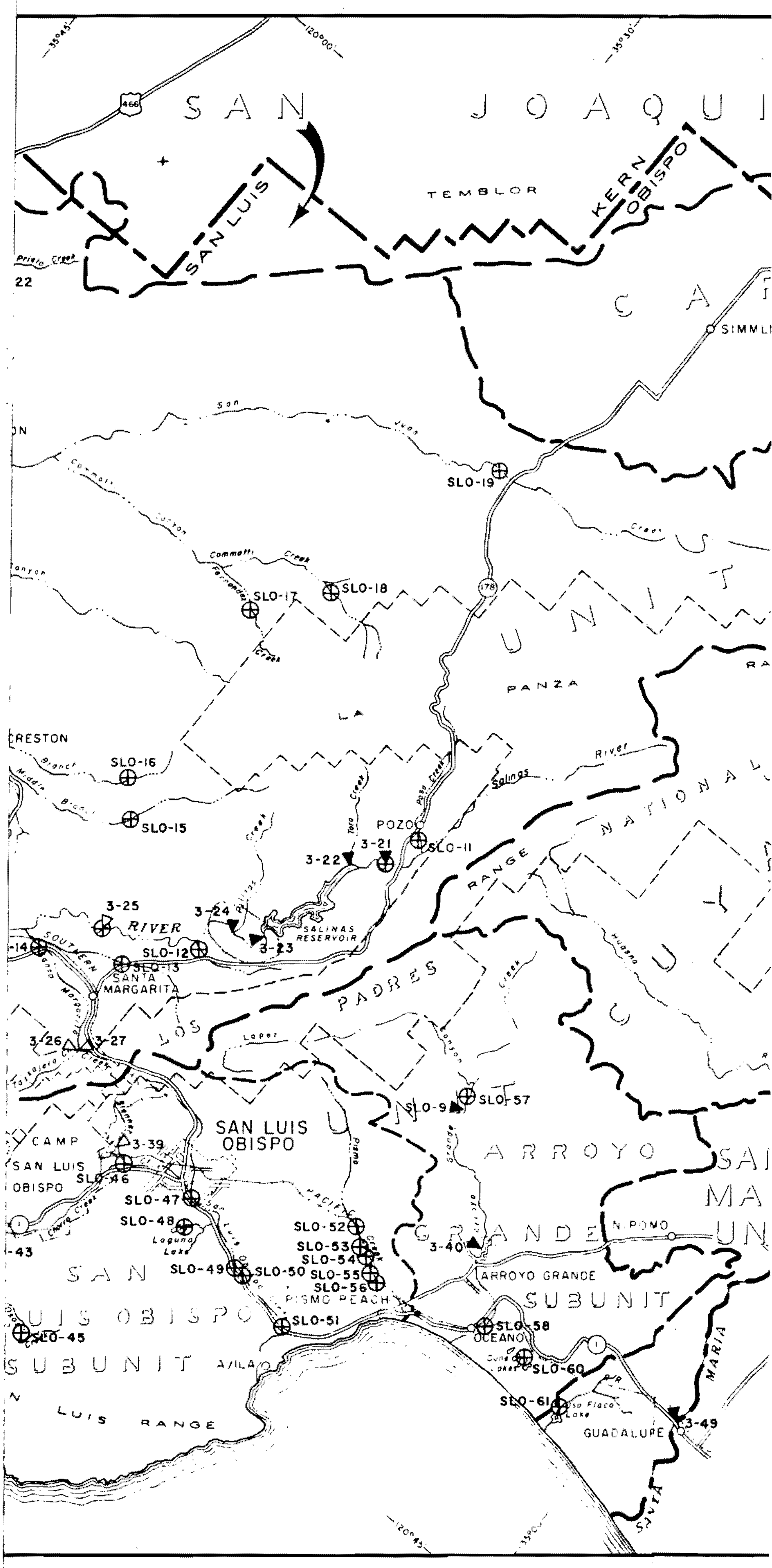
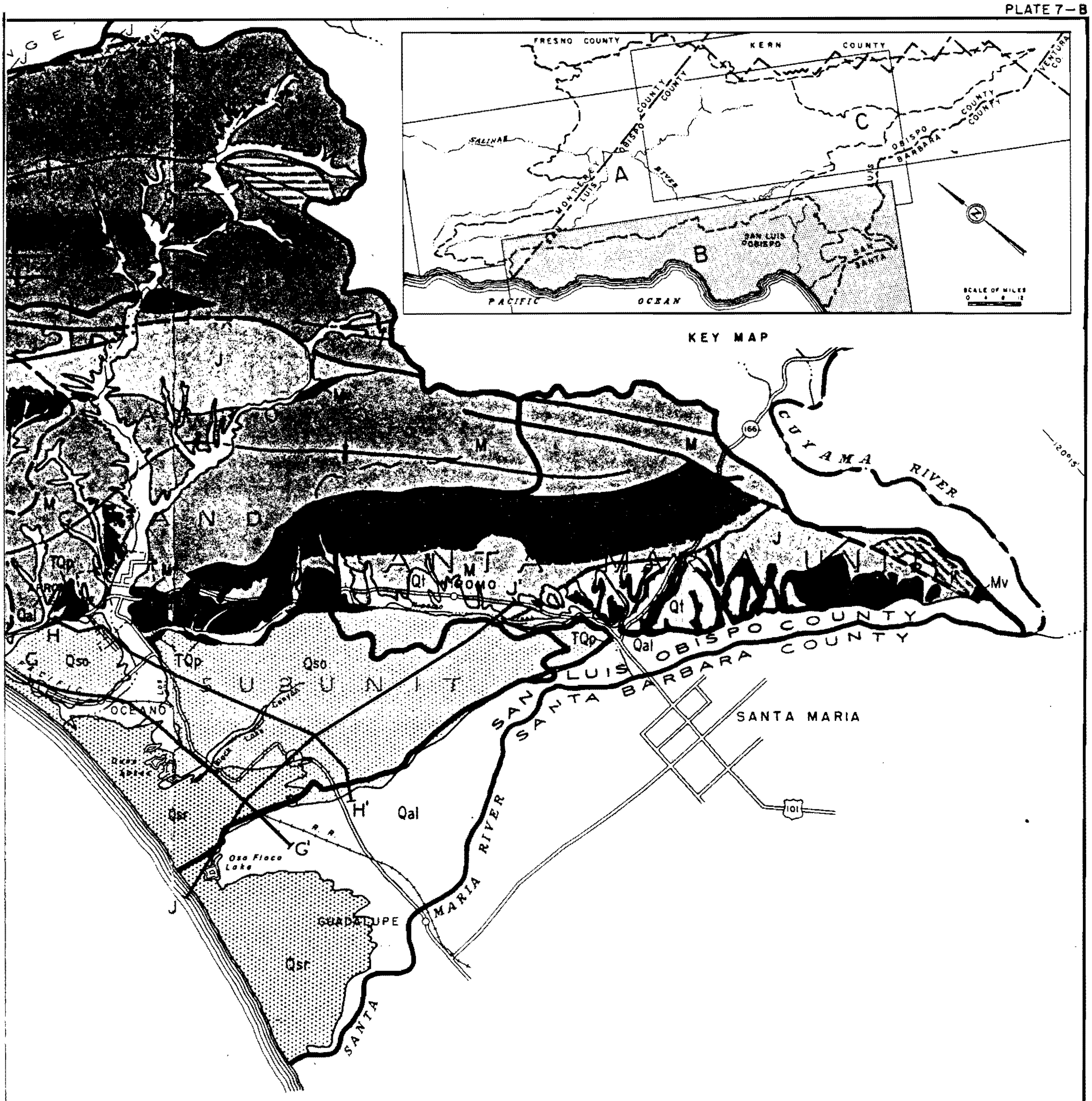
ARROYO DE LA CRUZ BASIN
SAN SIMEON BASIN
SANTA ROSA BASIN
CAMBRIA
SAN SIMEON
R.8E
R.7E
R.7E
R.6E
R.9E
R.8E
T.31S
T.32S
R.14E
R.13E
T.32S
T.12N
T.12N
T.11N
R.34W
R.35W
R.35W
R.36W
T.12N
T.11N
ARROYO GRANDE BASIN
ARROYO GRANDE
MT. DIABLO BASE AND MERIDIAN
SAN BERNARDINO BASE AND MERIDIAN
NIPOMO MESA BASIN
PACIFIC
SCALE OF MILES
1
0
1
2
3
DETAIL MAP


T.23S
T.24S
T.31S
T.32S
R.13E
R.12E


UNIT
COUNTY
COUNTY
RANGE
PLAIN
RIZO
SODA LAKE
UNIT
SLO-30
SLO-59
SLO-64
CUYAMA
SB-2
SB-1
VENTURA
399
399
CALIENTE
RANGE
UNIT
RIVER
COUNTY
COUNTY
166
SLO-62
SLO-63
OBISPO
BARBARA
FOREST
LUIS
CUYAMA
SANTA
MTNS
RAFAEL
SAN
3-43
3-42
3-44
3-48
166
SISQUOC
SAN
RIVER
SANTA MARIA
SLO-10
101
LEGEND
RECORDING STREAM GAGING STATION, ACTIVE
RECORDING STREAM GAGING STATION, INACTIVE
NON-RECORDING STREAM GAGING STATION, ACTIVE
NON-RECORDING STREAM GAGING STATION, INACTIVE
SURFACE WATER SAMPLING STATION
STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES
SAN LUIS OBISPO COUNTY INVESTIGATION
STREAM GAGING AND WATER SAMPLING STATIONS
1954
SCALE OF MILES
0 2 4 6 8 10
120°30'


SAN JOAQUI
466
TEMBLOR
SAN LUIS
KERN
OBISPO
Prieto Creek
22
CA
SIMMLE
San Juan
SLO-19
Creek
Commatti Creek
SLO-17
SLO-18
178
UNIT
PANZA
LA
CRESTON
SLO-16
SLO-15
Salinas River
NATIONAL
POZO
SLO-11
3-21
3-22
RANGE
3-24
3-25
RIVER
SALINAS RESERVOIR
3-23
SLO-12
SLO-13
SANTA MARGARITA
PADRES
LOS
3-26
3-27
Lopez
SAN LUIS OBISPO
SLO-9
SLO-57
ARROYO
CAMP SAN LUIS OBISPO
3-39
SLO-46
SLO-47
SLO-48
Laguna Lake
SLO-52
SLO-53
SLO-54
SLO-55
SLO-56
GRANDE
3-40
NIPOMO
SLO-49
SLO-50
SAN
ARROYO GRANDE
SUBUNIT
PISMO BEACH
SLO-51
SLO-58
OCEANO
SLO-45
LUIS OBISPO
SUBUNIT
AVILA
SLO-60
SLO-61
GUADALUPE
3-49
LUIS RANGE
SANTA
MARIA
SAN MA UN
-43
-14
RA



SEE PLATE 8—B FOR GEOLOGIC CROSS SECTIONS

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

SAN LUIS OBISPO COUNTY INVESTIGATION

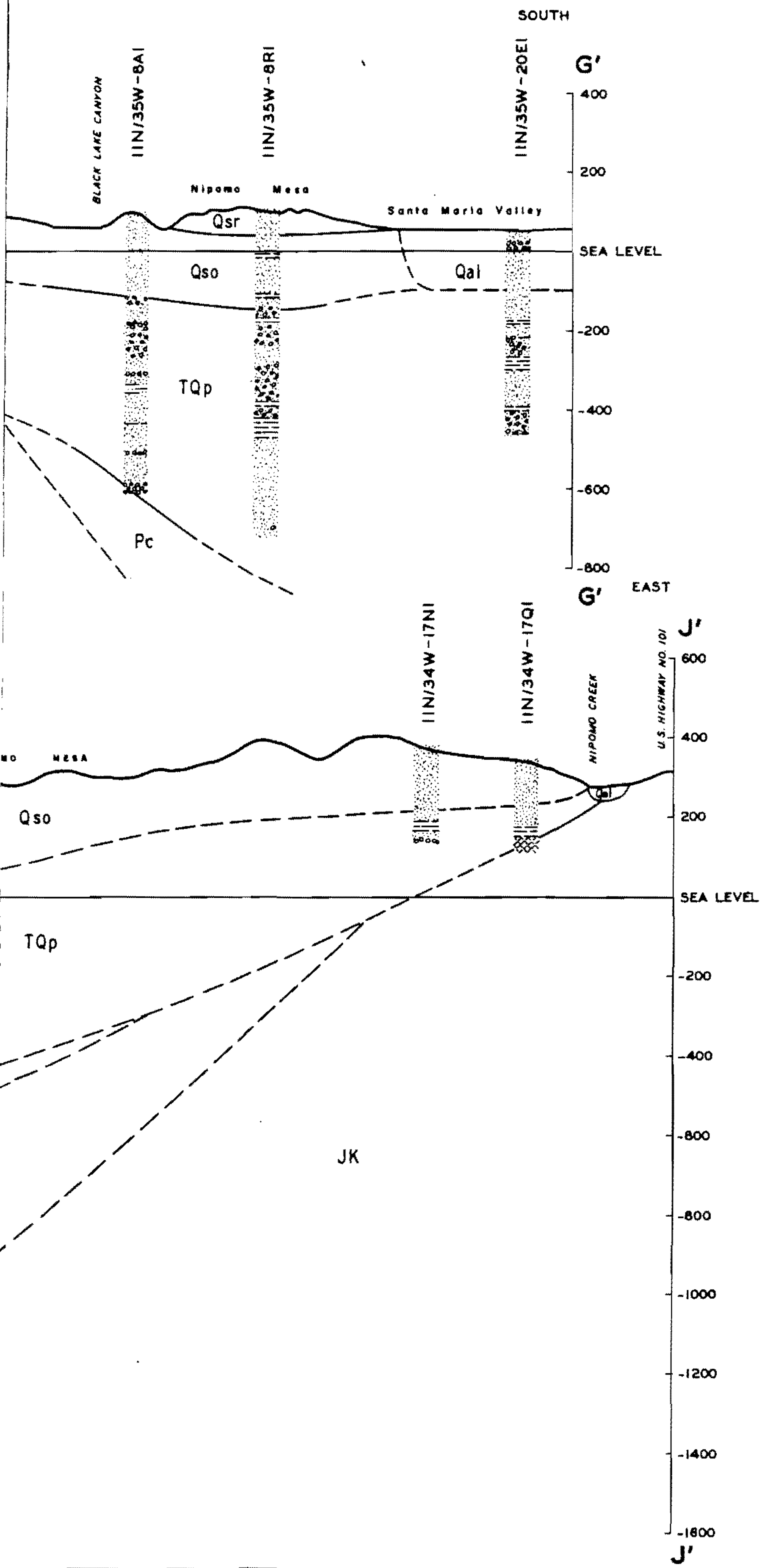
COASTAL AND SANTA MARIA HYDROLOGIC UNITS

AREAL GEOLOGY

1954

SCALE OF MILES
1 0 1 2 3


SANTA MARGARITA
NATIONAL
PADRES
CAMP SAN LUIS OBISPO
SAN LUIS OBISPO
MORRO BA
CAYUCOS
PISMO BEACH
SAN LUIS OBISPO
OCEAN
Qal
Qt
Qsr
Qso
Mv
J
M
E
E'
ND
Ql LAKE DEPOSITS
LAY
O OLDER ALLUVIUM
ENTAL SAND, GRAVEL, AND CLAY
ATION
GRAVEL, SILT, CLAY, FRESH WATER
FF. (UPPER PASO ROBLES FORMATION
SIN)
S FORMATION
NLY IN PASO ROBLES BASIN)
Y TO UPPER PASO ROBLES FORMATION
FOLDED
ENTAL SANDSTONE, CONGLOMERATE,
NENTAL SANDSTONE, SHALE, AND
STONE, CONGLOMERATE, AND SHALE
, SHALE, AND CONGLOMERATE
, CONGLOMERATE, AND SHALE
IGNEOUS ROCKS
TIC, AND RHYOLITIC ROCKS
X
WATER-BEARING
NONWATER-BEARING
WHERE INFERRED
ED WHERE APPROXIMATELY LOCATED
IERE APPROXIMATELY LOCATED,
NCEALED
120°45'
120°30'
121°00'
35°00'



LEGEND

- SAND
- GRAVEL
- CLAY
- HARD ROCK
- OIL WELL

WATER BEARING:

- Qal — RECENT AND UPPER PLEISTOCENE ALLUVIUM
- Qsr — RECENT SAND DUNES
- Qso — UPPER PLEISTOCENE SAND DUNES
- TQp — PASO ROBLES FORMATION
- Pc — CAREAGA SAND

NONWATER BEARING:

- Mv — VOLCANICS OF MIOCENE AGE
- Tu — UNDIFFERENTIATED TERTIARY FORMATIONS
- JK — UNDIFFERENTIATED JURASSIC AND CRETACEOUS FORMATIONS

NOTE: LOCATION OF CROSS SECTIONS ARE SHOWN ON PLATE 7B.

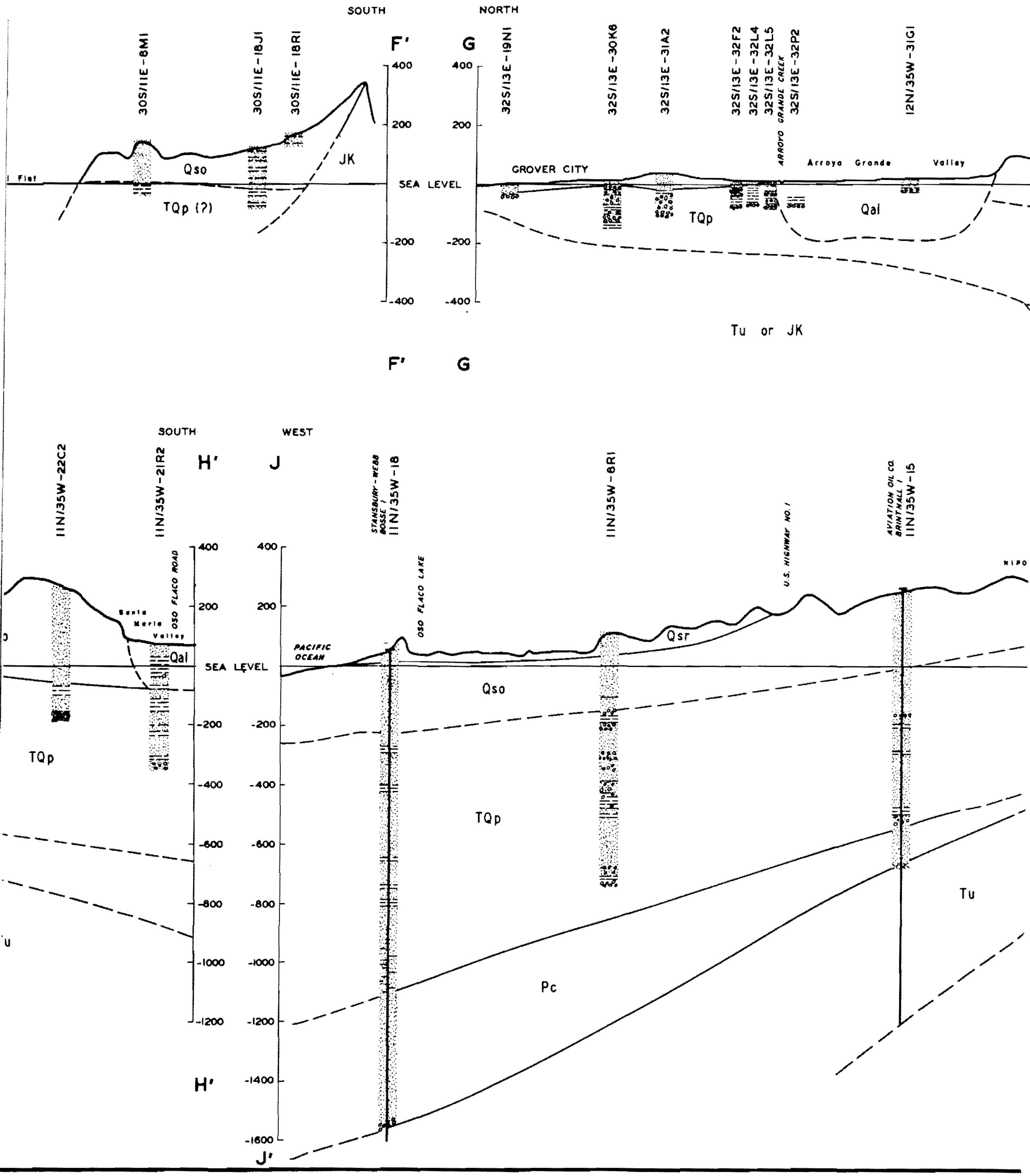
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

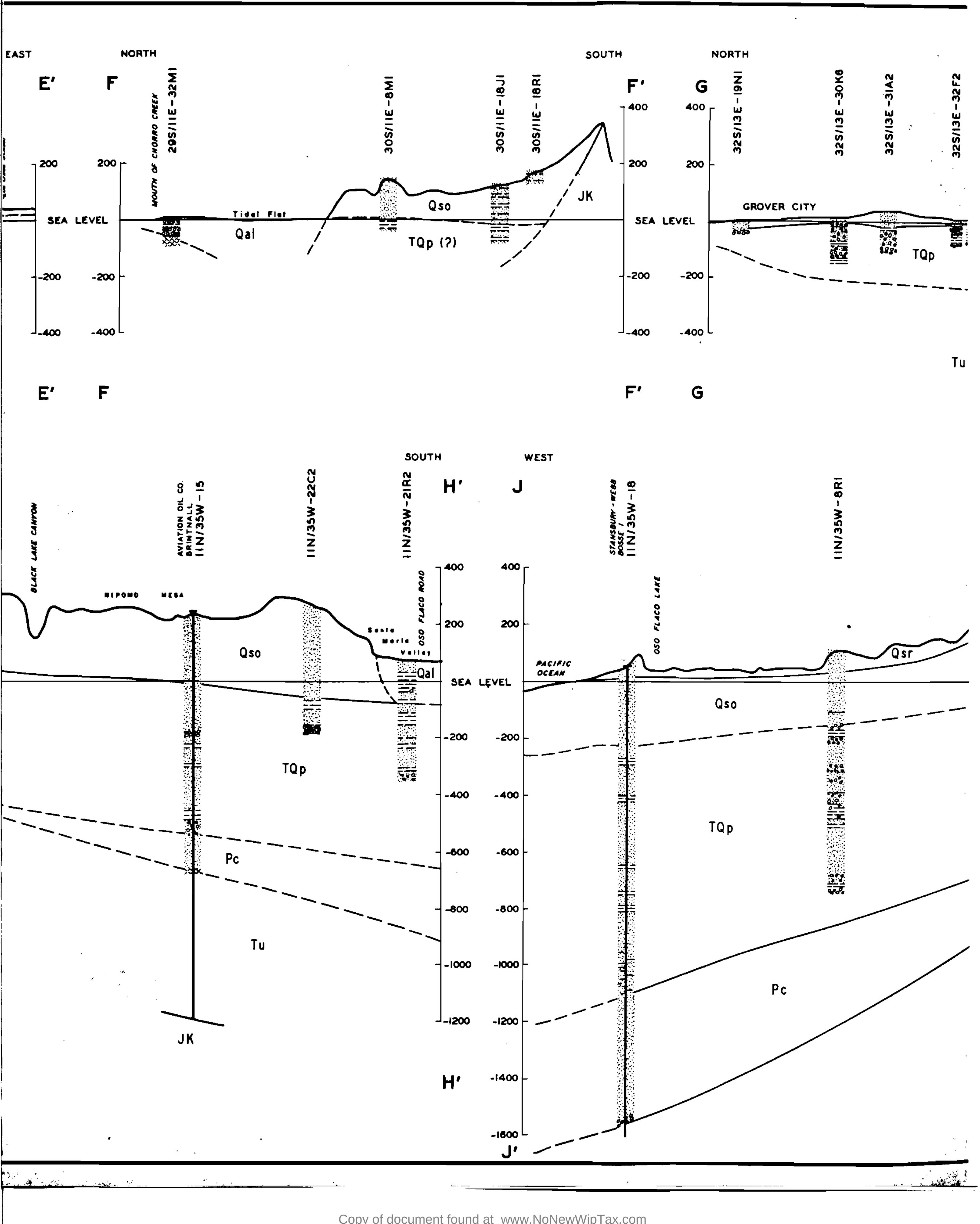
SAN LUIS OBISPO COUNTY INVESTIGATION

GEOLOGIC CROSS SECTIONS E-E', F-F', G-G', H-H' AND J-J'

1955

HORIZONTAL SCALE IN MILES
0


SOUTH
NORTH
F'
G
30S/11E-8M1
30S/11E-18J1
30S/11E-18R1
32S/13E-19N1
32S/13E-30K8
32S/13E-31A2
32S/13E-32F2
32S/13E-32L4
32S/13E-32L5
ARROYO GRANDE CREEK
32S/13E-32P2
12N/35W-31G1
400
200
SEA LEVEL
-200
-400
Qso
JK
TQp (?)
GROVER CITY
Arroyo Grande Valley
TQp
Qal
Tu or JK
F'
G
SOUTH
WEST
H'
J
11N/35W-22C2
11N/35W-21R2
OSO FLACO ROAD
Santa Maria Valley
Qal
TQp
STANSBURY-WEBB BOSSE 1
11N/35W-18
OSO FLACO LAKE
PACIFIC OCEAN
11N/35W-8R1
U.S. HIGHWAY NO. 1
AVIATION OIL CO. BRINTNALL 1
11N/35W-15
NIPO
Qsr
Qso
TQp
Pc
Tu
-600
-800
-1000
-1200
-1400
-1600
H'
J'


EAST
NORTH
E'
F
MOUTH OF CHORRO CREEK
29S/11E-32M1
30S/11E-8M1
30S/11E-18J1
30S/11E-18R1
SOUTH
F'
G
NORTH
32S/13E-19N1
32S/13E-30K6
32S/13E-31A2
32S/13E-32F2
SEA LEVEL
Tidal Flat
Qal
Qso
TQp (?)
JK
GROVER CITY
TQp
Tu
E'
F
F'
G
BLACK LAKE CANYON
NIPOMO MESA
AVIATION OIL CO. BRINTNALL 11N/35W-15
11N/35W-22C2
SOUTH
11N/35W-21R2
H'
OSO FLACO ROAD
Santa Maria Valley
Qso
Qal
TQp
Pc
Tu
JK
WEST
J
STANSBURY-WEBB BOSSE 1 11N/35W-18
OSO FLACO LAKE
11N/35W-8R1
PACIFIC OCEAN
SEA LEVEL
Qsr
Qso
TQp
Pc
H'
J'

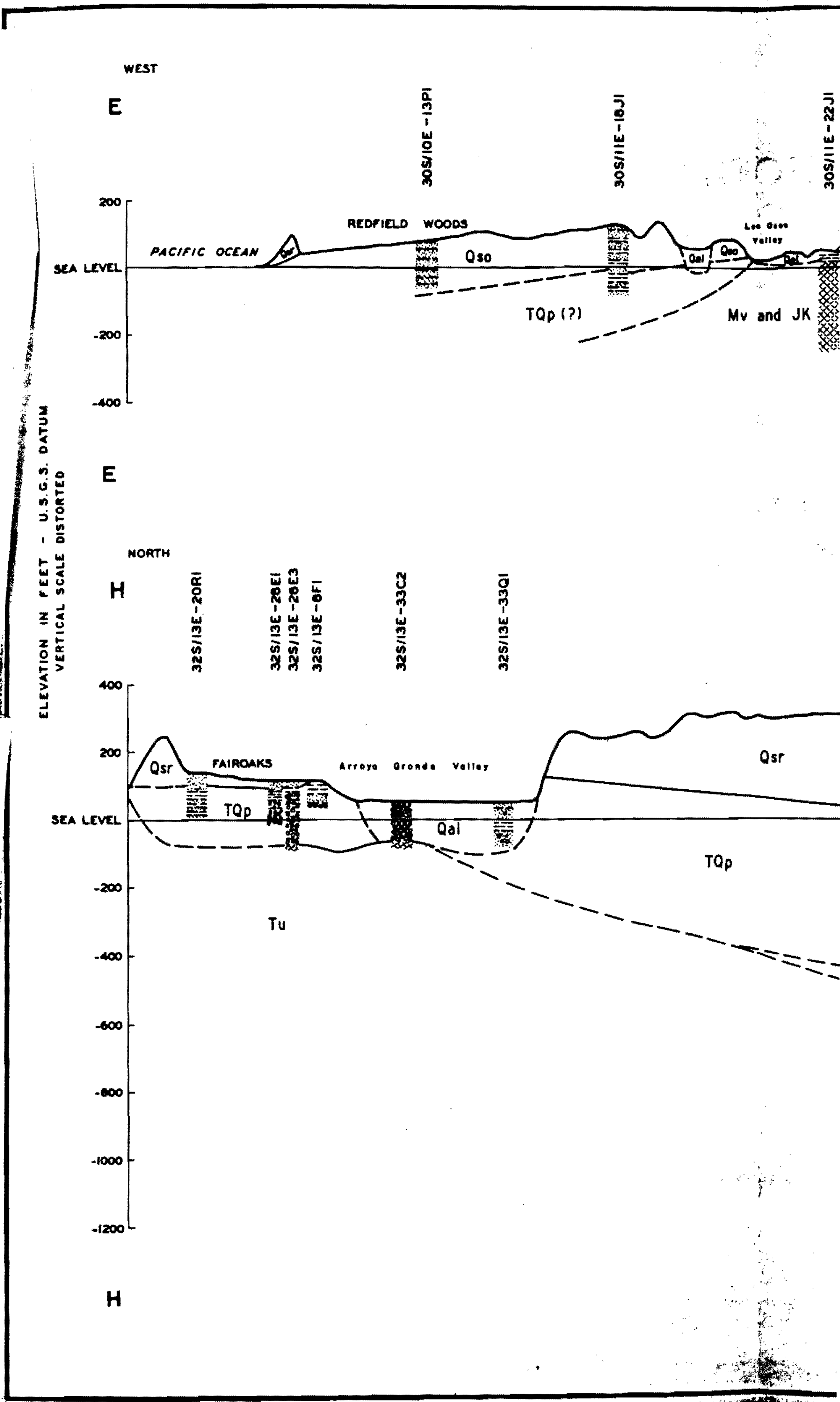
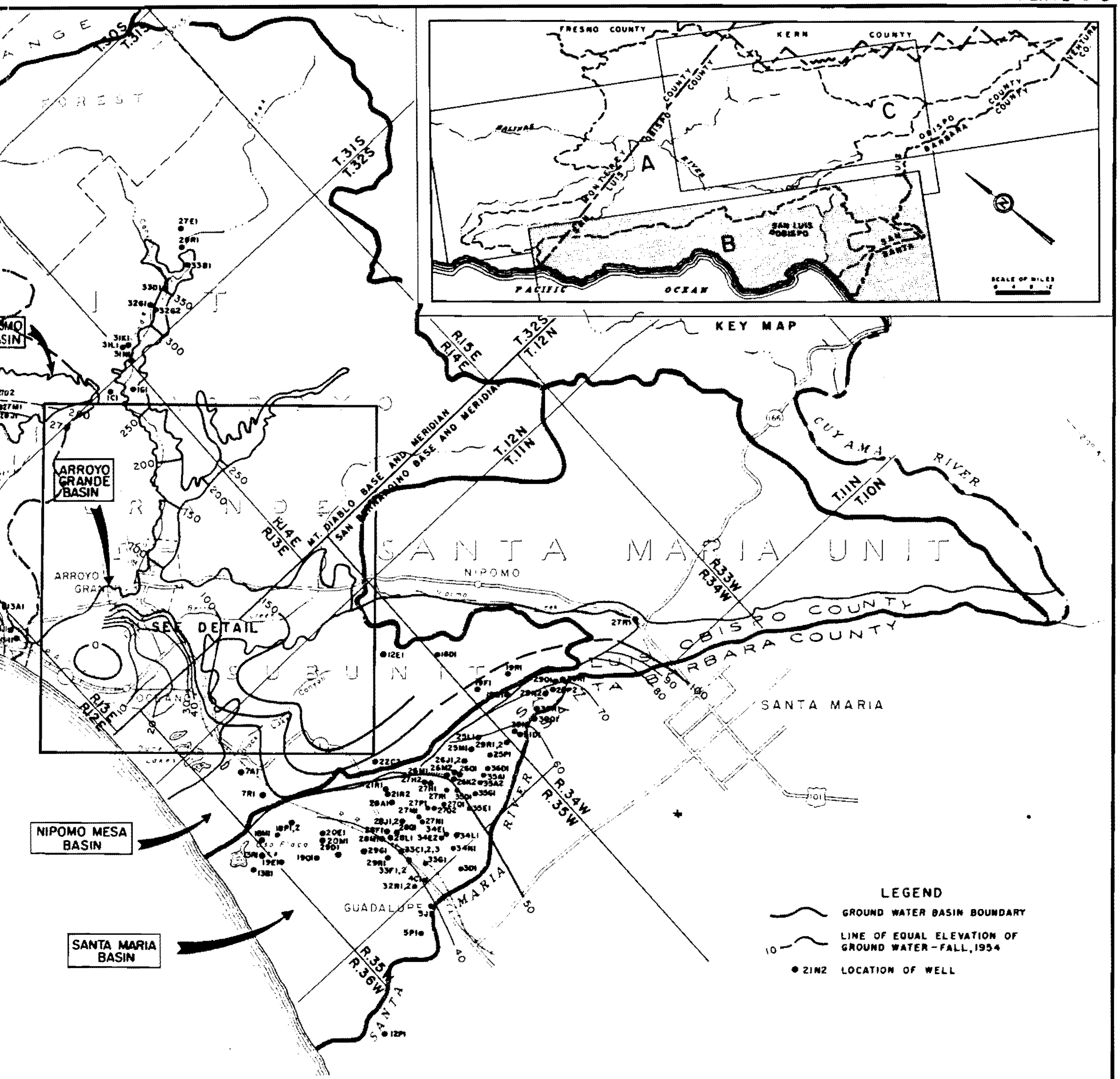

WEST
E
30S/10E-13P1
30S/11E-18J1
30S/11E-22J1
200
SEA LEVEL
-200
-400
PACIFIC OCEAN
REDFIELD WOODS
Qso
Qal
TQp (?)
Mv and JK
ELEVATION IN FEET - U.S.G.S. DATUM
VERTICAL SCALE DISTORTED
E
NORTH
H
32S/13E-20R1
32S/13E-28E1
32S/13E-28E3
32S/13E-6F1
32S/13E-33C2
32S/13E-33Q1
400
200
SEA LEVEL
-200
-400
-600
-800
-1000
-1200
Qsr
FAIROAKS
Arroyo Grande Valley
TQp
Qal
Tu
Qsr
TQp
H

PLATE 9-B



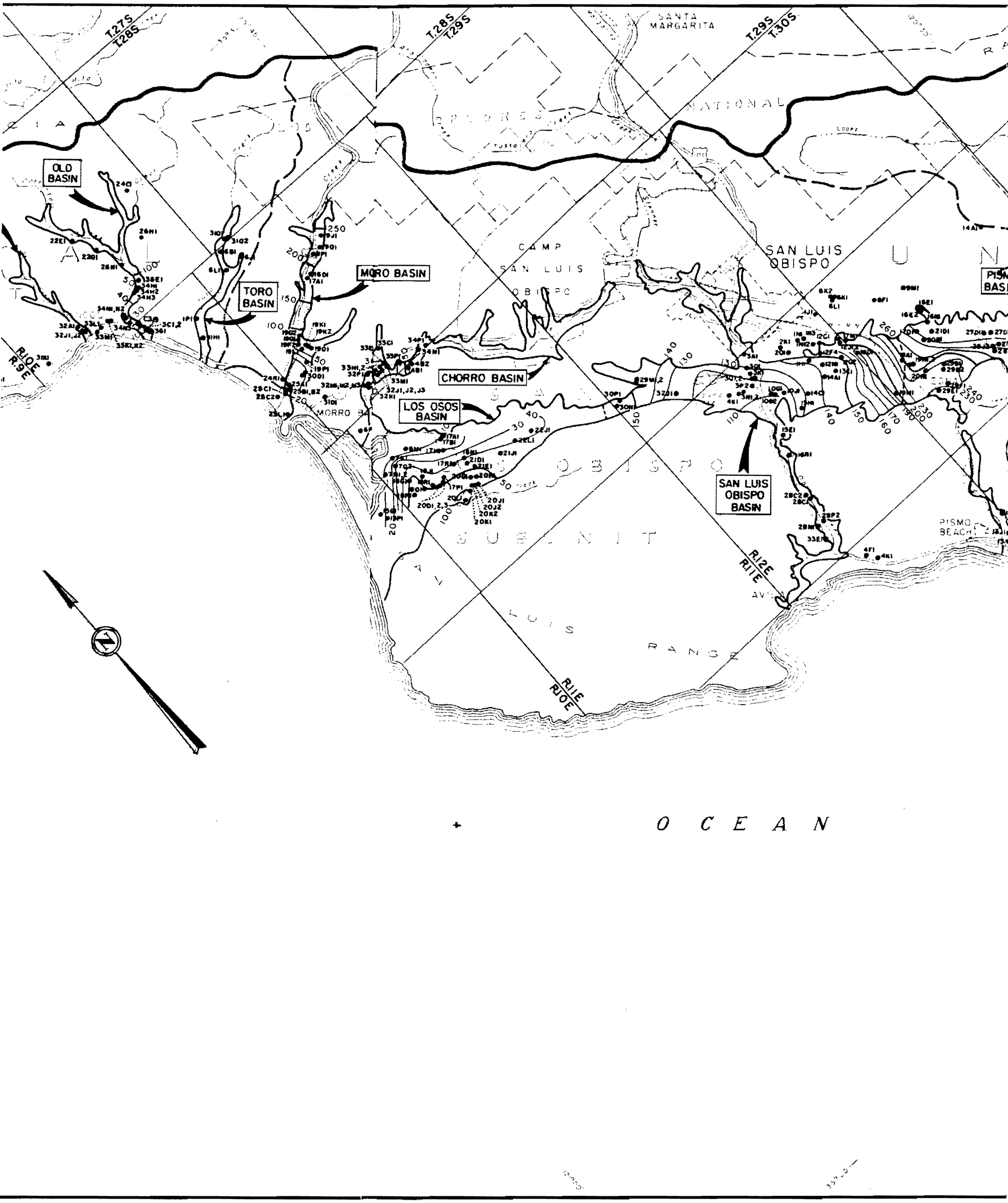
STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

SAN LUIS OBISPO COUNTY INVESTIGATION

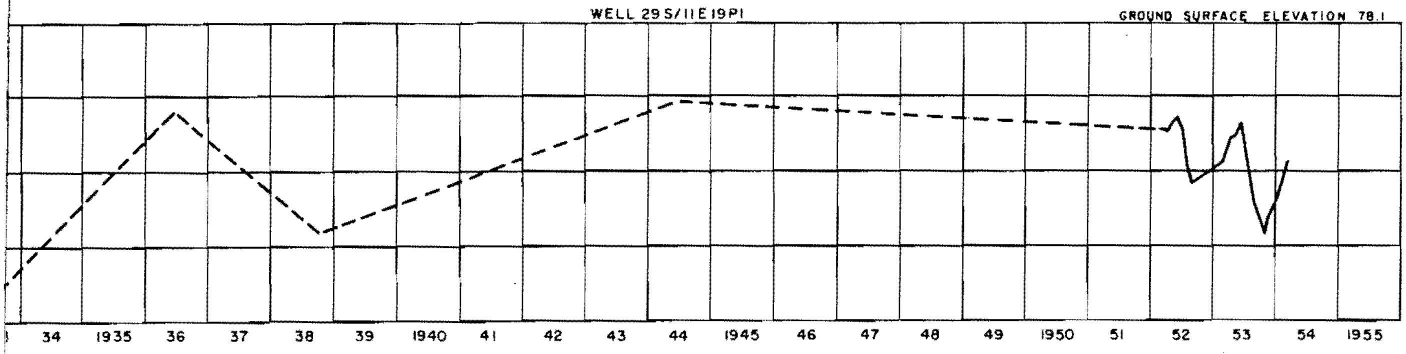
COASTAL AND SANTA MARIA HYDROLOGIC UNITS

LINES OF EQUAL ELEVATION OF GROUND WATER FALL, 1954

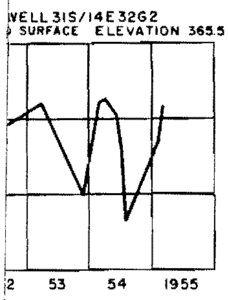
SCALE OF MILES
0 1 2 3

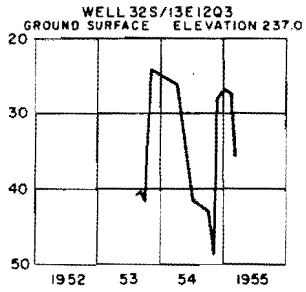

T.27S
T.28S
T.29S
T.30S
SANTA MARGARITA
NATIONAL
OLD BASIN
TORO BASIN
MORO BASIN
CHORRO BASIN
LOS OSOS BASIN
SAN LUIS OBISPO BASIN
CAMP SAN LUIS OBISPO
SAN LUIS OBISPO
PISMO BEACH
SUBUNIT
RANGE
R10E
R9E
R11E
R12E
OCEAN

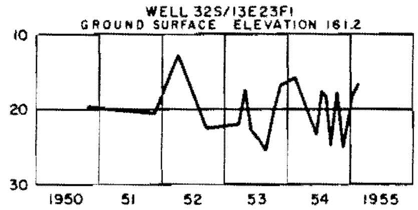
MORRO BASIN

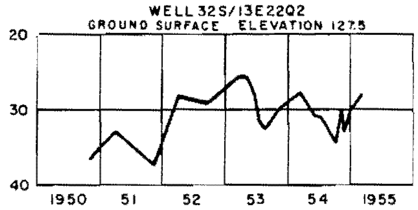


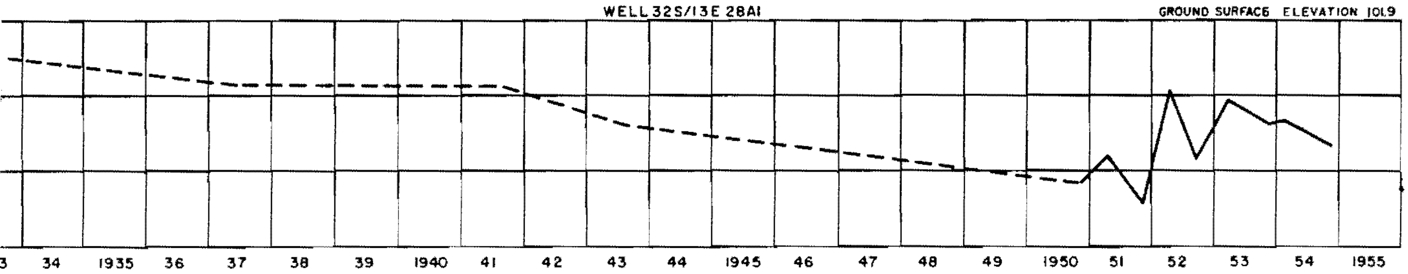
ARROYO GRANDE BASIN







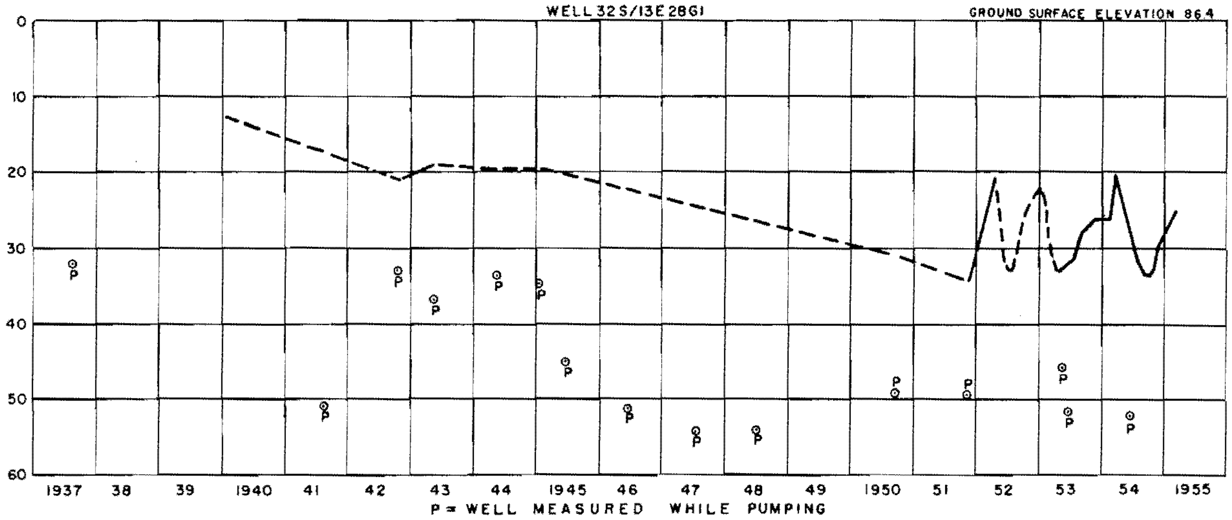




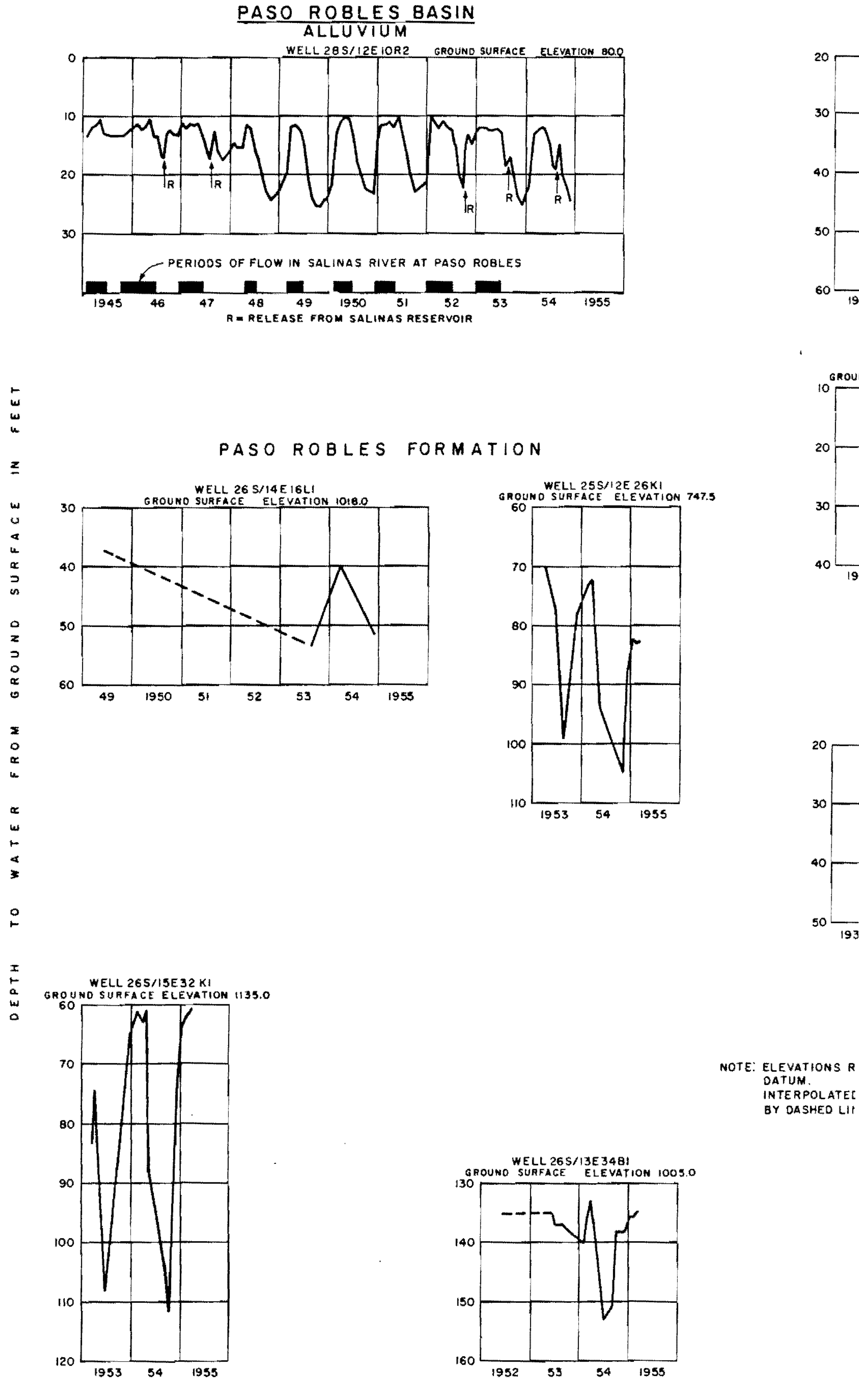
…FERRED TO U.S.G.S.

…LEVELS INDICATED

…E.

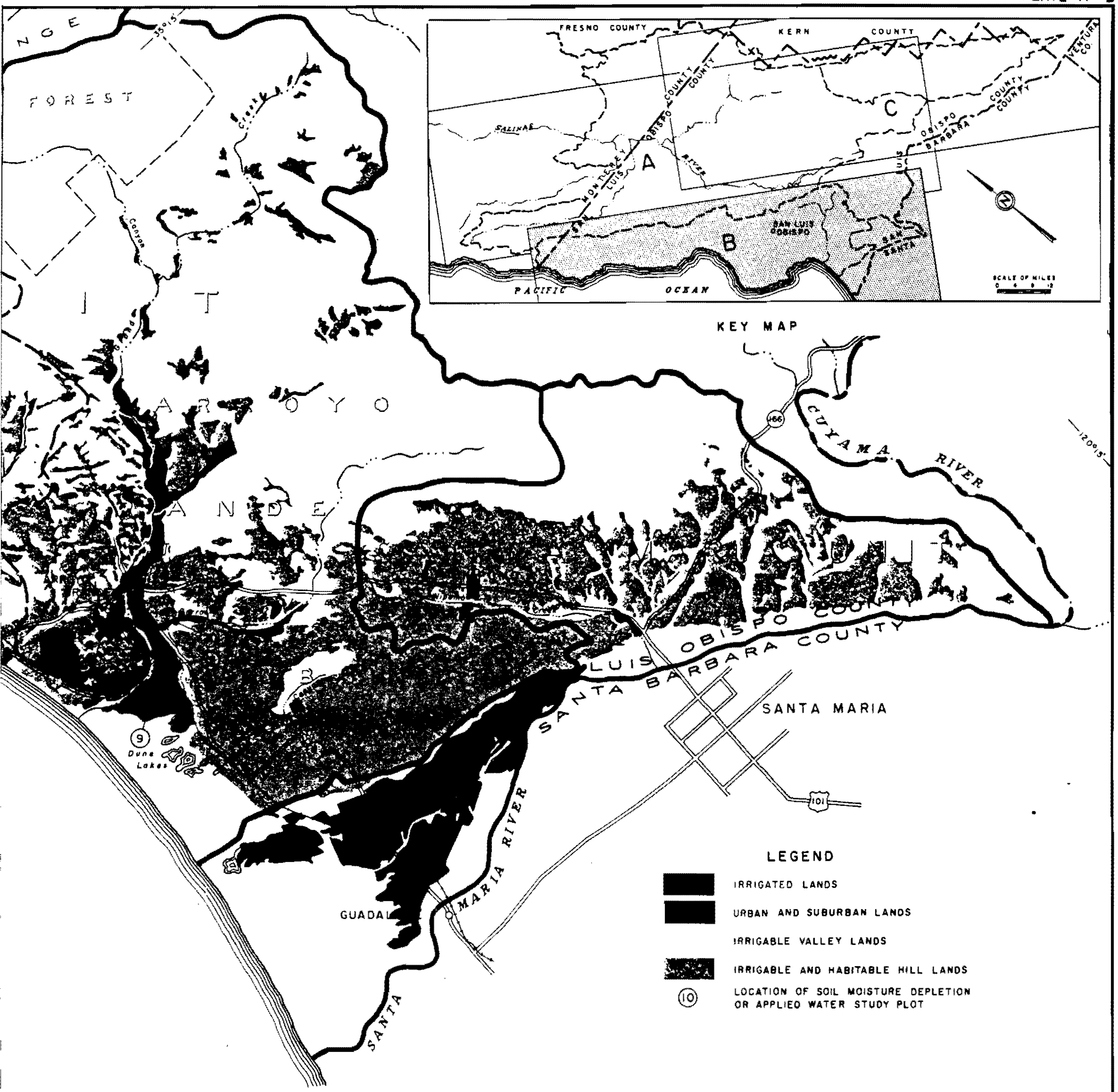


…WATER LEVELS AT SELECTED WELLS



FLUCTUATION OF

DEPARTMENT OF WATER RESOURCES



STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
DIVISION OF RESOURCES PLANNING

SAN LUIS OBISPO COUNTY INVESTIGATION

COASTAL AND SANTA MARIA HYDROLOGIC UNITS

PRESENT AND PROBABLE ULTIMATE LAND USE

1954

SCALE OF MILES
1 0 1 2 3


SANTA MARGARITA
120°30'
120°45'
35°30'
PADRES
NATIONAL
LOS
CAMP
SAN LUIS OBISPO
101
8
22
19
6
OBISPO
SUBUNIT
LUIS
RANGE
PISMO BEACH
OCEAN
121°00'
35°00'