South Pacific Division

Water Resources Development

by the

U.S. Army Corps of Engineers in

California

January 1979

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DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO ATTENTION OF: DAEN-PAR

January 1979

TO OUR READERS:

Water, as every American is learning, is a finite resource. And we of the United Stated Army Corps of Engineers are the stewards and principal developers of this most vital of the Nation's resources. This booklet is only one of a series which covers our past, current, and proposed activities for every state in the Union.

Our work began in 1824 when the Congress first directed us to begin navigation work on the waterways of the United States so that an improved transportation system could open up the West for expansion. Since that time, the Engineers have found themselves widening their efforts into flood control, water supply, hydroelectric power, recreation, and water conservation to meet the needs and the demands of the American people. Today, there is increased emphasis on conservation, wetland protection, non-structural engineering solutions, metropolitan and flood plain water management, and the preservation and enhancement of the environment. We of the Corps take great satisfaction in our long record of service to meet the changing needs in water resource management.

We find that our engineering experience has achieved international recognition, and demands for our services have grown into work for foreign countries. Through State Department sponsorship, we are exporting our technology to such far-flung places as Saudi Arabia and Nigeria, and overcoming some unique engineering challenges.

This booklet summarizes our efforts in only one state. Other booklets cover Corps' water resource programs in other states, possessions, and territories.

J. W. MORRIS
Lieutenant General, USA
Chief of Engineers

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FOREWORD

The Corps of Engineers has been engaged in developing California's water resources for well over 100 years. This booklet illustrates the role of the Corps in investigating, planning, constructing, and operating water projects, and provides information on projects that have been completed, are under construction or authorized for construction, or under study for possible authorization. Project information is grouped by hydrographic area, that is, by major river basin or group of contiguous stream basins that have generally similar characteristics. A chapter is devoted to each hydrographic area.

Information about special activities, work done to counter flood and other emergencies, flood plain management, the various authorities under which Congress has mandated Corps participation in water resources development, the genesis of Corps projects, and the way that cities and counties take part is covered in the final chapters of the booklet. Additional information on the Corps of Engineers in California can be obtained from any of the following:

Division Engineer South Pacific Division	630 Sansome Street San Francisco 94111
District Engineer San Francisco District	211 Main Street San Francisco 94105
District Engineer Sacramento District	650 Capitol Mall Sacramento 95814
District Engineer Los Angeles District	300 N. Los Angeles Street Los Angeles 90012

The area of jurisdiction of each District Engineer is shown on the map on page 11.

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Cover Photograph: "Marin Coast" courtesy of Betty Berryman, Sacramento.

Note: Unless otherwise credited, photographs in this booklet were taken by Corps of Engineers photographers.

1 WATER RESOURCES DEVELOPMENT BY THE CORPS OF ENGINEERS IN CALIFORNIA

INTRODUCTION

California, the Golden State, comprises a land and water area of about 160,000 square miles. The state has more than 1,200 miles of scenic coastline, and its topography is more varied than any other part of the United States except Alaska. Elevations range from 282 feet below sea level in Death Valley to 14,495 feet above sea level at the top of Mount Whitney, the lowest and highest points in the conterminous United States. In total, the state consists of twelve geomorphic provinces, each of which is distinctive from its neighbors. The dominant provinces are the Coast Ranges, the Central Valley, and the Sierra Nevada.

The Coast Ranges extend for nearly 600 miles just inland from the ocean. Their numerous, often indistinct, ridges rise from 2,000 to 7,000 feet and are separated by the valleys of numerous major rivers and other smaller streams.

The Central Valley lies east of the Coast Ranges and west of the Sierra Nevada. It is a vast alluvial plain 400 miles long by 50 miles wide. The southward flowing Sacramento River drains the northern portion of the valley and, except for a closed area at the southern end of the valley, the northward flowing San Joaquin River drains the southern portion. The rivers meet at the head of Suisun Bay, an easterly extending arm of San Francisco Bay. A very flat, low-lying, triangular shaped region lies upstream from the junction of the rivers. This region has been reclaimed from primordial swamp by hundreds of miles of levees along natural and manmade waterways that divide it into about 100 tracts locally known as "islands." The whole area (more than 1,000 square miles), which is known as the "Delta," is under the influence of the tides.

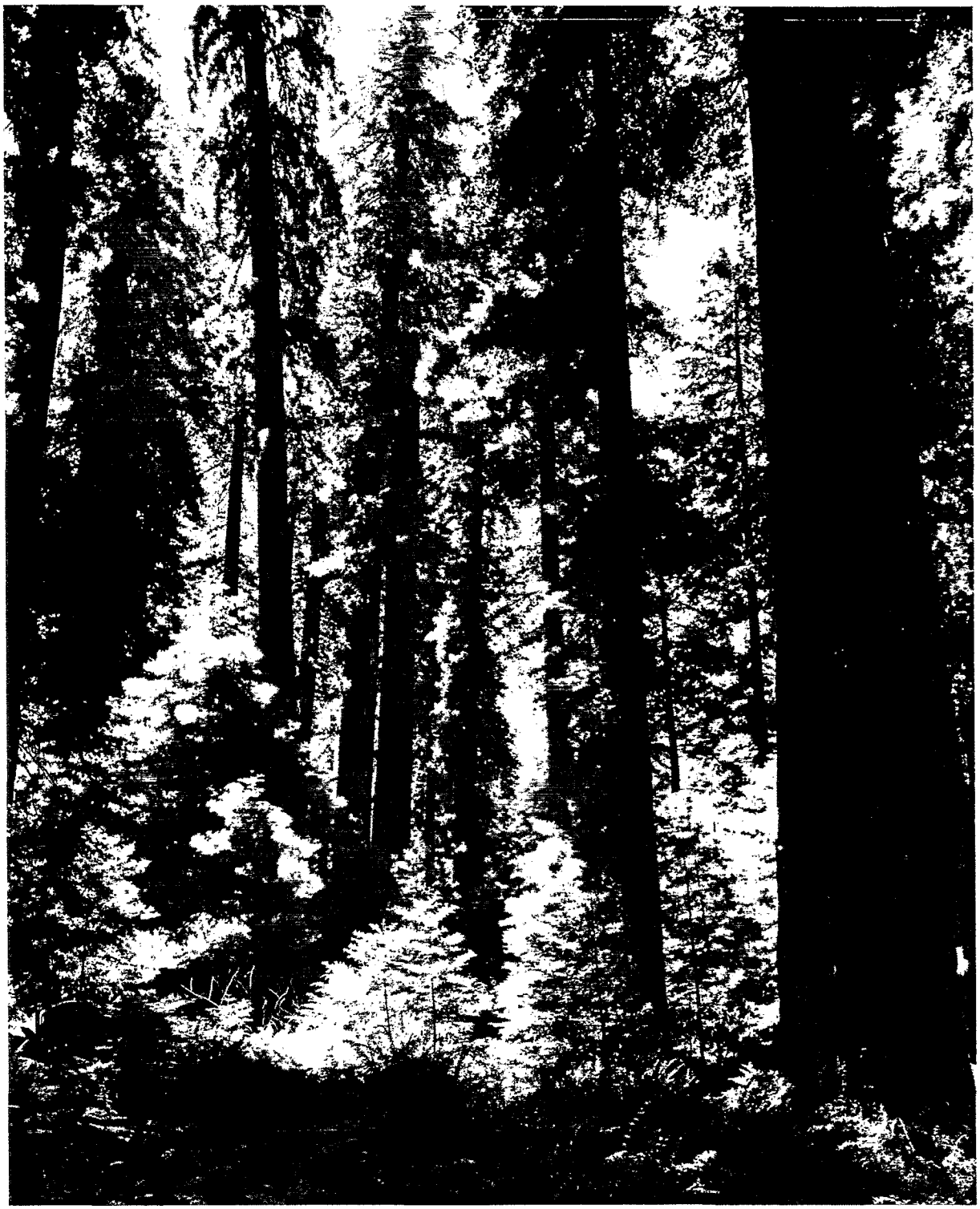
In the Sierra Nevada, a great westward dipping fault block 385 miles long and 85 miles wide, lofty peaks tower above precipitous gorges and canyons. About a dozen major streams traverse the western slope of the range and flow into the Sacramento and San Joaquin Rivers. Many of these streams occupy valleys as deep as ½ mile. By far the most spectacular of these is Yosemite, which was carved by glaciers many thousands of years ago. In the northern part of the Sierra Nevada, the highest peaks reach to about 8,500 feet. Mountain top elevations increase toward the south to culminate in Mount Whitney. Precipitous drops in elevation characterize most of the east side of the Sierra Nevada. Near Mount Whitney, this drop is almost 2 miles in a horizontal distance of 6 miles.

Other geomorphic provinces of the state are studies in contrasts. They range from the rugged, densely timbered Klamath Mountains and great redwood forests in the northwest sector of the state to high and low desert areas in the southeast sector, and to the volcanic cone studded Modoc Plateau in the northeast sector. The Transverse Ranges, of which the Channel Islands represent a seaward extension, break the typical southeastward grain of California topography and instead trend eastward as a group of linear ranges. The peaks in one of these ranges, the San Gabriel Mountains just north of Los Angeles, reach almost 10,000 feet. The Los Angeles-Long Beach metropolitan complex—the sixth largest in the world in population—lies on a broad coastal plain not much above sea level. The extreme variation in the physiography of California is illustrated in the series of photographs beginning on the opposite page.

The climate of California is as varied as its physiography but is generally considered to be mild. Instead of the usual four seasons, most of California has two—a cool, wet winter season and a warm, dry summer season. Coastal areas have a marine or mediterranean type climate with warm winters, cool summers, little daily and seasonal range in temperature, and high relative humidity. Inland from the coast, as the marine influence lessens, the climate becomes more continental with warmer summers, colder winters, greater range in daily and seasonal temperatures, and lower humidity. The change from mediterranean to continental climate results from topography, which also controls the amount and distribution of precipitation. In large portions of windward slopes of the northern Coast Ranges and the northern mountain region, annual precipitation is 50 inches or more. Annual precipitation decreases to about 20 inches in valley floor areas of the northern Central Valley, less than 10 inches in valley floor areas of the southern Central Valley, and less than 5 inches in the southeastern desert areas. Average annual precipitation ranges from 110 inches in parts of the northern Coast Ranges to less than 2 inches in parts of Death Valley. Most of the annual precipitation occurs in the winter season, which extends from November through March in the southern part of the state and from October through April in the northern part.

Snow occurs at elevations as low as 2,000 feet in the Sierra Nevada foothills but does not remain on the ground below 4,000 feet. The zone of heavy snowfall is from 7,000 to 8,000 feet. Melting of the normally deep snowpack in these and higher elevations sustains continuous flow of most Sierra Nevada streams during the summer.

Temperatures ranging from 134° to -45° have been recorded in California. On the basis of continued periods of high temperatures, Death Valley is the hottest place in the world. Along the coast, the range in temperature from day to night and from winter to summer is very small. Daily and seasonal ranges in temperature increase with distance from the coast and, in periods of extreme summer heat, the temperature in Death Valley can be twice that recorded along the north coast.



Redwood Forest, North Coastal Basins (Photo courtesy U.S. Bureau of Reclamation)

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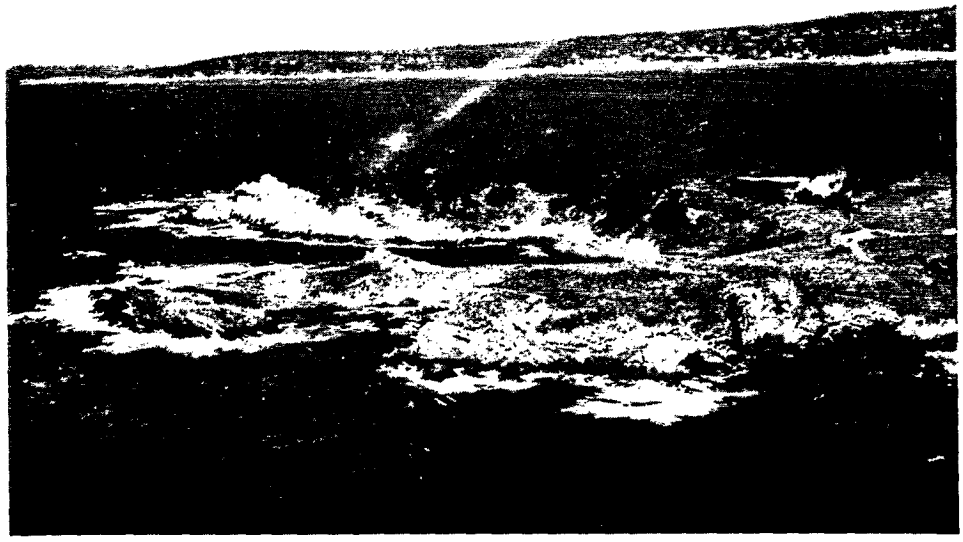
Point Arena, Northern California coast (State Water Resources Control Board photograph)



Point Lobos, Central Coastal Basins area (State Water Resources Control Board photograph)

The Warner Range. One of the source areas of the Sacramento River in northeast California.(State Water Resources Control Board photograph)

Typical agricultural lands, Central Valley (Photo courtesy U.S. Bureau of Reclamation)

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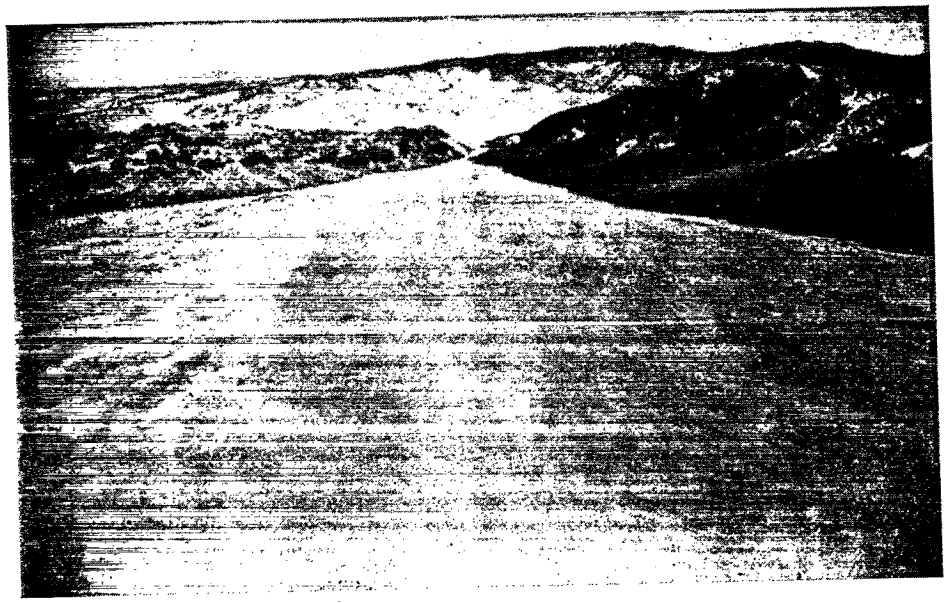
San Joaquin Delta (NASA U2 photograph)

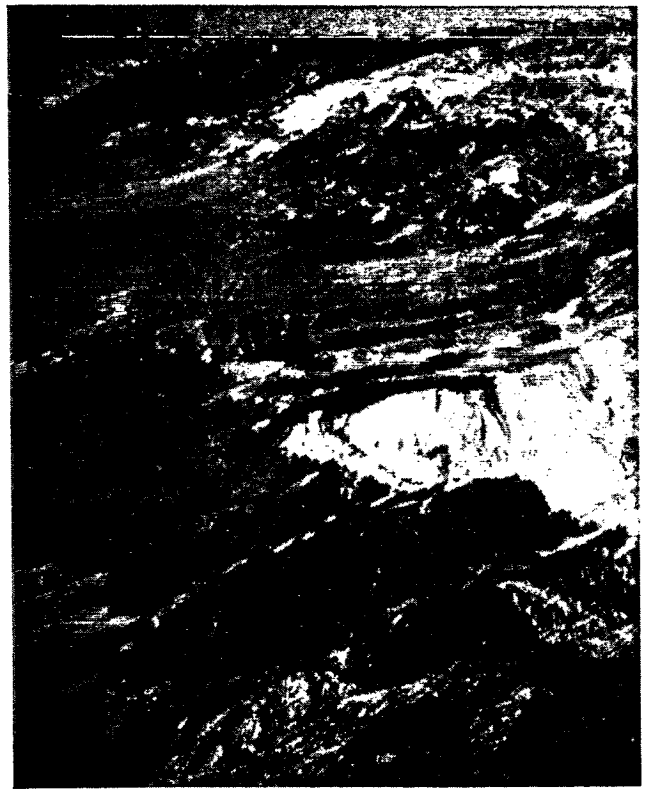
Geothermal resources area, Sonoma and Lake Counties (Photo courtesy Pacific Gas and Electric Company)

East escarpment of the Southern Sierra Nevada (State Water Resources Control Board photograph)

Black Divide Peak, Southern Sierra Nevada. Drainage separates to the San Joaquin Basin—left side—and to the Tulare Lake Basin—right side. (Fresno Bee photograph)



A segment of Death Valley, South Lahontan Territory (State Water Resources Control Board photograph)



Chocolate Mountains, Colorado Desert east of the Salton Sea (State Water Resources Control Board photograph)

Sand dunes on the east side of the Imperial Valley, Colorado Desert (Photo courtesy U.S. Bureau of Reclamation)

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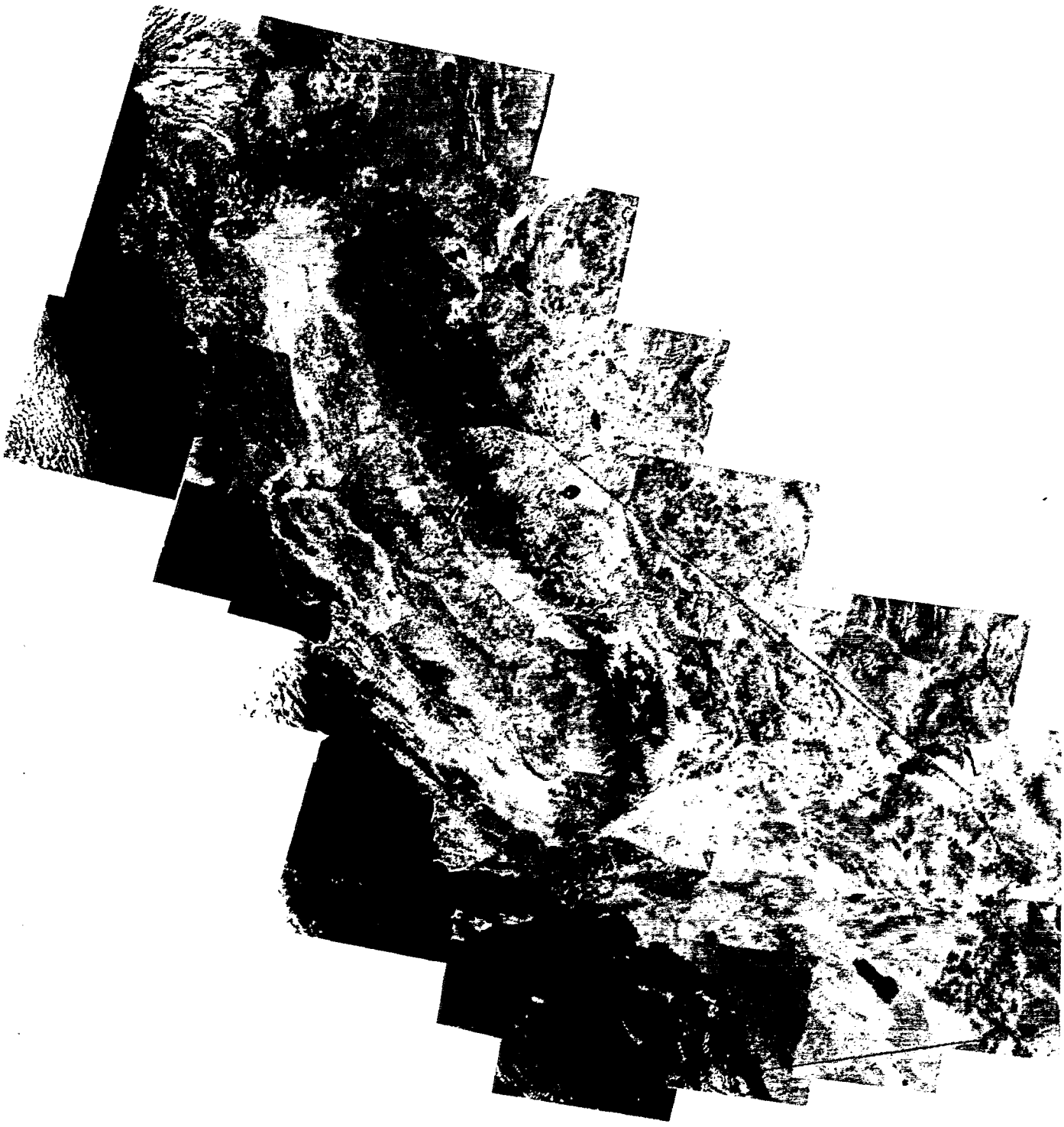

California from space (This mosaic was produced from false color infrared imagery collected by NASA Earth Resources Technology Satellite 1 orbiting at an elevation of 570 miles. Infrared imagery enhances the presence of growing vegetation, which appears reddish in the mosaic.) (California Department of Water Resources photograph—File No. 4505-9)

Thunderstorms occur in the summer in the interior, high mountain, and desert areas. Where precipitation is very light, lightning can cause forest fires. Tornadoes occur some place in California on the average of about once a year. Although flooding can occur at any time of the year, the worst floods usually occur in winter as a result of prolonged, widespread rainstorms accompanied by above normal temperatures that melt the snowpack. However, flooding from snowmelt may result from unseasonally warm weather in April, May, and early June. In the Delta, flood levels are significantly influenced by the tides. Severe flooding occurs when high tides and strong onshore winds coincide with flood outflow from the Central Valley.

California has abundant water, fuel, and forest resources as well as metallic and nonmetallic minerals. Its agricultural soils are some of the best in the world and crops grown anywhere in the United States can be grown in California. Further, because of an unusually long frost-free period, many crops grown in California cannot be grown commercially elsewhere, and agriculture based on irrigation is the predominant factor of the economy of the state. In total, however, the economy of the state is highly diversified with about 9,800,000 people gainfully employed. Distribution of employment shows about 3,100,000 persons employed in basic industries such as agriculture, forestry, mining, manufacturing, and fishing; and about 6,700,000 employed in service industries. The January 1978 population of California, just over 22,000,000, is expected to increase to around 30,000,000 by the year 2000.

California has extensive development for municipal, industrial, and irrigation water supplies and sufficient water is developed by completed projects, or will be developed by those under or nearing construction, to meet most urban and irrigation needs foreseen for the near future. However, additional conveyance facilities are needed to deliver developed supplies to certain service areas. While additional major storage projects may not be needed immediately for water conservation, they may be warranted for flood control because flood problems are increasing. Indeed, intensification of land use resulting from increasing population will require a vigorous flood control program for many years to come. Local agencies should carefully consider flood plain management in addition to construction of flood control facilities. The increasing demand for water associated recreation will require the development of additional water surface and shoreline, particularly near major urban centers.

More than four-fifths of the additional electrical energy needed by about the year 2000 is expected to be derived from fossil or nuclear fueled steamplants, which require large amounts of cooling water. If half of the projected increase in generating capacity is from inland sites, due to limited acceptability of coastal sites, the demand for cooling water could comprise one of the largest increases in future water demand.

California has a highly developed system of modern, well maintained state and interstate freeways and highways, and a variety of commercial and recreational navigation facilities exist along its 1,200-mile coast, within its natural bays and estuaries, and on the Sacramento and San Joaquin Rivers. Major commercial navigation developments exist in the San Francisco and Los Angeles areas. However, present trends in ship design — for example, 50-foot draft tankers and 70-foot draft supertankers — and advanced cargo handling techniques indicate that major improvements are required if existing ports and waterways are to operate efficiently in the future. Future commercial navigation needs also include construction of coastal harbors for light draft commercial vessels, extension and enlargement of inland waterways and harbors, and extension of off-shore petroleum terminals to deeper water. A chain of harbors of refuge is needed for intracoastal cruising by recreational vessels.

HYDROGRAPHIC AREAS OF CALIFORNIA

To present information on projects and activities in a region with such wide variations in physiography and climate as California, the state has been divided into the following eleven areas:

North Coastal Basins
San Francisco Bay Area
Central Coastal Basins
South Coastal Basins
Sacramento Basin
Delta-Central Sierra Area
San Joaquin Basin
Tulare Lake Basin
North Lahontan Territory
South Lahontan Territory
Colorado Desert

A chapter is devoted to each area, the boundaries of which coincide generally with major hydrographic (drainage) areas that have been used in various statewide studies. Each area represents relatively homogeneous characteristics of streamflow, existing and potential water resources development, and topographic and economic independence.

A map showing the hydrographic areas used in this booklet is shown on the following page.

CORPS OF ENGINEERS ACTIVITIES IN CALIFORNIA

The water resources development program or "civil works mission" of the Corps of Engineers in California began in 1852 when Congress appropriated $30,000 for levee construction and fencing at the mouth of the San

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END	DETAILED MAP (PAGE)
NAME	
North Coastal Basins	19
San Francisco Bay Area	27
Central Coastal Basins	51
South Coastal Basins	61
Sacramento Basin	93
Delta-Central Sierra Area	115
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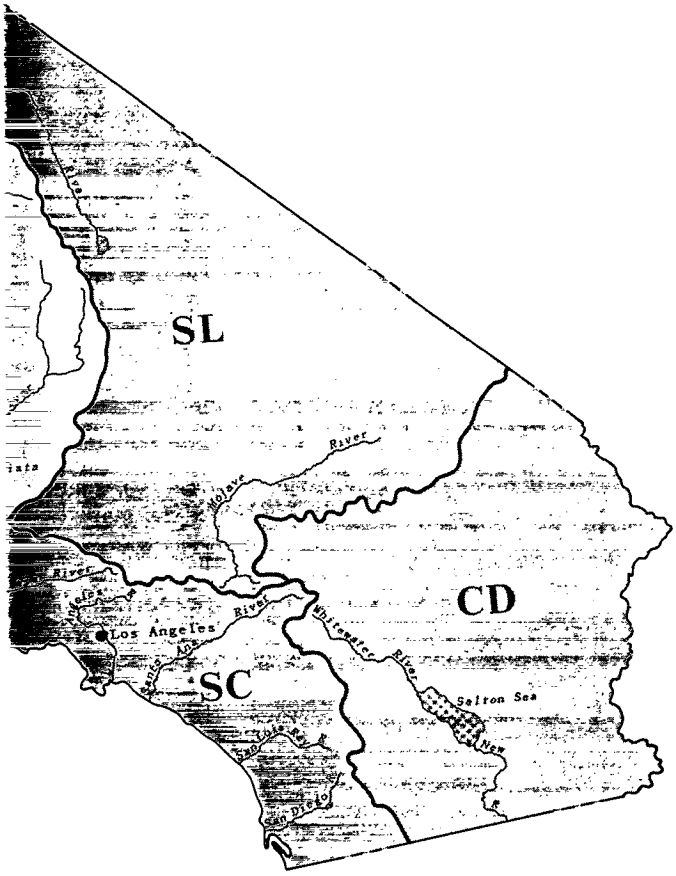
South Lahontan Territory	149
Colorado Desert	153

San Francisco District
Sacramento District
Los Angeles District



Diego River, thus originating facilities that would ultimately evolve into today's important San Diego Harbor. Other early navigation work included San Francisco Harbor, 1868; Oakland Harbor, 1874; and San Joaquin River, 1876. Several other navigation projects were authorized prior to the turn of the century.

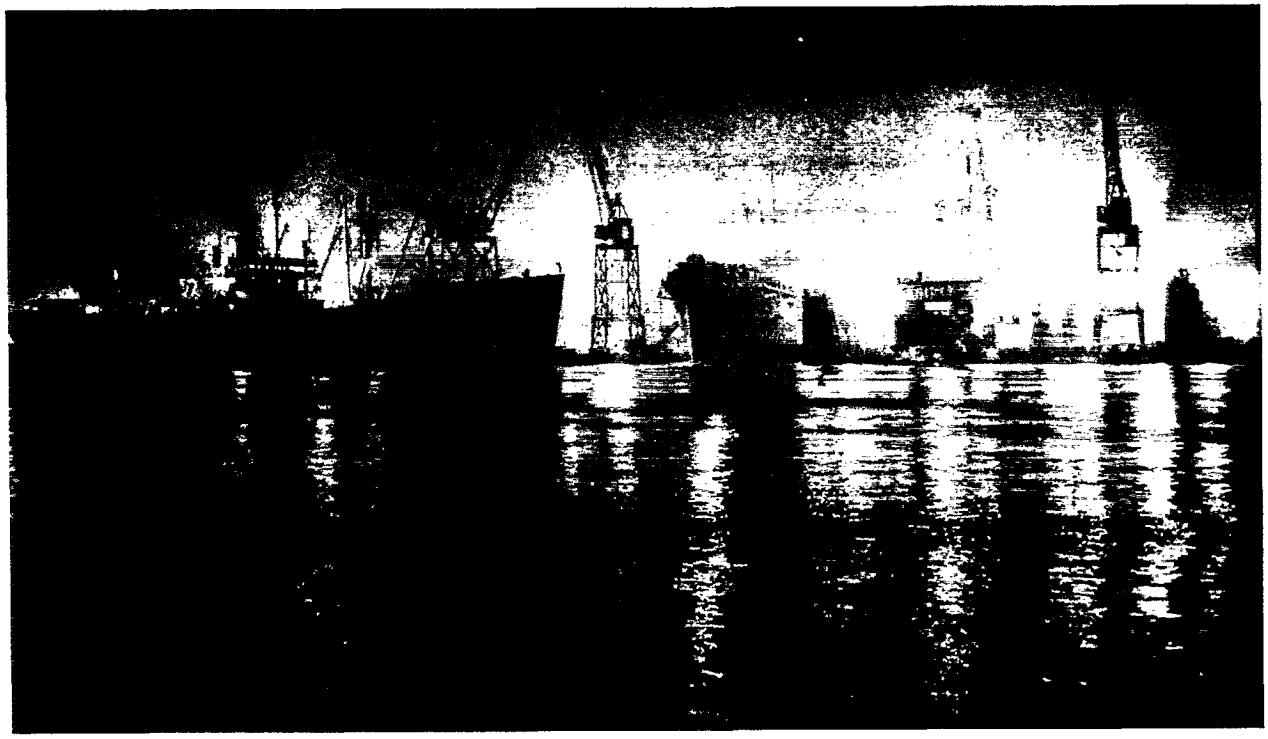
On the basis of a report prepared by the California Debris Commission in 1907, the first flood control work by the Corps of Engineers in California was authorized by the River and Harbor Act of 1910. The work consisted of increasing the flood-carrying capacity of the Sacramento River downstream from the mouth of Cache Slough. The existing Sacramento River Flood Control Project, substantially as conceived by the Debris Commission as a result of studies directed by Congress in 1910, was authorized in 1917 in the first major flood control legislation in the history of our country. Subsequent to these early beginnings, Corps of Engineers activities in California have expanded into almost all facets of water resources development.

Participation in water resources development projects and related activities by the Corps of Engineers is at the direction of Congress, and a large body of applicable authorizing legislation has been adopted. Chapter 16 contains information on various authorities; on initiation, authorization, and construction of projects; and on local participation in projects.

Navigation Program

Improvements for deep and shallow draft navigation are directed by Congress primarily to assist in developing and conducting waterborne commerce. In general, navigation projects can be divided into two types: coastal harbors and inland waterways. The former comprise channels and anchorages for deep draft and shallow draft shipping, harbors of refuge for small craft, and breakwaters and jetties to provide protection against winds and waves. Shallow draft navigation includes commercial fishing, recreational boating, and barge traffic. Improvement of inland waterways consists essentially of widening and deepening to facilitate transportation of bulk commodities economically by boat or barge. Integrated with railroads and highways, improved waterways help meet increasing transportation needs. The navigation program of the Corps of Engineers in California includes improvement and maintenance of all major coastal harbors in the state; development of shallow and deep draft inland waterways; and, when authorized, maintenance of navigable streams.

From 1853 to 1884, large volumes of hydraulic mining debris were deposited in the main waterways of the Central Valley. These deposits greatly impaired the flood-carrying capacity of streamways and their usefulness for navigation. In 1893, Congress created the California Debris Commission (an element of the Corps of Engineers) to regulate hydraulic mining. This function is part of the navigation program.



Night view of Los Angeles Harbor, part of the largest seaport complex in the world

Flood Control Program

The flood control program of the Corps of Engineers in California functions to protect urban, suburban, and agricultural areas. Existing projects have prevented more than $4,500,000,000 in flood damage throughout the state. These projects include many units of levee and channel improvements and a large number of flood control storage projects.

Flood control projects regulate or contain floodflows and thus prevent flood damage. Flood control storage and levee and channel improvement works may be used separately or in combination. Storage projects retain floodwater for later release at non-damaging rates. Most flood control storage projects are authorized for multiple purposes and may be planned to provide additional storage space for any or all of the following: irrigation, power, flow maintenance for navigation, municipal and industrial supply, water quality control, recreation, and enhancement of fish and wildlife resources. Some projects authorized for flood control may also be used incidentally for other purposes such as recreation or fish and wildlife enhancement. Levee and channel improvement projects provide sufficient channel capacity to carry peak flows by dredging, clearing, and straightening the waterway; by constructing levees; by building a channel with smooth surfaces to improve flow characteristics; by providing bypasses; or by some combination of these methods. Recreation facilities may be included in levee and channel improvment projects.

During the 1969 flood, Prado Dam impounded a lake 4 miles long, 3 miles wide, and 68 feet deep, thereby preventing damage estimated at $440,000,000

On completion, levee and channel improvement projects are usually transferred to local authorities for operation and maintenance. Flood control storage projects are operated and maintained by the Corps of Engineers unless the protection provided is essentially local in nature.

Under assigned responsibilities, the Corps of Engineers (through the Secretary of the Army) prescribes regulations for the use of storage space reserved for flood control or navigation in all reservoirs constructed wholly or in part with Federal funds. In carrying out that responsibility, operating regulations for flood control space have been developed for several Bureau of Reclamation projects.

The Corps of Engineers also cooperates in the Watershed Studies Program of the Soil Conservation Service and the Small Reclamation Project Program of the Bureau of Reclamation.

Congress may authorize Federal participation in the cost of a non-Federal project when warranted in the interest of flood control. Dams and reservoirs built under this arrangement are known as "Partnership Projects."

Although the flood control program provides effective protection to project areas, many streams still remain uncontrolled and many areas of the state remain entirely unprotected.

While urban centers generally have better protection than rural areas, they are still potentially liable to serious damages from large floods. Comprehensive planning and construction programs must be continued in order to check periodic floods which cause destruction and damage, and waste to the ocean vast amounts of water that could be conserved for the benefit of the people, agriculture, and industry of California.

Shore Protection Program

The purpose of shore protection works is to prevent wave and tidal current damage to publicly owned beaches, shoreline parks, and conservation areas, and thus promote and encourage healthful recreation. Protection is generally provided by constructing bulkheads, seawalls, or revetments to prevent erosion of shoreline cliffs; by constructing groins to retain or build beaches; by importing sand to supplement natural beach building processes; or by some combination of these methods. Maintenance of completed shore protection improvements is generally the responsibility of local interests.

Small Projects Program

Under continuing authorities and when approved by the Chief of Engineers, small navigation, flood control, and shore protection projects may be undertaken by the Corps of Engineers without the specific authorization of Congress. Works constructed under small projects authorities must be complete in themselves, constitute a complete solution to the problem, and not commit the Federal Government to additional improvements to ensure effective operation. Small projects are subject to the same requirements of feasibility, economic justification, and cost sharing as projects that require the specific authorization of Congress and must be coordinated with the state or other local interests concerned. They are based upon favorable reconnaissance-type investigations and subsequent detailed project reports, which serve as bases for authorization of projects and preparation of plans and specifications.

Status of Projects

For convenience in designating the status of Corps of Engineers projects in California, they have been classified as completed, under construction, or authorized but not started. Existing and potential future projects are summarized according to these classifications at the bottom of this page. A map showing the general location, type, and status of projects is shown on the back cover.

Each project is briefly described in the appropriate hydrographic area chapter, and its location is shown on maps accompanying those chapters. Information on projects may also be found in the Chief of Engineers' annual report on civil works activities.

Recreation Facilities at Corps of Engineers Projects

As part of its water resources development program, the Corps of Engineers has provided basic public use facilities at most of its storage projects. Local agencies and private interests have provided supplemental facilities and services. A summary of facilities and public use in 1977 appears on the following page. Public use data are not collected for stream-oriented recreation areas.

Investigations, Studies, and Reports Program

In most cases, Congress requires a detailed investigation and report that is basic to its decision on

Type of Project	Status			
	Completed	Under Construction	Authorized, Not Started	Total
Navigation	32	8	2	42
Debris Control	3	0	0	3
Small Navigation	5	0	0	5
Multipurpose	30	2	8	40
Flood Control	32	8	18	58
Small Flood-Control	18	0	0	18
Shore Protection	6	4	0	10
Small Shore Protection	1	0	1	2
Total	127	22	29	178

WATER RESOURCES DEVELOPMENT BY THE CORPS OF ENGINEERS IN CALIFORNIA

Name of Project	Normal Pool Surface Acres	Normal Pool Shoreline Miles	Recreation Facilities: Water Access Areas	Launching Lanes	Picnic Areas	Swimming Beaches	Tent & Trailer Spaces	Organized Camps	Number of Rental Boats	1977 Attendance Total	1977 Attendance Peak Day
Black Butte Lake, Stony Creek	2,845	25	6	7	2	1	99	0	0	183,700	1,200
Brea Dam, Brea Creek	[1]	[1]	[2]	[2]	1	[2]	[2]	[2]	[2]	342,400	2,975
Carbon Canyon Dam	3[3]	0.5[3]	1	[2]	1	[2]	[2]	[2]	[2]	230,000	1,750
Englebright Lake, Yuba River	750	10	6	4	2	0	85	0	4	175,390	750
Fullerton Dam, East Fullerton and Brea Creeks	4[3]	0.5[3]	[2]	[2]	1	[2]	[2]	[2]	[2]	87,300	850
Hansen Dam, Tujunga Wash	125	3	1	2	3	1	[2]	[2]	0	1,482,300	9,830
Isabella Lake, Kern River	6,250	30	30	10	1	1	632	3	160	618,340	17,250
Lake Kaweah, Kaweah River	570	8	5	8	3	0	78	0	9	445,970	5,835
Lake Mendocino, Russian River	1,700	14	7	12	5	2	320	2	15	1,310,000	24,680
Martis Creek Lake, Martis Creek	71	2	1	0	1	0	25	0	0	327,120	325
Mojave River Dam	[1]	[1]	[2]	[2]	1	[2]	50	[2]	[2]	57,600	760
New Hogan Lake, Calaveras River	2,650	42	3	11	1	2	196	0	20	116,950	2,440
North Fork Lake, N. Fk. American River	280	15	1	1	2	2	0	0	0	27,000	600
Pine Flat Lake, Kings River	3,450	53	5	11	11	1	121	0	30	625,520	12,780
Prado Dam, Santa Ana River	15[3]	1[3]	1[3]	[2]	3	[2]	[2]	1	[2]	379,000	2,495
Sepulveda Dam, Los Angeles River	[1]	[1]	[2]	[2]	2	[2]	[2]	[2]	[2]	1,349,300	4,200
Success Lake, Tule River	600	7	6	7	3	0	304	0	20	696,750	10,850
Whittier Narrows Dam, Rio Hondo and San Gabriel River	76	4[3]	1[3]	[2]	3	[2]	[2]	[2]	32	1,230,400	6,000

[1]No permanent pool.

[2]Not applicable.

[3]Recreation lake.

authorization of a navigation, flood control, or shore protection project. Preauthorization investigations for projects are usually directed by the Public Works Committees, but may be directed by the full Congress in a Flood Control or River and Harbor Act. Preauthorization studies require extensive coordination with the various agencies concerned. The Pacific Southwest Interagency Committee on Water Resources, which is composed of representatives of six Federal agencies and nine Pacific Southwest states, coordinates water resources development activities on a regional basis. At meetings held three to four times a year, each member state and agency presents a brief on what it has been doing and what it proposes to do.

Congress may also direct that a special investigation be made to examine a water resources problem that is beyond the scope of a project preauthorization investigation. Ongoing special investigations in California are discussed in Chapter 15.

An Urban Studies Program was authorized in 1970 as a joint planning effort of the Corps of Engineers, other Federal agencies, states, and local governments. A major objective of the program is to develop realistic plans that can help solve water and related problems for about the next 50 years in selected urban areas. The specific functions in which the Corps will be involved are flood control and flood plain management; municipal and industrial water supply; wastewater management; bank and channel stabilization; lake, ocean, and estuarine restoration and protection; water-oriented recreational development in conjunction with other project purposes; and development of regional harbors and waterways. The solutions to problems in these disciplines are closely interrelated and a solution to one specific problem may create a new problem in another discipline. The interrelationship of problems requires complete and timely interchange of planning information since it is essential that urban planning alternatives be evaluated in concert with proposals and programs of other agencies concerned. Urban studies are conducted so as to provide input for local urban area planning, and to avoid duplication of effort among participating Federal agencies. Ongoing urban studies in California are discussed in Chapter 15.

A summary of the investigation, studies, and reports program in California follows:

Status of Study	Type and Number of Studies					
	Navigation	Flood Damage Prevention	Shore Protection	Special Investigation	Urban Study	Total
Completed[1]	2	2	0	0	0	4
In Progress	11	17	4	4	2	38
Unscheduled or Not Started[2]	8	2	1	1	0	12
	—	—	—	—	—	—
Total	21	21	5	5	2	54

[1]Completed at District and Division levels and in process to Congress through higher authority.

[2]Study authorized but not started or temporarily suspended.

In addition to other investigations and studies, the Corps of Engineers may reevaluate completed navigation and flood control projects in light of economic and physical conditions significantly changed since the project was originally authorized and built. The findings of reevaluation studies are reported to Congress with recommendations for structural modification of the project, operational changes, or other changes that would benefit the environment in the public interest.

The Corps of Engineers conducts a program of research and development for solving new problems that arise in project design, operation, maintenance, and evaluation, and for progressive improvement of engineering techniques and procedures. Research and development studies conducted in California have involved experimental equipment for measuring streamflow velocity, utilization of laser beams in measuring movement of large concrete structures, use of epoxy compounds to prevent erosion of certain internal surfaces of flood control outlet structures, and utilizing automatic data processing to improve procedures for collecting and analyzing recreation use data.

The need to accelerate improvement of hydrologic engineering techniques, to train engineers in applying these techniques, and to take advantage of computers in water phenomena research led to the establishment of the Corps of Engineers Hydrologic Engineering Center in 1964. Located in Davis, it provides Corps-wide technological services, trains personnel, and systematizes procedures in hydrologic engineering. Additional information on the Hydrologic Engineering Center is contained in Chapter 15.

Flood Plain Management Services Program

Simply defined, a flood plain is the relatively flat lowland adjoining a river or creek. These areas are integral parts of the stream system and have been covered by floodflows in the past, and, in the absence of protective works, most assuredly will be flooded in the future. Human encroachment on flood plains reduces the capability of the stream to carry floodflows and offsets the protection afforded by flood control improvements. Flood damage can be reduced by the wise use of flood plains and cooperative action toward this objective is a primary purpose of the flood plain management services program. This program, which provides for Corps of Engineers assistance and guidance to state and local agencies in their efforts to solve local flood problems, is discussed in Chapter 13.

Emergency Work

When flood emergencies occur, continuing Congressional authorities permit the Corps of Engineers to undertake immediate measures to prevent a flood situation from arising, participate in flood fighting and rescue operations, protect streambanks and levees from erosion, and restore flood control structures damaged by floods. Continuing authorities also provide for emergency clearing and snagging as well as the removal of wrecked vessels in the interest of navigation. Congress may provide special and specific authority for the Corps of Engineers to meet an unusual emergency situation.

In any major disaster, the Federal Disaster Assistance Administration[1] may request the Corps of Engineers to assist in relief and recovery actions. Such assistance usually consists of inspecting disaster areas, clearing debris and wreckage, providing technical advice, restoring damaged public facilities, undertaking measures to protect life and property or maintain public health and welfare, and preparing evaluation reports for Federal reimbursement of local agency costs for emergency repair and restoration work.

Information on historical floods and other natural disasters in California, a series of related photographs, and specific discussion of Corps of Engineers emergency work are included in Chapter 14.

Miscellaneous Functions and Activities

Regulatory Functions Under Section 404, Federal Water Pollution Control Act Amendments of 1972, as amended; other related legislation; and long standing authorities evolving from the River and Harbor Act of 1899, the Corps of Engineers is responsible for administering certain laws enacted to preserve and protect the navigable waters of the United States. These responsibilities pertain to:

Approving sites and plans for dams and dikes.

Permits for structures or operations in navigable waters.

Removing obstructions to navigation.

Establishing danger zones, dumping grounds, fishing areas, restricted areas, and harbor lines.

Permits for discharge or placement of dredged or fill materials.

Regulatory authority for controlling discharge or placement of dredged or fill materials extends to the headwaters[1] of all streams tributary to navigable waters, to natural lakes greater than 10 acres in surface area, to bodies of standing water created by impounding streams with a normal flow of 5 or more cubic feet per second, and to the wetlands adjacent to these lakes and streams.

Permit applications are coordinated with various Federal, state, and local agencies as well as with other interested parties. Although hundreds of permits for construction and operations in the navigable waters of California have been issued, many applications for permits have had to be disapproved.

Water Pollution and Water Quality Control Under the 1948 Water Pollution Control Act, as amended, other related legislation, and certain Executive Orders, water quality and pollution control must be fully considered in planning, constructing, and operating Federal water resources development projects. Capacity to store water for regulation of streamflow to maintain water quality may be included in storage projects, but not as a substitute for treatment or other methods of controlling pollution at the source.

In 1970, the Supreme Court construed the regulatory authority of the Corps of Engineers as including pollution as well as structures and operations in navigable waters and their tributaries. Accordingly, an application and permit program for existing and future discharges into navigable waters or their tributaries was established. In 1972, responsibility for the program was transferred to the Environmental Protection Agency. In California, administration of the program has been delegated to the State Water Quality Control Board, but the Environmental Protection Agency retains a veto power on approval of applications. The Water Quality Control Board submits applications to the Corps of Engineers for review and necessary comment.

[1]Soon to be incorporated into an "umbrella" emergency organization to be known as the Federal Emergency Management Agency.

[1]The point above which flow is usually less than 5 cubic feet per second.

Dam Inspection Program In 1975, an inventory of dams made in response to the National Dam Inspection Act revealed that approximately 9,000 dams in the United States had high hazard potential. These dams are located upstream from populated areas that would be seriously affected if dam failure occurred. The purpose of this program is to fund and administer the inspection of non-Federal dams with high hazard potential due to location; dams with intermediate hazard potential on Federal property; and a limited number of non-Federal dams determined, through consultation with state officials, to present an immediate threat to public safety. The initial phase of the program, which will also include updating the 1975 inventory, is expected to take about 4 years.

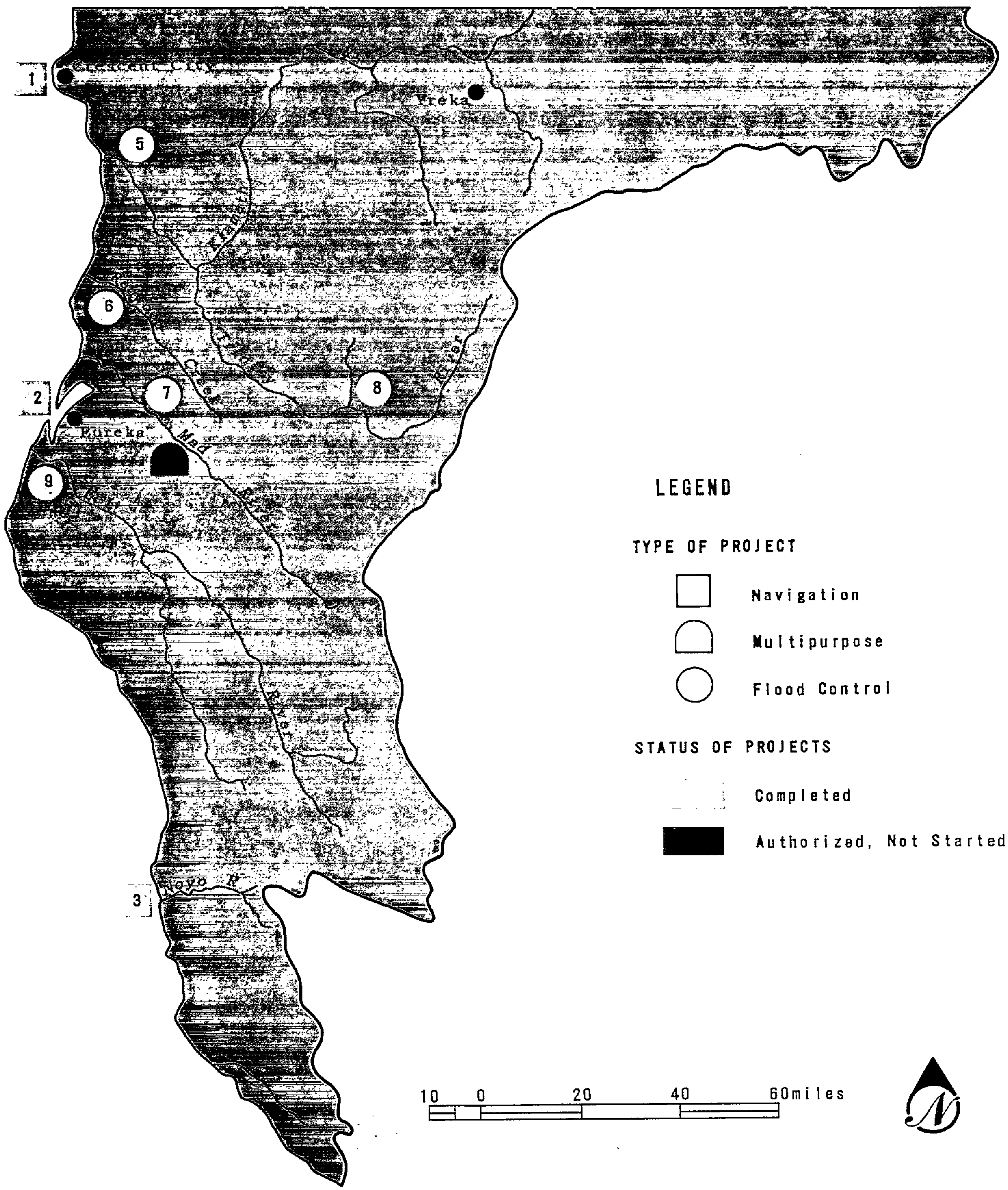
This is a cooperative program in which states are expected to assure implementation of an effective dam safety program, assist in the program by participating in training and making actual dam inspections, and assuring that remedial actions are taken when unsafe dams are found.

In California, about 1,100 dams will be involved in the inventory update. The number of dams to be inspected under Phase I of the program is indefinite, but it is judged that 400-600 inspections will be required.

Development of Water Supplies Water supply is of vital interest to the national economy and security, and the Corps of Engineers gives full consideration to this subject in the planning of water resources development projects. Section 6 of the 1944 Flood Control Act provides authority to contract with states, municipalities, private concerns, or individuals for surplus water that may be available at Corps of Engineers projects. The 1958 Water Supply Act, as amended, permits cooperation with states and local interests in developing domestic, municipal, and industrial water supplies in constructing, maintaining, and operating Federal storage projects. Space for storage of water supply may be included in projects if local interests agree to repay project costs allocated to that function. Reimbursement of such costs may be extended over a 50-year period. The Water Resources Development Act of 1974 authorized cooperation with states in preparing comprehensive plans for developing, utilizing, and conserving water and related resources of drainage basins within the boundaries of a particular state. Not more than $200,000 may be spent in 1 year in a single state.

Cargo Statistics Under responsibilities devolving from the Federal Reports Act of 1942 and the Budget and Accounting Procedures Act of 1950, the Corps of Engineers compiles annual statistics on domestic commercial cargoes and passengers handled by coastal and inland ports. These data are highly important in determining the need and justification for the improvement and maintenance of rivers and harbors for commerce and navigation. They are also of value to commercial and shipping concerns, various Federal and local agencies, and others interested in transportation.

2 NORTH COASTAL BASINS
(San Francisco District)



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[1]Number following project name denotes Congressional District.

DESCRIPTION

The North Coastal Basins extend from the Russian River Basin to just north of the California-Oregon border. In California, the basins include all of Del Norte, Humboldt and Trinity Counties, and parts of Mendocino, Siskiyou, Sonoma, Lake, Glenn and Modoc Counties.

Throughout most of the area, mountains and rolling hills that extend to the ocean create some of the most impressive coastal scenery in the state. The major mountain ranges are the Klamath Mountains and the Coast Ranges, which are the sources of the largest streams: the Klamath, Eel, Mad, Smith, and Mattole Rivers, and Redwood Creek. The Klamath River, which drains 15,500 square miles, is the largest North Coastal Basins stream.

The present population of the North Coastal Basins, about 375,000, is projected to increase to around 570,000 by the year 2000. Eureka, Crescent City, Yreka, Weaverville, and Fort Bragg are the principal urban centers.

Since nearly half of California's commercial forest land is located in the area, lumbering and processing forest products are major industries. Sport and commercial fishing; general recreation; and agricultural activities, particularly dairying, also contribute significantly to the economic base.

King and silver salmon and steelhead trout abound in the north coastal streams. Approximately 30 percent of the king salmon and virtually all of the silver salmon in California are found here. Various species of deer are the dominant big game. Black bear and the remnants of a once large population of Roosevelt elk inhabit the redwood forests. Pronghorn antelope are also native to inland regions.

Climate in the lower elevations is characterized by mild, dry summers with frequent fog, and mild, very wet winters. Mountainous areas usually have warm, dry summers and cold winters with snow and heavy rain. Temperatures range from near freezing in winter to around 100 degrees in summer in the lower areas and from well below freezing in winter to 80-90 degrees in summer in the mountainous regions. Rainfall ranges from an average annual of about 40 inches along the coast to 110 inches in the higher mountain areas.

The precipitous cliffs and jutting promontories of the shoreline are frequently beset by severe storms, strong winds, and squalls. Heavy waves generated by storms in the North Pacific buffet the coast during summer as well as winter, and this part of the California coast is particularly subject to tsunamis (great sea waves sometimes called tidal waves).

Flood control facilities in the North Coastal Basins are very limited, and past floods have caused serious damage. Due to steep stream gradients, floods are characterized by rapid rises and recessions. Most floods result from rain and are of such short duration that streams seldom top their banks for more than a day or two. Snowmelt is rarely a contributing factor.

Facilities for commercial navigation include Humboldt Harbor (deep draft) and Crescent City Harbor (shallow draft). Waterborne commerce consists principally of lumber and petroleum products; however, this is changing as the economy of the area diversifies.

NAVIGATION PROJECTS

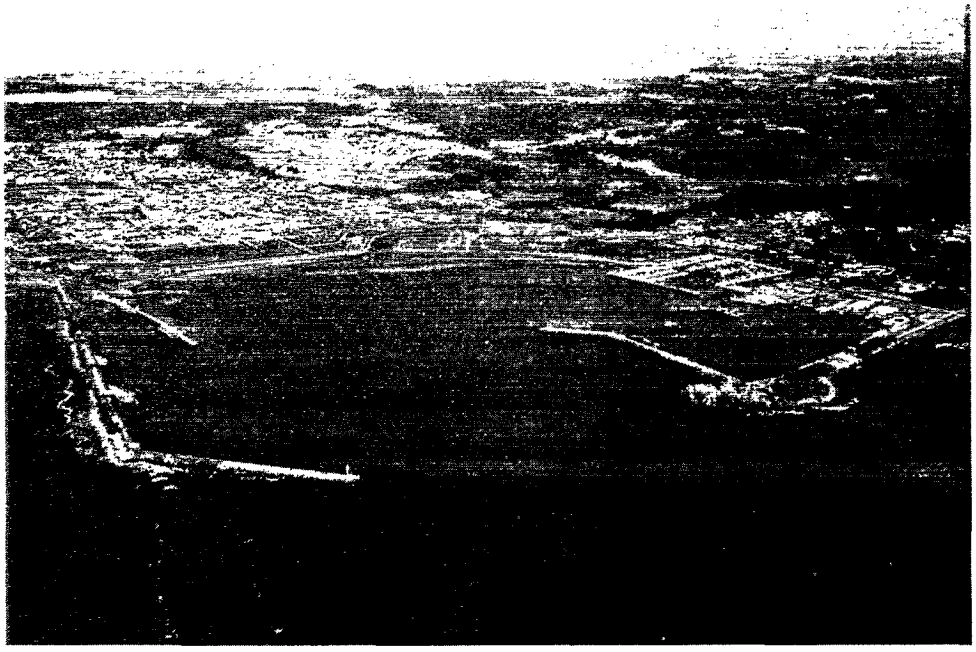
Crescent City Harbor

Crescent City Harbor is located midway between San Francisco Bay and the mouth of the Columbia River. The project consists of a 4,700 foot outer breakwater, a 1,200 foot inner breakwater, a 2,400 foot sand barrier, and inner and outer harbor basins. Controlling depths range from 10 to 18 feet. Project facilities are being maintained by the Corps of Engineers.

Project modifications authorized in 1965 comprised a 400 foot extension of the inner breakwater and a tee-shaped inner harbor basin. Construction of the inner breakwater was completed in 1973, but work on the inner harbor basin has been deferred indefinitely. Major rehabilitation work was performed in 1964 and 1974.

The Federal cost of completed work totals $7,800,000. Local interests contributed $300,000 to the project.

Crescent City Harbor serves an area of about 13,000 square miles in northern California and southern Oregon. Waterborne commerce in the harbor was about 290,000 tons in 1977 and averaged about 284,000 tons annually during the period 1968-1977. Except for 9,000 tons of fish, cargo consisted entirely of petroleum products in 1977.



Crescent City Harbor.

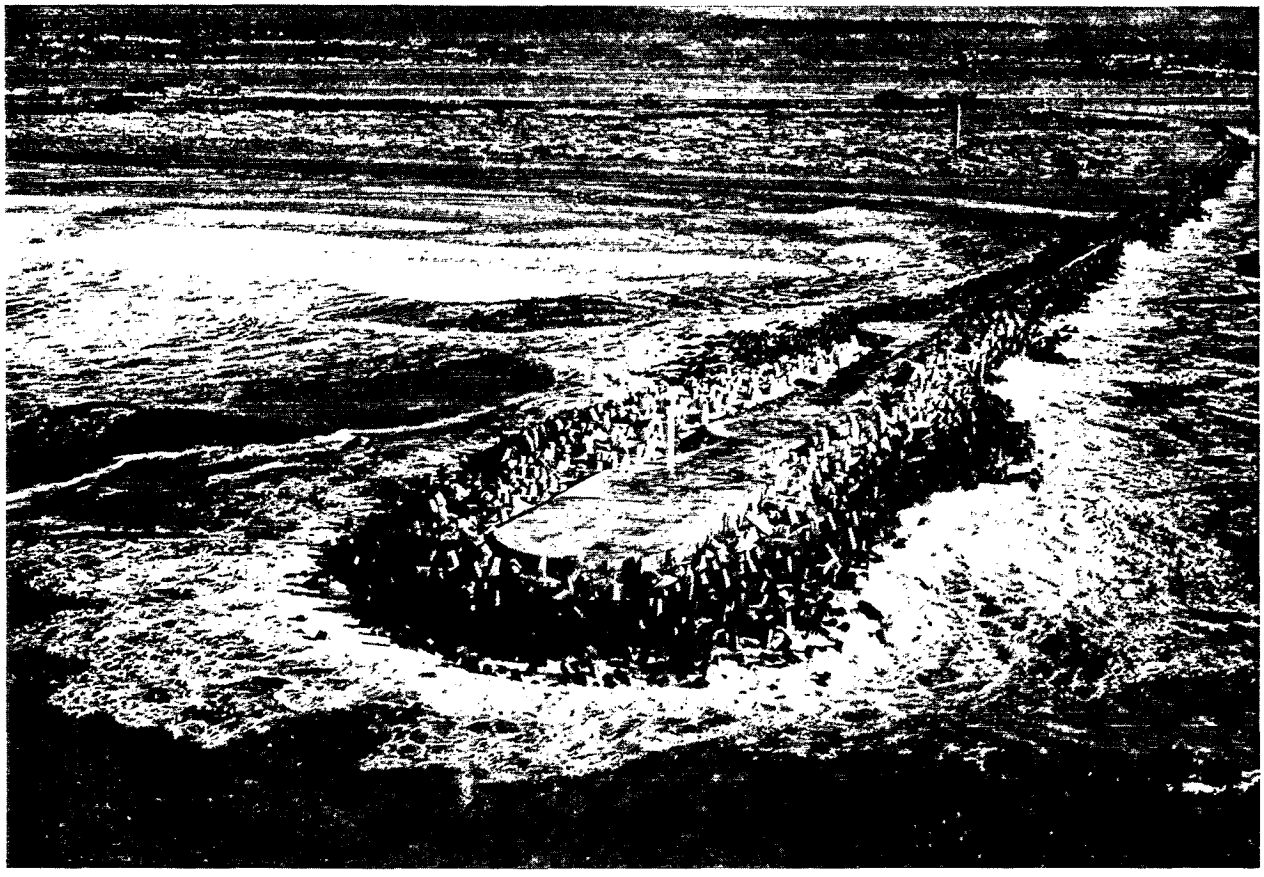
Humboldt Harbor and Bay

Humboldt Harbor is on a landlocked bay at Eureka. Project facilities consist of nearly 2 miles of jetty, about 11 miles of channels, and a turning basin. Harbor depths range from 26 to 40 feet. Federal cost of completed work was $3,000,000, supplemented by a local contribution of $1,000,000. The estimated cost of authorized project modifications is $5,900,000, 80 percent of which will be borne by the Federal Government.

The jetties, completed in 1927, are subject to recurring storm damage and have periodically required repair. In 1957, severe winter storms dislodged protective armor stone, undermined concrete side slopes, and carried away portions of the concrete cap and underlying core. Repair was completed in 1964. Extensive repairs were also made in 1973-74, and minor repair comprising stone replacement was completed in 1977.

Commerce in Humboldt Harbor during 1977 totaled about 1,600,000 tons primarily consisting of logs, wood chips, lumber, wood pulp, gasoline, and fuel oil. Commercial cargo averaged about 1,500,000 tons annually during the period 1968-1977.

A special investigation of economic, environmental, and social uses of the Humboldt Harbor and Bay region was initiated in 1976 and is discussed in Chapter 15.



About 2,500 interlocking concrete armor units, each weighing 42 tons, protect the Humboldt Harbor jetties

Noyo River and Harbor

Noyo Harbor is located about 135 miles northwest of San Francisco. It is the only improved harbor between Bodega Bay, 87 miles to the south, and Humboldt Bay, 87 miles to the north.

The project consists of a north jetty and wall, a south jetty, and entrance and river channels. North and south breakwaters have been authorized but not built. A mooring basin and a 400-foot channel extension were constructed by the Noyo Harbor District with funds provided by a grant from the Economic

Development Administration and a loan from the State of California. The mooring basin is maintained by local interests; the channel extension is maintained by the Corps of Engineers. Federal cost of the project was $200,000. Local costs totaled $1,000,000.

Noyo Harbor supports a sport and commercial fishing industry, which is vital to the economy of the community of Noyo. Two hundred fishing boats are permanently berthed at Noyo and about 500 use the harbor during the salmon trolling season. In 1977, the commercial fish catch was about 7,800 tons.

Part of the commercial fishing fleet in the older part of the Noyo Harbor Project

MULTIPURPOSE PROJECT

Butler Valley Dam and Blue Lake Project

Authorized in 1958 for flood control, municipal and industrial water supply, and recreation, Butler Valley Dam would be located on the Mad River east of Eureka. Blue Lake would have a storage capacity of 460,000 acre-feet. Due to lack of local interest support, the project has been classified "inactive."

FLOOD CONTROL PROJECTS

Eel River, Sandy Prairie and Delta Area

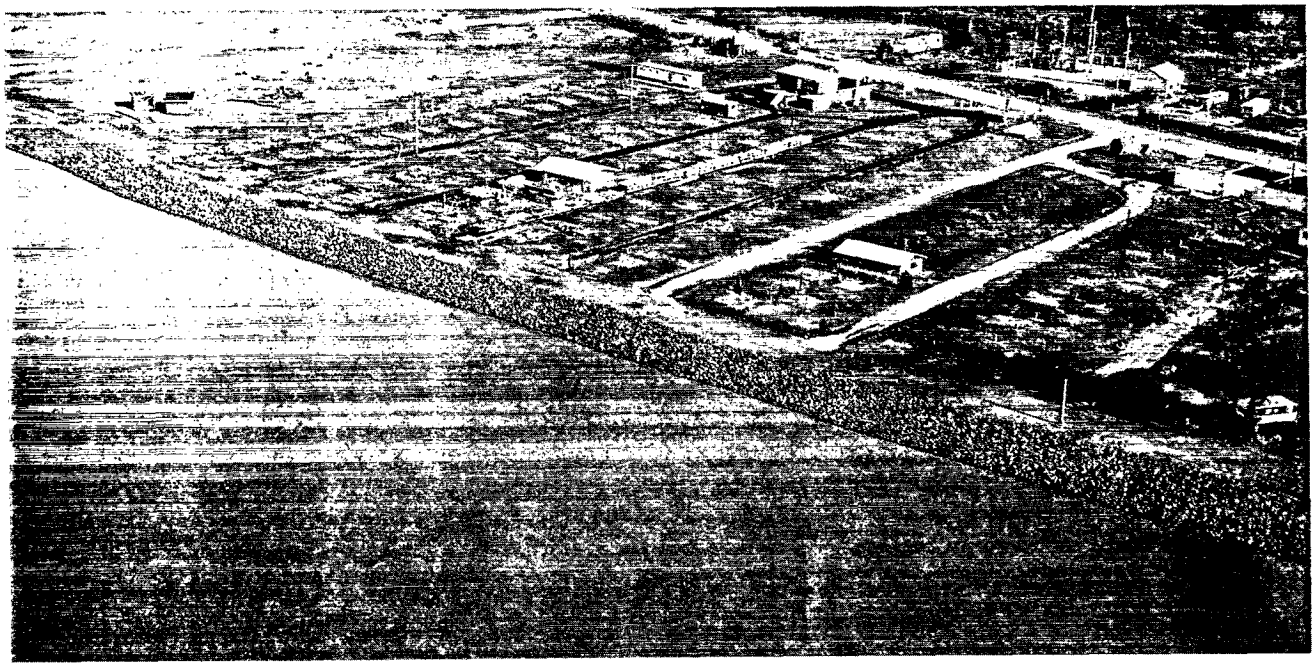
The delta at the mouth of the Eel River is subject to recurring damage due to limited discharge capacity and a constantly shifting channel. Completed in 1959, this project consists of about 4 miles of levee (1 mile riprapped for slope protection) on the left bank of the Eel River. Project cost was $680,000 Federal expenditure and $300,000 non-Federal expenditure.

Authorized modification of the project comprises additional levees and alteration of existing levees in the Eel River delta and along the lower reaches of the Salt River, and construction of a boat launching facility. These improvements, however, have been classified "inactive."

Klamath River Project

Communities such as Klamath, Klamath Glen, Camp Klamath, and Requa, which are in the flood plain of the Klamath River near the ocean, have periodically experienced flood damage. In December 1964, Klamath was completely inundated and the surrounding area devastated. A flood control project for the area consists of a new flood-free townsite at Klamath (completed in 1968), a levee at Klamath Glen (completed in 1971), bank protection work along the lower Klamath River (completed in 1972), and flood plain management measures for flood plain areas. The new townsite was built by filling a 50-acre area behind a new freeway embankment. Local interests are responsible for managing the development of the remaining flood plain, which covers about 2,200 acres. Federal cost of project improvements was $7,800,000. Local interests contributed $745,000.

Klamath and Klamath Glen are protected by the project and it benefits the economy of the river basin by increasing employment opportunities and improving land use. The lower Klamath River is internationally known for salmon and steelhead fishing, and the local economy is largely dependent upon these activities. Due to the natural attractions of the area, annual recreation use is expected to increase to about 1,400,000 visitor days and permanent population of the flood plain expected to triple by the year 2000.



Completed bank protection work along the Klamath River

Redwood Creek, Humboldt County

Redwood Creek drains an area of about 280 square miles and empties into the Pacific Ocean about 50 miles south of the Oregon border. The project, completed in 1968, consists of 3.4 miles of channel straightening and 6.3 miles of levees along the creek. It provides flood protection to the town of Orick and adjacent areas.

Federal cost of the project was $4,500,000. Local interests contributed $570,000 and are responsible for maintaining the project improvements.

FLOOD DAMAGE PREVENTION STUDY

Northern California Streams

Authorized by the Flood Control Act of 1962, this study includes all streams in Northern California flowing into the Pacific Ocean, including the Sacramento River and its tributaries. Work on the study has been divided between the San Francisco and Sacramento Districts. The San Francisco District will study and report on the coastal streams, and the Sacramento District will study and report on the interior streams. A number of

separately authorized studies are to be completed within the framework of the study, which is scheduled for completion in 1982.

In late December 1964 and early January 1965, all of the counties in the North Coastal Basins were declared disaster areas as a result of unprecedented flooding. The floods resulted in the loss of at least 24 lives; evacuation of entire communities; destruction of bridges, highways, and utilities; and widespread property damage. An evaluation showed flood damages approached $240,000,000. By comparison, the record-breaking flood of 1955-1956 caused damages estimated at $44,000,000. These flood events demonstrated the need for flood control measures, and growing water supply requirements in the study area showed the need for water conservation and related improvements.

In the North Coastal Basins area, preliminary investigations have been made for a number of small coastal streams and the Navarro and Mad River Basins. At present, however, the study effort in north coast areas is dormant. See page 47 for discussion of the San Francisco Bay Area portion of this study, and page 111 for the Sacramento Basin portion.

SMALL FLOOD-CONTROL PROJECTS

East Weaver Creek, Trinity County

Construction of channel improvements and levees to provide flood protection to the town of Weaverville was completed in 1963. The project consists of about 2,200 feet of trapezoidal-section earth channel with riprap protection and about 3,000 feet of levees.

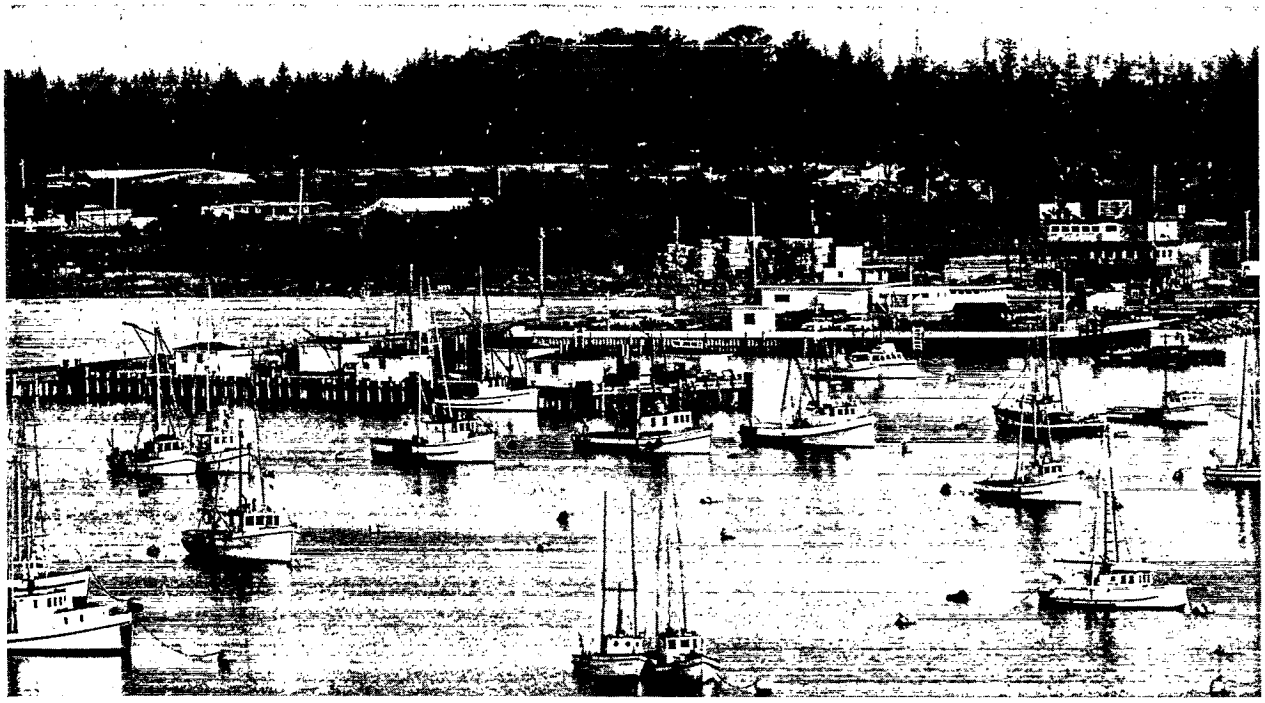
The Federal cost of the project was $200,000, while local costs totaled $100,000. The improvements are maintained by local interests.

Mad River at Blue Lake

A small flood-control project on the north fork of the Mad River near the community of Blue Lake was completed in 1955. This project, consisting of channel clearing and construction of about 3,000 feet of levee, provides flood protection to adjacent agricultural and industrial lands.

To prevent deterioration of existing levees and to provide additional protection to the community of Blue Lake, construction of about 2,000 feet of new levee and raising and riprapping of about 7,000 feet of existing levees was completed in 1963.

The Federal Government bore $390,000 of the project costs, while local interests contributed $60,000 and are responsible for project maintenance.



The Klamath River offers some of the world's best sport fishing for salmon. Crescent City Harbor provides sheltered anchorage for a large commercial fishing fleet.

C-104094

3 SAN FRANCISCO BAY AREA
(San Francisco & Sacramento Districts)

10 0 10 20 30miles

5 0 5 15miles

San Pablo Bay

Suisun Bay

Walnut Creek

San Francisco Bay

LEGEND

TYPE OF PROJECT

- Navigation
- Multipurpose
- Flood Control

STATUS OF PROJECTS

- Completed
- Under Construction
- Authorized, Not Started

C-104095

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[1]Number following project name denotes Congressional District.

DESCRIPTION

The San Francisco Bay Area includes the Russian River Basin, all other coastal stream basins discharging into the ocean between the Russian River in Sonoma County and the San Lorenzo River in Santa Cruz County, and all stream basins draining into San Francisco Bay west of the junction of the Sacramento and San Joaquin Rivers.

San Francisco Bay system consists of four separate embayments: Suisun, San Pablo, South San Francisco, and San Francisco Bays. The San Francisco Bay Area encompasses about 6,100 square miles and includes 280 miles of bayshore and 150 miles of scenic ocean coastline. Its most outstanding physiographic feature is the bay, a vast landlocked estuarine complex through which runoff from the entire Central Valley drains to the ocean. One of the major natural bays of the North American Continent, and one of the most important port complexes on the Pacific Coast, San Francisco Bay is considered the "Gateway to the Orient." The bay, about 42 miles long and from 5 to 13 miles wide, is connected to the Pacific Ocean by a narrow passage known as the "Golden Gate."

Topography of the area is varied and includes rugged mountains, rolling hills, numerous small stream valleys, large fertile valleys, extensive tidelands and marshlands, and some of the most spectacular coastline in the United States. Climate is characterized by warm, dry summers and mild, wet winters, and is marked by wide contrasts within short distances. For example, during summer, coastal areas are cool with frequent morning and evening fog, while the inland valleys a few miles to the east are quite warm. Average annual precipitation is about 32 inches and occurs almost entirely as rain. Snowfall is rare.

Streams in the area are subject to large variations in flow, most of them running dry in summer. Major streams are the Russian, Napa, and Guadalupe Rivers, and Alameda and Coyote Creeks. The San Francisco Bay Area is water deficient and depends on importation of municipal and industrial supplies.

Coastal streams serve as spawning and nursery ground for numerous anadromous fish. About one-half million anadromous fish annually pass through San Francisco Bay to reach spawning areas in the Sacramento and San Joaquin Basins. The bay is also highly important to shrimp, clams, and oysters as well as to many lesser known yet vital links in the food chain. Although the area around San Francisco Bay is highly urbanized, the hills, agricultural areas, and mountains provide habitat for a variety of wildlife. Two varieties of blacktail deer are common, and pheasant, quail, and dove inhabit grass and woodland areas. A portion of the area is on the Pacific Flyway and large numbers of migrating waterfowl use its water areas and marshlands for feeding and resting.

Of the eleven hydrographic areas, the San Francisco Bay Area ranks second in population. Its 1978 population of 4,750,000 is expected to increase to about 5,750,000 by the year 2000. The economy of the area is dominated by highly diversified industrial, manufacturing, and commercial activities. The key to its industrial development and high level of economic activity has been its geographical setting coupled with excellent air, surface, and water transportation facilities. Waterborne commerce of the area accounts for about 40 percent of the total waterborne commerce of California.

Floods in the area result from intense rainstorms, generally preceded by prolonged rainfall that has saturated the ground. Peak flows are usually of short duration. Historically, major flood problems have occurred in urban areas located in the relatively flat, wide valleys near the mouths of rivers. However, the frequency of flooding on the Russian River, particularly near Guerneville, is among the highest in the state.

About 130 miles of shoreline are actively eroding. This condition is so severe along 12 miles of coastline in San Francisco and northern San Mateo Counties that urban areas are threatened. Other water-related problems in the area are associated with San Francisco Bay itself and the surrounding metropolitan complex. These principally comprise pollution, waste disposal, and silting. The waste disposal problem is especially complex and will become more so as population growth and industrial development further overtax treatment facilities. The bay has been neglected as a recreational resource; only a few miles of its shoreline are included in waterside parks.

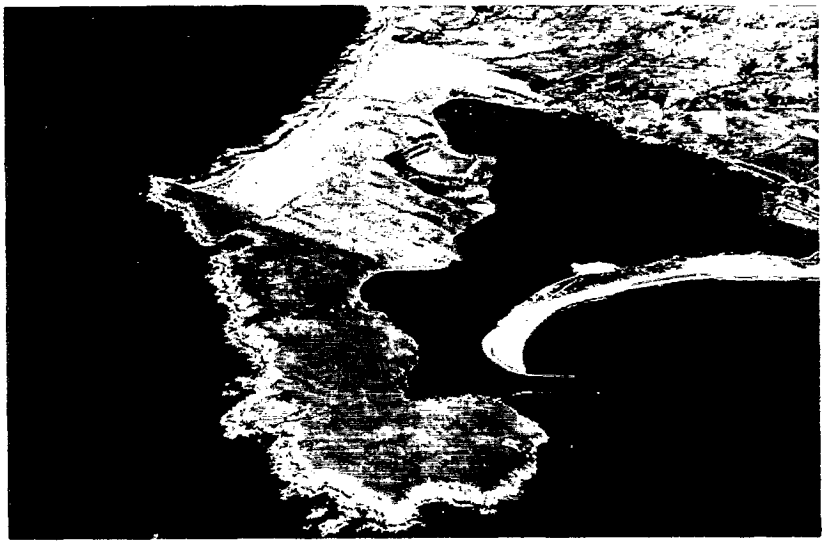
NAVIGATION PROJECTS

Bodega Harbor

Bodega Harbor is a triangular shaped coastal lagoon situated at the northern end of Bodega Bay, about 55 miles north of San Francisco. Improvements completed in 1943 consist of a bulkhead to retain a sand spit, two jetties, entrance and navigation channels, and three turning basins. Controlling depth of the harbor is 12 feet. Federal cost of improvements was about $700,000. Local interests contributed $52,000.

Construction of a 4,500 foot earth mole and the Doran Beach Channel have been authorized but not yet built. During advanced engineering and design studies, Spud Point was found to be a more desirable location for expansion of the harbor facilities. Pending provisions for meeting requirements of local cooperation for new work, the project is being held in abeyance.

Bodega Harbor is the only improved harbor in the 140-mile reach between San Francisco Bay and Noyo Harbor. It serves as an important harbor of refuge and as the home port for a small commercial fishing fleet. Commerce in the harbor in 1977 amounted to about 1,900 tons of fish.



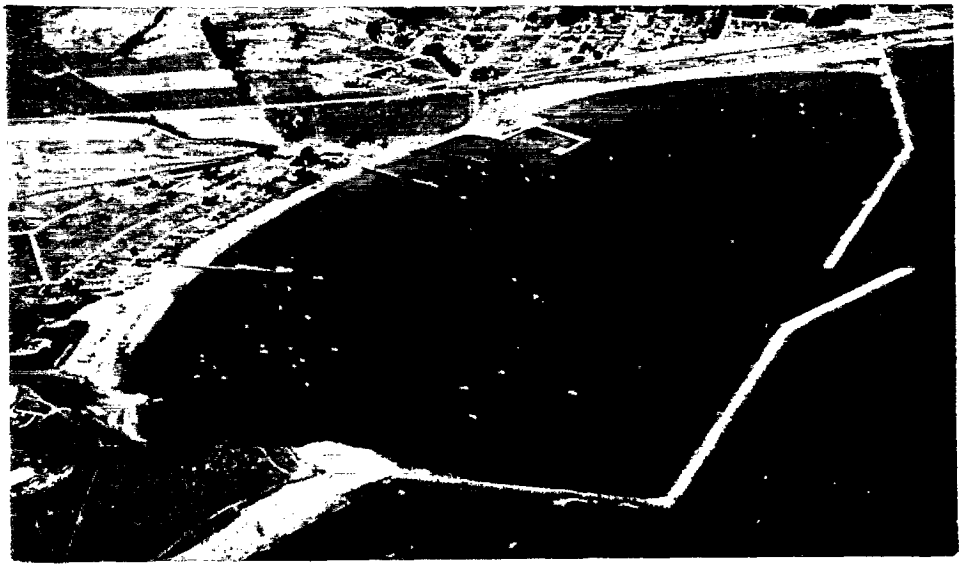
Bodega Harbor provides a refuge for small boats along the Marin-Sonoma coast

Half Moon Bay Harbor

Half Moon Bay is located on the coast about 15 miles south of San Francisco. The project consists of two breakwaters that form a protected harbor for commercial fishing vessels and recreational craft. It was authorized by the 1948 River and Harbor Act and completed in 1961. As a remedial measure to alleviate surge, construction of a 1,050 foot extension of the west breakwater was completed in 1967. The minimum depth of the 245 acre harbor is 6 feet.

Total Federal cost of the project was $6,700,000 for new work and maintenance. The cost of meeting requirements for local cooperation was about $1 million.

The waterborne commerce of Half Moon Bay Harbor, which amounted to about 570 tons in 1977, consists entirely of fresh fish and shellfish. The town of Princeton at the northern end of the bay is the center of commercial fishing and the fish processing industry. The project has expanded harbor usage by commercial and pleasure craft and stimulated industrial and and recreational activities in the tributary area. It provides a needed harbor of refuge during storm periods.



Half Moon Bay Harbor

John F. Baldwin and Stockton Ship Channels

Improvement of existing navigation projects extending from the Port of Stockton to the main ship channel crossing San Francisco Bar outside the Golden Gate was authorized by the 1965 River and Harbor Act. Five navigation projects located in the San Francisco and Sacramento Districts are involved in this project, which consists mainly of improving channels, constructing new navigation facilities, and providing facilities for recreation use. The five existing projects, the district of jurisdiction, and the major improvements authorized are:

Stockton Deep Water Ship Channel (Sacramento District) Deepen the channel from 30 to 35 feet, realign it to follow the False River cutoff route, and place rock to protect levees along the channel.

Suisun Bay Channel (San Francisco District) Deepen and widen the existing project channel to depths and widths presently under study, and possibly provide maneuvering areas and turning basins in the existing project reach.

San Pablo Bay and Mare Island Strait (San Francisco District) Deepen Pinole Shoal Channel to 45 feet, lengthen it to about 11 miles, and dredge a 45 foot maneuvering area adjacent to Oleum Pier.

Richmond Harbor (San Francisco District) Deepen the West Richmond Channel through the west navigation opening of the Richmond-San Rafael Bridge from 35 to 45 feet, and enlarge and deepen the approach area to Richmond Long Wharf to provide a maneuvering area 45 feet deep, 600-2,800 feet wide, and 8,400 feet long.

San Francisco Harbor (San Francisco District) Deepen the main ship channel across San Francisco Bar from 50 to 55 feet, and deepen the main internal bay channels to 45 feet.

Total cost of the project is estimated at $151,630,000, of which $117,900,000 is the Federal cost of new work (including U.S. Coast Guard navigation aids and recreation facilities) and $33,730,000 is the non-Federal cost of meeting the requirements of local cooperation. Local interests must provide, operate, and maintain adequate terminal facilities and assume responsibility for operation and maintenance of public recreation areas.

Bank protection work from Venice Island to Stockton and dredging the main ship channel across San Francisco Bar were completed in 1972 and 1974, respectively. Further construction has been deferred pending a complete reassessment of the environmental impact of the project, which is in progress. Planning studies, including a 2-year study of salinity intrusion and preparation of the General Design Memorandum, are continuing.

Napa River

Improvement of the navigable reach of the Napa River—i.e., downstream from Napa—was first authorized in 1888. Subsequent authorizations, the most recent in 1946, provided more extensive improvements. Project works completed (1950) comprise a channel 100 feet wide and 15 feet deep from Mare Island Strait Causeway upstream to Asylum Slough (69,000 feet), thence 75 feet wide and 10 feet deep to Third Street in Napa (17,000 feet); a cutoff at Horseshoe Bend; and a turning basin at Jack's Bend. Dikes and revetments possibly needed where navigation is difficult are authorized but now classified "inactive." Federal cost of the project was about $1,000,000. Local interests participate in maintenance activities by providing lands, easements, rights-of-way, disposal areas, and impounding and drainage works.

Commerce on the Napa River usually comprises cargoes of sand, gravel, crushed rock, fabricated metal products, and salt. In 1977, cargo moving on the waterway amounted to 153,000 tons.

Oakland Harbor

Oakland Harbor is a major west coast seaport. It is located on the east side of San Francisco Bay and consists of entrance and access channels; inner and outer harbors; a tidal canal; and appurtenant channels, turning basins, and jetties. Controlling depths range from 18 to 35 feet[1]. Improvements that ultimately became part of this harbor complex were first authorized for Corps of Engineers construction in 1874. They consisted of jetties along the entrance to Oakland Estuary. These jetties are now part of the inner harbor because of extensive land fills that have been made behind them. The existing outer harbor, which serves the Oakland Army Terminal, is located just south of the Oakland approach to the Bay Bridge. Oakland's main commercial waterfront is along the inner harbor.

[1]Additional physical data on major project features are:

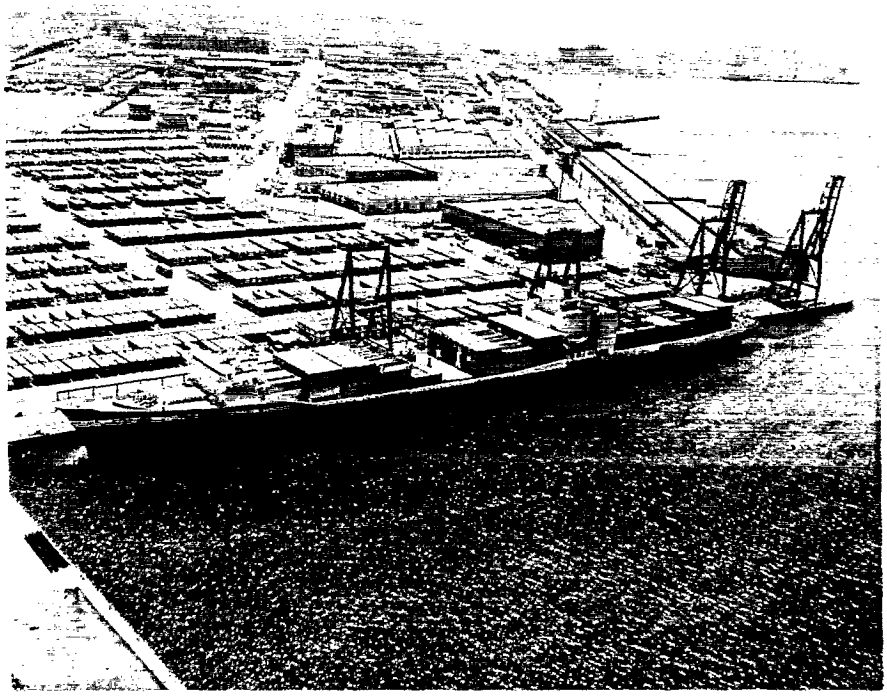
Feature	Depth (Ft.)	Width (Ft.)	Approximate length (Ft.)
OUTER HARBOR:			
Entrance Channel	35	800-600	9,000
Channel and Turning Basin	35	600-950	8,000
INNER HARBOR:			
North Jetty	—	—	9,500
South Jetty	—	—	12,000
Entrance and Inner Channels and Turning Basin	35	800-275	37,000
NORTH CHANNEL	35	300	5,000
TIDAL CANAL CHANNEL	18	275	6,000

The jetties authorized in 1874 were completed in 1894. Dredging existing channels and basins was done primarily from 1910 to 1931, except that 35-foot depths (authorized in 1962) were attained in 1975. Authorized deepening of the tidal canal has been recommended for deauthorization due to lack of economic justification. Cost of the project was about $25,500,000, approximately one-half of which was the cost of local cooperation.

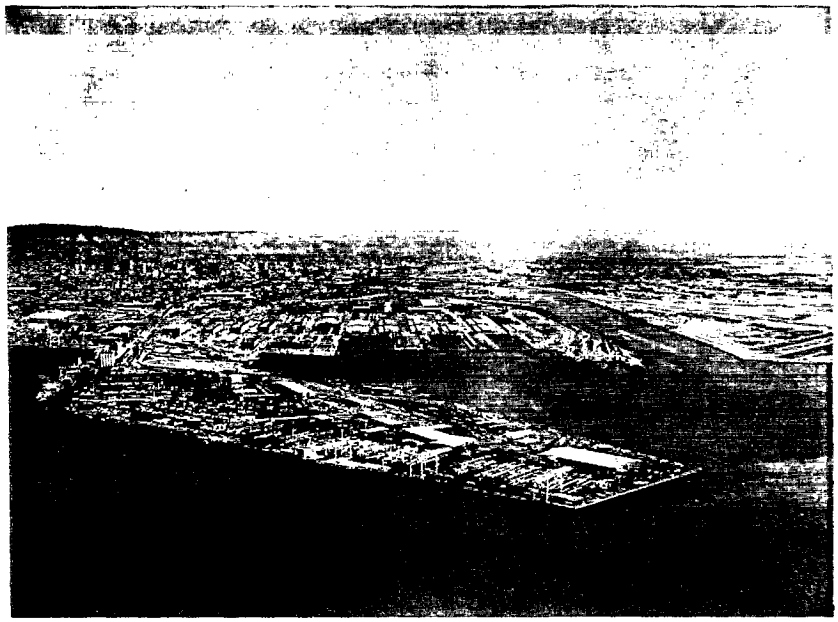
Three bridges across the tidal canal were also features of the project. Two of these bridges (at Park and High Streets) were replaced by local interests. Reconstruction of Fruitvale Avenue Bridge was authorized in 1962. This was originally a combined highway and railroad crossing, but a parallel bridge for rail traffic only was built in 1951. Subsequent inspection revealed that rehabilitation of the existing bridge (now used for vehicular traffic only) was not feasible and Federal participation in construction of a new bridge was authorized. The new bridge was completed in 1973.

Improvement of Oakland Harbor has substantially contributed to expansion of commercial shipping in the east bay area, enhanced military activities, and afforded opportunities for recreational boating. By selective placement of spoil materials from harbor dredging operations, several thousand acres of submerged land or swamp have been reclaimed for industrial, commercial, and military uses. Waterborne commerce at Oakland Harbor, exclusive of cargo carried in military vessels, amounted to about 6,800,000 tons in 1977 and averaged about 6,200,000 tons annually for the period 1968-1977. Commercial cargo handled at Oakland Harbor is extremely varied, but major classes of cargo in 1977 comprised food and food products, petroleum products, and iron and steel products. Other important cargo consisted of wood products, and sand, gravel, and crushed rock.

A study of developing the outer harbor to better serve deep draft shipping is being accomplished in conjunction with an in-depth investigation of San Francisco Bay and tributary deep water ports. See page 185.



Container ship operations, Oakland Outer Harbor



Oakland Inner Harbor

Petaluma River

Improvement of the Petaluma River was first authorized by the 1880 River and Harbor Act. Subsequent improvements were authorized by a number of later River and Harbor Acts. The project consists of about 5 miles of channel across the flats along the edge of San Pablo Bay, about 15 miles of river channel, and a turning basin. Channel width ranges from 40 to 200 feet and controlling depth ranges from 4 to 8 feet.

The project was completed in 1933 and is being maintained by the Corps of Engineers. Federal cost was $300,000 and the cost of meeting requirements of local cooperation for construction of the project was $200,000.

Cargo carried on the waterway in 1977 consisted of about 25,000 tons of unmanufactured marine shells and miscellaneous nonmetallic mineral products.

Redwood City Harbor

Redwood City Harbor is on the west side of San Francisco Bay about 20 miles south of San Francisco. It is situated at the mouth of Redwood Creek. Project improvements consist of an entrance channel, two turning basins, a connecting channel, an inner channel, and the offshore San Bruno Shoal approach channel. Controlling depth is 30 feet except in the inner channel where it is 5 feet. Channel width ranges from 500 feet (San Bruno Shoal) to 150 feet (inner channel). Channel length totals about 8 miles. The project was completed in 1965 and is under maintenance by the Corps of Engineers.

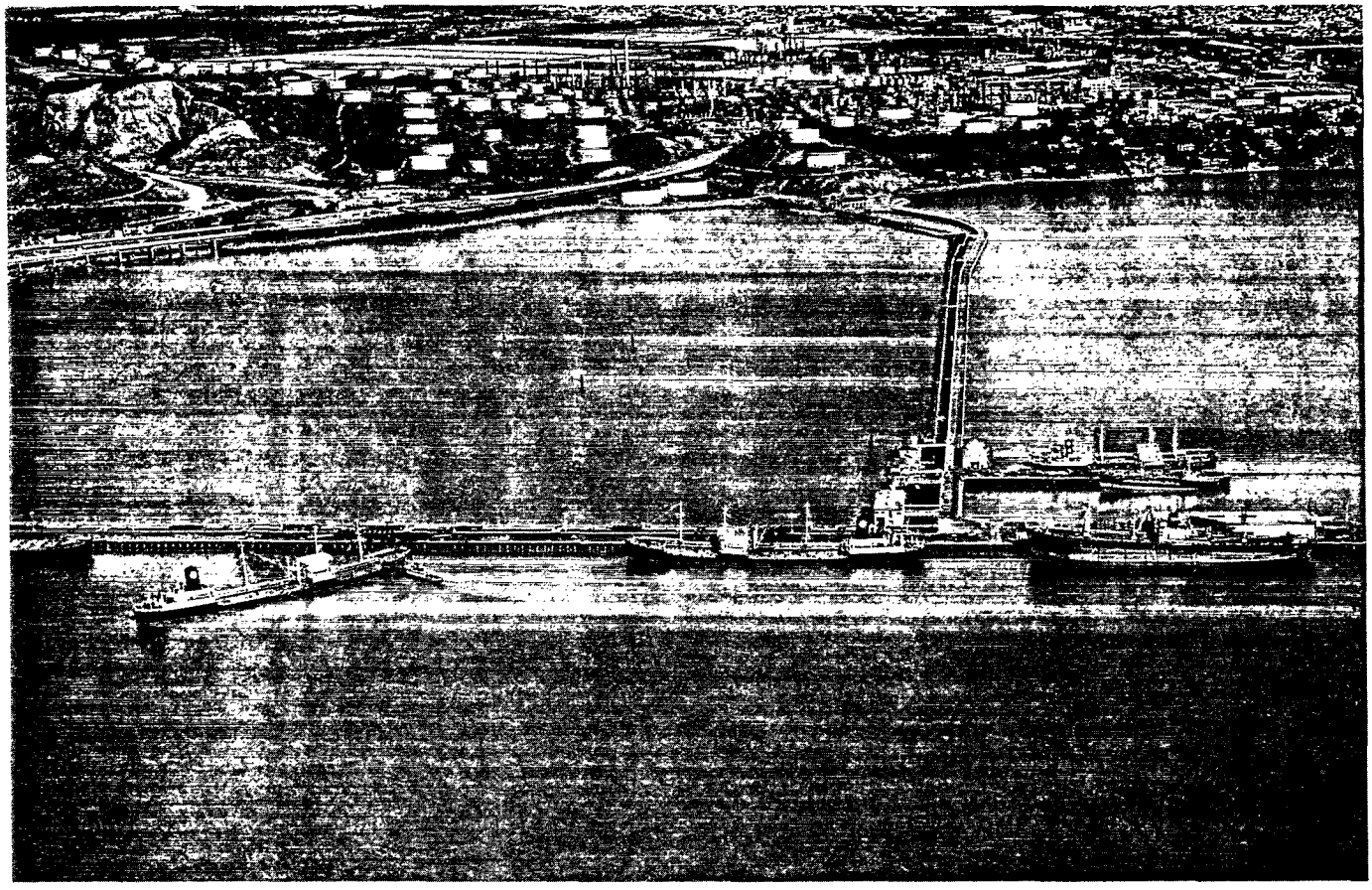
Federal cost of the project was $1,700,000 and the cost of meeting requirements of local cooperation was $200,000. The Port of Redwood City has spent more than $1,200,000 for additions and improvements to municipally owned and operated shore facilities. Commerce in the harbor amounted to about 400,000 tons in 1977 and averaged about 1,200,000 tons annually during the period 1968-1977. Major items handled are salt, building cement, petroleum products, and iron and steel scrap.

In 1951, the Leslie Salt Company opened a multimillion dollar salt production, storage, and bulk shiploading facility at the upper limit of Turning Basin No. 2. The loading facilities are available for public use through contractual arrangements with the Port of Redwood City.

A study of increased harbor usage and resulting environmental effects is being accomplished in conjunction with an in-depth investigation of San Francisco Bay and tributary deep water ports. (See page 185.)

Richmond Harbor

Richmond is the site of extensive commercial petroleum refining and handling facilities and a Department of the Navy fueling depot. Richmond Harbor, which is north of San Francisco Harbor and east-northeast of



Richmond Long Wharf is largely devoted to petroleum handling facilities

Oakland Harbor, serves these petroleum and fueling facilities as well as general commercial shipping. In general, the harbor complex comprises approach, entrance, and inner harbor channels; turning basins; a maneuvering area; and a training wall[1].

Project channel dredging was started in 1918 and carried on intermittently until 1940. The project was completed in 1957 except for dredging West Richmond Channel and enlarging and deepening the maneuvering area off Richmond Long Wharf, both of which are currently unscheduled. Federal cost for completed work was about $3,000,000. Local interest cost amounted to $4,000,000. Estimated cost of authorized but unscheduled improvements is about $15,000,000.

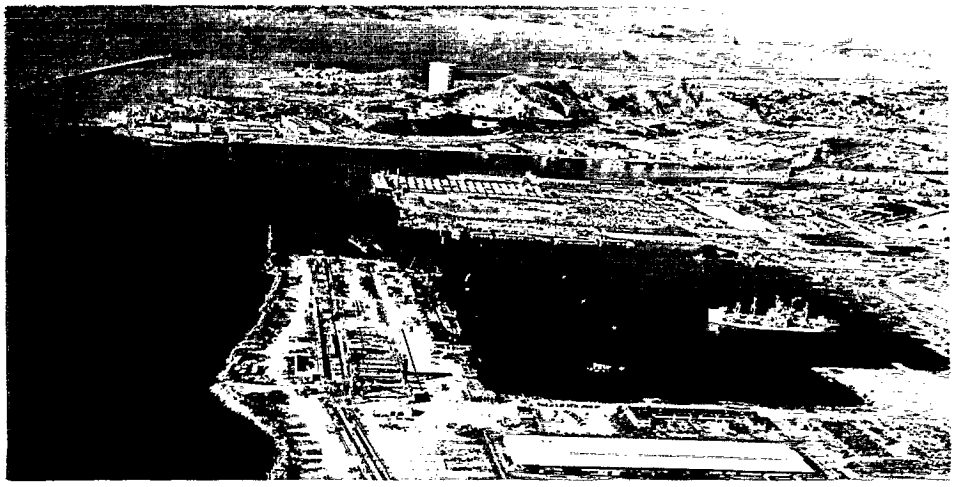
[1]Selective physical data on project features are:

Feature	Depth (Ft.)	Width (Ft.)	Approximate length (Ft.)
Point San Pablo Channel	20	150	2,000
Southampton Shoal Channel	35	600	4,000
Outer Harbor:			
Approach to Richmond Long Wharf	35	2,000	4,000
Approach to Point Orient	32	400	4,000
Enlarged Maneuvering Area[1]	45	600-2,800	8,400
Inner Harbor:			
Approach and entrance channel	35	500-850	12,000
Santa Fe Channel:			
Lower portion	35	200	2,000
Upper portion	30	200	1,000
Turning Basin	30	200-600	1,000
West Richmond Channel[1]	45	600	13,200
Rubblemound Training Wall	—	—	10,000

[1]Authorized but not yet constructed.

Waterborne commerce through Richmond Harbor totaled about 23,800,000 tons in 1977. Major cargo carried (over 90 percent of the total) was petroleum and petroleum products. The remaining cargoes mainly comprised food products, chemicals, and iron and steel scrap. Commerce through Richmond Harbor averaged about 17,000,000 tons annually during the period 1968-1977.

A study of Richmond Harbor is being made in conjunction with an in-depth investigation of San Francisco Bay and tributary deep water ports. (See page 185.)



Richmond Harbor facilities

San Francisco Harbor

The San Francisco Harbor Project extends from the approach channel seaward of the Golden Gate to San Francisco International Airport, which is located on the bay shore south of San Francisco. Improvement of this great harbor has been almost continuous since 1869, when work authorized by the 1868 River and Harbor Act was begun. Channel dredging and removal of rocks authorized by various acts from 1872 to 1937 were completed in 1959[1].

This project will be modified by the John F. Baldwin Ship Channel Project, which provides for deepening the main ship channel across San Francisco Bar from 50 to 55 feet (completed in 1974), and for deepening the main internal bay channels to 45 feet. Wave action, tidal currents, and littoral sand movement offshore from the Golden Gate continually build up the San Francisco Bar, and dredging the channel across the bar is a continuing maintenance operation performed with a hopper dredge.

The total Federal cost of the project was $2,700,000 for new work. Local interests met all requirements for local cooperation, including a cash contribution of $135,000.

[1]Specific project data are:

Feature	Depth (Ft.)	Width (Ft.)	Approximate length (Ft.)
San Francisco Bar Channel	55	2,000	20,400
Islais Creek Approach	35	700-3,000	2,000
Airport Channel	10	750	7,000
Airport Turning Basin	10	2,000	2,000
Alcatraz, Presidio, and Black Point Shoals; Blossom Rock; and Rincon Reef Rocks	40	—	—
Point Knox Shoal and Harding, Shag, and Arch Rocks	35	—	—

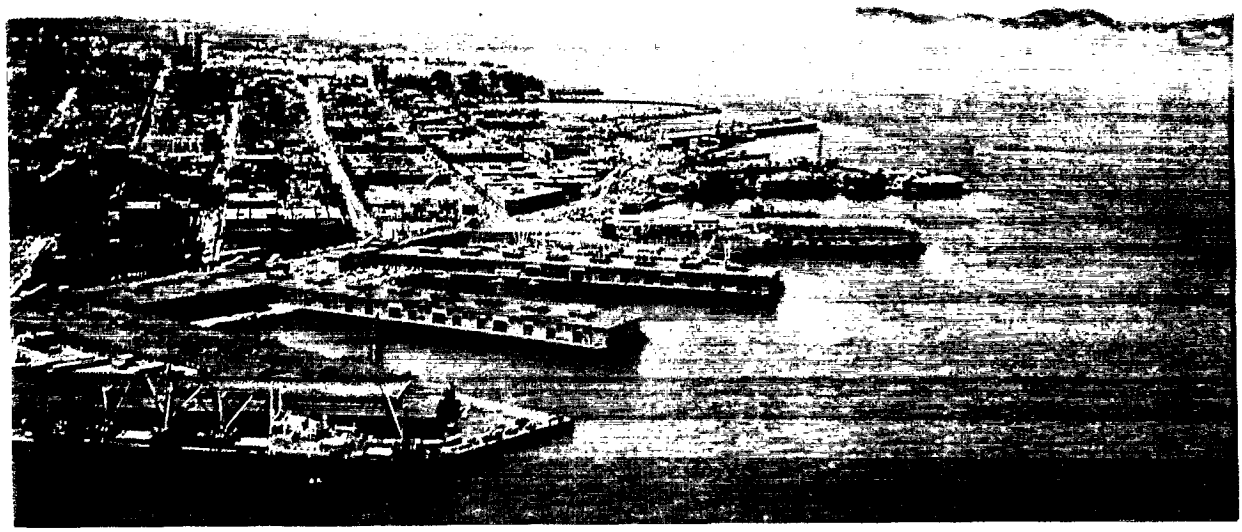
In addition to the primary military and commercial use of the harbor, traditionally heavy recreational use is increasing. The accelerated interest in boating, which has been apparent nationally, is reflected locally by construction of new small-boat facilities on tributary streams as well as in communities adjacent to the bay proper.

Waterborne commerce through the harbor comprises commercial cargo, both foreign and domestic, and a large volume of military cargo. Cargo received and shipped at the Port of San Francisco in 1977 amounted to about 1,900,000 tons, exclusive of military cargoes, and averaged 3,200,000 tons annually during the period 1968-1977. Commerce through the Golden Gate amounted to nearly 56,200,000 tons in 1977.

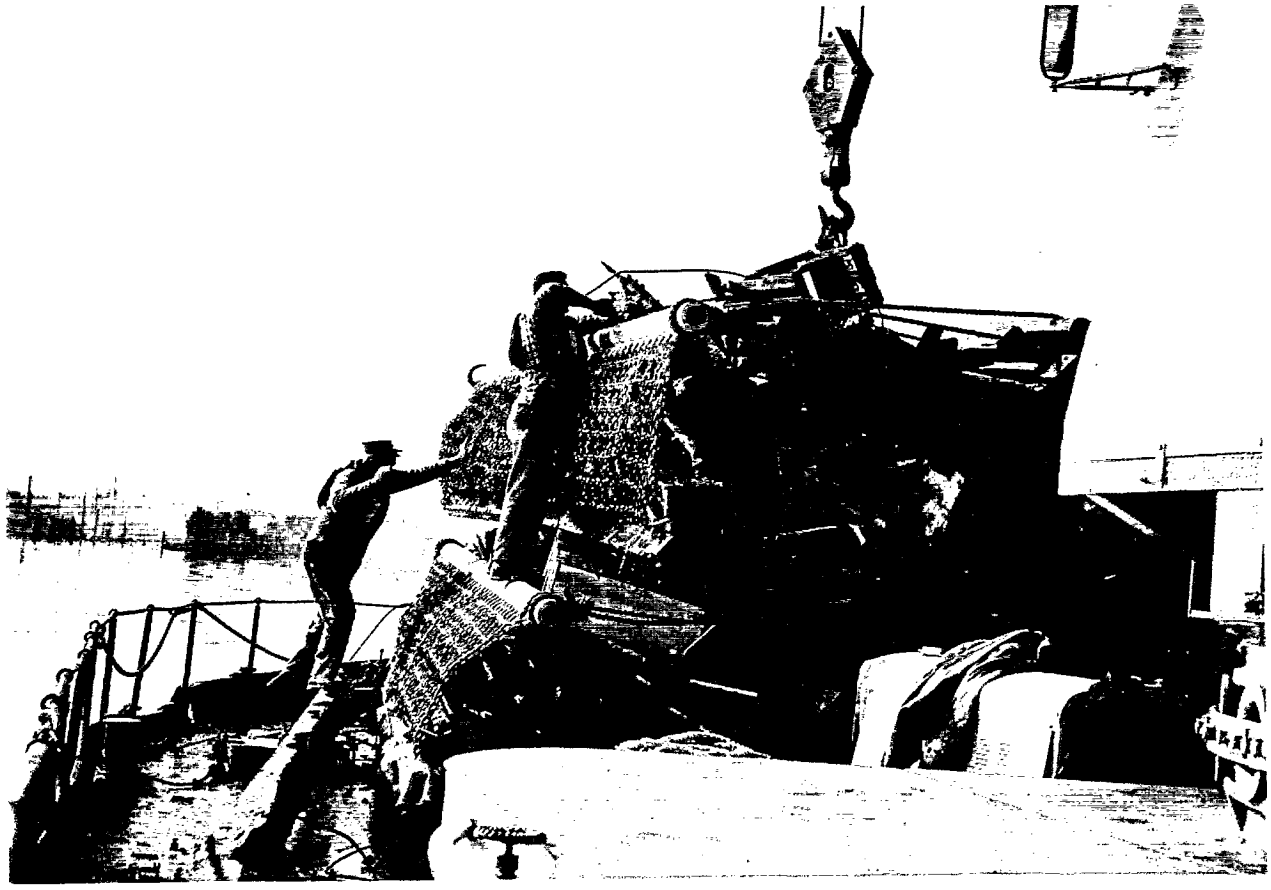
San Francisco Harbor and Bay, Collection and Removal of Drift

To reduce hazards to navigation and seaplane operations, a project for collecting and removing drift from San Francisco Bay was authorized in the 1950 River and Harbor Act. However, funds for constructing floating plant and other equipment have not been provided and the project is classified "inactive." Since 1950, floating debris has been collected and removed from bay waters as maintenance work under the San Francisco Harbor Project. A tugboat and two Navy YSDs (with bow modifications to hold collection nets) are being used by the Corps of Engineers to collect debris, which is disposed of by land fill methods.

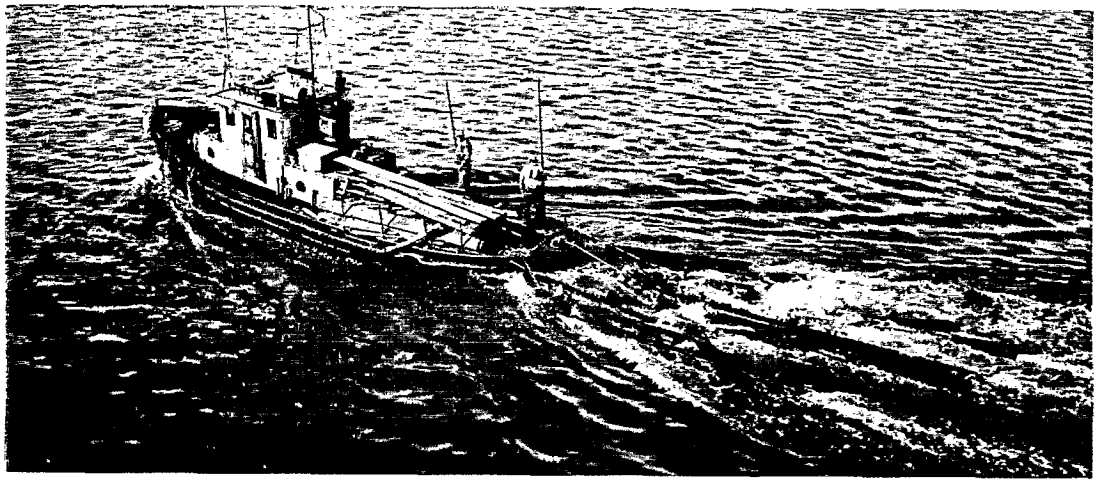
Also, to reduce the volume of debris floating in San Francisco Bay, the Corps inspects known dumping grounds and waterfront construction areas, and investigates all reports of illegal disposal of materials. Backed by Federal law against polluting navigable waters, legal action has been brought against offenders. Recent urbanization of shoreline areas, abandonment of antiquated facilities, and derelict vessels have increased quantities of drift and debris entering the bay. A study of the debris collection and removal project is in progress. (See page 39.)



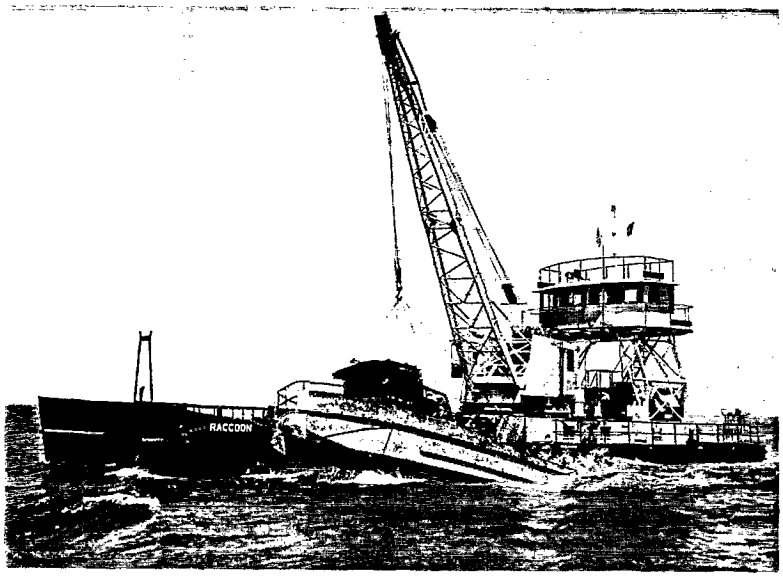
Terminal facilities, San Francisco Harbor



A load of drift from San Francisco Bay



Collecting drift with the debris boat "Lobos"



Sweeping with the debris boat "Raccoon" removes serious hazards to navigation

San Leandro Marina

San Leandro Marina, a recreational complex, is located immediately south of Oakland International Airport. Built in 1962 and presently maintained by the City of San Leandro, the marina consists of a small-boat launching ramp, turning basin, entrance channel, berthing facilities, and parking areas. Controlling depth is 8 feet. The authorized project comprises deepening the main entrance channel and maintaining the main and interior access channels. Annual Federal maintenance cost is estimated at $76,000. Construction has not yet been started.

A breakwater protecting the marina was subject to constant erosion until a permanent breakwater 700 feet long and 12 feet high was completed in 1976 as a small navigation project. Cost of the improvement was about $210,000.

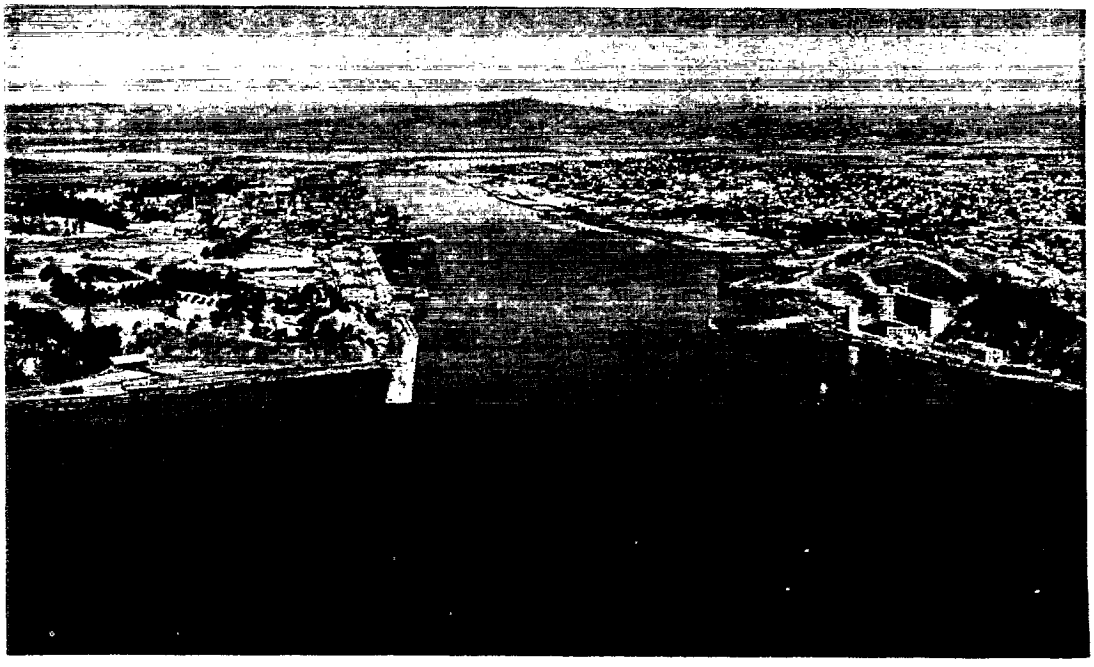
San Pablo Bay and Mare Island Strait

San Pablo Bay is the main northerly arm of the San Francisco Bay system. Mare Island Strait, the estuary of the Napa River, provides access to Mare Island Naval Shipyard and commercial and recreational docking facilities in the City of Vallejo.

The project consists of the 40,000 foot Pinole Shoal Channel, the 17,000 foot Mare Island Strait Channel and turning basin, and a maneuvering area at Oleum Pier. Controlling depths range from 30 to 45 feet. Cost of project improvements was $1,400,000. Local cooperation was not required for this project because it is used extensively by the Navy.

Enlargement of the Pinole Shoal Channel and deepening of the maneuvering area have been authorized as part of the San Francisco Bay to Stockton Project.

The channel in San Pablo Bay carries commerce en route to Mare Island Strait, the Napa River, Carquinez Strait, Suisun Bay, and ports on the Sacramento and San Joaquin Rivers. In addition to its uses for commercial and military purposes, the waterway also is used extensively by recreational craft. Total commerce on this waterway in 1977, exclusive of cargo carried in military vessels, amounted to 32,700,000 tons, of which 5,900,000 tons were destined for, or originated from, ports in San Pablo Bay and Mare Island Strait. The remainder was through traffic. Commerce carried on the waterway averaged about 26,800,000 tons annually for the period 1968-1977. In 1977, about 80 percent of the traffic comprised petroleum and petroleum products.



Mare Island Strait

San Rafael Creek

San Rafael Creek is a small tidal stream that empties into the northwestern part of San Francisco Bay about 14 miles north of the Golden Gate. It is one of the most popular recreational craft harbors in the San Francisco Bay area, serving as home port for about 1,000 small vessels.

Improvement of San Rafael Creek was completed in 1928. Maintained by the Corps of Engineers, the project consists of a 10,000 foot entrance channel, a 9,000 foot river channel, and a turning basin. Controlling depth is 8 feet in the entrance channel and 6 feet in the river channel and turning basin. Total Federal cost was $30,000. Local cooperation for construction required an additional $40,000.

Suisun Bay Channel

Suisun Bay Channel is situated in Suisun Bay between Martinez and Pittsburg. The project was completed in 1934 at a Federal cost of $140,000. It consists of a 13 mile main channel leading to the mouth of New York Slough and a 2 mile auxiliary channel. Controlling depths are 30 feet and 20 feet, respectively. Maximum channel width is 300 feet.

Suisun Bay Channel is the interconnecting link between San Francisco Bay and the navigation channels of the Sacramento and San Joaquin Rivers. It permits transit of nearly all types of vessels, including most oceangoing ships. Biennial dredging is required to maintain project depths and widths. This project will be modified by the San Francisco Bay to Stockton Project. (See page 31.)

Commerce on this waterway was about 7,900,000 tons in 1977. Commerce averaged 7,700,000 tons annually during the period 1968-1977.

Suisun Channel

A navigation project for the improvement of Suisun Slough, a tidal inlet connecting Suisun City with Suisun Bay, was completed in 1947. The project consists of a turning basin at Suisun City and about 13 miles of channel 125 to 200 feet wide and 8 feet deep. Federal construction cost was $200,000. Commerce handled on this waterway in 1977 was 13,000 tons of petroleum products.

NAVIGATION STUDIES

Bolinas Lagoon

A lagoon is a temporary topographic feature of a coastline. Its life is dependent upon deposition of material eroded from the shoreline; sediment carried into the lagoon by winds, tides, and streams; and the residues of organisms living in the lagoon. The presence of tide flats and salt marshes indicates that Bolinas Lagoon is in the last stages of lagoonal existence. Comparison of old and new maps shows that extensive sedimentation has taken place during the last 100 years.

In earlier years, Bolinas Lagoon was studied as a possible harbor of refuge. Its location, about 12 miles upcoast from San Francisco, favored it to provide substantial relief from the hazards of wind and weather facing fishing and recreational vessels along this coastal reach. Since the lagoon is a placid place and the habitat for diverse wildlife species, its preservation as well as its use as a harbor had to be considered. Rather than allow natural and human processes to accelerate conversion of the lagoon into a marshy meadow, a preventive management program could be devised to assure continued enjoyment of the area in its natural state. A study of the lagoon to develop an ecologically sensitive land and water management plan that would meet human needs without destroying environmental quality was authorized in 1976. Local interest in natural resources offers the opportunity to make Bolinas Lagoon a model or demonstration project in environmental conservation.

Specifically, the study is to provide viable management alternatives for lagoon development. It will include, but not be limited to, investigation of rehabilitative dredging and other means of restricting deposition of sediments. This will involve study and evaluation of sedimentation processes; aquatic and land resource uses and impacts; and the ecology, water quality, and hydrology of the area. Various physical, geological, chemical, and biological processes will be incorporated into a numerical model to judge their influences on the lagoon. The effect of different planning schemes on the lagoon ecosystem will be observed through use of the model, which will also provide a general tool for coastal planners interested in evaluating alternatives when many complex processes must be taken into account. At present, the initiation and completion of the study is indefinite.

Fisherman's Wharf

Fisherman's Wharf, on San Francisco Bay near the Golden Gate, contains an intensively used commercial and recreational fishing boat facility with one of the highest vessel densities for its size in the state. It is a major tourist attraction with numerous restaurants and shops.

The existing berthing area is vulnerable to storms and the fishing and pleasure craft docked there have been repeatedly damaged by waves and surges. A report on varying methods to reduce these adverse effects on the 150 boats using the area and to provide safe berthing for an additional 300 boats was sent to the Secretary of the Army in 1978.

San Francisco Bay and Tributaries, Deep Water Ports (Dredging)

Disposal of dredged materials is a major problem in the waters of the San Francisco Bay complex. The State Water Quality Control Board (San Francisco Bay Region) and the Environmental Protection Agency are developing criteria for disposal of dredged materials, and it is expected that present disposal methods will be revised or that hopper dredges will have to have pumpout capabilities for land fill disposal. Either of these would increase dredging costs. Further, the option for land fill disposal is rapidly diminishing and long distance disposal would significantly increase Federal and local interest costs for dredging. The disposal problem is accentuated because local interests usually furnish lands, easements, and rights-of-way for construction and subsequent maintenance of projects.

Study of these problems, authorized in 1970 but not yet started, will examine effective, efficient, and economic means of maintaining authorized navigation channels. Environmental and ecological factors, completion of authorized projects, future navigation requirements, and technological developments will be considered.

San Francisco Harbor and Bay, Collection and Removal of Drift

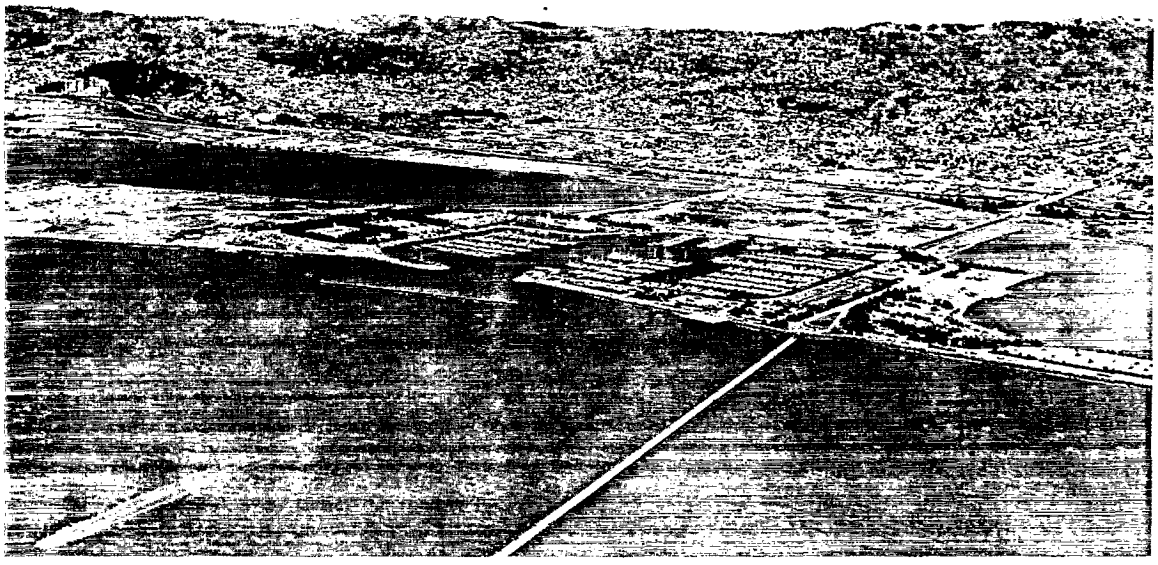
A study of the project to collect and remove floating debris from San Francisco Bay (see page 35) was started in 1976. Its purpose is to evaluate methods of reducing the need for continuing drift removal activities, costs of which have increased from about $200,000 to more than $700,000 annually over the last 30 years. The study is in progress, but its completion is indefinite.

SMALL NAVIGATION PROJECTS

Berkeley Harbor

Completed in 1965, this small navigation project consists of a detached rubble-mound breakwater protecting the entrance channel of Berkeley Harbor. Federal cost was about $160,000, including aids to navigation provided by the U.S. Coast Guard. The cost of meeting requirements of local cooperation for

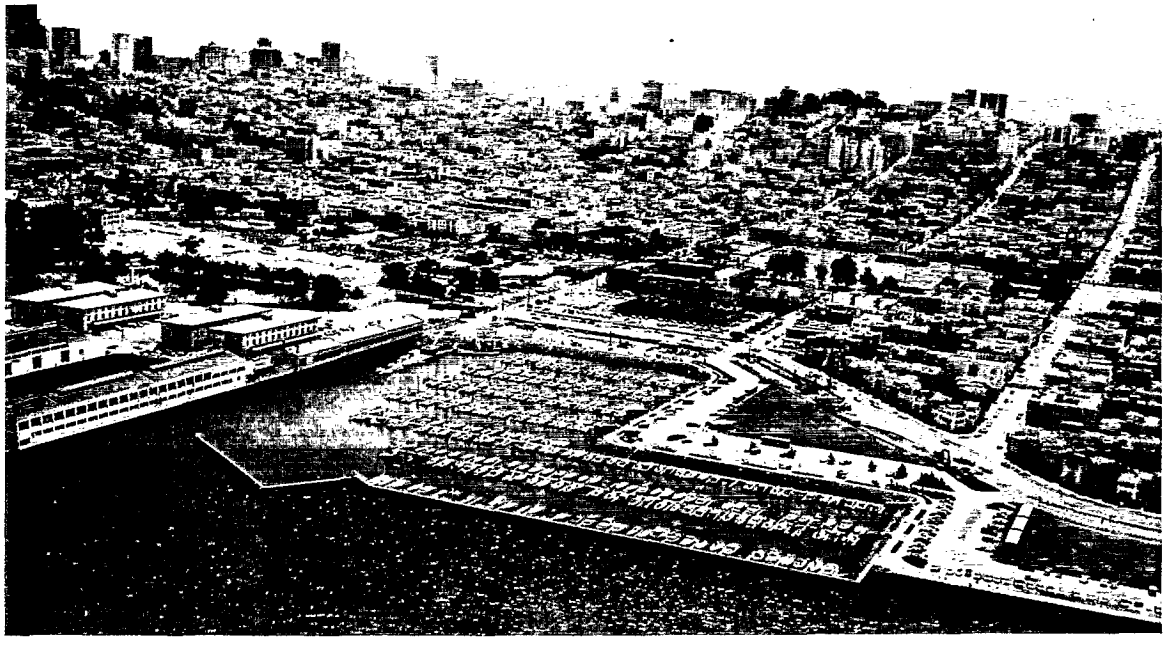
construction was also $160,000. In 1977, commercial use of Berkeley Harbor comprised movement of 16,800 tons of sand, gravel, and crushed rock, and landing of 25 tons of fish.



Berkeley Harbor

Gas House Cove (East Harbor Facility, San Francisco Marina)

Gas House Cove is a small-craft harbor located at the east end of San Francisco Marina. Wind, waves, and surge have created very hazardous conditions for moored boats in the harbor area. These problems were solved by a 117 foot concrete sheet pile breakwater connecting two existing breakwaters. Construction was completed in 1975 at a Federal cost of $180,000. Local interest cost was about $154,000.



Gas House Cove Harbor

Suisun Point Channel

A small navigation project in Upper Carquinez Strait and Lower Suisun Bay was completed in 1964 to alleviate serious collision and grounding hazards to deep draft navigation. It consisted of widening and deepening the existing Suisun Point and Bulls Head Channels in the vicinity of the Martinez-Benicia bridges, a reach of about 2 miles, to provide maneuvering area for deep draft vessels and to create a settling basin to reduce shoal intrusion into the main navigation channel.

Federal cost of the project was about $190,000. Local interests furnished lands, easements, and rights-of-way necessary for the project and provided works to retain dredger spoil.

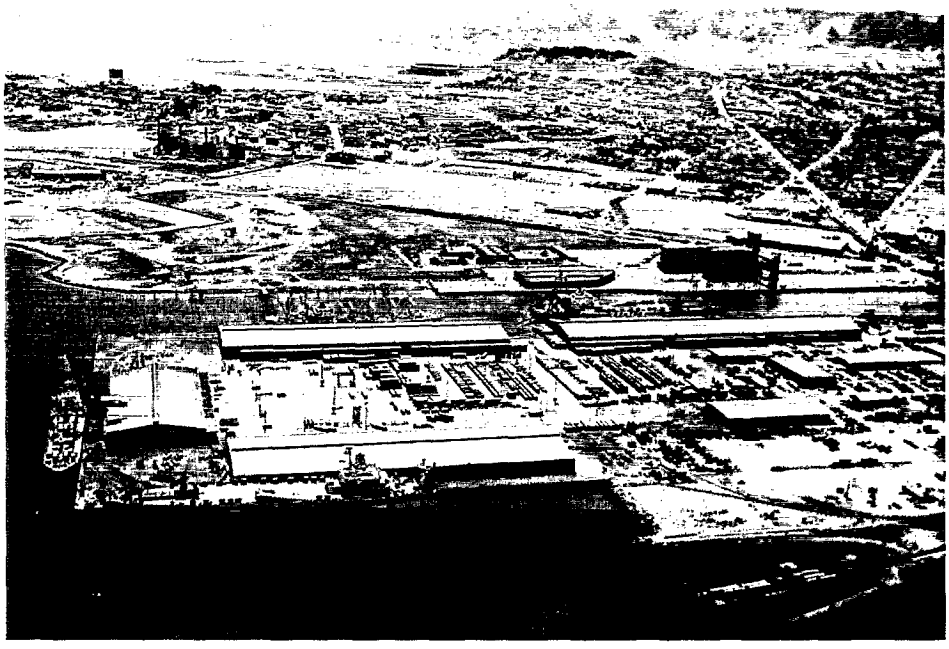
Islais Creek Channel

Islais Creek Channel, which is located at the south end of the Port of San Francisco, extends from the main ship channel in South San Francisco Bay to the Army Street Terminal. A small navigation project to deepen the channel from 35 to 40 feet was completed in 1977 at a Federal cost of about $850,000. Annual commerce carried on the channel is about 1,000,000 tons.

MULTIPURPOSE PROJECTS

Lake Mendocino (Coyote Valley Dam) and Russian River Channel

Lake Mendocino, which is impounded by Coyote Valley Dam, is on the Russian River about 5 miles north of Ukiah. Completed in 1959, the dam is an earthfill structure 160 feet high and 3,560 feet long. Bank stabilization works have been constructed along critical reaches of the river in Mendocino and Sonoma Counties. Lake Mendocino, which has a gross storage capacity of 122,500 acre-feet, provides a high degree of flood protection in the Ukiah and Hopland Valleys. A lower degree of protection is afforded areas farther downstream. The project also provides urgently needed water supply for irrigation and a rapidly growing urban and suburban area. Planned releases are made to augment normal streamflow during the summer months and permit continuing use of downstream recreation areas. Releases for water conservation purposes are made according to requirements of the Sonoma County Flood Control and Water Conservation District. Lake Mendocino was the first phase of a comprehensive plan of development for the Russian River. The Warm Springs Project and Knights Valley Lake, respectively, comprise the second and third phases of the comprehensive plan.

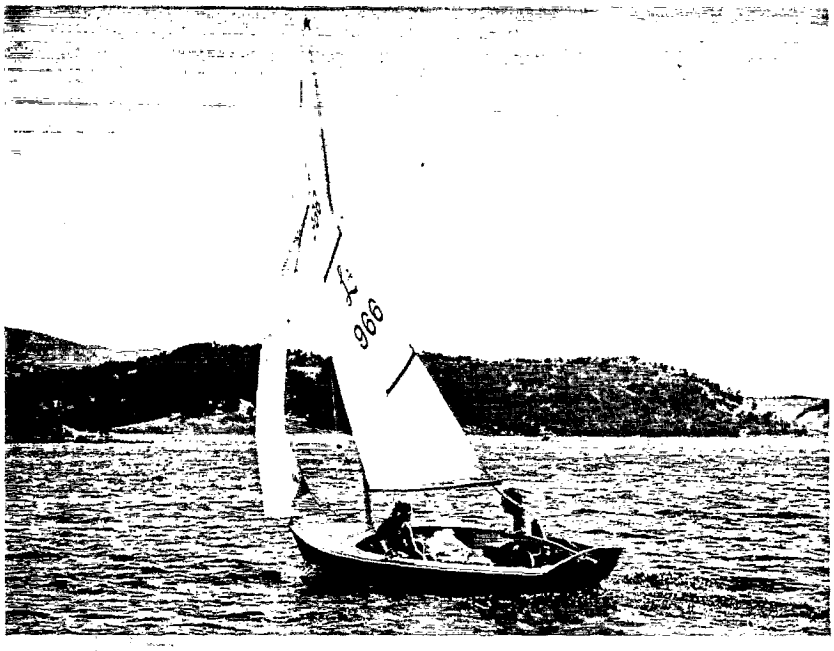


Islais Creek Channel (across center of picture) affords a 40-foot channel to Army Street Terminal

Lake Mendocino and Coyote Dam, Russian River

Federal cost of the Lake Mendocino Project, including bank stabilization work, was $15,400,000. Local interest cost for sharing in the project was $5,800,000. In addition, local interests have spent about $10,000,000 for water distribution facilities and $1,000,000 for partial flood protection work in project areas. The Corps of Engineers maintains and operates the dam and lake while local interests maintain the channel stabilization works.

An interpretive/cultural center is being designed for construction near the Pomo Recreation Area at Lake Mendocino. It will offer the public an opportunity to learn about the ecology and cultural history of the project area and the various recreational opportunities it affords. There will also be exhibits to orient visitors to the Corps' mission and history with special emphasis on local involvement. The center is planned for completion in 1979.

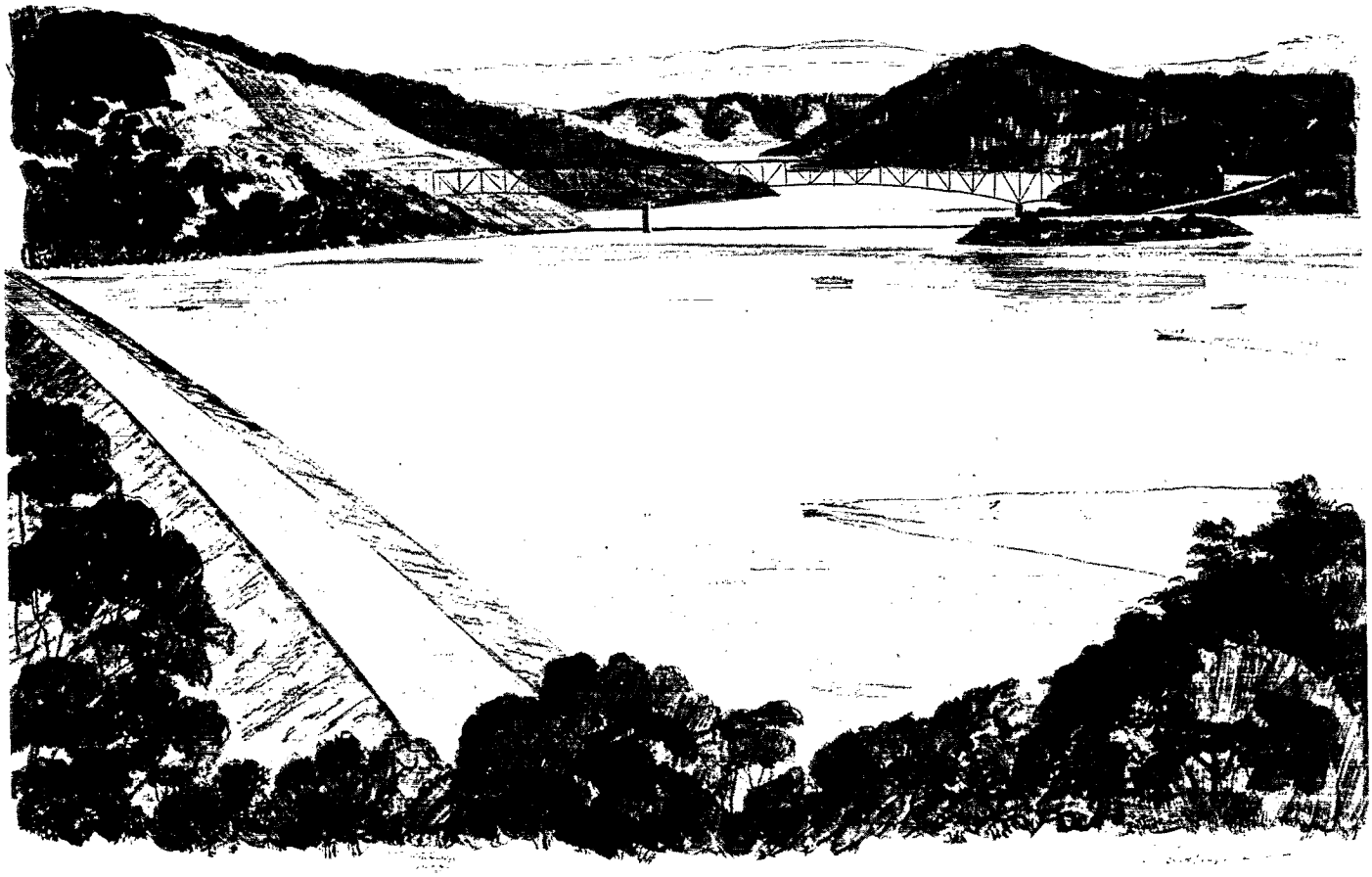


Lake Mendocino offers good sailing

Dry Creek (Warm Springs) Lake and Channel

Dry Creek drains a rugged area of about 220 square miles in the southwestern portion of the Russian River Basin. A multipurpose project on Dry Creek was authorized by the 1962 Flood Control Act as the second phase of a basin plan of development. The project consists of a dam just below the confluence of Dry and Warm Springs Creeks; a 381,000 acre-foot capacity lake for flood control, water supply, and recreation; and channel stabilization work along Dry Creek downstream from the dam. Land acquisition and road relocations are continuing; construction of the outlet works, Warm Springs Creek diversion, the fish hatchery, and other project facilities is in progress; and the main dam embankment has been started. It is expected that the project will be operational in 1983.

Federal cost of the Warm Springs Project is estimated at $232,000,000. Local interests will provide lands required for the downstream channel improvement works at an estimated cost of $85,000 and will maintain the channel improvements after completion. Under provisions of the 1958 Water Supply Act, the Sonoma County Water Agency contracted for perpetual rights to 132,000 acre-feet of storage capacity for water supply. This was the first contract of its kind to be negotiated with the Corps of Engineers in California. Local interests must reimburse the Federal Government for costs allocated to water supply storage. This reimbursement is estimated at $63,900,000, exclusive of interest.



Artist's conception of Dry Creek (Warm Springs) Project

About 20,500 acres of land downstream from the project will be protected from floods. These lands are used for agriculture and recreation, and include around 15 resort communities and numerous summer and permanent homes. If the project had been completed and in operation during the December 1964 flood, it would have prevented damage estimated at $3,600,000.

Knights Valley Lake

A multipurpose project in the drainage areas of Franze and Maacama Creeks was authorized in 1966 as the third phase of a comprehensive plan of development for the Russian River Basin. The project authorized comprised three-stage construction of two dams that would create a 1,500,000 acre-foot capacity lake for flood control, water supply, and recreation. Water conveyance facilities also comprised a project feature. Due to lack of local support, however, the project was recommended for deauthorization in 1976 and formally deauthorized in 1977 under the provisions of Section 12 of the Water Resources Development Act of 1974.

FLOOD CONTROL PROJECTS

Alameda Creek

Alameda Creek, which drains an area of about 700 square miles, rises on the western slopes of the Diablo Range, flows northerly and westerly for about 40 miles, and empties into South San Francisco Bay. The Federal project for flood control on Alameda Creek consists of levees, channel enlargement, bank protection work, and a recreation trail system along the coastal plain reach of the creek, and participation in the cost of Del Valle Dam on Arroyo Valle, the main tributary streamway. Channel improvement work and associated facilities were completed in 1977 at a Federal cost of about $21,000,000. Del Valle Dam, completed in 1968, was built by the State of California as a unit of the State Water Project. The reservoir has a storage capacity of 77,000 acre-feet. State cost for the dam and reservoir was about $33,000,000 and the Federal contribution, which reflected the flood control accomplishment, was $5,660,000.

Del Valle Dam and Reservoir and the channel improvement work provide flood protection to rapidly growing areas in Livermore Valley, Niles Canyon, and the coastal plain reach of the creek. The reservoir also provides urgently needed water supply in an area where pumping from the ground water basin has exceeded recharge for the last 30 years and the threat of saltwater intrusion is serious. Land use in the protected areas is continuing to change from agricultural to urban.

Alhambra Creek

Alhambra Creek flows into Carquinez Strait at the City of Martinez. A flood control project authorized in 1968 consists of channel improvements and diversion works on Alhambra and Franklin Creeks in Martinez. Federal cost of the project is estimated at $17,000,000 and the cost of meeting the requirements of local cooperation is estimated at $1,900,000. The project would provide a high degree of protection to about 660 acres in Martinez, but it was classified "inactive" in 1974 due to lack of local support.

Channelization of Alameda Creek affords protection to a rapidly growing area in Alameda County

Corte Madera Creek

Corte Madera Creek and its tributaries drain an area of about 28 square miles in Marin County. The creek basin is essentially a residential area (suburban to San Francisco), and two separate areas are subject to extensive flooding. The larger area extends through Ross Valley into tidal marshlands and includes the communities of San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, and Greenbrae. The other is within the City of Fairfax. Flooding has caused substantial property damage in these communities.

The project consists of channel improvements from San Francisco Bay to Sir Francis Drake Boulevard. Improvements and landscaping have been completed on Tamalpais Creek and on Corte Madera Creek from Lagunitas Road to Sir Francis Drake Boulevard. Completion of the project has been delayed until 1980 to study alternatives to the authorized improvements.

Federal first cost of the project is estimated at $16,300,000. Local interest cost is estimated at $7,100,000. Local interests will be responsible for maintaining the completed project, which will protect residential, commercial, and public property in the Corte Madera Creek Basin.

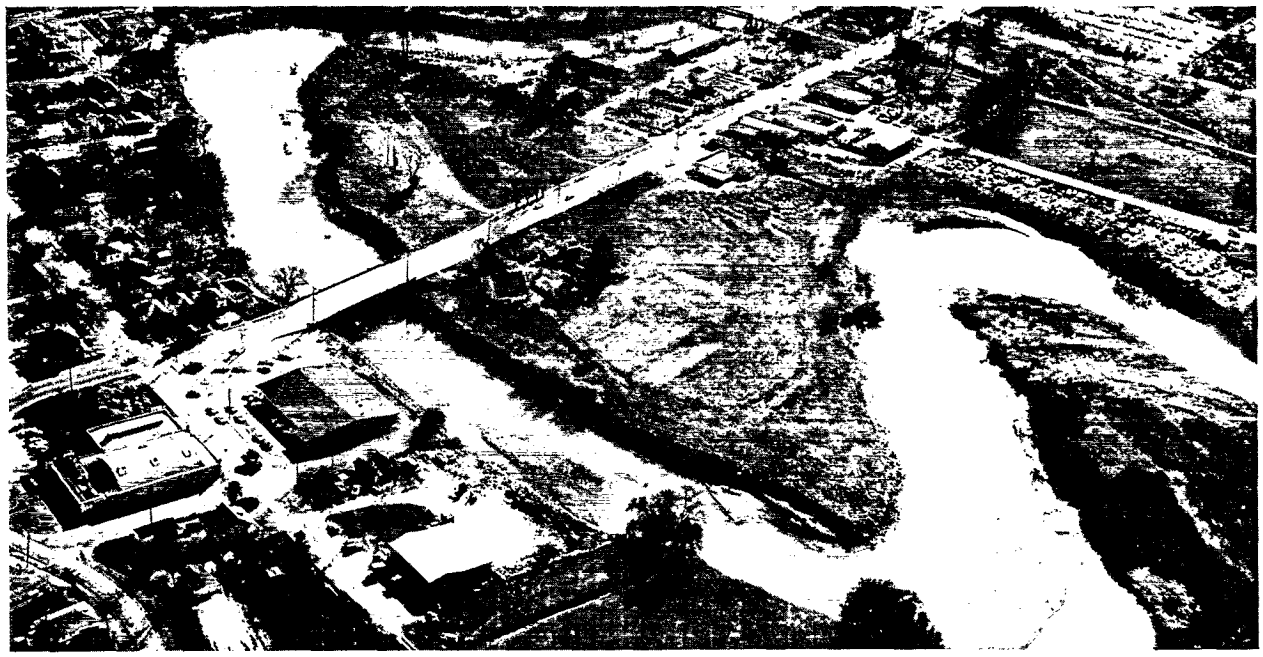
Fairfield Vicinity Streams[1]

A flood control project comprising channel improvement work, structures to reduce flow velocities, diversion channels, appurtenant new bridges and culverts, and recreation facilities was authorized in 1970 for streams in the vicinity of Fairfield. Estimated project cost is $16,850,000. Due to lack of local support and unresolved environmental issues, preconstruction planning was discontinued and the project classified "deferred" in 1977.

Napa River Basin

Napa River rises in Napa County on the southern slope of Mount St. Helena. It flows southerly about 50 miles to discharge into Mare Island Strait in the vicinity of Vallejo. The drainage basin comprises 426 square miles and ranges from tidal marshes to mountains. In the lower reach of the river, flood conditions are aggravated by high tides and local runoff.

Authorized in 1965, the flood control project for the Napa River provides for channel enlargement and realignment, levees and floodwalls, and public boat launching facilities in an 11-mile reach downstream from Trancas Road in Napa. Cost of the project is estimated at $59,000,000, of which $16,700,000 would be a local expense.



Napa River at Napa. The authorized project will eliminate the oxbow and substantially improve flood carrying capacity.

[1]This project is under the jurisdiction of the Sacramento District.

The project will provide a high degree of flood protection to urbanized areas, especially in Napa. Construction is being delayed pending adoption of the project by local election and provision of rights-of-way.

San Lorenzo Creek, Alameda County

San Lorenzo Creek flows through a highly developed residential area on the eastern side of San Francisco Bay about 15 miles southeast of San Francisco. The project consists of 1.4 miles of levees, a 3.9 mile rectangular concrete channel, and levees constructed by local interests in the lower reach of the creek. San Lorenzo Village and Hayward are afforded flood protection by the project. Federal cost of the project was $5,200,000, and the cost of meeting requirements of local cooperation was $1,000,000. Local interests are maintaining the levees.

Sonoma Creek Basin

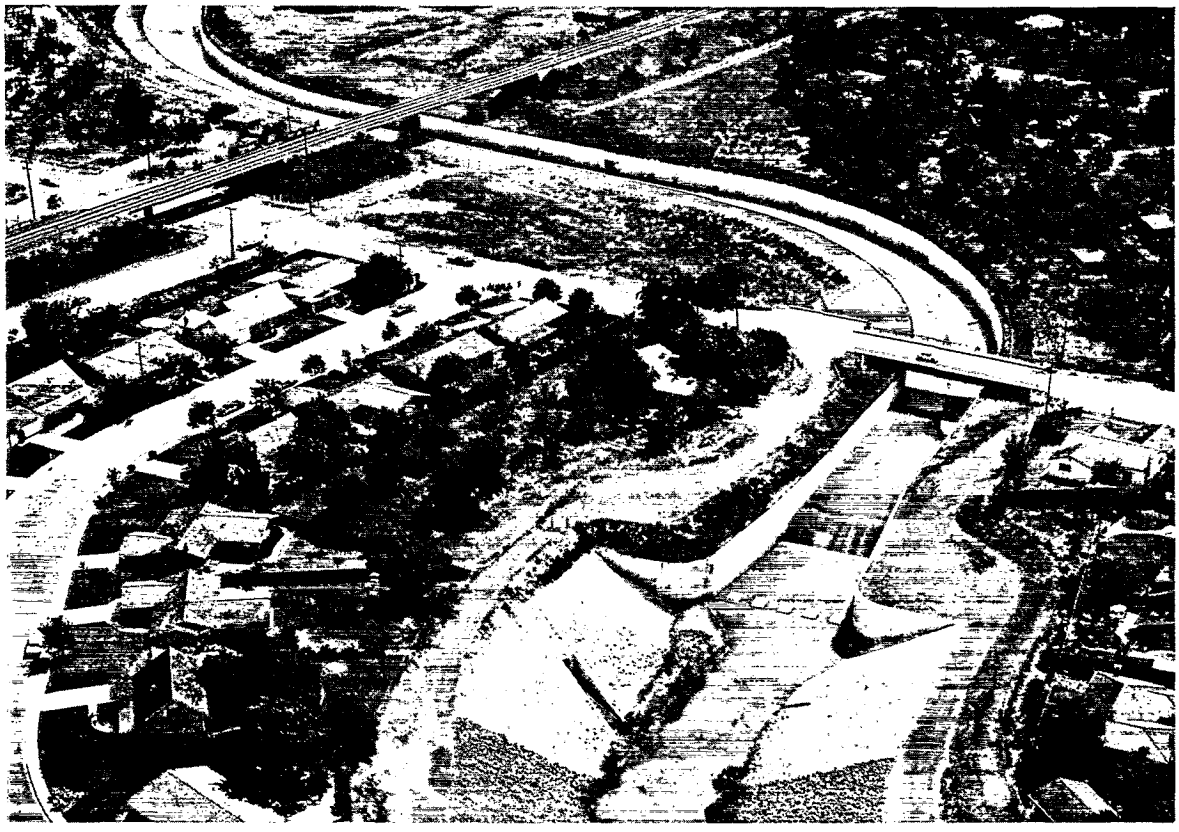
Sonoma Creek and its tributaries drain an area of about 154 square miles in Sonoma County. The stream basin is tributary to San Pablo Bay, an arm of San Francisco Bay. A flood control project authorized in 1965 consists of channel improvements and appurtenant works on the lower 15 miles of the creek. Federal cost of the project is estimated at $18,600,000, and the local interest cost is estimated at $1,200,000.

Although the Sonoma Creek Basin is subject to recurring major flood damages, land use in the area is changing rapidly from agricultural to residential and industrial. Population of the basin has increased about 50 percent in the past decade and is expected to total about 155,000 by the year 2000. The project is designed to provide a high degree of flood protection to 10,700 acres of urbanizing land. Due to lack of local support, however, it was classified "inactive" in 1974.

Walnut Creek

The Walnut Creek Project provides for enlarging and straightening the channels of Walnut Creek and lower San Ramon Creek, and building levees and channel stabilization structures where required; building levees and doing incidental work on Grayson and Pacheco Creeks; and improving the channels of Pine and Galindo Creeks.

Total cost of the project is estimated at $79,500,000, of which $60,200,000 would be Federal cost and $19,300,000 local interest cost. Local interests will operate and maintain the project after its completion.



A completed section of the Walnut Creek Project

Construction was started in 1964 and is scheduled for completion in 1984. Work remaining includes channel improvements on sections of Walnut and San Ramon Creeks and along lower Pine and Galindo Creeks. Channel improvements on the remaining reaches are being studied. A bypass plan, which would permit existing creeks to be left in their natural state, is being investigated.

The project will provide a high degree of flood protection to about 6,670 acres in the flood plain at and below the City of Walnut Creek. A study of the Walnut Creek Basin authorized in 1963 is continuing, but its completion is indefinite. (See page 48.)

Wildcat and San Pablo Creeks

Wildcat and San Pablo Creeks are tributary to San Pablo Bay, flowing to that body of water in the vicinity of San Pablo and Richmond. The channels of these streams are inadequate to pass even minor floodflows, and overbank flow occurs on an average of once in 3 years. A flood control project for Wildcat and San Pablo Creeks was authorized in 1976 by the Senate and House Public Works Committees under provisions of Section 201 of the 1965 Flood Control Act.

The plan of improvement authorized consists of 15,900 feet of channel improvement on Wildcat Creek and 9,600 feet of similar work on San Pablo Creek. Work contemplated includes channel deepening, levee construction, stilling basins, and flow control structures. A park to include picnic facilities and related utility systems, and a 2-mile trail connecting to other regional park trails is also a feature of the project.

Advanced engineering and design studies, started in 1976, are scheduled for completion in 1979. Federal cost of the project is estimated at $9,100,000 and local interest cost at $7,500,000.

FLOOD DAMAGE PREVENTION STUDIES

Guadalupe River and Adjacent Streams

The Guadalupe River drains an area of 800 square miles in Santa Clara and Alameda Counties and flows into lower San Francisco Bay at a point 10 miles east of Palo Alto. Inadequate and decreasing channel capacities and subsidence of the valley floor in recent years have contributed to flooding, bank erosion, and (in the lower reaches of the river) tidal inundation from the bay.

This investigation is oriented toward flood control improvements for that portion of the Guadalupe River included in the Department of Housing and Urban Development Model Cities Program for San Jose. Improvements along Silver Creek will also be studied. A target date late in 1980 has been set for completion of the study.

San Francisco Bay Shoreline

An investigation of flood and related problems of lands lying below the high water line along the San Francisco Bay shoreline of San Mateo, Santa Clara, Alameda, Napa, Sonoma, and Solano Counties was authorized in 1976. Its purpose is to determine the feasibility of (and examine the Federal interest in) providing protection against tidal and stream flooding. The investigation will cover the effects of any proposed improvements on wildlife preservation, agriculture, and municipal and urban interests, and be carried out in coordination with Federal, state, regional, and local agencies with particular reference to preserving existing marshland in the San Francisco Bay region. This investigation has not yet been initiated.

Northern California Streams

An authorized investigation of all streams in Northern California flowing into the Pacific Ocean, including the Sacramento River and its tributaries, has been divided between the San Francisco and Sacramento Districts. San Francisco District will study and report on coastal streams and Sacramento District will study and report on interior streams. A number of individual studies and reports will be made within the framework of the comprehensive investigation, which is scheduled for completion in 1982. See page 24 for discussion of the North Coastal Basins portion of this study and page 111 for the Sacramento Basin portion.

In the San Francisco Bay Area, a study of the Russian River Basin is in progress. Its purpose is to investigate providing flood control consistent with good water quality and a protected and enhanced environment. Among other things, the investigation will consider preserving flow capacity at the mouth of the river, preserving and enhancing the fishery, water quality releases from Lake Mendocino and other storage projects, and the effects of channel stabilization works. Completion of this phase of the overall study is scheduled for completion in late 1980.

Novato Creek and Tributaries

An investigation of flood and related problems along Novato Creek and its tributaries in Marin County is in progress. Its purpose is to examine the feasibility of building levees and realigning or otherwise improving stream channels to protect urbanizing areas. Completion of the study is scheduled for 1979.

Walnut Creek Basin

A study of the Walnut Creek Basin was authorized in 1963. Its purpose is to determine whether the authorized project (refer to page 46) should be extended to provide flood control on tributary waterways. Such an extension might incorporate works already existing and proposed by the Soil Conservation Service, and existing and potential improvements on major and minor tributaries to Walnut Creek. As a result of urbanization, much of the basin is experiencing flood and drainage problems. Existing waterways are inadequate to carry floodflows. The Soil Conservation Service and the local flood control district have jointly provided a flood detention basin on Pine Creek along with general channel improvements, realignment, and enlargement, and bank revetment on other tributary streams.

The basin study was started in 1965. With the exception of the Diablo area, all study areas have been evaluated. Feasible projects have not yet been identified. Completion of the study is indefinite.

SMALL FLOOD-CONTROL PROJECTS

Coyote Creek, Marin County

A small flood-control project to improve Coyote Creek comprises 7,500 feet of concrete-lined or trapezoidal section earth channel completed in 1965. It protects the community of Tamalpais Valley, which is about 8 miles north of San Francisco. Cost of the improved channel was $1,400,000, which was equally divided between the Federal Government and local interests. Project maintenance is a local responsibility.

Green Valley Creek, Solano County

Green Valley Creek and its tributaries drain a 26 square mile area northerly of Suisun Bay. A small flood-control project primarily consisting of realigned and enlarged channel along Green Valley and Dan Wilson Creeks was completed in 1962 at a Federal cost of $140,000. The local interest share of project cost was $80,000. Orchards and vineyards, pastureland, and cropland are protected by the project.

Pinole Creek, Contra Costa County

Construction of a small flood-control project to protect the town of Pinole, a suburban residential community of about 5,000 persons, was completed in 1966. The project consists of about 1.5 miles of trapezoidal section earth channel, riprap-lined chutes in the channel to reduce high velocity flow, and rectangular concrete sections under two bridges.

Total Federal cost of the project was about $860,000. The cost of meeting requirements of local cooperation was about $120,000. The improvements are maintained by the local interests.

Rheem Creek

A small flood-control project on Rheem Creek, Contra Costa County, was completed in 1960. The project consists of about 1.5 miles of concrete-lined and trapezoidal section earth channel. It protects the City of San Pablo, a community of about 20,000 located on the east side of San Francisco Bay.

Federal cost of the project was $400,000 and the cost of meeting the requirements of local cooperation was about $190,000.

Rodeo Creek, Contra Costa County

A small flood-control project to protect the community of Rodeo, which is located in a narrow valley at the mouth of Rodeo Creek, was completed in 1966. The project consists of about 4,450 feet of trapezoidal section earth channel, riprapped as required, and about 1,450 feet of rectangular section concrete-lined channel.

Total Federal cost of the project was $990,000. The cost of meeting requirements of local cooperation was about $330,000.

San Leandro Creek

Construction of channel improvements as a small flood-control project in the lower reach of San Leandro Creek was completed in 1973. The creek forms part of the boundary between the cities of Oakland and San Leandro and drains a 48 square mile area into San Leandro Bay, an arm of San Francisco Bay. The project is located in the lower 2 miles of the creek and consists of about 1.3 miles of trapezoidal section earth channel and 0.5 mile of rectangular concrete section channel.

The Federal first cost of the project was $1,000,000 and the non-Federal first cost $285,000. Local interests maintain the project.

The protected area includes residential, light industrial, and agricultural areas; a public school; major arterial highways; and railroad spur tracks.

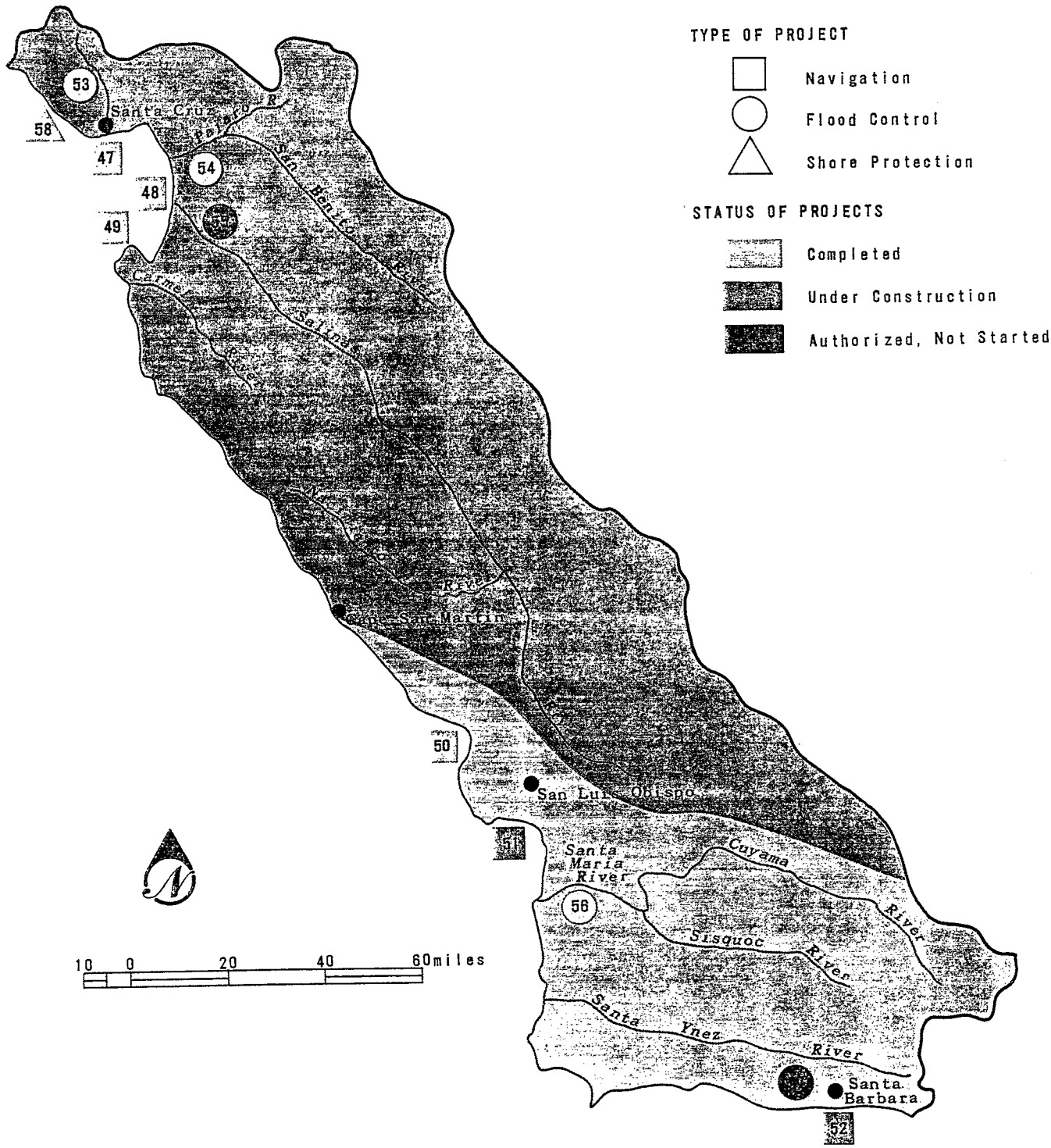
SHORE PROTECTION STUDY

City of Alameda Shoreline

For many years, the 2 miles of bayfront beaches in the City of Alameda have experienced erosion problems. Although erosion loss has averaged about 3 feet of beach per year, loss in some reaches has been as much as 400 feet. Stabilizing the shoreline of the City of Alameda to prevent further erosion has been under study for a number of years, and this beach area has been selected and authorized as a demonstration project under the authority of the Shoreline Erosion Control Demonstration Act of 1974. The purpose of the project is to study and demonstrate effective, low cost methods of preventing and correcting shoreline erosion. The materials to be used in these activities must be inexpensive, readily available, and easily emplaced. Also, corrective and preventive facilities emplaced must require little maintenance and minimal attention to assure continued effectiveness. The categories of erosion control measures that have been selected for study include offshore breakwaters, groins, beach fill, and coastal vegetation. Sixteen methods involving various materials within these categories will be studied. Construction and emplacement of facilities is expected to start around the beginning of 1979. A 2-year period of analysis will follow completion of construction and emplacement.

Golden Gate Bridge is a world-famous trademark of the San Francisco Bay Area. Historic Fort Point appears in the left foreground.

4 CENTRAL COASTAL BASINS
(San Francisco & Los Angeles Districts)



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[1]Number following project name denotes Congressional District.

DESCRIPTION[1]

All or portions of Santa Cruz, Monterey, San Benito, San Luis Obispo, Santa Barbara, and Ventura Counties comprise the Central Coastal Basins area. It extends along the coast from about Santa Cruz on the north to Santa Barbara on the south, and covers a land and water area of about 11,500 square miles. Broad coastal plains are not characteristic of the shoreline of the Central Coastal Basins. Generally, mountainous terrain and rolling hills extend to the sea, thus creating a rugged, scenic coastline. Important mountain chains paralleling the coast are the Santa Lucia, Diablo, La Panza, and Gabilan Ranges, and the Sierra Madre, San Rafael, and Santa Ynez Mountains. The principal streams are the San Lorenzo, Pajaro, Salinas, Carmel, Santa Maria, and Santa Ynez Rivers. The largest stream of the Central Coastal group is the Salinas River, which drains about 40 percent of the total watershed area. Lesser streams comprise the Morro-San Simeon, San Luis Obispo-Arroyo Grande, and Santa Barbara County groups.

The economy of the Central Coastal Basins is supported primarily by production and processing of various food products (the main segment of the economy), by production and processing of petroleum products and other nonmetallic minerals, and by a variety of light manufacturing activities. Meeting the needs of vacationists and recreationists is important along the coast where the rugged scenic beauty and opportunity for water-oriented activities attract many visitors. The coastline of Santa Barbara County is frequently referred to as the "American Riviera." Major urban centers are Salinas, Monterey, Carmel, Santa Cruz, Watsonville, San Luis Obispo, Santa Maria, and Santa Barbara. In 1970, the population of the Central Coastal Basins was about 810,000. Its present population, about 940,000, is projected to increase to 1,400,000 by the year 2000.

Major water resources development problems include flood and erosion control along streams, and shoreline protection along most coastal reaches. Floodflows are characterized by extremely rapid rise and high velocity due to steep stream gradients. Agricultural and urban areas are subject to flood damage, and severe streambank erosion results in deposition of large volumes of sediment in flood plain areas. In the upper watersheds, erosion rates are increased as an aftermath of wildfires.

[1]Stream basins north of Cape San Martin are in the San Francisco District, and basins to the south of that point are in the Los Angeles District. Cape San Martin is on the Monterey County coast about 10 miles north of the boundary between Monterey and San Luis Obispo Counties.

NAVIGATION PROJECTS

Monterey Harbor

Monterey Harbor is located at the southern end of Monterey Bay, one of the earliest known anchorages along the California coast. The harbor improvement, which is in the vicinity of the municipal wharves of Monterey, consists of three breakwaters that create a protected harbor with two 400-foot wide entrances. It was completed in 1947 at a Federal cost of $700,000 plus a local contribution of $80,000. Additional breakwater construction authorized in 1960 is presently inactive due to lack of local support. In 1977, commerce in Monterey Harbor totaled about 10,600 tons of fish and various nonmetallic minerals.

Moss Landing Harbor

Moss Landing Harbor is on Monterey Bay about midway between the cities of Santa Cruz and Monterey. The project consists of harbor entrance jetties, a 1,900-foot entrance channel, a 3,200-foot lagoon channel, and a turning basin. Controlling depth is 15 feet. Completed in 1947 at a Federal cost of $340,000, the harbor is maintained by the Corps of Engineers. Local interests provided rights-of-way and disposal areas for harbor construction. Enlarging the lagoon channel is being investigated. (See page 187.)

The economy of Moss Landing is sustained by commercial fishing and by offshore handling of petroleum products by pipeline and barge. Commerce in Moss Landing Harbor consisted of 2,200,000 tons of petroleum products and 10,000 tons of fresh fish in 1977.

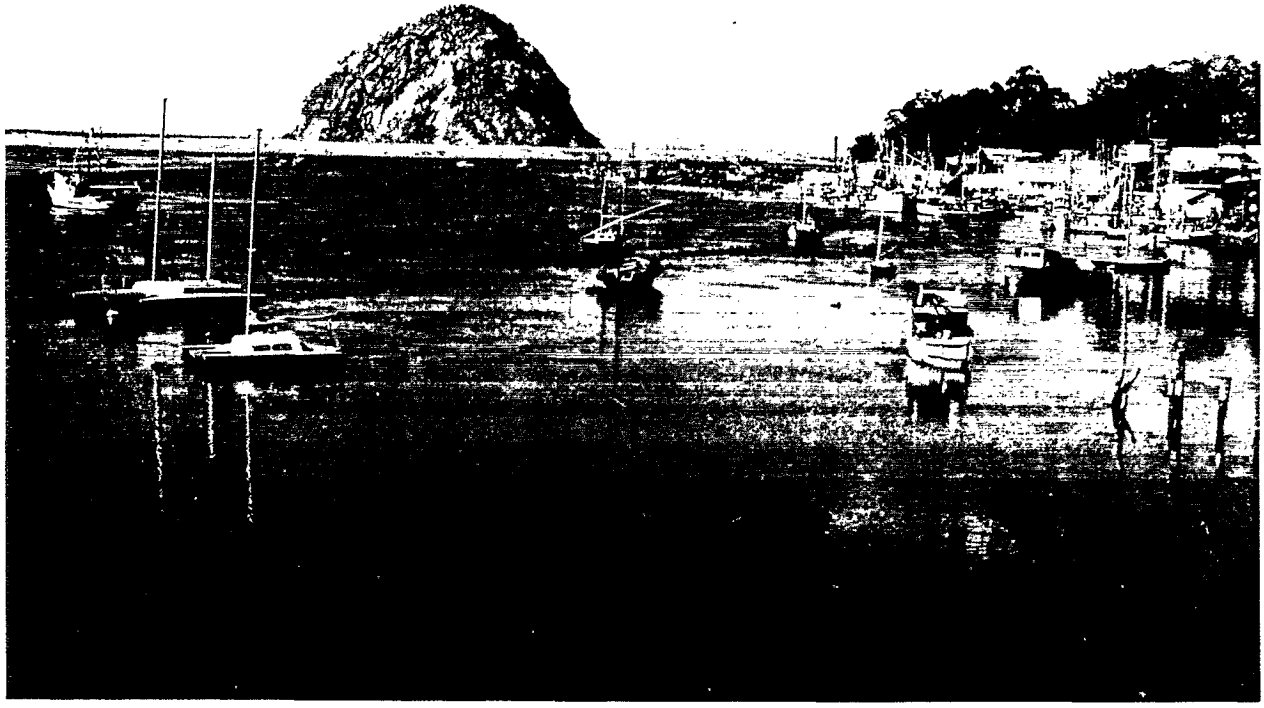
Moss Landing Harbor

Morro Bay Harbor

Morro Bay, the only natural landlocked anchorage along the San Luis Obispo-Santa Barbara County reach of coastline, is about midway between San Francisco and Los Angeles. Harbor improvements comprise an entrance channel protected by breakwaters, two harbor channels, and revetment along the City of Morro Bay waterfront. Other improvements consist of a stone groin, a stone dike, and a levee protecting shorelines in the project area. The entrance channel has a design depth of 16 feet. Navy and Morro Channels (the harbor channels) have design depths of 16 feet and 12 feet, respectively. Morro Channel joins a natural channel leading to a small-craft harbor at a state park near White Point.

Completed in 1946 at a cost of about $2,600,000 (Department of the Navy funds), project improvements are maintained by the Corps of Engineers. San Luis Obispo County, the City of Morro Bay, the California Wildlife Conservation Board, and other local interests have provided about $3,400,000 for public use facilities in project areas.

Morro Bay Harbor serves as home port for a U.S. Coast Guard patrol boat and about 350 small boats. It is used regularly by about 180 commercial and sport fishing boats. During the fishing season, approximately 200 vessels based at other ports land fish at Morro Bay Harbor. Commercial traffic consisted of 2,600 tons of fish in 1977. Investigation of modifying the existing project is authorized. (See page 57.)



Morro Bay Harbor

Port San Luis

Formerly known as San Luis Obispo Harbor, Port San Luis is on San Luis Obispo Bay, a semisheltered cove roughly 190 miles north along the coast from Los Angeles and 245 miles south of San Francisco. In its early history, the cove was known as Port Harford and was a rendezvous of pirates. One of the earlier navigation projects along the California coast, harbor improvements for San Luis Obispo Bay were first authorized in 1888.

Completed in 1913 (as modified by authorizations in 1893 and 1898) at a Federal cost of about $570,000, the existing project consists of a rubblemound breakwater extending from Point San Luis to Whaler Island, thence southeasterly about 1,800 feet for a total breakwater length (including the island) of 2,400 feet. The breakwater is 20 feet wide at the top and extends 6 feet above mean high water.

Project modifications authorized in 1970 and 1976 provide for rehabilitating the existing breakwater; removing rock pinnacles; building new breakwaters; and dredging a main interior channel, entrance channels, and anchorage and refuge areas. Controlling depth is 15 feet except for one refuge area where it is 12 feet. Preparation of plans and specifications for construction of the authorized project modifications is nearing completion. Estimated cost of the work is about $13,000,000, of which $7,000,000 would be Federal cost and $6,000,000 would be non-Federal cost.

About 300 commercial and recreational boats use harbor facilities at Port San Luis. Due to potential storm damage to boats in the winter, however, recreational boating in this area is limited to about 8 months of the year. Waterborne commerce based on facilities at Port San Luis is estimated at about 2,000,000 tons per year and the annual value of the commercial fish catch is estimated at about $1,000,000.

The improved harbor would accommodate over 900 commercial and recreational craft, provide a harbor of refuge for transient boats, prevent storm damage to berthed vessels, increase commercial and sport fishing, and alleviate the need for berths and moorings in the region.

NAVIGATION STUDY

Morro Bay Harbor

An investigation of the advisability of modifying the Morro Bay Harbor Project to accommodate additional small boats was authorized in 1963. As noted earlier, this project serves as home port for over 500 commercial and recreational boats, and about 200 boats based at other ports land fish during the fishing season. Morro Bay and the harbor facility have a tributary region with a population expected to increase to around 2,500,000 by the year 2000. Need for berths for small boats, currently about 3,000, is projected to increase to 5,000. Modifications to be investigated include realigning the entrance channel and widening the existing interior channels, and providing additional channels, mooring basins, and other facilities for small boats. The investigation is currently unbudgeted and its completion is indefinite.

FLOOD CONTROL PROJECTS

Pajaro River Basin Project

A flood control project along the Pajaro River and its tributaries in the vicinity of Watsonville and Gilroy was initially authorized in 1944. Authorized work comprising levee reconstruction and extension along the Pajaro River and Corralitos Creek near Watsonville was completed in 1949 at a Federal cost of $748,000. Local interests provided lands, easements, rights-of-way, and relocations for project construction; and have maintained the improvements completed. Lengthening and enlarging an existing levee along the left bank of Carnadero Creek in the vicinity of Gilroy has been classified "inactive" due to lack of local support.

Modification and extension of the existing levee system along the Pajaro River and Corralitos and Salsipuedes Creeks was authorized in 1966. Preconstruction planning for these improvements, however, has been deferred. A flood damage prevention study of the Pajaro River is continuing.

Salinas River Basin Project

A flood control project comprising channel improvement work, levee construction, and protective planting along the lower 93 miles of the Salinas River was authorized in 1946. These improvements would stabilize the river on an improved alignment. Advance planning has been deferred pending construction of reservoirs proposed by local interests.

San Lorenzo River

The San Lorenzo River flows generally southeast from the Santa Cruz Mountains to the City of Santa Cruz where it empties into Monterey Bay. Branciforte Creek, a major tributary, joins the river in the city. A flood control project comprising levees, floodwalls, channel work, and other improvements on these streams was completed in 1959. Correction of problems of interior drainage was completed in 1965. Federal cost of project improvements was $4,320,000 and the cost of meeting the requirements of local cooperation was about $3,270,000. Local interests maintain the project works.

A review investigation of silt accumulation in the San Lorenzo River channel was authorized in 1978. Development of a basin plan of improvement will be considered under the Salinas-Monterey Bay Area urban study.

Levee along the San Lorenzo River after landscaping under the Model Cities Program

Goleta and Vicinity

Improvements for flood control on Atascadero Creek and its tributaries in and near Goleta (greater Santa Barbara area) were authorized in 1970. Specifically, the project would provide about 1.3 miles of channel clearing, 11.2 miles of channel construction, a diversion channel, beautification of project areas, protection of streamway ecology, and recreation use developments. About 2,300 acres of rapidly developing urban area in the Goleta Valley would be afforded flood protection.

The Federal cost of project improvements is estimated at $30,900,000. Non-Federal cost would be about $9,300,000. Funds have not yet been appropriated for preconstruction planning studies.

Santa Maria River Basin Project

The Santa Maria River Basin Project consists of 22 miles of levee and channel improvements along the Santa Maria River, a leveed diversion channel 2 miles long to carry floodflows from Bradley Canyon to the Santa Maria River, and the multipurpose Twitchell Reservoir on the Cuyama River, a tributary of the Santa Maria River. Twitchell Reservoir, completed in 1958 by the Bureau of Reclamation, is operated for flood control according to regulations prescribed by the Corps of Engineers. About 90,000 acre-feet of the total 240,000 acre-foot storage capacity is reserved for flood control operation. The levee and channel improvements along the river and Bradley Canyon diversion were completed in 1963. These facilities in combination with flood control operation of Twitchell Reservoir afford a high degree of flood protection to Santa Maria and about 20,000 acres of intensively cultivated agricultural land in the Santa Maria Valley. During floods that occurred early in 1978, the project prevented damage estimated at $6,400,000.

Federal cost for the levee and channel work was $5,536,000. Non-Federal cost was $1,248,000. Floodflows in 1969 resulted in damage to the Santa Maria River levees. Remedial work (estimated to cost $4,360,000) is under study to determine the most suitable corrective measures.

FLOOD DAMAGE PREVENTION STUDIES

Carmel River and Tributaries

The Carmel River rises in the Santa Lucia Range and Sierra de Salinas. It flows northwesterly through western Monterey County to empty into the ocean at Carmel, which is about 80 miles south of San Francisco. An extremely scenic coastline and major points of interest in the area attract many visitors to Carmel, one of the larger urban centers in the basin. Permanent population, about 20,000 in 1970, is expected to increase to about 35,000 by the year 2000. The basin economy is largely dependent on tourism.

Continuing flood problems in agricultural and residential areas result from the runoff from heavy spring rains. Local interests have indicated that a supplemental water supply of 40,000 acre-feet per year is needed to meet the demands of the service area. An investigation of water resources problems in the basin, which is in an environmentally sensitive region, was started in 1971 and is currently scheduled for completion in 1979. A multiple-purpose reservoir for flood control, water supply, recreation, and other purposes is under consideration.

Pajaro River Basin

Although the completed portions of the Pajaro River Basin Project provide flood protection and have prevented substantial flood damage, Watsonville, Gilroy, and extensive agricultural lands in the basin remain subject to damage during large floods. Modification and extension of project works as authorized in 1966 would provide a higher degree of protection. The Pajaro River Basin requires a supplemental water supply. Multiple-purpose storage projects and local flood protection works such as channel improvements and levee construction (particularly on Uvas and Carnadero Creeks) are being considered in an ongoing water resources development investigation.

San Lorenzo River

Subsequent to completion of flood control improvements on the San Lorenzo River and Branciforte Creek in the City of Santa Cruz, silt has accumulated in the river channel to the extent that it cannot carry the project design flood. This condition is believed to be due to lack of large flows, which would tend to scour the streambed, and to inadequate maintenance. The volume of siltation experienced, however, is possibly greater than anticipated in the project design. A review investigation of the siltation problem was authorized in April 1978. Its purpose is to examine the problem generally within, but not restricted to, the limits of the authorized project. Detailed studies of the causes of the siltation problem will be made, and possible solutions and their impact on the existing project will be examined.

San Luis Obispo County

Due to its proximity to the ocean and favorable climate, San Luis Obispo County is a haven for people seeking relief from urban sprawl and congestion. This area has had very rapid growth during the past 15

years, and further industrial, commercial, and residential development is expected. Population is projected to increase from about 100,000 in the 1970s to 160,000 by the year 2000. Severe floods that occurred in 1969 and 1973 resulted in Presidential declarations of disaster for the county and more than $9,000,000 damage. Floods that occurred early in 1978 were more severe than those of 1969 and 1973. Damage estimated at $11,000,000 resulted, and the county was again declared a disaster area.

A study of flood and related water resources development problems in San Luis Obispo County was authorized in 1974 and started in 1976. It will include consideration of reservoir storage projects, levee construction and channel improvements, flood plain management measures, and various combinations of these approaches to flood damage prevention. Work on the study is scheduled for completion in 1981.

SHORE PROTECTION PROJECT

Santa Cruz County

The Santa Cruz County coast extends from near Point Ano Nuevo south to the mouth of the Pajaro River, a distance of about 40 miles. A shore protection project authorized in 1958 provides for Federal reimbursement of part of the costs of shore protection works to be emplaced or constructed by local interests at and in the vicinity of Santa Cruz. Specifically, the project relates to seawalls at intermittent locations opposite West Cliff and East Cliff Drives; beach fill at Twin Lakes Beach State Park; and a stone groin at Black Point, the south end of Twin Lakes Beach. A jetty built by the Corps of Engineers at the entrance to Woods Lagoon (Santa Cruz Harbor Project) serves as a protective groin for the northern end of Twin Lakes Beach.

About 5,200 feet of seawalls have been completed. Beach fill, the groin at Black Point, and certain seawall construction remain to be completed. Due to lack of local support, remaining work was classified "inactive" in 1973. Also, accretion in the Twin Lakes Beach area indicated the authorized work there was not required. Further, remaining work was judged beyond the scope of the authorized project. About $250,000 of an estimated total Federal reimbursement of $1,490,000 has been spent on this project.

Shore protection work at Santa Cruz

5 SOUTH COASTAL BASINS (Los Angeles District)

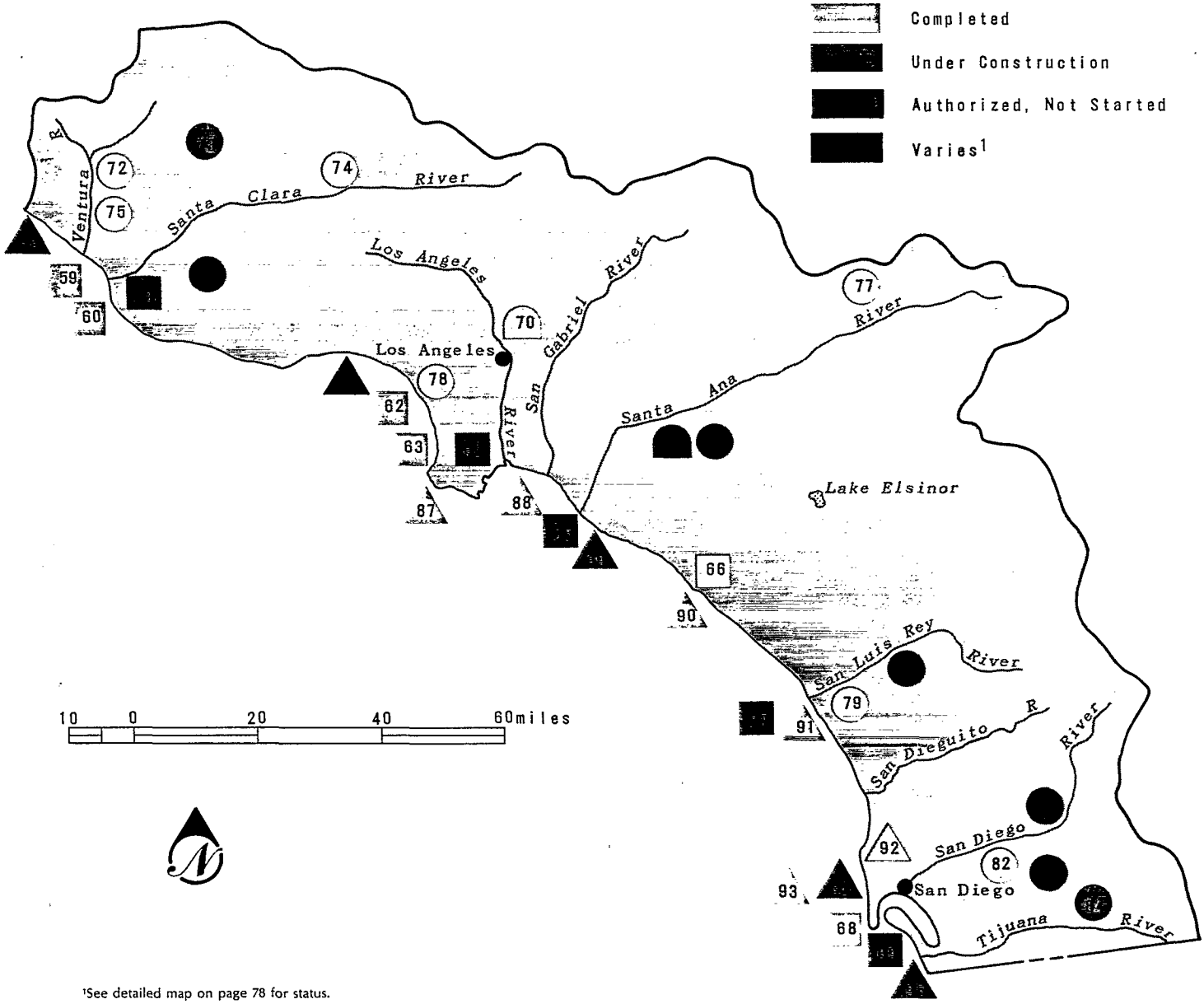
LEGEND

TYPE OF PROJECT

- Navigation
- Multipurpose
- Flood Control
- Shore Protection

STATUS OF PROJECTS

- Completed
- Under Construction
- Authorized, Not Started
- Varies[1]



[1]See detailed map on page 78 for status.

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[1]Number following project name denotes Congressional District.

[2]See page 75 for detailed map.

[3]See page 78 for detailed map.

DESCRIPTION

The South Coastal Basins extend along the Pacific Ocean from just south of Santa Barbara to the Mexican border. They have a scenic coastline of 233 miles and cover about 11,000 square miles. Topography includes gently sloping coastal plains, fertile valleys, rolling foothills, and rugged mountains. The basins extend eastward from the ocean to the watershed divides of the Tehachapi, San Gabriel, San Bernardino, San Jacinto, and Santa Rosa Mountains, and the coastal ranges of San Diego County. White sandy ocean beaches, steep cliffs rising from the sea, snow-covered mountains, irrigated farmlands, and sprawling metropolitan areas make this region a land of contrasts and great natural beauty. About one-third of it is coastal plains.

Climate along the coast is characterized by light precipitation and mild temperatures that have small daily and annual ranges. Inland temperature variations are greater and precipitation is heavier. In general, the climate varies from desert to subtropical conditions. Annual precipitation ranges from about 10 inches along the coast to more than 40 inches in some of the higher mountain areas.

The principal streams are the Santa Clara, Los Angeles, San Gabriel, Santa Ana, Santa Margarita, San Luis Rey, San Dieguito, San Diego, and Tijuana Rivers. However, the area is water-deficient and depends on importation for about half of its municipal and industrial supplies. Average annual runoff is 1,200,000 acre-feet.

The South Coastal Basins are densely populated with over half the population of California (almost 12,000,000 people) in less than 7 percent of the entire area of the state. Population of the basins is projected to increase to about 15,600,000 by the year 2000. Principal population centers are the Los Angeles-Long Beach, Ventura-Oxnard, and San Diego metropolitan complexes, all of which have had phenomenal growth and expansion.

The area has a varied economic base that includes (among many other important activities) automobile assembly; television and motion picture production; petroleum production and processing; aircraft production; and the manufacture of tires, furniture, and wearing apparel. Agricultural activities are also substantial and include production of citrus and subtropical fruits and numerous truck crops. Numerous military establishments form a significant segment of the economic base of the area.

Transportation facilities are highly developed and include an extensive freeway-highway network, transcontinental and local rail service, international and domestic air service from several airports, and deep draft harbors for foreign and coastal trade. The Los Angeles and Long Beach Harbors, the largest man-made seaport complex in the world, serves the Los Angeles area, which has become the commercial center of southern California. More than 30 percent of the waterborne commerce of California (64,310,930 tons in 1977) passes through these harbors. Recognition that the great natural harbors of the South Coastal Basins must be maintained and improved resulted in the first civil work by the Corps of Engineers in California. It comprised restoring the silt-carrying San Diego River to its original course to False (now Mission) Bay. Congress appropriated funds for this work in 1852.

Although many flood control projects have been constructed in densely developed areas, particularly in the Los Angeles metropolitan complex, intensive development in other urban areas adjacent to unimproved or partly improved stream channels has greatly increased the flood damage potential in most areas on coastal plains. This trend is continuing, with more agricultural and undeveloped land being developed for urban use, thereby magnifying potential flood problems.

Swimming, sunbathing, surfing, fishing, water skiing, and boating are year-round activities along the ocean shores of the South Coastal Basins. Recreational boating in these waters has been growing since 1886 when the San Diego Yacht Club was formed. As a result, most small-craft harbors are now fully developed and cannot provide additional berthing or mooring facilities. Although the Corps of Engineers has constructed eight small-craft harbors, some reaches of coast between all-weather harbors exceed 35 miles—the spacing considered desirable for small-craft harbors of refuge.

Erosion along the coast is a continuing problem. Only about 27 miles of the 233-mile coastline reach are considered to be stable. The remaining shoreline is being eroded at varying rates. Erosion is critical along 163 miles of shoreline. Erosion threatens highways, homes, business properties, and recreational beaches.

NAVIGATION PROJECTS

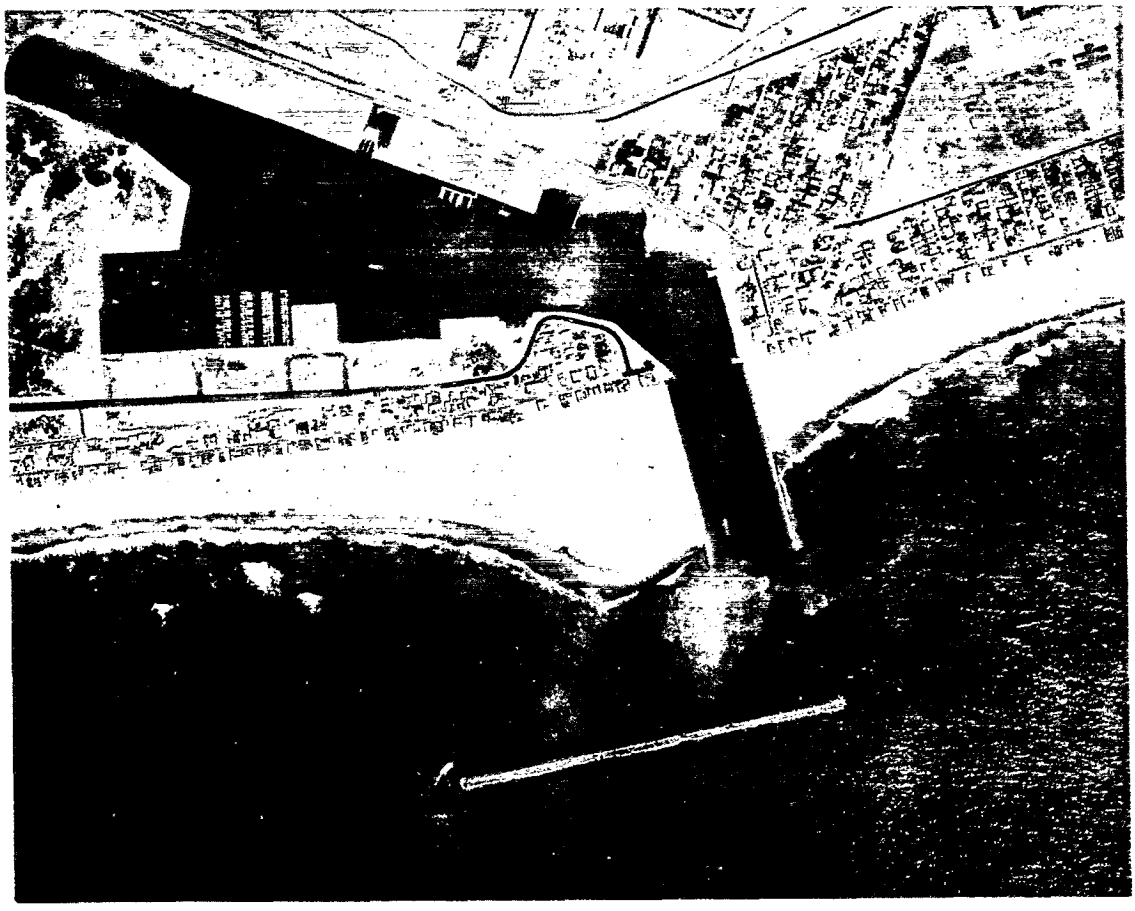
Channel Islands Harbor

Channel Islands Harbor is a combination small-craft harbor and shore protection project at the south end of the Santa Barbara Channel. The harbor improvement is about 1 mile northwest of Port Hueneme and comprises an offshore breakwater and entrance channel jetties; an entrance channel; and entrance, inner, and side harbor basins. Controlling depth varies from 20 feet in the entrance channel and basin to 10 feet in the inner and side basins.

In constructing Channel Islands Harbor, about 6,200,000 cubic yards of dredged material were deposited on the downcoast shore to protect the beach between the Port Hueneme east jetty and Mugu

Lagoon. This beach was eroded due to the effect of the Port Hueneme jetties, which were part of a harbor facility acquired from local interests. About 2,000,000 cubic yards of material are dredged from the Channel Islands Harbor sand trap biennially for deposit on the downcoast beach.

Completed in 1961 at a Federal cost of $6,500,000, Channel Islands Harbor berths about 1,000 small vessels. The local interest share of project cost was about $800,000. Private interests have spent about $10,000,000 for harbor facilities and motels and restaurants in the harbor area.



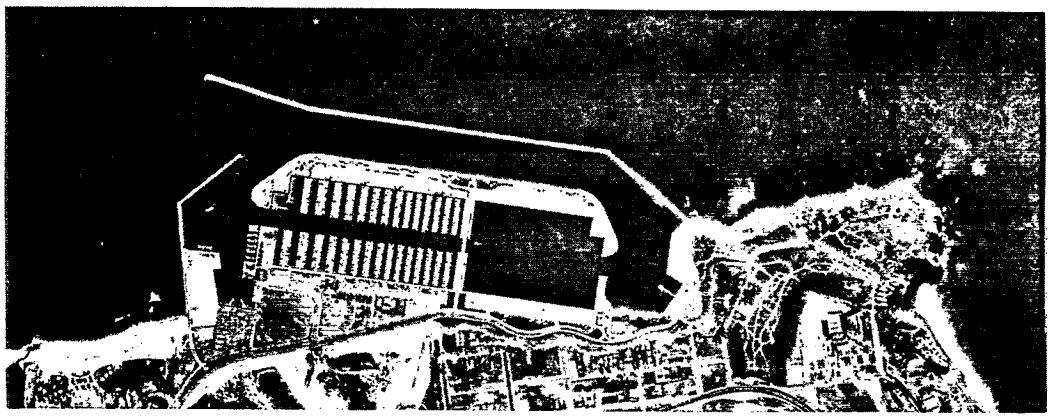
Channel Islands Harbor (VTN Corp. photograph)

Dana Point Harbor

Dana Point Harbor, completed in 1970, consists of east and west breakwaters, entrance and interior channels, an anchorage area, and a turning basin. Controlling depths range from 10 to 20 feet. Cost of the improvement was about $9,500,000, which was shared about equally by Federal and non-Federal interests. Orange County spent $10,000,000 for harbor improvements, and other local interests have provided support facilities costing about $5,000,000. The harbor, which berths about 2,500 small boats, provides an important link in the chain of harbors of refuge for light draft vessels along the Pacific Coast.

Dana Point Harbor was planned with special environmental awareness and was coordinated with redevelopment of Doheny State Beach. A marine life refuge will be established adjacent to the harbor, and a site within the harbor is devoted to a marine studies institute. Marine life in the harbor has rapidly multiplied due to environmental changes resulting from construction of the breakwaters and an internal seawall.

The project had an unusual construction history in that its design was the first to be model-tested at the Corps of Engineers Waterways Experiment Station in Vicksburg, Mississippi, and it was the first project to have a laser beam used in the alignment of breakwaters.



Dana Point Harbor (VTN Corp. photograph)

Los Angeles and Long Beach Harbors

Los Angeles and Long Beach Harbors comprise one of the most extensive harbor improvements in the world, and it took bold initiative and creative vision to transform an open roadstead off historic San Pedro into the two great harbors that exist today. Initial harbor work consisted of a breakwater at Wilmington. Authorized in 1871, the original breakwater is now an internal harbor structure. Throughout the late 1800s,

Los Angeles-Long Beach Harbors (VTN Corp. photograph)

enterprising citizens of Los Angeles urged construction of a deep water harbor, but it was not until the Los Angeles District of the Corps of Engineers was established in 1898 that the existing harbor complex began to become a reality. San Pedro Breakwater was authorized in 1896. It was completed to its originally authorized length in 1910, but extended to its present length in 1912. Subsequent authorizations during the period 1912 to 1960 provided for the existing harbor complex, which affords more than 18 square miles of water surface in the lee of stone breakwaters, two outer harbors with protected anchorage areas, two inner harbors connected by a navigable waterway, and an extensive system of turning basins and connecting channels. The harbor complex can accommodate almost all oceangoing vessels.[1]

Construction of Los Angeles and Long Beach Harbors cost $36,300,000, of which $34,600,000 was from Federal sources and $1,700,000 was from local sources. The cost of project modifications authorized in 1976 but not yet started is estimated at $44,000,000 ($18,600,000 Federal funds and $25,400,000 non-Federal funds). These modifications would involve dredging in channels and turning basins of Los Angeles Harbor.

Commercial cargoes passing through Los Angeles and Long Beach Harbors include a wide range of commodities. In 1977, traffic totaled more than 64,000,000 tons, of which about 45,000,000 tons were crude petroleum and petroleum derivitives such as gasoline and fuel oils. During the 10-year period 1968-1977, commerce through the harbor complex averaged 50,500,000 tons. More than 1,500,000 passengers arrived at or departed from these harbors in 1977. About 3,000 small recreational craft are berthed in Los Angeles Harbor and about 1,700 are berthed in Long Beach Harbor.

Investigations of improving Los Angeles and Long Beach Harbors and the effects of further development on San Pedro Bay are in progress. (See page 72.)

[1]Pertinent physical data on major project features are:

Feature	Depth (Ft.)	Width (Ft.)	Length (Ft.)
LOS ANGELES HARBOR:			
Entrance Channel	40[1]	1,000	5,800
Turning Basins:			
Outer Harbor	40	1,500	3,500
Inner Harbor	35[2]	1,600	1,600
Los Angeles Channel	35[2]	1,000	12,700
East Basin Channel	35[2]	650	3,200
Cerritos Channel	35	400	4,600
East Basin	35[2]	[3]	[3]
West Basin	35[2]	[3]	[3]
Anchorage Areas A & B	40	[3]	[3]
LONG BEACH HARBOR:			
Cerritos Channel	35	400	6,000
Turning Basin	35[4]	600-1,200	2,100
Entrance Channel	35[5]	300-500	6,900
BREAKWATERS:			
San Pedro	—	—	11,152
Middle	—	—	18,500
Long Beach	—	—	13,350

[1]Deepening to 45 feet authorized. Local interests have dredged about 3,700 feet of the channel to a depth of 52 feet.

[2]Deepening to 45 feet authorized.

[3]Varies.

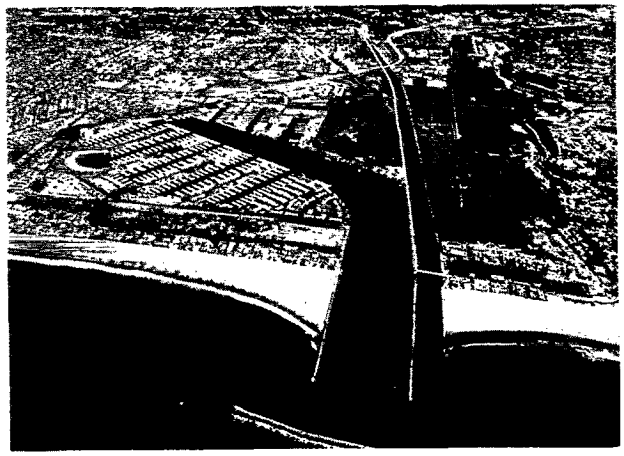
[4]Dredged to 55 feet by local interests.

[5]Dredged to 62 feet by local interests.

Marina del Rey

Marina del Rey, one of the world's largest harbors for small boats, is about 20 miles upcoast from Los Angeles Harbor. Authorized in 1954 and completed in 1965, the project was a joint development of the Corps of Engineers and Los Angeles County. It consists of an offshore breakwater, entrance channel jetties, entrance and main channels, and bank revetment along the upper part of the entrance channel. Controlling depths range from 10 to 20 feet. The local share of project cost, $23,200,000, included the cost of dredging eight side basins and a contribution of half the cost of the Federal work.

Approximately 5,800 small boats used entirely for sport fishing and other water oriented recreational activities are berthed at Marina del Rey. The project serves as a link in the chain of harbors of refuge along the California coast. Private interests have spent about $153,000,000 to provide motels, restaurants, condominiums, luxury apartment complexes, and other facilities in the immediate project area.



Marina Del Rey

Mission Bay Harbor

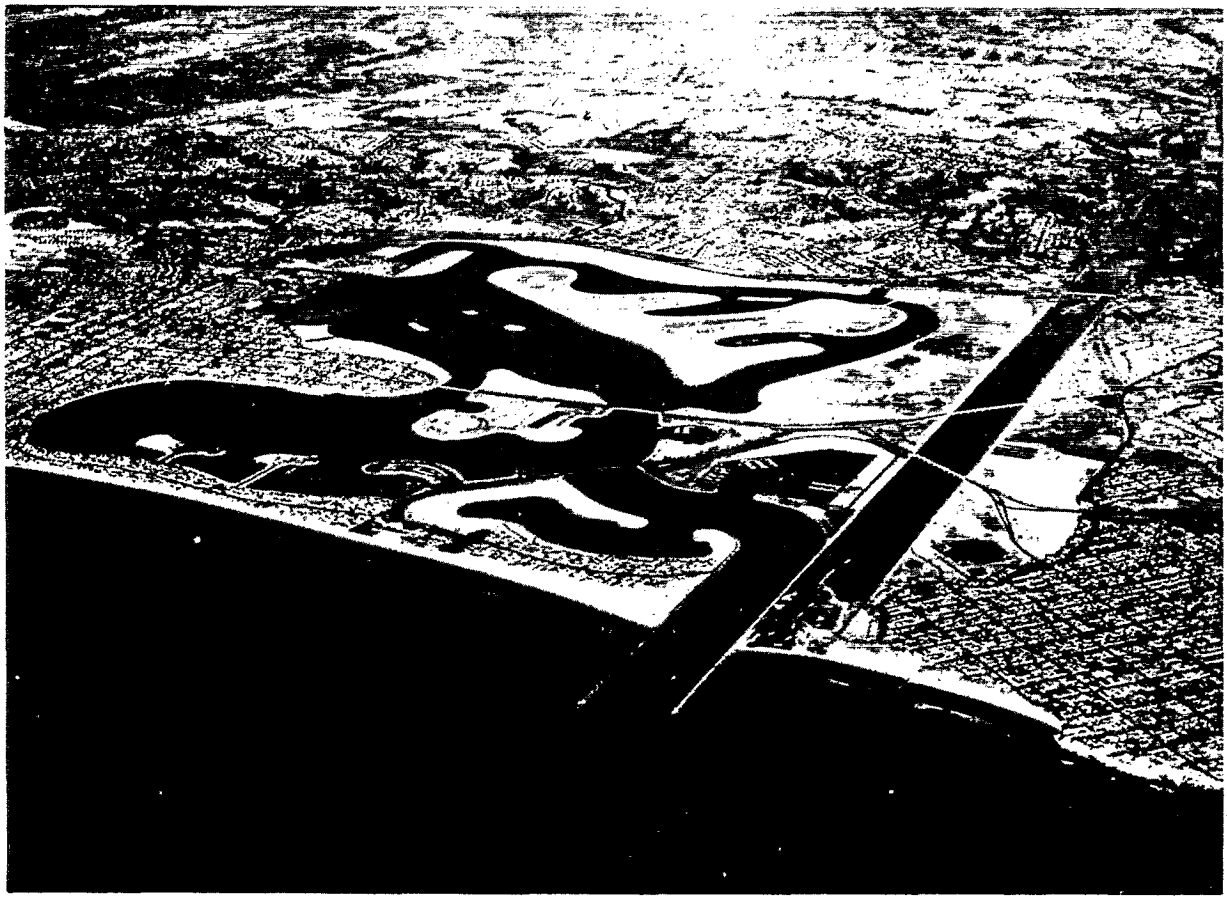
Mission Bay is adjacent to the mouth of the San Diego River in the City of San Diego. Mission Bay Harbor is part of a dual-purpose project designed for flood control along the lower 3 miles of the San Diego River and for shallow draft navigation on Mission Bay.[1] The navigation features of the project consist of an

[1]Flood control features of the dual-purpose project are discussed on page 83.

entrance channel; north, middle, and south entrance jetties; a main channel; a turning basin; anchorage areas; and stone revetment along the entrance channel, main channel, and turning basin. The entrance jetties stabilize the harbor entrance and the lower end of the San Diego River floodway, and the middle jetty, which serves to separate the harbor entrance channel from the floodway, is a feature of both the navigation and flood control improvements. Controlling depths in the harbor range from 15 to 25 feet.

Mission Bay Harbor was completed in 1959. Demonstration of need for remedial construction in one anchorage area is pending. Project cost, including remedial work, is estimated at $34,100,000 ($16,600,000 Federal expenditure and $17,500,000 non-Federal).

More than 2,000 recreational and commercial sport fishing boats are berthed in Mission Bay Harbor. When fully developed, the harbor area will consist of about 2,000 acres of navigable water and an equal area of land. It is expected that the harbor will eventually berth about 3,000 small boats. A new marina for an additional 500 boats is scheduled for development.



Mission Bay Harbor and San Diego River Floodway. Note how the middle jetty separates the navigation channel from the floodway.

Newport Bay Harbor

Newport Bay Harbor, which is about 24 miles downcoast from the Los Angeles-Long Beach Harbor complex, was the first harbor built in California exclusively for small boats. Authorized as a Public Works Administration project in 1934, the harbor is a popular year-round resort for vacationers and pleasure boat enthusiasts. The project consists of entrance jetties; entrance, main, and inner channels; a turning basin; and anchorage areas. Authorized controlling depths range from 10 to 20 feet. Project cost ($1,600,000) was shared equally by the Federal Government and local interests. Orange County and the City of Newport Beach have spent about $4,000,000 for dredging and jetty work that supplement Federal facilities.

At present, the project is about three-quarters complete. Work remaining consists of widening the main channel, deepening Newport Channel (one of the inner channels), and deepening two anchorage areas. This work, however, is currently classified "inactive."

Newport Bay Harbor, the first recreational use harbor built by the Corps of Engineers in California

Oceanside Harbor

Oceanside Harbor is in the beach front of the City of Oceanside. It is about 30 miles upcoast from San Diego and immediately north of the mouth of San Luis Rey River. The project provides for maintaining the general navigation features of Oceanside and Camp Pendleton Harbors. Project features comprise an approach channel common to both harbors, entrance channels to both harbors, and (Oceanside Harbor) a north groin and south jetty, inner harbor channels, a turning basin, and stone revetment adjacent to the turning basin and entrance channel. Camp Pendleton Harbor, which is also known as Del Mar Boat Basin, was built by the U.S. Navy and is used exclusively as the harbor for Camp Pendleton. Controlling depth is 20 feet in Camp Pendleton Harbor and varies from 10 to 20 feet in Oceanside Harbor.

Authorized in 1958, Oceanside Harbor was developed in conjunction with dredging operations required for a shore protection project to restore the beach at Oceanside. Initial dredging was completed in 1963. The most recent maintenance dredging was completed in 1976. Federal funds totaling about $5,300,000 have been spent for the project, including maintenance of Del Mar Boat Basin.

Oceanside Harbor has storage facilities for about 825 small boats. Twelve commercial fishing boats regularly use the harbor. Thirty-five mooring spaces are maintained for visiting small boats, and permanent mooring is provided for a Coast Guard cutter.

A problem of rapid shoaling in the Oceanside Harbor entrance channel and the feasibility of modifying the existing project to increase its capacity are under investigation. (See pages 89 and 90.)

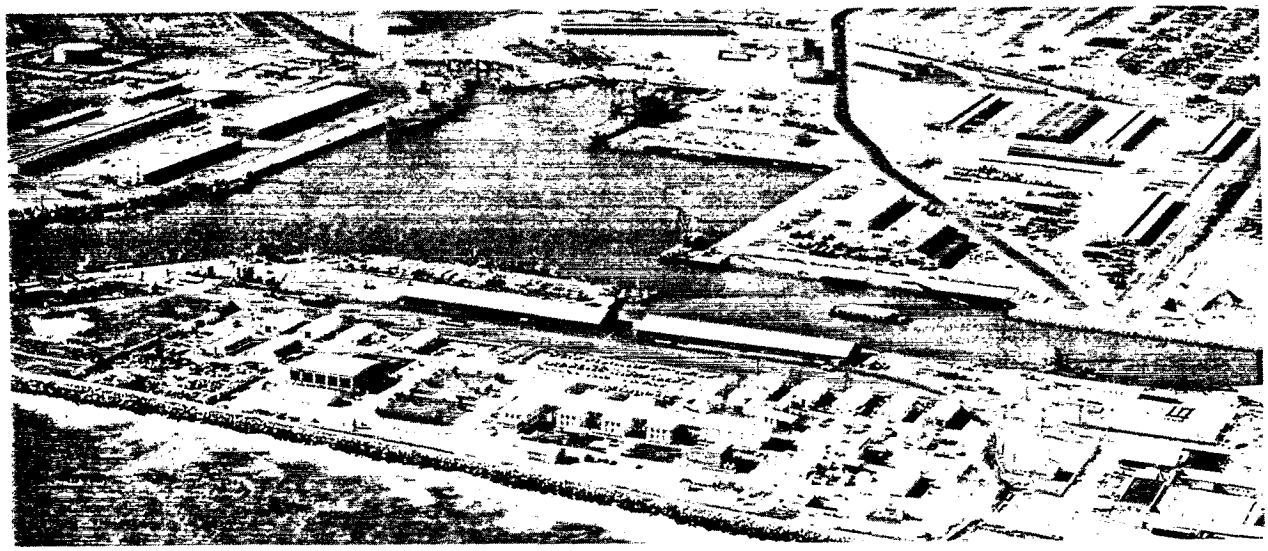
Port Hueneme Harbor

Port Hueneme Harbor is the only deep draft seaport between the Los Angeles-Long Beach Harbors, 65 miles to the south, and the San Francisco and Oakland Harbor complexes, more than 400 miles to the north. Authorized in 1968, the project plan provides for maintenance, modernization, and expansion of an existing harbor built by local interests in 1940 and taken over by the Navy in 1942. The existing facility consists of east and west jetties; approach, entrance, and interior channels; and a central basin. Controlling depths range from 35 to 40 feet. Specifically, the project provides for maintaining the jetties and the entrance and approach channels, and for improving the central basin and interior channel. The estimated cost of authorized improvements is about $2,300,000, of which the non-Federal share would be about $600,000.

Port Hueneme is used by Navy as well as commercial vessels. At present, the Navy has berthing and terminal facilities around the central basin, along the sides of a 600 by 800 foot slip off the central basin, and along the north side of the interior channel. Local interests have berthing areas and terminal facilities along the south side of the channel. In 1977, commercial traffic at Port

Hueneme, mostly crude petroleum and fuel oils, amounted to about 1,900,000 tons. Commerce averaged about 1,300,000 tons for the period 1973-1977.

Local interests have done some of the authorized work by lengthening and widening the interior channel. They will be reimbursed by the Federal Government for this improvement.

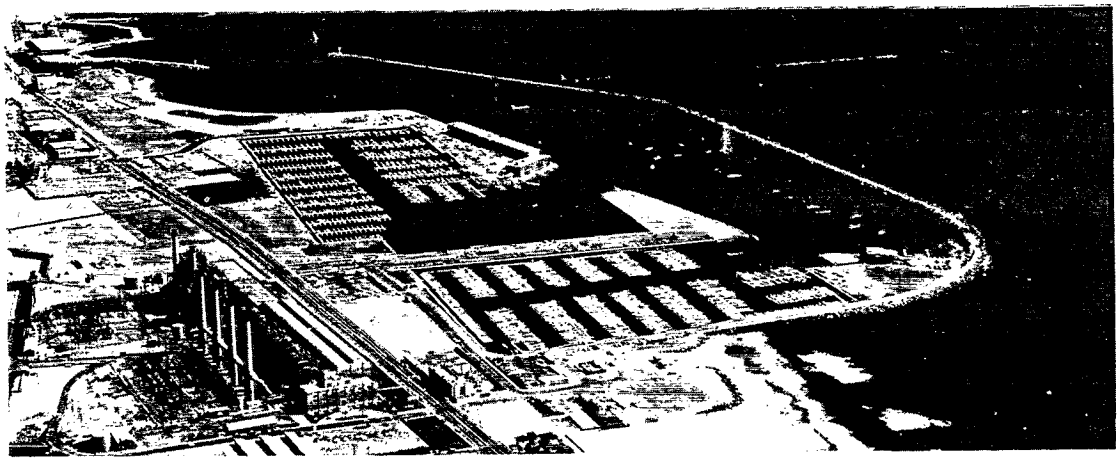


Port Hueneme is the only deep draft harbor between Los Angeles and San Francisco

Redondo Beach King Harbor

Redondo Beach King Harbor is in the southern part of Santa Monica Bay about 18 miles south of the Los Angeles-Long Beach Harbors. Completed in 1958, the project was named for Congressman Cecil King, who played a major role in obtaining appropriations.

Specifically, the project consists of reconstructing part of the existing north breakwater, extending the north breakwater, and constructing a south breakwater to create a protected small-boat harbor and protect a rapidly eroding shore area fronting the city of Redondo Beach. Three boat basins inside the breakwaters were built by local interests. Controlling depths in the harbor range from 8 to 30 feet.



Redondo Beach King Harbor

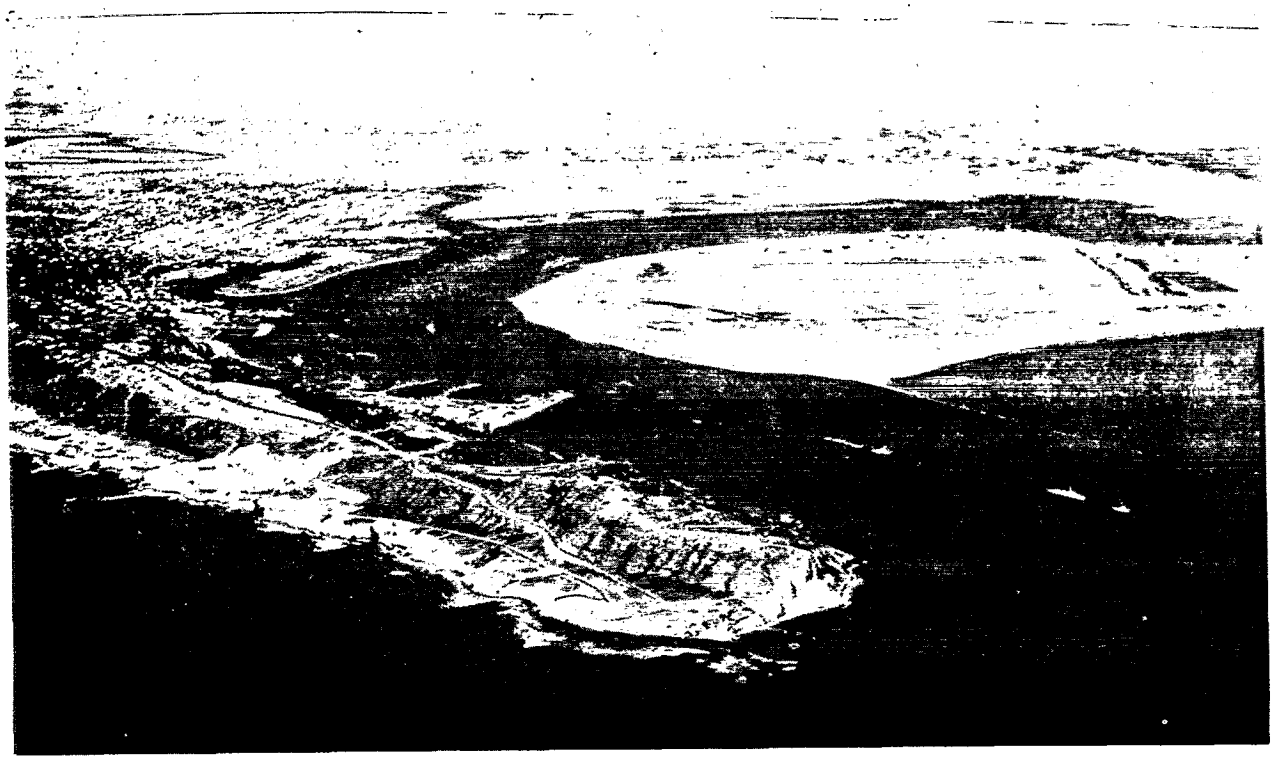
Project modifications to provide greater protection from the action of storm waves, which periodically damaged boats and structures in the harbor, were authorized in May 1964. Remedial measures adopted following highly sophisticated research studies and model tests consisted of raising the crest elevation of 2,050 feet of the north breakwater to 22 feet above mean lower low water, and sealing that part of the breakwater to 9 feet above mean lower low water. These modifications were completed in November 1964. In 1976-77, timber baffles that prevented surge in the boat basins were replaced with concrete baffles. The timber baffles had been damaged by marine organisms.

Federal cost of the project improvements, including remedial work, totaled about $5,000,000. Local interests have spent more than $9,000,000 for harbor improvements, including mooring and docking facilities for about 1,500 small boats berthed in the boat basins. Dry storage facilities are available for 200 small recreational craft.

San Diego Harbor

San Diego Harbor is in San Diego Bay, a landlocked body of water on the California coast just north of the Mexican border. The bay is hook-shaped with its entrance (the point of the hook) at the north end. It fronts San Diego, National City, and Chula Vista on the east, and is separated from the ocean by North Island and a narrow sand beach known as Silver Strand. Point Loma protects the bay entrance from northerly storms.

In ancient times, the San Diego River emptied into False (now Mission) Bay. Historically, it changed its course to enter San Diego Bay, and, due to its sandy streambed, deposited much sand in the bay, especially during freshets and floods. Because the river is intermittent, it afforded no substantial scouring effect in the bay. A levee across the mouth of the San Diego River to restore it to its original course and thus prevent shoaling of the sand carried into the bay was built under the authority of the 1852 River and Harbor



San Diego Harbor is used extensively by the Navy, commercial vessels, fishing boats, and small recreational vessels. More than 2½ million tons of commercial cargo moved through San Diego in 1977.

Act.[1] However, the levee was not protected with stone revetment and it disappeared under the impact of floodflows within 2 years. In 1875, a substantial dike was authorized and built to keep the San Diego River in its original course. Numerous improvements authorized and constructed subsequently comprise the existing harbor complex, the major elements of which include an entrance channel jetty, entrance and interior channels, anchorage areas, turning basins, and seaplane basins. Controlling depths range from 20 to 42 feet.[2]

It must be noted that substantial work on San Diego Harbor has been done by the Navy, and that improvements have also been made by the San Diego Port District. Terminal facilities comprise almost 40,000 feet of privately-owned wharves and appurtenances. Extensive Government-owned terminal facilities are restricted to military uses.

Federal cost of improving San Diego Harbor was about $26,300,000 and local interest cost something over $2,000,000. The harbor, which has a water area of 18 square miles, is home port for part of the Navy as well as numerous commercial vessels, fishing boats, and recreational craft. Three yacht basins (Shelter Island, Harbor Island, and Glorietta Bay), which berth about 3,300 small boats, have been provided. Waterborne commerce through the harbor totaled 2,264,000 tons—largely refined petroleum products—in 1977 and averaged more than 2,000,000 tons per year during the period 1968-1977. Projections indicate that commerce in San Diego Harbor will increase to 5,000,000 tons by the year 2000.

[1]This was the first civil works by the Corps of Engineers in California.

[2]Pertinent data on major project features are:

Feature	Depth (Ft.)	Width (Ft.)	Length (Ft.)
Old Government Dike	—	—	7,735
Zuniga Jetty	—	—	7,500
Entrance Channel	40	800	12,000
Bay Channel	35	2,200	17,000
South Bay Channel	30	1,500-2,500	20,000
Chula Vista Channel	20	200	2,600
Anchorage areas	26-35	1,200	12,000
Western triangular approach[1]	26	800	—
Eastern triangular approach[1]	35	900	—
Seaplane basin (Area M)	8	1,500	12,000
Turning basin	35	[2]	[2]
Seaplane basin (Area S)[3]	10	5,000-8,500	21,000
MODIFICATIONS[4]			
Entrance Channel	42	800	12,700
North Bay Channel	42	600-800	24,900
Turning basin	42	1,900-2,900	2,800
Central Bay Channel (with turning basin)	35-40	600-1,900	23,600[5]
South Bay Channel (with turning basins)	35	600-1,350	6,500

[1]Deleted by 1968 River and Harbor Act.

[2]3,600 foot diameter.

[3]Partly deleted by 1968 River and Harbor Act.

[4]Authorized in 1975.

[5]8,700 feet 40 feet deep; 14,900 feet 35 feet deep.

In earlier years, San Diego Harbor was one of the most polluted in the Nation. However, great effort to improve its ecology and environment during the last 15-20 years has transformed it into the cleanest major commercially used estuary in the United States. Water quality at the south end of the bay has been so improved that marine plants and animals now thrive where almost no organic life existed 15 years ago. The harbor is central to an industrial and recreational complex that provides jobs and varied water oriented recreation opportunities for many thousands of people.

A study to determine the need for an entrance to San Diego Harbor through Silver Strand is in progress. (See page 73.)

Ventura Marina

Ventura Marina is located approximately 6 miles northwesterly (upcoast) from Channel Islands Harbor. The Federal project consists of maintaining an entrance channel and entrance channel jetties constructed by local interests, building a detached breakwater to protect the entrance channel, dredging a sand trap leeward of the breakwater, and installing facilities for recreational fishing from atop the jetties. Controlling depth in the entrance channel is 20 feet. Completed in 1973, the project cost $3,400,000, which was shared equally by the Federal Government and local interests.

Since 1963, when the local interest project facilities were completed, the Ventura Port District has spent more than $6,000,000 for harbor facilities, and private interests have spent more than $1,500,000 to provide facilities for recreation and sport fishing craft. A privately constructed residential marina, Ventura Keys, adjoins the harbor and has access to the ocean through the Ventura Marina entrance channel. In addition to fueling, launching, boat repair, and other marina facilities, the harbor has 800 slips and dry storage for 155 small boats. A visitor's center for Channel Islands National Monument (Anacapa and Santa Barbara Islands) is located at Ventura Marina.

An investigation of high waves at the downcoast end of the breakwater under winter sea conditions has been authorized but not yet started. (See page 73.)

NAVIGATION STUDIES

North Coast of Los Angeles County

A continuing need for a centrally located harbor of refuge exists in the 25-mile reach of the Los Angeles County coast from Santa Monica to the Ventura

Ventura Marina

County line. The nearest small-craft harbor downcoast is Marina del Rey, which is about 4 miles southeast of Santa Monica. Channel Islands Harbor, about 15 miles northeast from the Ventura County boundary, is the nearest small-craft harbor upcoast. Continuing loss of life and property shows the need for a harbor of refuge along this reach of coast. It is estimated that, on the average, one fatality, five injuries, and around $75,000 in boat damage occur each year. Also, numerous minor accidents and injuries that are not reported occur as a result of attempts to launch or land small boats through heavy surf.

An investigation of modifying existing small-boat harbors or constructing new ones to provide harbors-of-refuge was authorized in 1945. Sites considered or to be considered include Malibu Creek, Paradise Cove, Point Dume, and Santa Monica Harbor. The area that would be served by a central harbor of refuge includes the western part of Los Angeles County and a small portion of southeastern Ventura County. This area has a population of around 4,000,000. The study was started in 1968 and continued for a number of years, but it is now unfunded and its completion is indefinite.

Los Angeles and Long Beach Harbors

An investigation of Los Angeles and Long Beach Harbors was started in 1965. Its purpose is to determine whether the existing harbors should be modified to handle deeper draft vessels, especially those classed as supertankers.

Population of the area served by Los Angeles and Long Beach Harbors (the entire Pacific Southwest) increased from 10,700,000 in 1960 to about 21,300,000 in 1978. It is projected to increase to 34,500,000 by the year 2000. Commerce through these harbors increased from about 32,000,000 tons in 1960 to over 64,000,000 tons in 1977. In the year 2000, commercial traffic is expected to reach 256,000,000 tons. Prevailing controlling depth in the inner harbor areas of the Los Angeles Harbor complex is 35 feet and many vessels must await favorable tides to enter or depart. The outer harbor areas of the Los Angeles-Long Beach Harbor complex have potential for depths in the range of 80-100 feet. At present, there are only three ports in the United States (Los Angeles, Long Beach, and Seattle) where vessels in the 100,000 tons dead weight load range can be fully

loaded at berth. Deepening the inner harbors and providing additional channels and turning basins in the outer harbors, offshore anchorage and loading facilities for tankers, and additional shallow-draft vessel facilities are being studied.

As recommended in an interim report made under this study authorization, deepening Los Angeles Harbor to a controlling depth of 45 feet was authorized in 1976. A final report, which will include recommendations for optimum development of Los Angeles and Long Beach Harbors, is scheduled for completion in 1980.

Oceanside Harbor

A study to determine the feasibility of modifying the existing Oceanside Harbor was started in 1969. Specifically, the need to modify the existing project to meet existing and future mooring facility requirements is being investigated. The berthing deficit, which will continue to grow as population increases, is about 700 spaces. Population in the area served by Oceanside Harbor (about 580,000 in 1978) is expected to increase to more than 1,000,000 by the year 2000. Shoaling in the entrance channel, which is taking place at a rapid rate, is hindering vessel movement in and out of Oceanside Harbor as well as Del Mar Boat Basin. Investigation of this shoaling problem is being closely coordinated with an ongoing shore protection study scheduled for completion in 1979. (See page 90.) A possible solution to the shoaling problem is to extend the south entrance channel jetty and to construct a south breakwater beginning at the mouth of the San Luis Rey River. The investigation of Oceanside Harbor is scheduled for completion in 1981.

San Diego Harbor

From Point Loma to the National City Marine Terminal, San Diego Bay is heavily congested with naval and recreational traffic. Annually, about 700 commercial vessels must pass through this congestion to reach docks and terminals to the south. An investigation to determine the need for constructing a second entrance to San Diego Harbor was authorized in 1958 and is scheduled for completion in 1979.

Due to projected increases in commercial traffic, the San Diego Unified Port District strongly supports a second entrance to the harbor. The Navy has indicated that another entrance is desirable but not essential to conducting naval operations in the area. Improvements in a master plan prepared by the Port District to provide optimum development of the bay will be considered in the investigation, which is being coordinated with all interested Federal, state, and local agencies.

San Pedro Bay Ports

A study to determine water and surface transportation needs that would result from further development of port facilities on San Pedro Bay was authorized in 1976. Among other things, the study will include consideration of the feasibility of enlarging Dominguez Drainage Channel for flood control purposes. Dominguez Channel is a local drainage improvement that discharges into the Los Angeles Harbor complex by way of the Consolidated Slips and the East Basin. The study was started in 1978 and is scheduled for completion in 1982.

Sunset Harbor

An investigation to determine the advisability of constructing Sunset Harbor and providing other facilities in the vicinity of Sunset Beach on the Orange County coast was authorized by the River and Harbor Act of 1945 and by congressional resolution in 1964. It is scheduled for completion in 1983. Specifically, the study will examine general navigation improvements and an entrance channel on Bolsa Chica Bay, marina improvements proposed by local interests, and reestablishing a salt marsh to restore and preserve wildlife habitat in the Bolsa Chica Bay area. The latter would include evaluation of levees, channels, and other works needed to maintain tidal regimen in the proposed marsh, which would be located on lands controlled by the state. Sunset Harbor would serve the Los Angeles-Long Beach and Anaheim-Santa Ana-Garden Grove metropolitan areas, where the existing deficit in small boat berthing spaces is estimated at 4,700.

Ventura Marina

Under certain winter sea conditions, considerable wave action occurs at the downcoast end of the detached breakwater at Ventura Marina. Since the entrance channel to the harbor is located adjacent to that end of the breakwater, a hazard in the form of high waves may be encountered by boats entering and leaving the harbor. Also, floodflows from the Santa Clara River, which seriously damaged Ventura Marina in 1969, created a large delta in the area off the end of the breakwater. Additional deposition of material around the harbor entrance occurred during floods in February and March 1978. Alteration of bottom contours around the breakwater may be intensifying the winter wave conditions. An investigation of these problems was authorized in 1973, but it has not been started.

West Newport Beach Harbor

An investigation of the advisability of constructing a harbor for small boats at the mouth of the Santa Ana River was authorized in 1975. The potential harbor

would be on the east side of the river in the vicinity of West Newport Beach. A privately conducted engineering study indicates that a growing need for a harbor exists in this area, and that a small-craft harbor accommodating 3,000 boats would be feasible. The Corps of Engineers' study will be started when funds can be made available.

MULTIPLE PURPOSE AND SINGLE PURPOSE (FLOOD CONTROL) PROJECTS

Prefatory Note: Flood damage prevention in the great urban-suburban metropolitan complexes of the South Coastal Basins has been accomplished in part by massive comprehensive projects that combine project works having multiple as well as single purposes. Also, improvements in a number of separate stream basins may be involved in a single comprehensive project. Therefore, improvements for flood control in these basins are discussed partly on an areal rather than a strictly functional basis.

Los Angeles County Drainage Area Project

One of the most comprehensive projects ever built to protect a metropolitan area, the Los Angeles County Drainage Area Project is about 99 percent complete. It includes project facilities on the mainstems and tributaries of the Los Angeles and San Gabriel Rivers, the Rio Hondo, and Ballona Creek. A cooperative venture of the Los Angeles County Flood Control District and the Corps of Engineers, project works consist of five dams and twenty-two debris basins, almost 300 miles of improved channel, and extensive facilities for recreation. The dams, one debris basin, and channel improvements authorized before 1941 are maintained by the Corps of Engineers. Los Angeles County maintains all other project facilities. Uncompleted work, improvement of Sierra Madre Wash (Rio Hondo Basin), is classified "inactive."

Excluding expenditures of the Flood Control District for existing and planned future improvements ($1,370,000,000 and $1,400,000, respectively), project cost was $433,300,000 ($354,600,000 Federal expenditure and $78,700,000 non-Federal). An additional $8,000,000 spent for recreation facilities has been shared equally by the Corps of Engineers and various local interests.

Over the years, completed portions of the project have prevented almost $3,000,000,000 flood damage, most of which was prevented during the decade 1969-1978. In the most recent flood events (February and March 1978), damages estimated at $1,200,000,000 were prevented. During floods that occurred in January 1969, the project prevented damage estimated at more than $1,000,000,000. In addition to providing flood protection, the project contributes to ground water recharge through a system of spreading grounds that are fed water retained in debris basins and behind dams after flood-producing storms are over. This water percolates through sand and gravel into the ground water basin. The Flood Control District has installed special inflatable dams in soft-bottom sections of the San Gabriel River to trap end flow from storms, thus allowing additional percolation to the ground water. Each year the project adds more than 330,000 acre-feet of water to the underground supply. On the basis of a per capita daily use of 150 gallons, the water added meets the annual needs of almost 2,000,000 people.

The Corps of Engineers and local interests, principally the City and County of Los Angeles, have cooperatively provided extensive improvements for recreation in conjunction with project works. These developments afford opportunities for camping, picnicking, hiking, bicycling, golf, archery, and tennis, as well as for water-oriented activities such as fishing, swimming, boating, and water skiing.

Although the project functions effectively and provides extensive protection, some areas are still unprotected. A study of the drainage area with a view to increasing protection was authorized in 1969. (See page 85.) A map of the Los Angeles County Drainage Area Project is shown on page 75. Information on the five dams that are integral parts of the project follows.

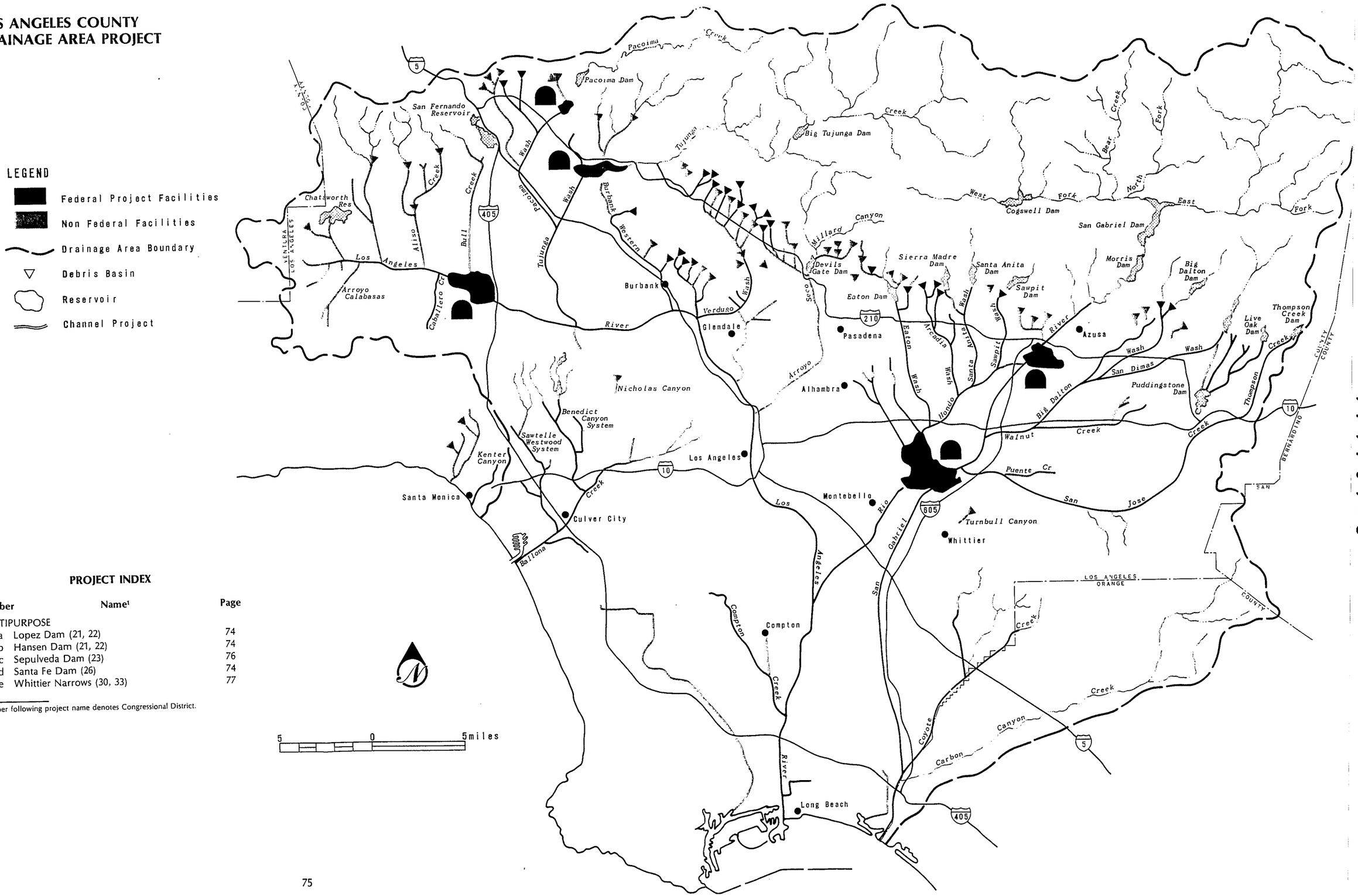
Hansen Dam Hansen Dam is an earthfill structure 97 feet high and 10,475 feet long on Tujunga Wash about 9½ miles upstream from its junction with the Los Angeles River. The dam can impound 29,700 acre-feet of floodwater. This project unit was completed in 1940 at a Federal cost of $11,300,000. Facilities for recreation, which were developed by the City of Los Angeles, consist of a 125-acre lake with boat launching ramps and a swimming beach, picnic areas, riding and hiking trails, a golf course, and baseball fields. Existing recreation development cost about $4,000,000. About $1,000,000 for additional development is planned by the Corps of Engineers and the City of Los Angeles.

Lopez Dam Lopez Dam is on Pacoima Wash about 6 miles upstream from the junction with Tujunga Wash. An earthfill structure 50 feet high and 1,300 feet long, the dam can impound 230 acre-feet of floodwater. The project unit was completed in 1954 at a Federal cost of $729,000.

Santa Fe Dam Santa Fe Dam, an earthfill structure 92 feet high and 23,800 feet long, is about 29 miles upstream from the mouth of the San Gabriel River. The project unit, completed in 1949 at a Federal cost of $12,600,000, can impound 32,600 acre-feet of floodwater.

Existing recreation facilities (jointly provided by the Corps of Engineers and Los Angeles County) include a 20-acre lake, a swimming beach, and picnic facilities.

LOS ANGELES COUNTY DRAINAGE AREA PROJECT



PROJECT INDEX

Number	Name[1]	Page
MULTIPURPOSE		
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70b	Hansen Dam (21, 22)	74
70c	Sepulveda Dam (23)	76
70d	Santa Fe Dam (26)	74
70e	Whittier Narrows (30, 33)	77

[1]Number following project name denotes Congressional District.

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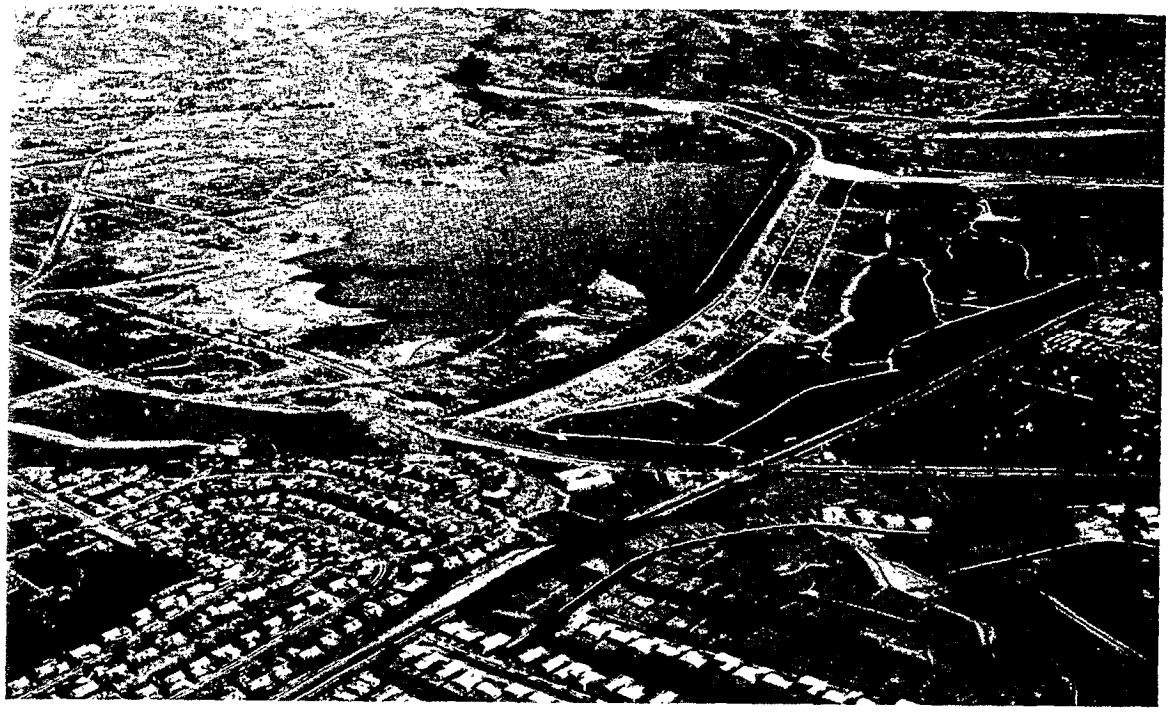
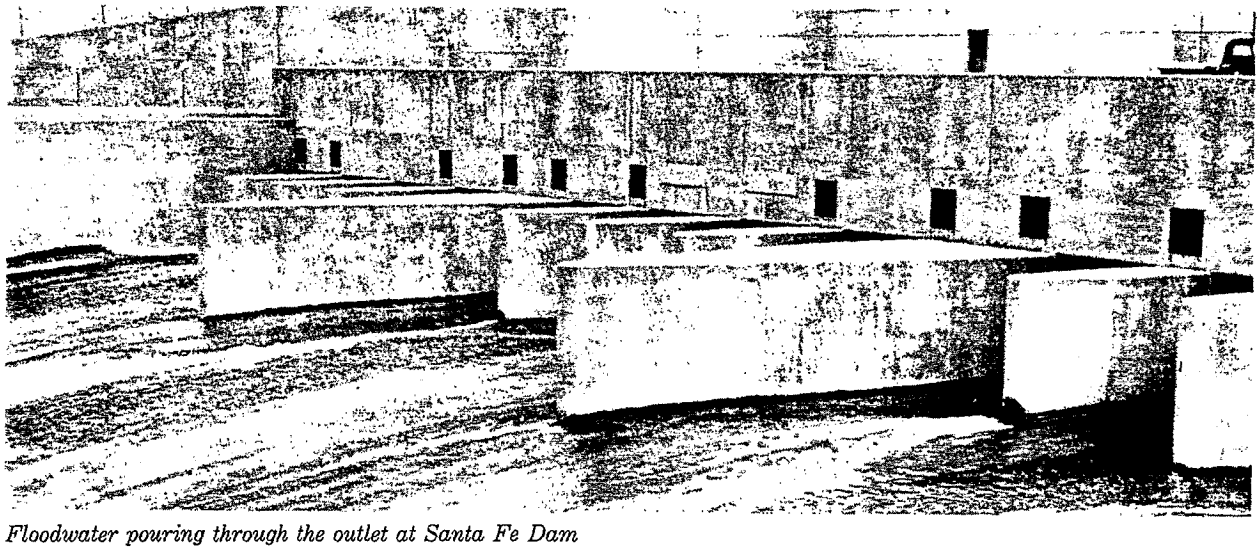


Hansen Dam. A permanent pool provides for year round recreational activities.



Floodwater pouring through the outlet at Santa Fe Dam

Planned improvements for recreation use include a 50-acre expansion of the lake, equestrian trails, a sports area, a group camping area, and additional picnic facilities at a cost of about $10,000,000. About $3,600,000 in Federal funds have been spent for recreation use developments at this project unit.

Sepulveda Dam Sepulveda Dam is on the upper Los Angeles River approximately 43 miles above the mouth. An earthfill structure 57 feet high and 15,444 feet long, the dam can impound 17,300 acre-feet of floodwater. This project unit was completed in 1941 at a Federal cost of $6,700,000.

The City of Los Angeles has developed the area behind Sepulveda Dam into one of the city's most popular recreation areas. It has a great variety of facilities that include golf courses, riding and hiking trails, model plane fields, competition areas, archery ranges, tennis and basketball courts, a bicycle racetrack, a baseball field, and picnic areas. A few acres in the project area are leased to local agencies that sponsor activities of youth groups.

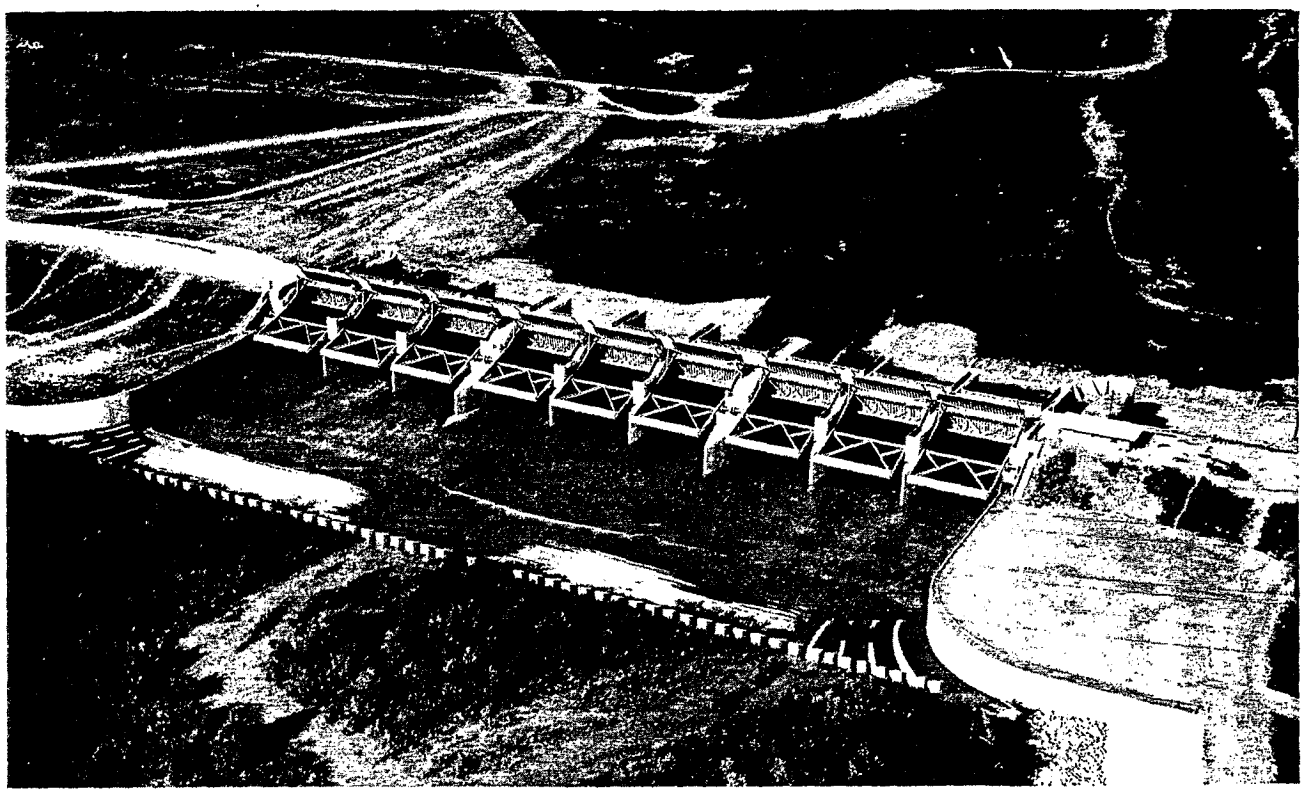
To date, the city has spent $4,600,000 for recreation facilities in the Sepulveda Dam area. In partnership with the City, the Corps of Engineers has spent

$700,000 for public use improvements. About $6,000,000 for extensive new recreation use areas is planned.

Whittier Narrows Dam Whittier Narrows Dam is across the main channels of the Rio Hondo and the San Gabriel River about 10 miles east of the City of Los Angeles. The dam is an earthfill structure 56 feet high and 16,960 feet long that can impound 36,100 acre-feet of floodwater. It was completed in 1957 at a Federal cost of $32,300,000.

Under a license from the Federal Government, most of the area behind the dam is being developed as a regional park by the Los Angeles County Department of Parks and Recreation. Facilities available include a 77-acre lake, a trailer campground, a wildlife preserve, a model hobby area, and a visitor center. Activities provided for include boating, fishing, skeet, baseball, golf, riding, and picnicking. A few acres of the project area are leased to local agencies that sponsor youth group activities.

The cost of recreation improvements built by local interests totals $5,250,000. In partnership with Los Angeles County and the City of Pico Rivera, the Corps of Engineers has spent more than $10,000,000 for public use improvements. Planned future development by the county includes a lake for swimming and additional picnic and parking areas. Planned future development by Pico Rivera includes expansion of a golf course and the trailer campground. The estimated cost of planned development is about $3,500,000.



Downstream side of spillway, Whittier Narrows Dam

Santa Ana River Basin and Orange County Project

Prefatory Note: Although a single comprehensive plan for flood control has been developed for the Santa Ana River Basin, improvements have been provided, as directed by Congress, under two basic authorizations. One of these provides for protection of the metropolitan area of Orange County, which includes some areas outside the Santa Ana River Basin. The other authorization provides for flood control in other areas of the basin. In this booklet, all improvements affording protection in the project area are discussed as units of a comprehensive plan. They are separated on the basis of multiple or single purpose functions insofar as it is possible to do so. A map of the project is shown on the opposite page.

Extensive facilities for public use and enjoyment have been provided by local interests and the Corps of Engineers (separately or in partnership) at many of the project units. In general, picnic areas and campgrounds; golf and tennis courts; playing fields; and hiking, bicycling, and equestrian trails are widely

SANTA ANA RIVER BASIN AND ORANGE COUNTY PR

C-104144

LEGEND

Drainage Area Bound

TYPE OF PROJECT

Multipurpose

Flood Control

STATUS OF PROJECTS

Completed

Under Construction

Authorized, Not Sta

PROJECT INDEX

Number	Name[1]
MULTIPURPOSE PROJECTS	
71a	Brea Dam (39)
71b	Fullerton Dam (39)
71c	Carbon Canyon Dam and Channel (3 Santa Ana River Main Stem, Santiago Creek and Oak Street Drain
71d	Santa Ana River Main Stem (36-4
71e	Santiago Creek Channel (38, 39)
71f	Oak Street Drain (36)
71g	Prado Dam (36)
71h	Mentone Dam (37)
FLOOD CONTROL PROJECTS	
71i	San Antonio Dam (35)
71j	Cucamonga Creek and Tributaries (3
71k	Lytle and Cajon Creeks Channel Improvements (35, 36)
71l	Devil, East Twin, and Warm Creeks Channel Improvements and Lytle Creek Levee (35, 36)
71m	San Antonio and Chino Creeks Channel (35, 36)
71n	Riverside Levees (37)
71o	Lytle and Warm Creeks Project (36)
71p	Mill Creek Levees (37)
71q	San Jacinto River Levee and Bautista Creek Channel (40)
INACTIVE PROJECT UNITS	
71r	University Wash and Spring Brook (36)
71s	Aliso Creek, San Juan, Trabuco and Villa Park Dams (39, 40)

[1]Number following project name denotes Congressional Di

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78

C-104144

available in project areas. Some project units have recreation lakes and special group use areas such as YMCA and Girl Scout camps; and specialized facilities such as minibike parks and model airplane fields have been made available. Natural areas have been preserved and ecological features have been enhanced by restoration and beautification programs. Local interests and the Corps of Engineers have plans for future development of additional public use facilities. Specific information on the public use facilities at a particular project unit is available from the Los Angeles District of the Corps of Engineers. Therefore, this information for elements of the Santa Ana River Basin and Orange County Project is not detailed in this booklet.

Multipurpose Projects

Brea Dam Brea Dam, an earthfill structure 87 feet high and 1,765 feet long, is on Brea Creek about 8 miles upstream from the junction of Brea and Coyote Creeks. Completed in 1942 at a Federal cost of $1,200,000, the dam is in the city of Fullerton. It can impound 4,000 acre-feet of floodwater.

Brea Dam and Reservoir on Brea Creek

Carbon Canyon Dam and Channel Carbon Canyon Dam is an earthfill structure 99 feet high and 2,610 feet long near the mouth of Carbon Canyon. It is 16 miles northeast of Santa Ana and 4 miles east of Brea. Completed in 1961 at a Federal cost of $5,300,000, the dam can impound 6,600 acre-feet of floodwater. A concrete channel (some sections open and some sections covered) extends for 4,080 feet downstream from the dam. The project unit protects about 8,000 acres of metropolitan and rural areas, including large parts of Anaheim, Los Alamitos, and the Los Alamitos Naval Air Station. Incidental water conservation benefits accrue from the project as a result of regulating floodflows to the capacity of spreading grounds downstream.

Fullerton Dam Fullerton Dam is on East Fullerton Creek 4 miles upstream from the junction with Brea Creek and 2 miles northeast of Fullerton. It is an earthfill structure 47 feet high and 575 feet long that can impound 800 acre-feet of floodwater. The project unit was completed in 1941 at a Federal cost of $411,000.

Santa Ana River Main Stem, Santiago Creek, and Oak Street Drain Recognizing that the threat of floods on the Santa Ana River is truly catastrophic, Congress in 1976 authorized preconstruction planning studies of the river from the San Bernardino Mountains to the ocean. The authorization was based on an interim investigation completed in 1976 after 10 years of effort and $3,000,000 in cost. The plan devolving from the interim investigation provides for:

Construction of a dam at the Mentone site.

Enlargement of the existing Prado Dam.

Flood plain management along the river from Mentone Dam downstream to Prado Reservoir,

and improvement of the carrying capacity of the river from Prado Dam downstream to the ocean.

Protective works along Santiago Creek in Santa Ana.

Protective works along Oak Street Drain in Corona.

Sixty possible alternative plans were evaluated in developing the plan recommended, which is the only one that meets the flood control, social, and environmental needs of a great metropolitan area. It was approved by San Bernardino, Riverside, and Orange Counties, and by the various cities directly affected by the threat of flooding and the proposed solution. Federal cost of the improvements proposed in the recommended plan is $834,000,000. The local interest share is estimated at $108,400,000. Additional information on the five elements of the Santa Ana River Main Stem, Santiago Creek, and Oak Street Drain Project follows. The status of each element is indicated on the map shown on page 78.

Mentone Dam — Mentone Dam would be an earthfill structure 230 feet high and 3.7 miles long. It would be located on the Santa Ana River near East Highlands in San Bernardino County. The dam would create a 151,000 acre-foot reservoir for flood control and other uses. Since Mentone Dam would directly affect the levee project on Mill Creek near Redlands, the recommended plan for the dam provides for modification of the levee unit.

Prado Dam — Prado Dam is an earthfill structure 106 feet high and 2,280 feet long located in Riverside County about 30 miles upstream from the mouth of the Santa Ana River. It forms a 195,000 acre-foot reservoir (in Riverside and San Bernardino Counties) for flood control and other purposes. The project unit was completed in 1941 at a Federal cost of $9,500,000.

Prado Dam has functioned efficiently since its completion and has prevented flood damages estimated at $546,000,000. However, increased urbanization downstream from the dam, better understanding of the basin hydrology, and improved methods of hydrologic analysis all show that a greater degree of protection than the dam now affords is needed. Recommended modifications include raising the dam 30 feet, raising the spillway crest level 20 feet, enlarging the outlet works for a maximum controlled release of 30,000 cubic feet per second, and increasing the reservoir area by 1,670 acres. These modifications would increase the storage capacity of the project to 363,000 acre-feet.

Santa Ana River Main Stem — For the 66 miles of the main stem of the Santa Ana River, the recommended plan provides for flood plain management rather than flood control structures. Specifically, from Mentone Dam to Prado Reservoir, a 35-mile reach, the plan provides for San Bernardino and Riverside Counties to restrict development to ensure that flood control releases from Mentone Dam, plus tributary inflow, would be nondamaging. This would be done by land use controls or by county acquisition of flood plain lands.

Downstream from Prado Dam, Santa Ana Canyon would be taken into public ownership and left in its natural state. The only structural work would be revetment to protect a railroad bridge, some curves on a freeway, and an existing trailer park. Otherwise, the canyon would become 1,760 acres of open space for recreation and wildlife habitat.

Downstream from the canyon, Orange County has channelized the river and built a series of percolation basins for water salvage. This channel work would be improved to carry flood control releases from Prado Dam, plus tributary inflow and local drainage. The spreading basins would be improved. At the mouth of the river, 92 acres of salt marsh would be acquired for wildlife habitat and preservation of endangered species.

Santiago Creek Channel — Protective works along Santiago Creek would consist primarily of a concrete channel along the lower 2½ miles of the creek, a direct tributary to the Santa Ana River. The channel would be rectangular in shape with a capacity of 23,000 cubic feet per second. Limited channel improvements would be provided in the 3-mile reach upstream from the proposed concrete channel.

Oak Street Drain — Protective works for Oak Street Drain in Corona principally consist of a main concrete channel for 2.7 miles upstream from Temescal Wash, a collector system (principally a channel from Lincoln Avenue to Oak Street Drain), and a debris basin for proper functioning of the main channel. The improvements recommended would afford a carrying capacity of 5,800 to 9,000 cubic feet per second for Oak Street Drain.

Flood Control Projects

Cucamonga Creek and Tributaries Construction of improvements on Cucamonga Creek and certain of its tributaries upstream from Prado Dam is under way. This project unit consists of 10 debris basins; about 9,000 feet of diversion, collection, and separation levees; and 26 miles of concrete channel. It will protect a 19,000 acre overflow area that includes commercial, industrial, and residential properties in Upland, Ontario, Alta Loma, Cucamonga, and San Antonio Heights. It will also protect Ontario International Airport, San Antonio Community Hospital, the Colorado River Aqueduct, and major railroads and interstate highways. Federal cost of the project is estimated at $86,200,000. Non-Federal cost is estimated at $18,400,000. Scheduled for completion in 1981, the

project unit would have prevented more than 95 percent of the damage that occurred in the project area during the 1969 and 1978 floods.

Devil, East Twin, and Warm Creeks Channel Improvements and Lytle Creek Levee Improvement of Devil Creek, completed in 1958, essentially comprises a diversion to carry floodflows from Devil and Badger Creeks to the contiguous Cajon Creek drainage. The facilities provided consist of an intercepting levee, an intake structure, and a concrete channel to Cajon Creek. Improvements on East Twin and Warm Creeks include revetment along local interest levees on Waterman and East Twin Creeks, a concrete channel along the lower reaches of East Twin and Warm Creeks, and revetment of channel side slopes. These improvements were completed in 1961. Lytle Creek levee, completed in 1965, extends along the right bank of the creek near Cajon Creek. This improvement comprises an addition to the Lytle and Cajon Creeks Channel Improvement Project.

Federal cost of improvements on Devil, East Twin, Warm, and Lytle Creeks was $7,800,000. The local interest cost was $3,300,000. These flood control works are designed to protect parts of San Bernardino and suburban areas nearby, and to protect water wells for Rialto, Bloomington, and adjacent irrigated farmlands.

Lytle and Cajon Creeks Channel Improvements The channel improvement project on Lytle and Cajon Creeks extends from 10 miles northwest to 2 miles south of San Bernardino. It comprises collecting levees and groins, an improved channel along the West Branch of Lytle Creek, and provisions for bypassing floodflows into the East Branch of Lytle Creek. Completed in 1948 at a Federal cost of $7,600,000 and a non-Federal cost of $600,000, the project protects parts of San Bernardino and Colton, adjacent suburban areas, and segments of transcontinental transportation systems.

Lytle and Warm Creeks Project Improvement of Lytle and Warm Creeks was completed in 1978 at a cost of about $40,000,000 ($33,000,000 Federal and $7,000,000 non-Federal). The project, which is in San Bernardino County, consists of a channel along 3.5 miles of the East Branch of Lytle Creek, a channel along 1.5 miles of Warm Creek, and channels and levees along 1.8 miles of the Santa Ana River. A 3,600 acre overflow area that includes commercial, industrial, and residential properties in San Bernardino and Colton is protected by the project improvements. A beautification program will be undertaken to enhance project areas.

Mill Creek Levees A levee project along the south side of Mill Creek near the base of the San Bernardino Mountains was completed in 1960. Situated in San Bernardino County and about 5 miles northeast of Redlands, the project extends from the mouth of Mill Creek Canyon downstream to near the junction of the creek with the Santa Ana River—a distance of 2.4 miles. Federal cost of the levees was $618,000 and the local interest share was $195,000. The project protects Redlands and Mentone and citrus groves in the area.

Construction of Mentone Dam would directly affect the Mill Creek levees, which have been nearly overtopped by floodflows in the past. Therefore, the recommended plan for improving the main stem of the Santa Ana River (see page 80) includes preconstruction planning studies of raising the Mill Creek levees and extending them into the Mentone Reservoir area to ensure that Mill Creek floodflows would be controlled by the storage project.

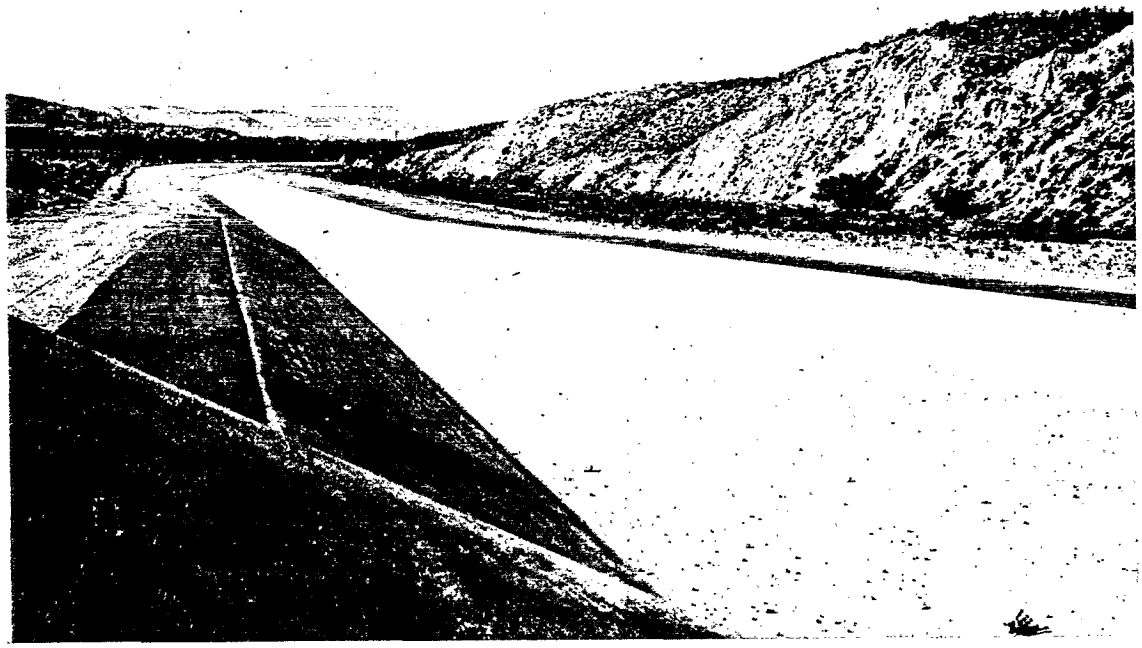
Riverside Levees Completed in 1958 at a total cost of $4,000,000, including $2,100,000 Federal funds, the Riverside Levees Project comprises levees along both sides of a 5-mile reach of the Santa Ana River near Riverside, Riverside County. The project protects the northwest section of Riverside and nearly all of Rubidoux.

San Antonio Dam An earthfill structure, San Antonio Dam is 160 feet high and 3,850 feet long. It is on San Antonio Creek about 20 miles (via Chino Creek) upstream from Prado Dam. Completed in 1956 at a Federal cost of $7,000,000, the dam can impound 7,700 acre-feet of floodwater. Functioning in conjunction with downstream channel improvements (on San Antonio and Chino Creeks), the dam protects agricultural lands and residential, commercial, and industrial properties in Pomona, Claremont, Chino, Ontario, and Upland. Development for recreation activities at San Antonio Dam would be considered if a local sponsor presents an acceptable general plan.

San Antonio and Chino Creeks Channel Completed in 1960, an improved channel on Chino Creek and its tributary, San Antonio Creek, extends from San Antonio Dam downstream to the reservoir area of Prado Dam. The project consists of 10.5 miles of concrete channel along San Antonio Creek and 5.2 miles of concrete channel along Chino Creek. Federal cost of these improvements was $10,900,000. Functioning in conjunction with San Antonio Dam, the channel improvements provide flood protection to agricultural lands and residential, commercial, and industrial areas in Pomona, Claremont, Chino, Ontario, and Upland.

San Jacinto River Levee and Bautista Creek Channel The project for flood control improvements on the San Jacinto River and Bautista Creek is in Riverside County near San Jacinto, Hemet, and Valle Vista. It consists of a levee along the left bank of the river and a concrete lined channel along the creek upstream from State Highway 74. Federal cost of these improvements was $3,000,000. The non-Federal share was $928,000. Completed in 1961, the project provides flood protection to San Jacinto, Hemet, Valle Vista, and agricultural areas nearby.

Riverside Levees, Santa Ana River



Upstream end, Bautista Creek Channel

Inactive Project Units

Aliso Creek, San Juan, Trabuco, and Villa Park Dams Earthfill dams and reservoirs or detention basins on Aliso, San Juan, and Santiago Creeks and Arroyo Trabuco were authorized as units of the Santa Ana River Basin and Orange County Project by the 1936 Flood Control Act, as amended. Aliso Creek, San Juan, and Trabuco Dams are presently classified "inactive" because they were not found economically feasible in the preliminary planning stage. With the approval of the California Department of Water Resources, the Orange County Flood Control District completed a dam and reservoir at the Villa Park site in 1962. This project is smaller than the improvement authorized, which is also classified "inactive." All of the authorized but inactive project units are to be restudied in conjunction with an on-going investigation of the Santa Ana River Basin and Orange County Project.

University Wash and Spring Brook As authorized, the University Wash and Spring Brook Project would consist of 2.7 miles of covered concrete channel along

University Wash, 2.2 miles of earth channel along Spring Brook, and beautification features. These improvements, which would be in or near Riverside, are presently classified "inactive" because they were not found economically feasible in the preconstruction planning stage.

OTHER FLOOD CONTROL PROJECTS

Calleguas Creek, Simi Valley to Moorpark

The project plan for Calleguas Creek from Simi Valley to Moorpark, Ventura County, provides for 7.4 miles of channel and levee work, management of the flood plain along a 5.8-mile reach of the creek, and development for recreational use of the streamway throughout the 13.2-mile project reach. Federal cost of project improvements is estimated at $33,600,000 and the non-Federal cost at $4,890,000. Phase I preconstruction planning studies were authorized in 1976 and started in 1978.

The project would alleviate serious flood problems along Calleguas Creek. It will protect Simi Valley, Virginia Colony, and Moorpark, and rapidly developing commercial and industrial areas outside of urban areas. About 5,300 people live in the 2,400-acre area subject to overflow by Calleguas Creek.

Kenter Canyon Conduit and Channel

Built as an emergency relief project in 1937, Kenter Canyon Conduit and Channel is located in the southwestern part of Los Angeles County. It begins near the intersection of Wilshire Boulevard and McClellan Drive in Los Angeles, extends for most of its 3-mile length beneath Broadway and Colorado Avenue in Santa Monica, and empties into the ocean at Pico Boulevard. Federal cost of the improvement was $1,000,000 and the non-Federal cost was $125,000.

San Diego River Levee and Channel Improvements

Extending from near Morena Boulevard to the ocean, the San Diego River Levee and Channel Improvement Project comprises the flood control features of a dual-purpose project for shallow-draft navigation on Mission Bay and flood control along the lower San Diego River. The flood control features[1] consist of a floodway along the lower 3.3 miles of the river and alteration of a railroad bridge that crosses the floodway at approximately Mile 2.5.

Since completion of the floodway in 1953, its south jetty has been extended, and the middle jetty (a feature integral to both the flood control and navigation functions) has been restored to afford an increased degree of flood protection. The cost of these modifications was about $412,000. First cost of the floodway and related improvements was about $5,500,000, which was shared about equally by the Federal Government and the local interests. Plans call for removal of a sand barrier at the mouth of the floodway at an estimated cost of $1,200,000.

The completed flood control improvements are maintained by the City of San Diego. Also, local interests must protect the carrying capacity of the floodway from future encroachment or obstruction.

San Diego River (Mission Valley) Project

As authorized, the San Diego River (Mission Valley) Project would consist principally of a concrete lined channel along the river from near Zion Avenue in Grantville downstream to near the upper end of the San Diego River Floodway. Other project features comprise a transition to the floodway, two inlet levees at the upstream end of the channel, and short sections of channel at the lower ends of Alvarado, Murphy, and Murray Canyons. The project would protect a 2,400-acre overflow area that includes developing commercial, industrial, and resort-type properties in Mission Valley.

Reformulation studies during preconstruction planning have shown that the authorized improvements are no longer justified, and the project has been classified "inactive" pending consideration of alternatives that include nonstructural measures.

San Luis Rey River Project

Authorized improvements for flood control on the San Luis Rey River consist of earth-bottom channel, channel grading, and stone revetted levees along the lower 7 miles of the stream. Cost of these improvements is estimated at about $25,400,000, of which $18,500,000 would be Federal expenditure and $6,900,000 would be non-Federal. Lands and improvements in or near Oceanside would be afforded a high degree of flood protection by the project works, which would permit optimum use and development of flood plains along the project reach. A program to beautify project areas and mitigate wildlife habitat loss is part of the authorized plan. In general, it provides for retaining and maintaining vegetation in and along the streamway, utilizing waste water for waterfowl development, providing percolation ponds, and preserving the Narrows and the lagoon at the mouth of the river.

Preconstruction planning for the project is scheduled for completion by 1980. Project formulation will be reviewed during the course of these studies with a view to determining whether the authorized plan is still the best plan for the area. All viable alternatives will be evaluated.

[1]The navigation features are discussed on page 66.

Santa Clara River Basin Project

An overall plan for flood control on the Santa Clara River was authorized in 1948. It provides for a two-unit development comprising the Santa Clara River Levee and the Santa Paula Creek Channel and Debris Basins. Santa Paula Creek is a tributary stream that joins the Santa Clara River from the north at Santa Paula.

Santa Clara River Levee Completed in 1961 at a total cost of $3,000,000, including $2,100,000 Federal funds, the Santa Clara River levee extends for 4.7 miles along the left bank of the lower river. A 53,000-acre overflow area that includes Oxnard and a Navy base at Port Hueneme is protected by the improvement. Since its completion, the levee has prevented an estimated $128,000,000 flood damage. In the 1978 floods, it prevented damage estimated at $60,000,000.

Santa Paula Creek Channel and Debris Basins As originally authorized, flood control improvement of Santa Paula Creek comprised a concrete lined channel from the mouth of Santa Paula Canyon downstream to the Santa Clara River. However, the debris producing characteristics of Santa Paula Creek during the 1969 floods demonstrated that the original plan was inadequate. As approved in 1973, a modified plan provides for a 2,250,000 cubic yard capacity debris basin on Santa Paula Creek, a concrete channel from the debris basin downstream to the Santa Clara River, a 155,000 cubic yard capacity debris basin on Mud Creek, and a concrete channel along Mud Creek from the debris basin downstream to Santa Paula Creek. The length of concrete channel required would be approximately 19,200 feet on Santa Paula Creek and 3,400 feet on Mud Creek. In developing the revised project plan, careful consideration was given to esthetics as well as function in the design of structures, to recreation facilities that would complement existing facilities, and to beautification measures that would enhance the natural environment in the project area. Accordingly, the revised plan includes a 12-acre lake for boating and fishing, waterfalls along natural channels through picnic areas, and a 30-acre riparian preserve with riding, hiking, and nature trails.

Cost of improvements on Santa Paula Creek is estimated at $24,400,000, of which $22,200,000 would be Federal and $2,200,000 would be non-Federal expenditure. The authorized improvements will protect the town of Santa Paula and agricultural areas nearby. During the 1969 floods, mud up to 7 feet deep was deposited in homes and businesses in Santa Paula, and boulders weighing as much as 1/3 of a ton were carried into Santa Paula Creek. In early 1978, severe flood damage was again sustained in the project area, and about $365,000 had to be spent for repair and restoration.

Construction of 1,700 feet of channel at the downstream end of the project has been completed and it is about 10 percent finished. Construction of the rest of the project had been enjoined pending the preparation, coordination, and filing of a new environmental impact statement.

Stewart Canyon Debris Basin and Channel

A 300,000 cubic yard capacity debris basin at the mouth of Stewart Canyon and 4,500 feet of concrete channel extending from the debris basin through Ojai, and thence to a dumped stone transition and a natural channel south of the city were completed in 1963. Built at a cost of $1,292,000, of which $940,000 was Federal expenditure, the project protects Ojai, nearby agricultural areas, a stretch of State Highway 150, and a branch line railroad. The Ojai area, however, is still subject to floods originating east of Stewart Canyon.

Sweetwater River Project

Now in the preconstruction planning stage, the Sweetwater River Project would consist of 3.4 miles of channel flanked right and left along much of its length by the north and south lanes of the proposed State Highway 54. Federal cost of the improvement is estimated at $14,900,000 and the non-Federal cost at $14,600,000. The project will provide flood protection to residential, commercial, industrial, and recreational properties in Chula Vista and National City.

Combining the flood control and highway construction plans permits the most efficient use of the limited lands available in the Sweetwater River Valley, and would reduce the cost of both improvements. Less land would be required for rights-of-way, relocation costs would be shared, and excavated materials from the channel would be used in the construction of the highway embankment.

Landscaping measures would be an important part of the project in that trees and shrubs planted along both banks of the channel would screen it from the highway. Equestrian and bicycle trails are planned to complement the proposed Sweetwater Regional Park at the upstream end of the flood control channel. In addition, 188 acres of marshland at the mouth of the channel in San Diego Bay would be acquired as a habitat for rare and endangered species.

Tijuana River International Flood Control Project

A flood control project on the Tijuana River at the international boundary of the United States and Mexico was authorized in 1966. Corps of Engineers' participation in the planning and construction of project improvements was requested by the United States Section Commissioner of the International Boundary and Water Commission, United States and Mexico. Project improvements now under construction and scheduled for completion in 1979 consist of a concrete flood control channel extending 1,400 feet

into the United States from the end of a similar channel ending at the international boundary, an energy dissipator, a low flow channel extending from the energy dissipator to the natural channel of the Tijuana River (a distance of about 1,100 feet), north and south levees along the flood control channel (total length about 1,800 feet), needed relocations, and landscaping. These improvements essentially comprise a relocation of the Tijuana River for a short distance inside the United States. Their estimated cost is $15,600,000, of which $13,320,000 would be Federal expenditure.

The plan of improvement was filed with the Council on Environmental Quality in 1976 and was selected by the San Diego City Council as in keeping with its land-use concepts for the Tijuana River Valley. Approval of the Mexican Section of the Boundary and Water Commission was documented in May 1977.

Completion of the project will fulfill an international commitment of the United States to Mexico, allow that country to complete its improvement of the river just south of the border, prevent backwater flooding in Tijuana, and reduce the velocity of floodflows. The project will also protect high value lands in the San Ysidro area and allow the City of San Diego to manage the lower Tijuana River Valley for multipurpose land uses.

Ventura River Levee

A rock-revetted levee 2.64 miles long on the left bank of the Ventura River at Ventura was completed in 1948. Federal cost was $1,500,000 and non-Federal cost $140,000. A 1,500-acre overflow area that includes part of an oil field and agricultural, residential, and business properties in or near Ventura is afforded flood protection by the project.

FLOOD DAMAGE PREVENTION STUDIES

Dominguez Channel

A study of the advisability of enlarging Dominguez Channel for purposes of flood control was authorized in 1976. Dominguez Channel is a local drainage improvement that discharges into Los Angeles Harbor via the Consolidated Slips and the East Basin. The study is to be completed in conjunction with a navigation study of water and surface transportation needs of ports on San Pedro Bay. That study is scheduled for completion in 1982. (Refer to page 73.)

Los Angeles County Drainage Area Project

A study of the Los Angeles County Drainage Area Project was authorized in 1969. In general, its purpose is to examine the adequacy of 7 existing channels, the need for improving channels along 44 project streamways, and the desirability of incorporating additional water conservation and recreation features at 4 existing dams. The feasibility of landscaping and adding environmental-recreation features at existing debris basins and along 295 miles of existing improved channels will also be examined. A report on the study is scheduled for completion in 1984.

Although the Los Angeles County Drainage Area Project has functioned well and prevented more than $2,000,000,000 damage during the most recent major floods in the region (1969 and 1978), unprotected areas incurred about $10,000,000 damage in 1969 and $12,300,000 in 1978. Population in the area protected by the project continues to increase. By the year 2000, it is expected that around 8,000,000 people will live in this area.

Santa Ana River Basin and Orange County

In recognition of the need for improvement to prevent catastrophic flood damage that reasonably can be expected to occur in the Santa Ana River Basin and Orange County Project areas, a comprehensive review investigation was authorized by Congress in 1964. The study area is in San Bernardino, Riverside, and Orange Counties except for a small part in Los Angeles County. Existing projects have prevented enormous amounts of flood damage in these areas, but they are no longer adequate to protect one of the most rapidly growing areas in the nation. If a great flood should occur, damage estimated at $4,000,000,000 could be expected in Orange County alone. Flood control improvements to be examined include 60 miles of levees, 340 miles of channels, 11 reservoirs, 9 alternative reservoirs, and 24 debris basins. In addition, seven existing reservoirs will be studied in detail.

Two interim studies within the framework of the comprehensive investigation are in progress and one has been completed. Flood control improvements on streams not studied on an interim basin will be covered in the main investigation. These streams include the San Jacinto River; upper Warm Creek; Salt, Day, East Etiwanda, San Sevaine, and San Diego Creeks; and tributaries to Sunset Bay and the Bolsa Chica. As noted earlier, authorized projects on Aliso, San Juan, and Santiago Creeks and the Arroyo Trabuco will be restudied in conjunction with this investigation. The interim studies are:

Santa Ana River, San Bernardino Mountains to the Ocean Completed in 1976 and reflecting 10 years of study effort, the report on this interim investigation contained recommendations for preconstruction planning studies of improvements that are further discussed under the headings "**Santa Ana River Main Stem, Santiago Creek, and Oak Street Drain**" (page 79) and "**Mill Creek Levees**" (page 81).

Coyote Creek Tributaries Interim investigation of Coyote Creek tributaries will include examination of modifying the operation of Brea, Fullerton, and Carbon Canyon Dams, and enlarging the channels of Brea, Fullerton, and Carbon Creeks to carry larger discharges from the dams downstream to Coyote Creek. The investigation is scheduled for completion in 1982.

Temescal and San Timoteo Creeks and Tributaries An interim investigation of channel improvements on Temescal Creek at Corona, San Timoteo Creek at Loma Linda, Zanja Creek at Redlands, and Wilson Creek at Yucaipa is nearing completion. It is expected that the report on this investigation will be finished in 1980.

The comprehensive investigation of the Santa Ana River Basin and Orange County will include study of recreational developments and ground water recharge as well as problems of flood control. A water resources development plan that will satisfy present and future needs is the primary objective of making the investigation, the report on which is scheduled for completion in 1983.

San Diego County Streams

San Diego County streams flowing to the Pacific Ocean drain an area of about 4,000 square miles, including 1,200 square miles in Mexico. The study area, which excludes the drainage areas of the Santa Margarita, San Luis Rey, and Tijuana Rivers,[1] covers about 1,800 square miles. Population in this area about doubled (from 900,000 to 1,700,000) between 1960 and 1978 and is expected to increase to more than 2,000,000 by the year 2000. Flood damage, which totaled an estimated $500,000 in 1965 and $2,700,000 in 1969, will continue to occur in the absence of preventive or corrective measures. With continuing changes in land use, existing problems in the study area will magnify and new problems will develop.

Streams that flow through the major cities, including San Diego, Chula Vista, La Mesa, and El Cajon, will be studied. Channel improvements appear to be the most probable solution to flood damage reduction, but reservoir control and non-structural solutions will also be examined. Protection and enhancement of the environment and consideration of needs for recreational developments are of special concern.

Recent study efforts have been directed toward improvements for Forester, Alvarado, Los Coches, Loma Alta, Nestor, Los Penosquitos, Poway, and Rattlesnake Creeks. A reconnaissance-type report for a detention basin and channel improvements or channel improvements only on Telegraph Canyon at Chula Vista has been completed. Completion of the overall study is scheduled for 1981.

[1]Studied under separate authorities.

Santa Clara River and Tributaries

An investigation of the Santa Clara River and its tributaries in Los Angeles and Ventura Counties was started in 1965. Flood control improvements are needed in this rapidly developing area, where agricultural lands are being subdivided for industrial, commercial, and residential uses. Population of the basin, about 250,000 in 1978, is expected to increase to more than 600,000 by the year 2000.

A comprehensive flood control plan that best meets the present and future needs of the area is the primary objective of the study. About 130 miles of channel improvements and 25 debris basins in Los Angeles County, and 60 miles of channel improvements and 10 debris basins in Ventura County are being considered. Water supply, fish and wildlife, and recreational development will also be examined as part of the study. The flood control aspects of the proposed Cold Springs and Topatopa Reservoirs (Bureau of Reclamation) and the completed Castaic Reservoir (State of California) have been evaluated. An investigation of flood problems along Sespe Creek in Fillmore is being made under the small flood-control project authority. The South Fork of the Santa Clara River in Santa Clarita Valley is being considered for investigation under that continuing authority. Completion of the overall investigation of the Santa Clara River and its tributaries is indefinite.

Ventura River Basin

A reconnaissance-type investigation of the Ventura River Basin has been completed. Its purpose was to determine whether modification of the recommendations in prior reports was advisable. The areas examined in detail were in or near Live Oak Acres and in the Ojai Valley along San Antonio Creek. A negative letter-type report is scheduled for submittal in 1979.

SMALL FLOOD-CONTROL PROJECTS

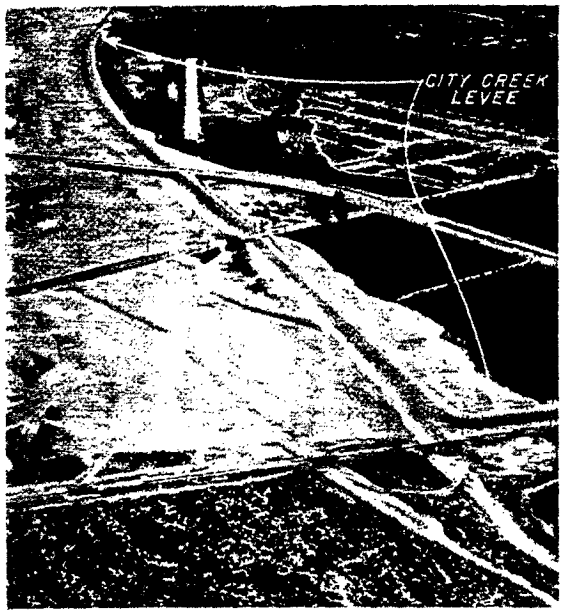
City Creek Levee

A small flood-control project on City Creek about 5.5 miles east of San Bernardino was completed in 1960 at a Federal cost of $400,000. Non-Federal expenditure was $485,000. The project consists of 2,500 feet of levee, revetment of 3,400 feet of previously existing levee, and 4,600 feet of channel excavation. Its purpose is to prevent the creek from overflowing to the west toward San Bernardino.

Rose Creek Channel

A small flood-control project on Rose Creek in San Diego was completed in 1970. It consists of 3,500 feet of channel improvement work extending southwesterly

from Highway 101 to Grand Avenue at Mission Bay. Constructed at a Federal cost of $982,000 and a non-Federal cost of $251,000, the improvement protects residential and commercial properties. During the 1978 floods, the channel prevented flood damage estimated at $1,000,000.



City Creek Levee, a small flood-control project near San Bernardino

SMALL FLOOD-CONTROL PROJECT STUDY

Sespe Creek

A detailed project report for a small flood-control project on Sespe Creek (a tributary to the Santa Clara River) in the Fillmore area is in progress. A levee along the east bank of the creek from Goodenough Road to State Highway 126, a distance of about 1.9 miles; floodgates at the east bank abutments of the Southern Pacific Company railroad and Telegraph Road bridges; and a flood warning alarm system for operation of the floodgates are being examined. The report is scheduled for completion in 1979.

SHORE PROTECTION PROJECTS

Prefatory Note: Since the 1930s, when Congress authorized the Corps of Engineers to cooperate with the states in finding ways to control beach erosion, preserving the shorefronts of the South Coastal Basins has been an important part of the work of the Los Angeles District.

Maintaining beaches along the coastline of the South Coastal Basins is a major problem that has peculiar characteristics. In contrast to beaches elsewhere in the United States, beaches in Southern California are not always nourished by sand washed in from the ocean. Instead, beach sand is constantly swept downcoast and offshore into submarine canyons by ocean waves. Lost sand was naturally replenished mainly by sand laden outflow from the Los Angeles, San Gabriel, and Santa Ana Rivers. In the 1940s, when these rivers were largely controlled by forcing their discharges through concrete channels, the coastal plains were protected, but the rivers could not provide the sand for natural replenishment of beaches.

Thus, in solving one problem, a new problem was introduced, and it was soon known that every manmade facility on the coast had an impact on the coastline. For example, problems result from construction of piers, breakwaters, and harbors that interfere with natural littoral drift or set up new wave patterns. As a result of manmade improvements, sandy beaches may disappear and ocean front cliffs may be undermined and topple into the ocean.

Shore protection studies made by the Los Angeles District and the projects evolved have played a significant part in protecting and developing the invaluable coastline resource of Southern California. With the cooperation of state, local, and other Federal agencies, the Corps is continuing its effort to protect the scenic and environmental integrity of the seacoast. Some specific information on projects constructed and studies being made by the Los Angeles District follows.

Anaheim Bay Harbor

A shore protection project for Anaheim Bay Harbor was completed in 1959 at a Federal cost of $89,000. It is located at Seal Beach, just upcoast from the harbor, and consists of a protective beach 300-1,200 feet wide and 5,000 feet long. The beach was formed by depositing 250,000 cubic yards of sand and constructing a groin 750 feet long. A study of the requirements of local cooperation for the project is in progress. (See page 90.)

As originally authorized, the Anaheim Bay Harbor Shore Protection Project included a Federal contribution toward creating a protective beach at Surfside. In 1962, however, this work was switched to the San Gabriel River to Newport Bay Shore Protection Project. (See page 89.)

Doheny State Beach

A shore protection project for Doheny State Beach was completed in 1966. It consists of a protective beach 100-130 feet wide and 6,000 feet long. The beach was formed by depositing 934,000 cubic yards of sand and constructing a groin 250 feet long. Federal cost was $579,000 and the non-Federal cost was $431,000.

In conjunction with Dana Point Harbor, which is immediately upcoast, Doheny State Beach is an important sea-and-shore recreation complex in a prime coastal reach. An artificial reef to create wave conditions for surfing is a unique feature of the shore protection project. It is located about 3,000 feet off the beach and was built as a by-product of dredging Dana Point Harbor. It may be the forerunner of similar reefs along the coast of Southern California.

Part of the shore protection project at Doheny Beach

Imperial Beach

Imperial Beach is in San Diego County about 5 miles north of the Mexican border. The shore protection project provides for a Federal contribution toward the cost of constructing five stone groins at 1,000-foot intervals along the beach front. Groins 1 and 2 were completed in 1959 and 1961, respectively, and an extension of Groin 1 was completed in 1963. Three groins hve been deferred pending demonstration of need. Project cost is estimated at about $2,700,000, of which $1,200,000 would be the non-Federal share.

Surveillance of the completed groins since their completion has shown that corrective measures are urgently needed to prevent further beach erosion, but it is now questionable whether the groin system will be suitably effective. A model study of plans to protect Imperial Beach has been completed as part of preconstruction planning. Study of alternatives and environmental impact is continuing.

One of two groins built to protect the shore at Imperial Beach

Ocean Beach

Ocean Beach is in the City of San Diego between the headland at Narragansett Avenue and the jetty on the south side of the entrance channel to Mission Bay Harbor. A shore protection project consisting of a protective beach 200 feet wide and 1,700 feet long was completed at Ocean Beach in 1955. The beach was formed by constructing a stone groin 530 feet long and

depositing 275,000 cubic yards of sand dredged from Mission Bay Harbor. Federal cost of the project was about $8,000 and the non-Federal cost was $16,000. Sand from dredging Mission Bay Harbor was obtained at no cost to the shore protection project.

Oceanside

The Oceanside Shore Protection Project is just downcoast from Oceanside Harbor, San Diego County. Built at a Federal cost of $1,400,000, the project consists of a protective beach 100-200 feet wide and 3.3 miles long. Developed in conjunction with construction of Oceanside Harbor and completed in 1963, the beach was formed by depositing 3,800,000 cubic yards of sand and constructing a groin 1,223 feet long.

Since its completion, the beach has been periodically replenished as a by-product of maintenance dredging at Del Mar Boat Basin (Camp Pendleton Harbor) and Oceanside Harbor. The material made available in this manner, however, has not been sufficient to maintain adequate beach width. Further, littoral processes that normally supply beach-building material along coastlines have been interrupted at Oceanside. A study of these problems is in progress. (See page 90.)

Point Mugu to San Pedro Breakwater

Work completed on the Point Mugu to San Pedro Breakwater Shore Protection Project consists of a barrier groin at Cabrillo Beach; a barrier groin at Topaz Street in Redondo Beach; and protective beach 200 feet wide between the Topaz Street groin and Malaga Cove, a distance of 7,800 feet. The beach was formed by depositing about 1,400,000 cubic yards of sand. Cabrillo Beach and Topaz Street groins were completed in 1962 and 1970, respectively, and the protective beach was completed in 1968. The cost of work completed was $2,492,000, which was shared about equally by Federal and non-Federal interests. Authorized improvements from Topanga Canyon to Topaz Street have been deleted from the project because the 16-year limit for completion (set in the authorizing act) expired in 1970.

San Buenaventura State Beach

San Buenaventura State Beach lies along the ocean front at Ventura. The shore protection project provides for a Federal contribution toward the cost of constructing groins and placing suitable material along approximately 12,000 feet of public beach. By 1967, seven groins had been built and 882,000 cubic yards of beach fill (about one-half the volume authorized) had been deposited. To date, Federal costs total $716,000 and non-Federal costs total $619,000. Local interests have also spent $117,000 for safety railings, lavatories, and a parking area. The beach is under continuing surveillance. Further construction is deferred pending demonstration of need.

Sunset Cliffs (San Diego)

Erosion of the shoreline cliffs and beach in the Sunset Cliffs area of San Diego progressively continued for many years. Streets were damaged and public and private improvements destroyed as a result of the retreat of the cliff line. Large cracks have appeared along the edge of the cliffs, parts of which fell into the ocean as the result of an earthquake in 1968. A shore protection project to reduce beach erosion and the landward retreat of the cliffs was authorized in 1966. It provides for shore protection along two reaches (Segments A and B) at an estimated cost of $4,200,000, which would be shared equally by the Federal Government and local interests.

Segment A (the northern reach) extends from Santa Cruz Avenue south to Osprey Street. Four groins would be built and about 720,000 cubic yards of beach fill would be placed in this reach to form and protect a beach 200 feet wide and 4,000 feet long. These improvements have not been made because local residents believe that the beach would attract an excessive number of visitors to what is now a quite residential area. Segment A improvements are being held in abeyance pending the city's acceptance of an alternative plan.

Segment B (the southern reach) extends from Osprey Street south to Ladera Street. Work in this reach, completed in 1973, consists of building 11 stone revetments and 2 stone dikes, and sealing 2 hazardous sea cave entrances. Cost of these improvements was about $490,000.

San Gabriel River to Newport Bay

For 50 years prior to initiation of the shore protection project, beach erosion in the project reach (Anaheim Bay Harbor south to Newport Bay Harbor) threatened destruction of some of the most expensive beach property in the United States. Sunset Beach, Huntington Beach, and Newport Beach are located along this 17-mile section of the coast. Work on the shore protection project has been in process since 1964 when 4,000,000 cubic yards of beach fill material were placed at Surfside and Sunset Beach.

Completed work now includes placing an additional 2,400,000 cubic yards of sand at Sunset Beach and Surfside; and placing 1,800,000 cubic yards of sand, installing 9 sheet pile or stone groins, and rehabilitating 2 sheet pile groins at Newport Beach. Work authorized, but deferred pending demonstration of need, consists of building an offshore breakwater at

Huntington State Beach, extending (as a groin) the south jetty at the mouth of the Santa Ana River, and placing 1,500,000 cubic yards of fill material in the Sunset Beach and Surfside areas.

Shore protection project at Newport Beach

Federal cost of project improvements is estimated at $12,100,000 and the non-Federal cost at $5,900,000. About $6,000,000 (Federal and non-Federal funds) has been spent for completed improvements.

SHORE PROTECTION STUDIES

Oceanside, San Diego County

Replenishing the protective beach—a shore protection project—at Oceanside by depositing additional material obtained from maintenance dredging at Camp Pendleton and Oceanside Harbors has been found inadequate to maintain suitable beach width. Further, natural beach-building along this reach of coastline has been interrupted. An investigation of these problems is in progress. Specifically, the objective of the investigation is to determine the extent and rate of erosion, the most effective and economical means to prevent beach loss, the extent of periodic beach replenishment needed to maintain adequate beach width, and appropriate cost sharing between Federal and non-Federal interests. Scheduled for completion in 1979, this investigation is being closely coordinated with an ongoing navigation study of shoaling in the entrance channel to Oceanside Harbor. (Refer to page 73.)

Seal Beach (Anaheim Bay Harbor)

A shore protection project for Anaheim Bay Harbor was completed in 1959. Project history shows that about 20,000 cubic yards of sand are lost from the beach each year. The City of Seal Beach has requested that replenishment be included in the Federal share of project maintenance as authorized by Public Law 87-874, which was enacted after the project was completed. A review of the requirements of local cooperation for the project, especially to examine cost sharing for maintaining adequate beach width, is in progress. The report on the review is scheduled for completion in 1979.

Ventura County

An investigation of beach erosion from Rincon Point to Sequit Point, a distance of 41 miles along the Ventura County coast, is in progress. Three major streams, three harbors, two submarine canyons, and a tidal lagoon influence the littoral regimen of the coastal reach under study. Serious erosion problems exist at Faria and Hobson Beach Parks, Emma Wood State Beach, and at Oxnard Shores. Constructing offshore breakwaters and stabilizing groins, placing beach fill, and placing rock revetment along the shore are being examined as remedial measures. The investigation is scheduled for completion in 1979.

SMALL SHORE PROTECTION PROJECTS

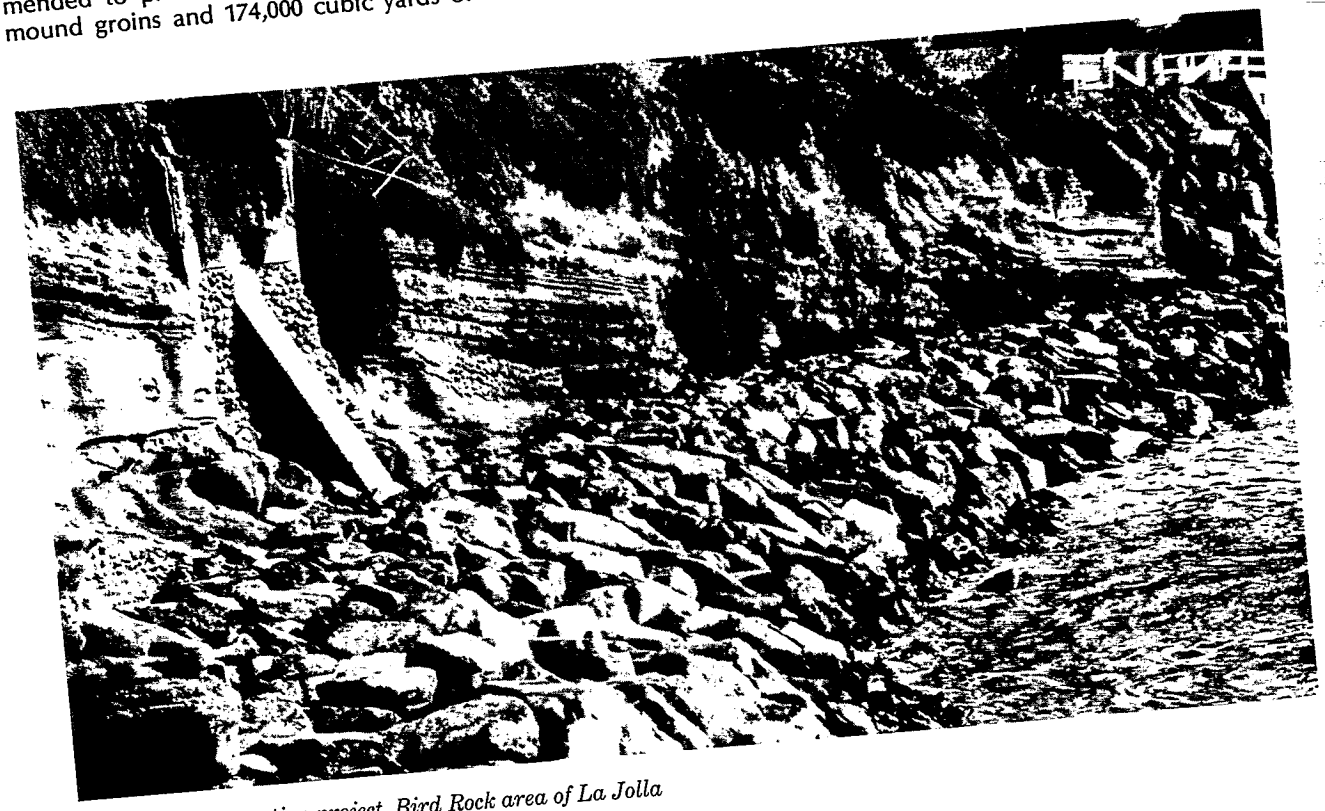
Bird Rock Area of La Jolla

A small shore protection project to protect the Bird Rock area of La Jolla was completed in 1966. It comprises 1,300 feet of revetment placed at a cost of $102,000, including a $76,000 non-Federal contribution. The project protects one of the most spectacular scenic sections of the California coast. This area is known for its high bluffs that have been carved into strange shapes by the action of waves. Before construction of the project, waves as high as 15 feet accelerated erosion to the point where destruction of the bluffs and residential property along their tops was threatened.

Las Tunas Beach Park

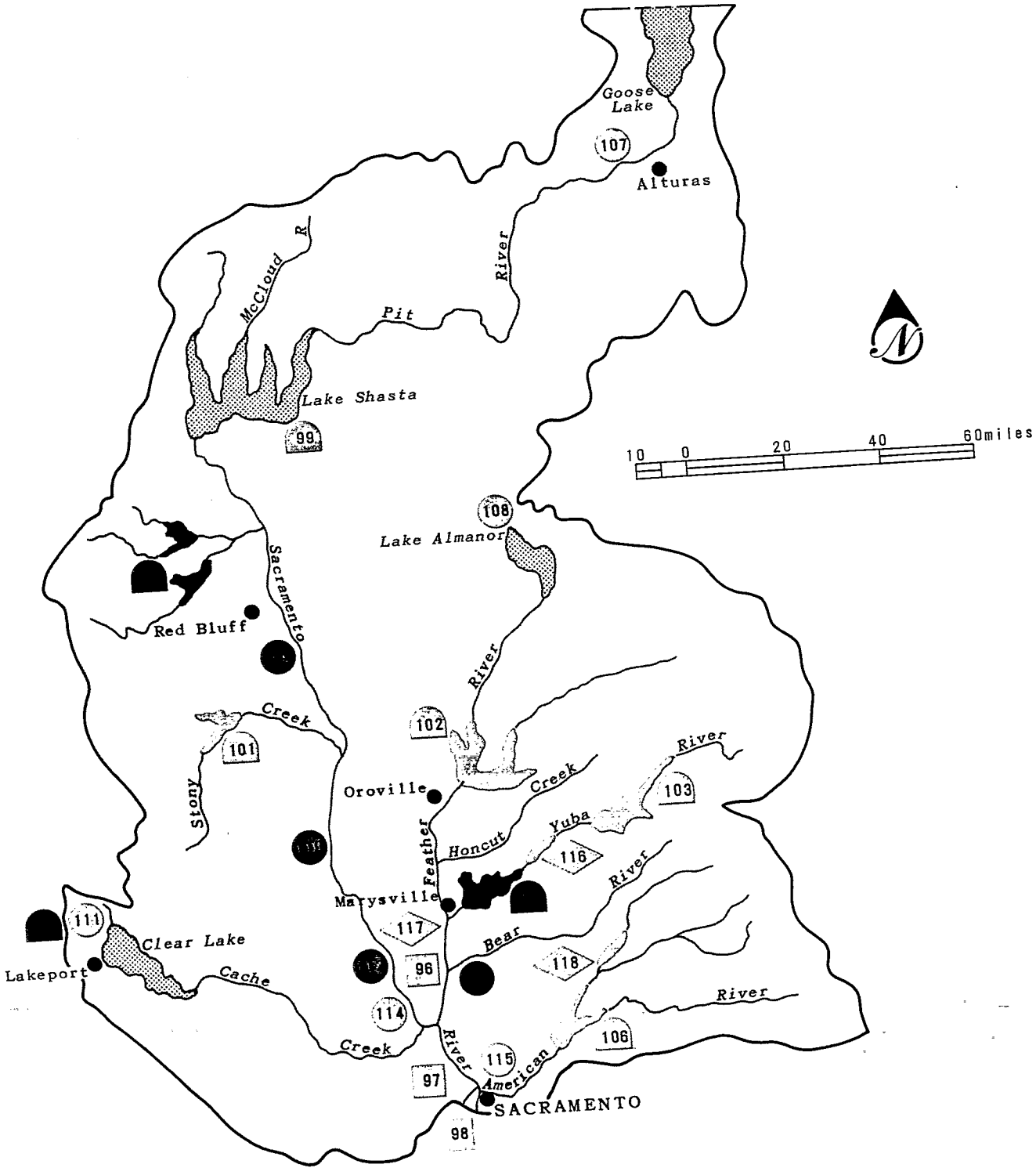
Due to erosion, the beach at Las Tunas Beach Park (a state-owned park operated by Los Angeles County and

located about 5 miles east of Malibu Point) has become barely usable. Six sheet pile groins are so deteriorated they are largely ineffective in retaining the beach, which is about 1,500 feet long. Improvements recommended to protect the beach include two rubble-mound groins and 174,000 cubic yards of beach fill. Also, parts of four existing groins would be removed and three existing road culverts would be extended. Cost of the shore protection improvements recommended is $1,142,000, including a non-Federal contribution of $611,000. Work will be started when funds are available.



Small shore protection project, Bird Rock area of La Jolla

6 SACRAMENTO BASIN
(Sacramento District)



LEGEND

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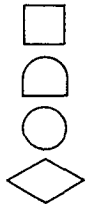

Navigation

Multipurpose

Flood Control

Debris Control

STATUS OF PROJECTS

Completed

Under Construction

Authorized, Not Started

60miles

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[1]Number following project name denotes Congressional District.

SACRAMENTO BASIN

DESCRIPTION

The Sacramento Basin is bounded by the Sierra Nevada on the east, the Coast Ranges on the west, the Cascade Range and Trinity Mountains on the north, and the Delta-Central Sierra Area on the south. A portion of the watershed of the Pit River, the most northerly tributary of the Sacramento River, lies north of the basin in Oregon, but drains from Goose Lake through the Cascade Range into the Sacramento Basin proper. The Sacramento Basin is about 280 miles long and up to 150 miles wide and has a land area of 26,500 square miles and a water area of 440 square miles.

The Sacramento River is the principal stream in the basin. Its major tributaries are the Pit and McCloud Rivers, which join the Sacramento River from the north, and the Feather and American Rivers, which are tributary from the east. Numerous tributary creeks flow from the east and west. The average runoff from the basin is second only to the North Coastal Basins and is estimated at 21,300,000 acre-feet per year. The melting snowpack in the Sierra Nevada maintains streamflow during most of the summer.

The climate of the valley floor areas of the basin is characterized by hot, dry summers and mild winters with relatively light precipitation. Warm, dry summers and cold winters with heavy rain and snow prevail in the mountainous areas. The average annual precipitation varies with elevation and ranges from less than 10 inches in the valley to over 95 inches in the Sierra Nevada and Cascade Range. Valley temperatures normally range from winter lows near freezing to summer highs of about 110 degrees. In the mountains, winter temperatures average about 30 degrees, and occasionally fall below zero.

The economy of the Sacramento Basin is based primarily on production of livestock and diversified crops. Related industries include food packing and processing, agricultural services, and the farm equipment industry. Another important segment of the economy consists of military and other Federal Government establishments, and the state government. The basin is served by a highly developed transportation system which includes Federal and state highways, airlines, railroads, and inland waterways. A deep draft navigation channel extends from Sacramento to Suisun Bay, an arm of San Francisco Bay. The present population of the basin, 1,357,000, is expected to increase to more than 2,000,000 by the year 2000.

Substantial progress has been made in water resources development and in the solution of related problems, but some areas are still threatened by floods and water shortages. Among these areas are the west side of the Central Valley, principally Yolo and Solano Counties; the Pit River Basin, primarily Big Valley; and scattered foothill and mountain areas on both sides of the valley floor.

NAVIGATION PROJECTS

Feather River

A navigation project on the Feather River extends from the mouth upstream to Marysville, a distance of about 28 miles. It consists of periodic removal of obstructions and construction of wing dams to maintain channel depth at an annual cost not to exceed $10,000. About $6,000 has been spent on the project. No work has been required since 1951. An incidental benefit of the project is improvement of the flood-carrying capacity of the streamway. In recent years, the channel has been used almost exclusively by pleasure craft.

Sacramento River, Shallow Draft Channels

A shallow-draft navigation project on the Sacramento River provides for channel depth of 10 feet from the mouth of the river upstream to Sacramento, 6 feet from Sacramento to Colusa, 5 feet from Colusa to Chico Landing, and depth as practicable from Chico Landing to Red Bluff. Channel work from the mouth of the river upstream to Colusa has been completed at a cost of about $600,000. Remaining work has been classified "deferred" pending a determination of economic feasibility.

Commercial navigation on the Sacramento River has markedly decreased in recent years with almost all shallow-draft barge traffic comprising local movement of sand, gravel, and rock for levee maintenance. About 120,000 tons of these materials moved on project waterways in 1977.

Continuing project maintenance will be largely limited to needed clearing and snagging. Continuing maintenance dredging to support the now very limited commercial shallow-draft navigation is not contemplated. Use of project channels for recreational boating and sport fishing continues to increase and is presently estimated at more than 3,000,000 user-days per year.

Sacramento River Deep Water Ship Channel

The Sacramento River Deep Water Ship Channel extends from Suisun Bay to Sacramento, a distance of 43 miles. It is mostly in the Delta-Central Sierra Area, but is included in this chapter because the tributary trade area is located in the Sacramento Basin.

The channel was formed by widening and deepening existing channels from Suisun Bay to a point near Rio Vista, and by excavating a new channel from that point to Lake Washington near Sacramento. In addition to the channel, the project includes a triangular harbor and turning basin in Lake Washington and a shallow-draft barge canal with navigation lock between the harbor and the Sacramento River. A single leaf

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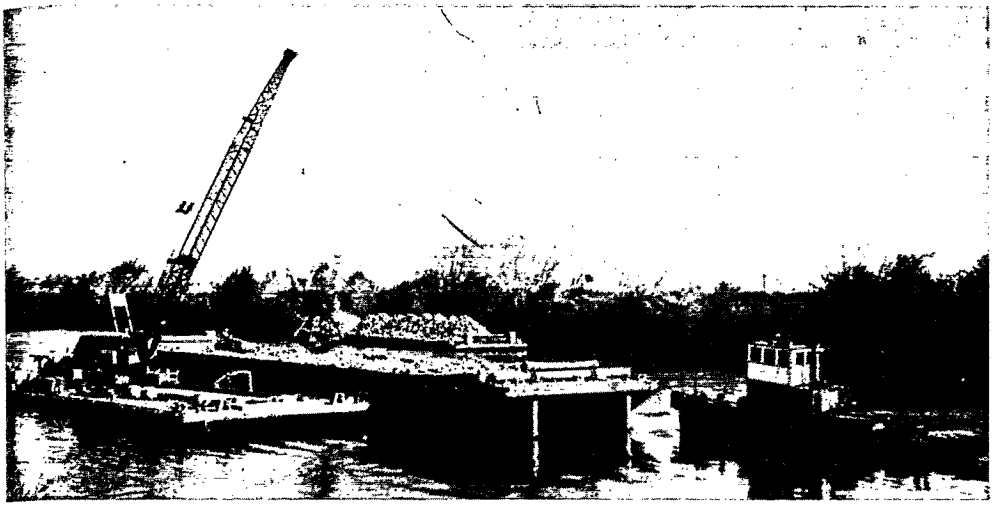
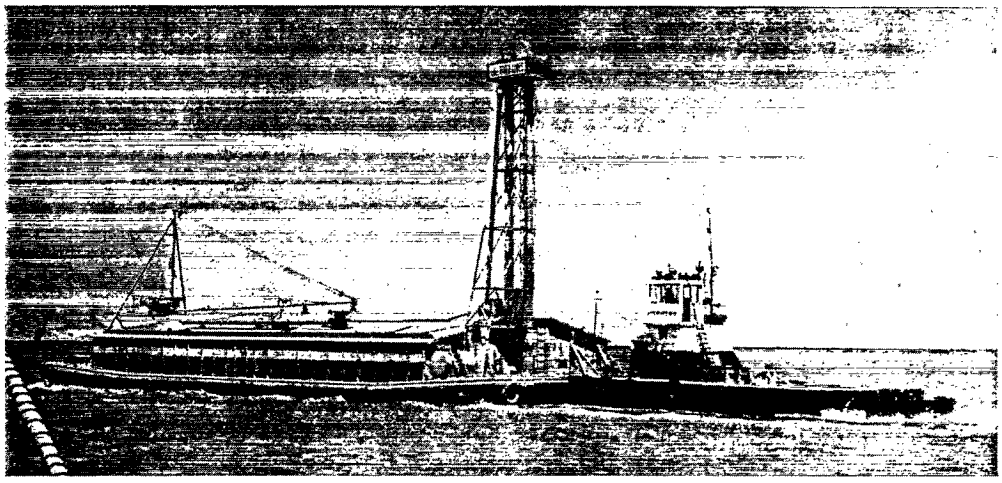
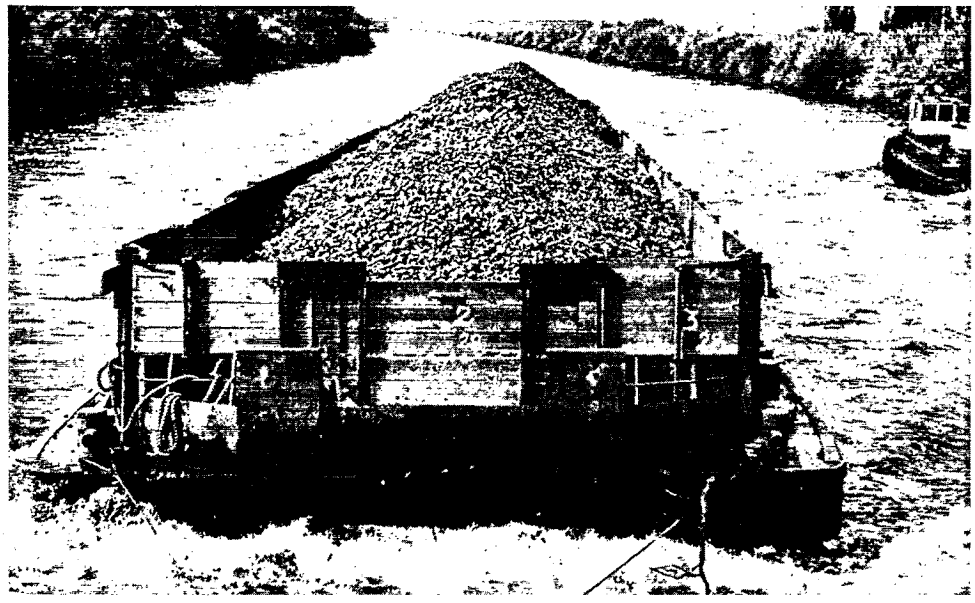




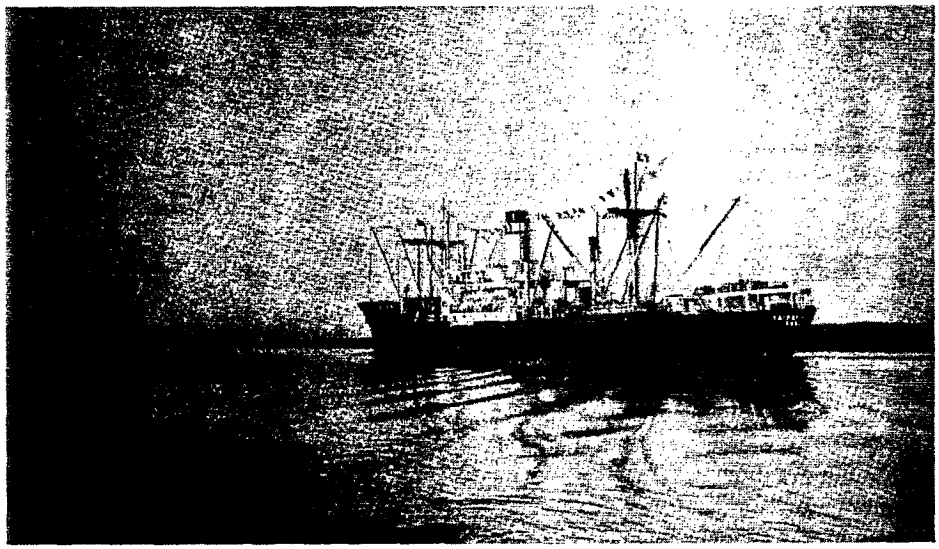


Typical shallow-draft traffic, Sacramento River

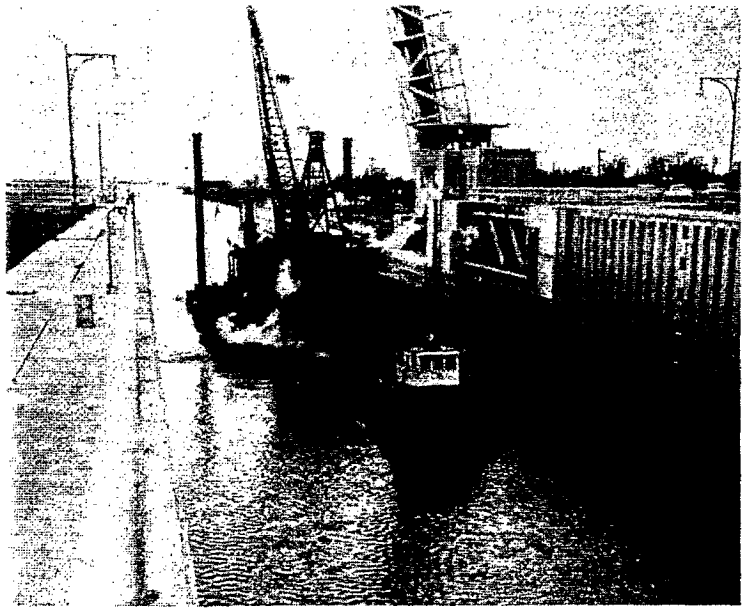
combination highway and railroad bascule (counterbalanced) bridge was provided across the canal. Controlling minimum depths are 13 feet in the barge canal and 30 feet in the ship channel.

The project was operationally complete in 1963. Total Federal cost was about $40,000,000, including $300,000 for navigation aids provided by the U.S. Coast Guard. Local cost for lands, relocations, terminal facilities, and a new bridge needed to permit passage of deep draft ships was $25,000,000.

The channel permits deep draft oceangoing vessels to proceed directly to the Port of Sacramento, thus reducing shipping costs to a trade area of about 75,000 square miles with a population of about 1,357,000. The major commodities moved on the project waterways are rice and other grains, logs and wood chips, prepared animal feeds, and canned foods—deep draft—and sand, gravel, and crushed rock—shallow draft. In 1977, total commerce was 1,500,000 tons, of which about 1,380,000 tons was deep draft traffic and 120,000 tons was shallow draft. Deep draft traffic averaged about 1,400,000 tons annually during the period 1968-1977. Commercial and recreational traffic on the barge canal requires about 3,400 lockages per year.



First ship through Sacramento Deep Water Ship Channel, July 8, 1963 (Photo by W.G. Stone)



Barge mounted derrick entering W. G. Stone Lock

Typical ocean-going vessel in the Port of Sacramento (Sacramento Bee photo)

NAVIGATION STUDIES

Sacramento Deep Water Ship Channel

A shoaling and sediment deposition problem in the Sacramento River downstream from the mouth of Cache Slough, the economic feasibility of deepening the ship channel and harbor at Sacramento, and the feasibility of dredging a turning basin on the channel about 10 miles downstream from Sacramento are under investigation. Completion of the study is expected in 1979.

Sacramento Valley Navigation

A study of improved shallow-draft navigation from Sacramento to Marysville is continuing and scheduled for completion in 1981. Specifically, an improved channel along the Sacramento River from Sacramento to around the mouth of the Feather River, and a canal parallel to the Feather River from the Sacramento River to Marysville are under consideration. Two navigation locks would be required along the canal. Improved shallow-draft navigation in the Sacramento Valley may be needed primarily to ship aggregates for various types of construction in the San Francisco Bay Area.

MULTIPURPOSE PROJECTS

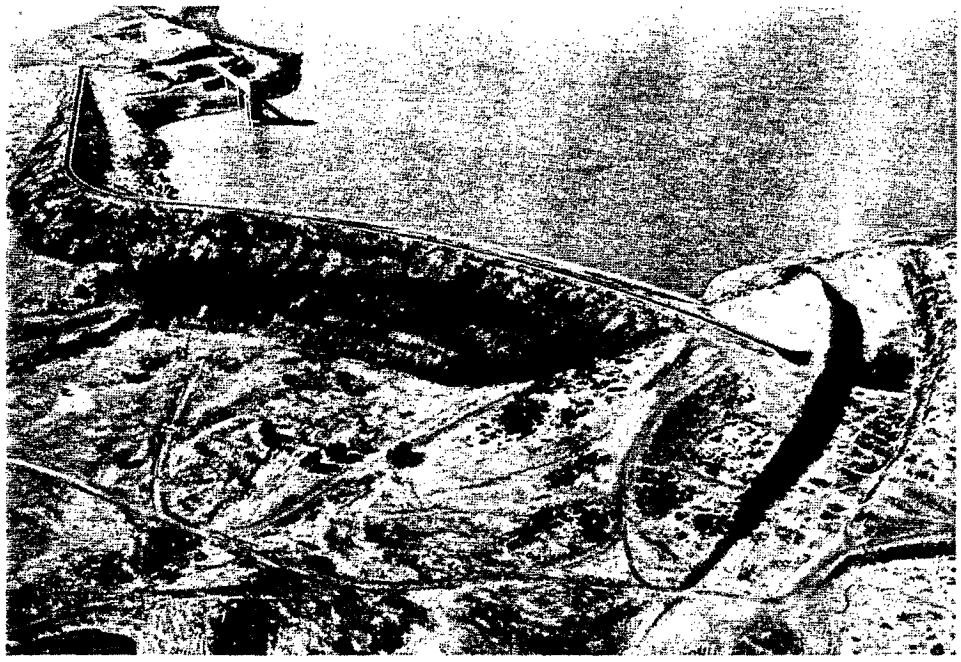
Black Butte Lake

Black Butte Lake is located on Stony Creek, a tributary of the Sacramento River, about 9 miles west of Orland. The project consists of an earthfill dam 140 feet high and 2,970 feet long, six auxiliary earthfill dikes, and a lake with a gross capacity of 160,000 acre-feet. Completed in 1963 at a Federal cost of $14,500,000, the project is operated and maintained by the Corps of Engineers. Local interests are required to reimburse the Federal Government for project costs allocated to the water conservation function of this project.

The project provides flood protection to 64,000 acres of farmland lying along the lower reaches of Stony

Creek, to Hamilton City and Orland, and to the Interstate 5 freeway. It also helps to reduce floodflows along the Sacramento River and in Butte Basin. In addition, the project provides about 56,800 acre-feet of new water annually for irrigation and related purposes.

The Corps of Engineers has spent $500,000 to provide public use facilities. These include campgrounds, picnic areas, boat launching ramps and associated access roads, parking areas, and systems for water supply and sanitation.



Black Butte Dam

Cottonwood Creek Project

The Cottonwood Creek Project will consist of two water storage facilities. One will be at the Dutch Gulch site on the main stem about 11 miles west of Cottonwood, and the other will be at the Tehama site on the south fork about 9 miles southwest of Cottonwood. Dutch Gulch Dam will be an earthfill structure 268 feet high and 21,810 feet long. It will create a 1,100,000 acre-foot reservoir. Tehama Dam will be 238 feet high and 29,340 feet long, and will create a 900,000 acre-foot reservoir. The project was authorized for flood control, irrigation, municipal and industrial water supply, general recreation, and enhancement of the anadromous fishery.

Project cost is estimated at $335,000,000. Local interests are required to repay construction costs allocated to irrigation and municipal and industrial water supply, plus one-half of the separable costs allocated to recreation and fish and wildlife enhancement, excluding those for the anadromous fishery. Reimbursement is currently estimated at about $240,000,000. Operation and maintenance of the completed project (other than for recreation facilities) will be the responsibility of the Federal Government.

The project will provide flood protection to lands along Cottonwood Creek and the Sacramento River, and will reduce damages in Butte and Colusa Basins. If this project had been completed and in operation in January 1970, it would have prevented an estimated $2,500,000 in flood damages. Dutch Gulch and Tehama Lakes will provide 40,600 acre-feet of water annually for irrigation and 235,000 acre-feet annually for municipal and industrial use.

The dams and appurtenances will be designed to minimize their impact on the natural beauty of the area. To compensate for inundation of wildlife habitat, about 13,000 additional acres of land will be acquired and improved to provide the food and cover needed by wildlife. Recreation facilities will afford opportunities for camping, picnicking, and a variety of water-oriented activities.

Although the dams will block minor spawning runs of chinook salmon and steelhead trout, measures to improve the anadromous fishery downstream of the dams are planned. Minimum releases will be made throughout the year, 3 miles of channel downstream from each dam will be acquired for control and management of spawning areas, and salmon propagation facilities will be constructed below Dutch Gulch Lake. Also, a program of fish trapping and hauling will be developed, and an existing hatchery will be expanded to maintain the steelhead run.

Preconstruction planning was initiated in October 1976 and is scheduled for completion in 1982.

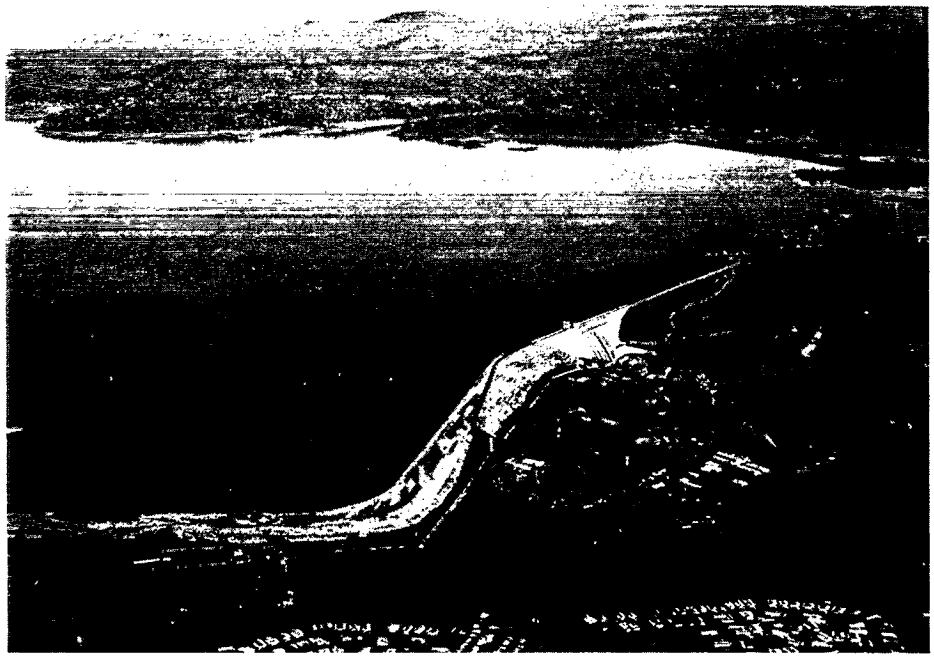
Folsom Lake

Completed in 1956, Folsom Lake is located on the main stem of the American River near the town of Folsom and 20 miles upstream from Sacramento. The project consists of a concrete gravity main dam with earthfill wing dams (total crest length, 10,200 feet; maximum height, 340 feet), and eight earthfill dikes along the perimeter of the reservoir, which has a storage capacity of 1,000,000 acre-feet. A 162 megawatt powerplant, an afterbay dam and 13.5 megawatt powerplant at Nimbus, and related transmission lines were concurrently built by the Bureau of Reclamation. After completion, the dam and reservoir were transferred to the Bureau of Reclamation for operation and maintenance as part of the Central Valley Project.

Federal cost of the project was about $100,000,000, of which $63,000,000 comprised the cost of storage facilities and $37,000,000 the cost of powerplant, afterbay, and transmission facilities.

The project provides flood protection to Sacramento and to adjacent suburban areas, makes 500,000 acre-feet of water available annually for irrigation and municipal uses, and generates about 500,000,000 kilowatt hours of hydroelectric power annually.

The project area, which has an extremely high recreational potential, has been developed as a state park by the California Division of Beaches and Parks. Annual public use of the area is about 2,600,000 recreation-days.



Folsom Dam

Lakeport Lake

Lakeport Lake, authorized for construction on Scotts Creek about 4 miles west of the City of Lakeport, will be created by a rolled earth and rockfill dam 1,540 feet long and 203 feet high. It will have a storage capacity of 55,000 acre-feet for flood control, irrigation, municipal water supply, fish and wildlife, and general recreation. Flowage and riparian preservation easements will be included in the project in lieu of levee construction and channel improvement work downstream from the dam. Scotts Creek is a triburary to Clear Lake.

Federal first cost of the project is estimated at $30,300,000, and local cost for acquiring flowage easements is estimated at $290,000. Local interests must also reimburse the Federal Government for project costs allocated to the water conservation function of the project and for one-half of the separable costs allocated to recreation. When completed, the storage facilities will be operated and maintained by the Federal Government.

The project will protect Scotts Valley and downstream canyon areas, reduce damages around Clear Lake by reducing inflow, provide about 18,000 acre-feet of new water annually for irrigation and municipal uses, and afford additional opportunities for water-oriented recreational activities.

The lake will inundate a portion of a small rainbow trout fishery and will reduce the spawning areas of the Sacramento Hitch, which migrate out of Clear Lake. In cooperation with the Corps of Engineers, the California Department of Fish and Game has agreed to carry out a plan for eliminating nongame fish and stocking warm water game fish in Clear Lake. A small fishery could also be sustained in Scotts Creek. Land will be acquired to help offset loss of wildlife habitat in the project area.

Preconstruction planning for the project was completed in 1976, but it was reclassified as "deferred" in 1977 due to lack of local support.

Marysville Lake

Marysville Lake is a multiple purpose improvement authorized for construction on the Yuba River system about 15 miles northeast of Marysville. This project is the third and final element of an operationally related water storage complex that also includes Lake Oroville on the Feather River and New Bullards Bar Reservoir on the North Yuba River. Marysville Lake will serve flood control, power generation, irrigation, general recreation, and fish and wildlife functions. Principal features of the project plan comprise dams on the Yuba River and its Dry Creek tributary, an afterbay dam on the Yuba River, and powerplants at the Yuba River and afterbay dams.

The Yuba River dam would be located just upstream from the State Highway 20 crossing at Parks Bar. It would have a concrete gravity center section with rockfill sections tying into the abutments, a length of 7,583 feet, and a height of 368 feet above streambed. The Dry Creek dam would be 1.5 miles north of the Yuba River dam. It would be a rockfill structure 6,000 feet long and 331 feet high. Together, these dams will create a 916,000 acre-foot reservoir that would include 240,000 acre-feet for flood control. Two rockfill dikes will be required in the westerly perimeter of the Dry Creek pool to prevent overflow into adjacent low areas. A connecting channel would be excavated through an intervening saddle to permit exchange of water between the Yuba River and Dry Creek pools. The afterbay dam would be a rockfill structure 4,800 feet long and 93 feet high creating 54,200 acre-feet of storage for reregulating power releases from Marysville Lake.

Power generation at the Marysville Lake plant would be a pumped storage operation. Essentially, this involves use of reversible turbines and excess power available during off-peak demand periods to pump water from the afterbay back into Marysville Lake (the forebay). The water pumped would be reused for power generation during peak demand periods. The main powerplant (three units, 1,350 megawatt capacity) would be located near the south bank downstream from the concrete gravity section of the Yuba River dam. It would be initially constructed to permit future addition of two more units for an ultimate capacity of 2,250 megawatts. Increasing the capacity of the main powerplant would require raising the afterbay dam to enlarge afterbay storage capacity to 80,800 acre-feet. Generating capacity at the afterbay powerplant would be 15 megawatts.

The entire first cost for construction of the project—$1,324,000,000—will be borne by the Federal Government. However, the Federal expenditure will be substantially reduced when local interests repay their share of costs allocated to water supply, power, and recreation. The project will be constructed, operated, and maintained by the Corps of Engineers. Its irrigation water yield (150,000 acre-feet per year) and its power generation capability will be integrated into the Central Valley Project.

About 33 miles of riparian wildlife habitat will be inundated by the lake. This type of habitat is in short supply, but its loss can be offset by acquiring and managing a comparable habitat nearby. Impacts on salmon spawning habitat will be offset by regulated flows and water temperature control. To enhance the salmon and steelhead fishery, a hatchery will be built and flows provided for artificial spawning areas in a secondary channel downstream from the dam.

Coordinated flood control operation of Marysville Lake, New Bullards Bar Reservoir, and Lake Oroville, together with existing levee systems, will provide flood protection to over 35,000 acres of highly improved land in the Yuba River flood plain and to the Marysville-Yuba City urban-suburban complex. Two mainline railroads, various Federal highways, state and county roads, and a 113,400 acre rural area along the Feather River would also be protected. Total population of the flood plain areas benefited is more than 60,000.

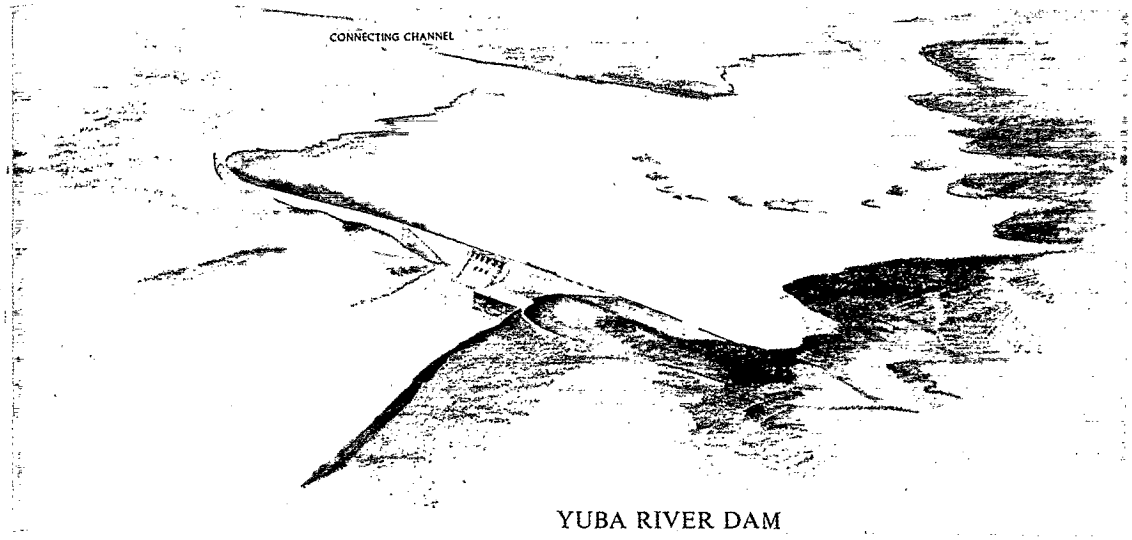
If Marysville Lake, New Bullards Bar Reservoir, and Lake Oroville had been completed and in operation during the December 1955 flood, their coordinated operation, in conjunction with existing levees, would have prevented levee failures along the Feather River, loss of 40 lives, and most of the $53,000,000 flood damage that occurred. The coordinated operation of these projects during the December 1964 flood would have prevented about $4,200,000 damage in addition to the $30,000,000 prevented by operation of the then partially completed Lake Oroville.

Preconstruction planning for Marysville Lake is in progress. The Phase I General Design Memorandum is scheduled for completion in 1979.

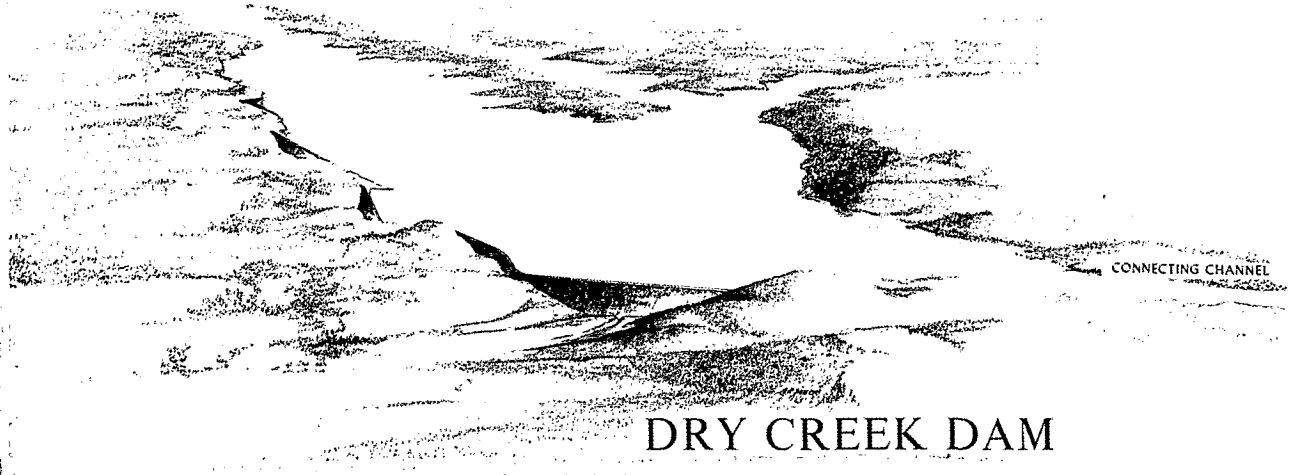
COOPERATIVE PROJECTS

Lake Oroville

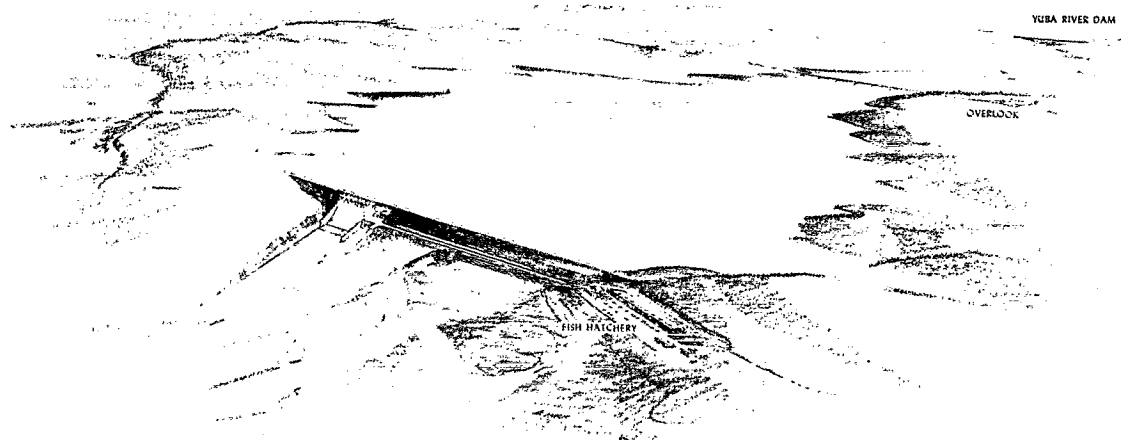
Lake Oroville, a multiple purpose partnership project on the Feather River near Oroville, was built by the



YUBA RIVER DAM



DRY CREEK DAM



AFTERBAY DAM

Artist's conceptions, Marysville Lake Project: Yuba River Dam and Marysville Lake (top), Dry Creek Dam (middle), and Afterbay Dam (bottom)

State of California as the key unit of the State Water Project. Completed in 1967, the project cost, exclusive of power and recreation facilities, was $387,000,000. Of this, the Federal Government contributed $69,100,000 for the flood control function.

Oroville Dam is 770 feet high and 6,850 feet long. It is the highest earthfill dam in the United States and impounds a 3,500,000 acre-foot reservoir, 750,000 acre-feet of which are reserved for flood control. Flood control operation of the project, according to rules prescribed by the Corps of Engineers, is coordinated with operation of New Bullards Bar Reservoir on the North Yuba River. Ultimately, coordinated operation with Marysville Lake on the main stem Yuba River is contemplated.

Oroville Dam

During the December 1964 flood, interim operation of the completed portion of the Lake Oroville Project prevented flood damage of about $30,000,000. If Oroville Lake, New Bullards Bar Reservoir, and Marysville Lake had been completed and in operation during the December 1955 flood, their coordinated operation, in conjunction with the existing levee system, would have prevented levee failures along the Feather River, loss of 40 lives, and most of the $53,000,000 flood damage that occurred. Lake Oroville affords flood protection to the cities of Oroville, Marysville, and Yuba City; to many smaller communities in the flood plain; to 9,000 acres of urban or suburban lands; to 283,000 acres of highly developed agricultural lands; and to important transportation facilities.

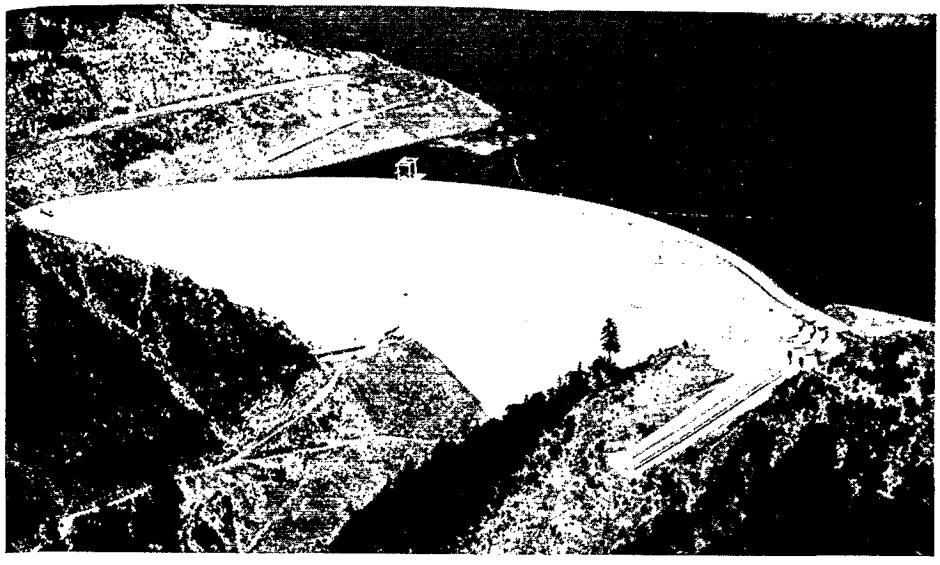
Lake Oroville provides extensive opportunities for water-oriented recreation activities and the state has developed numerous areas for recreational use. An underground powerhouse has a capacity of 600 megawatts and 2,000,000 acre-feet of storage capacity is used for conservation purposes.

New Bullards Bar Reservoir

New Bullards Bar Reservoir was completed in 1971. This multiple purpose partnership project consists of a concrete arch dam 645 feet high and 2,323 feet long at the crest, a 960,000 acre-foot capacity reservoir, and new powerhouses at the Colgate and Narrows sites. The project is located on the North Yuba River about 30 miles northeast of the City of Marysville. Exclusive of power and recreation facilities, project cost was $110,900,000, of which $12,900,000 was the Federal share for 170,000 acre-feet of storage capacity for flood control.

The project was built by the Yuba County Water Agency for purposes of irrigation, power, recreation, fish and wildlife, and flood control. It is operated for flood control in accordance with rules and regulations prescribed by the Corps of Engineers. Since its completion, major floods have not occurred on the North Yuba River. During the last significant flood event, January 1970, New Bullards Bar Reservoir was under construction. In the severe floods of December

1964-January 1965, over half of the $2,258,000 damage that occurred along the North and main stem Yuba Rivers would have been prevented by New Bullards Bar. In December 1955, it would have controlled Yuba River flow at Marysville to essentially non-damaging magnitude. Its coordinated operation with Marysville Lake and Lake Oroville is included in foregoing discussion of those projects.



New Bullards Bar Dam

Shasta Lake

Shasta Lake is a multiple purpose project built by the Bureau of Reclamation and operated for flood control in accordance with rules and regulations prescribed by the Corps of Engineers. Located on the Sacramento River near Redding, the dam is a concrete gravity structure 602 feet high and 3,460 feet long. It creates a reservoir with a capacity of 4,500,000 acre-feet, of which 1,300,000 acre-feet are reserved for flood control during the rainflood season.

Shasta Lake is the key unit of the Central Valley Project, one of the most extensive manmade water transport systems in the world. In addition to providing flood control, the project provides water for irrigation, municipal and industrial uses, power generation, fish and wildlife conservation, recreation, and sustained flow to improve shallow-draft navigation on the Sacramento River. By providing year-round releases, it helps prevent intrusion of salinity into the Delta.

Operation of Shasta Lake for flood control has substantially reduced flood damage in the Sacramento River Basin. In the several major and minor floods that have occurred since its completion in 1945, the project has prevented around $175,000,000 in flood damage.

Shasta Dam

FLOOD CONTROL PROJECTS

American River Levee

The American River Levee Project consists of a levee along the north bank of the American River in the vicinity of Sacramento, and two pumping plants discharging into the river to dispose of storm drainage collecting in low areas landside of the levee. The project levee extends from high ground near Carmichael downstream to a previously existing levee ending near the Interstate 80 crossing, a distance of about 7 miles. Functioning in conjunction with Folsom Lake, the levee permits maximum controlled releases for flood control (115,000 cubic feet per second) without damage along the river downstream. Completed in 1958, the project is operated and maintained by local interests. Federal cost of the project was about $2,100,000 and the local interest cost was $590,000.

Bear River Project

Flooding in the Bear River Basin occurs almost exclusively on the valley floor where Dry Creek, Yankee Slough, and the Western Pacific Interceptor Canal are the principal tributary waterways. The Interceptor collects drainage from the Linda and Olivehurst areas and flow from Best Slough and Reeds and Hutchinson Creeks. Project facilities authorized comprise 7 miles of new and improved channel, 5 miles of new levees, a sump area and pumping plant, nine new bridges or culverts, flowage and environmental easements, and trail-oriented recreation facilities.

Federal first cost of the project is estimated at $4,080,000 and non-Federal cost at $3,440,000, including a cash contribution for recreation facilities. Operation and maintenance of the completed works would be responsibilities of local interests.

The project would reduce flood damage on about 2,400 acres of existing and potentially urban area (including the communities of Linda and Olivehurst) in the lower Bear River drainage. Hiking and biking trails along new levees will afford opportunities for outdoor recreation.

Funds have not yet been appropriated to initiate preconstruction planning.

Chester, North Fork Feather River

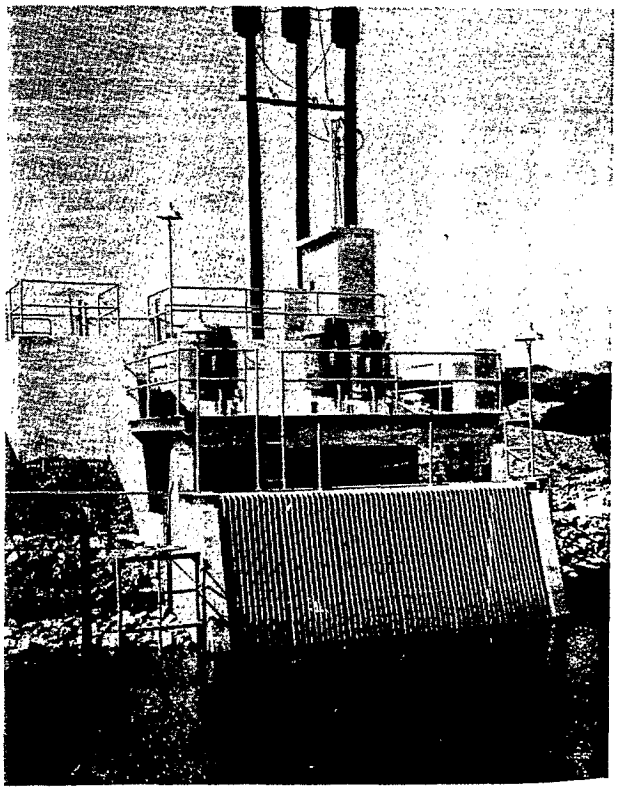
A diversion dam on the North Fork Feather River near the town of Chester and a partially leveed floodway to carry excess floodflows around the town and into Lake Almanor are the principal features of the Chester Project. The diversion dam is an earthfill structure 45 feet high and 960 feet long. Its uncontrolled outlet will permit non-damaging flow in the natural channel through the town. Excess floodflow is diverted into the floodway. Special features are included in the dam to permit passage of fish.

Protecting or relocating improvements existing in the floodway were provided for in the project plan, which also took into account state plans to relocate a section of Highway 89 and its junction with Highway 36. The project required construction of two bridges over the floodway and relocation of about 1 mile of county road.

Project cost was about $5,300,000, of which $3,700,000 was Federal cost and $1,600,000 was the non-Federal share. Local interests operate and maintain the project facilities, which were completed in 1977.

Middle Creek Improvement, Lake County

Middle Creek Improvement Project includes levees and incidental channel improvement work along 7 miles of Middle Creek, a channel to divert Clover Creek overflow around the town of Upper Lake and into Middle Creek, levees along lower Scotts Creek, and a pumping plant discharging into Middle Creek to dispose of drainage collecting behind the project levee. The project protects Upper Lake and 4,000 acres of highly developed agricultural lands.



Pumping plant, Middle Creek Improvement Project

Federal cost of the project was about $2,600,000, and local interest cost for lands and relocations was $1,300,000. Local interests operate and maintain the project, which was completed in 1967.

Sacramento River Flood Control Project

A major project for flood control on the Sacramento River and its tributaries was authorized by the 1917 Flood Control Act. This was the first flood control work federally authorized for construction outside the Mississippi River Valley. Earlier work on the Sacramento River served to increase its flood carrying capacity in the reach downstream from Cache Slough, but this work was authorized as a navigation improvement.

Under natural conditions, the flood plain of the Sacramento River varied from 2 to 30 miles wide, extended for about 150 miles along the river, and covered about 1,000,000 acres. Low, discontinuous levees built by individual landowners from the 1840s to the 1890s simply increased flood problems that were further intensified by hydraulic mining between 1853 and 1884. During this period, millions of tons of silt, sand, and gravel were deposited in streamways, and the beds of the Sacramento, Feather, Yuba, Bear, and American Rivers were raised as much as 20 feet in some reaches. In the 1870s, shipping on the main waterways almost stopped, and adjacent agricultural lands were being covered with mining debris. In 1884, virtually all hydraulic mining was stopped by court order. The California Debris Commission was created in 1893 and made responsible for regulating hydraulic mining, improving navigation, and controlling floodwaters in the Central Valley.

Prior to creation of the Debris Commission, much thought had been given to the flood and navigation problems of the Sacramento River and its tributaries. The concept of a system of reservoirs for the partial control of floods was considered as early as 1880 but abandoned as impractical. A system of storage projects primarily for irrigation was also considered as were channel improvement plans, natural and leveed bypass plans, and various combination plans involving these concepts. In 1910, Congress directed the Debris Commission to prepare a flood control plan for the Sacramento River system. The proposal made at that time, which incorporated the leveed bypass concept, became the basis of the present project. Reservoirs were recommended, but their construction was to be deferred until multipurpose projects were feasible. Most of these reservoirs have now been built.

The existing Sacramento River Flood Control Project, which is frequently referred to as the "Old Project," consists of a comprehensive system of levees, overflow weirs, outfall gates, pumping plants, leveed bypass floodways, overbank floodway areas, enlarged and improved channels, and dredging in the lower reach of the Sacramento River. Specifically, the principal project works are levees and channel improvements along the Sacramento River from its mouth upstream to near Chico Landing; levees and channel improvements along the lower reaches of the American, Bear, Yuba, and Feather Rivers; Moulton, Colusa, Tisdale, Fremont, and Sacramento Weirs; and the Sacramento, Tisdale, Colusa, Sutter, and Yolo Bypasses. Project works on the valley floor function in conjunction with 3,580,000 acre-feet of flood control storage space in four existing multipurpose reservoirs. A general map of the project appears on page 108.[1]

Reduction of the flood hazard has encouraged extensive development in the areas protected. In total, about 800,000 acres of prime agricultural lands are afforded a high degree of protection as are the cities of Colusa, Gridley, Live Oak, Yuba City, Marysville, Sacramento, Courtland, Isleton, Rio Vista, and numerous smaller communities; two transcontinental railroads; feeder railroads; and many state and county highways. The project has prevented more than $1,000,000,000 in flood damage during its history. A summary of damage prevented during major floods from 1950 to date is shown below.

SUMMARY OF DAMAGE PREVENTED

Total	Amount ($)
1950	75,000,000
1955-56	105,000,000
1958	100,000,000
1962	67,000,000
1963	133,000,000
1964-65	150,000,000
1966-67	10,000,000
1968-69	12,000,000
1970	100,000,000
1974	80,000,000

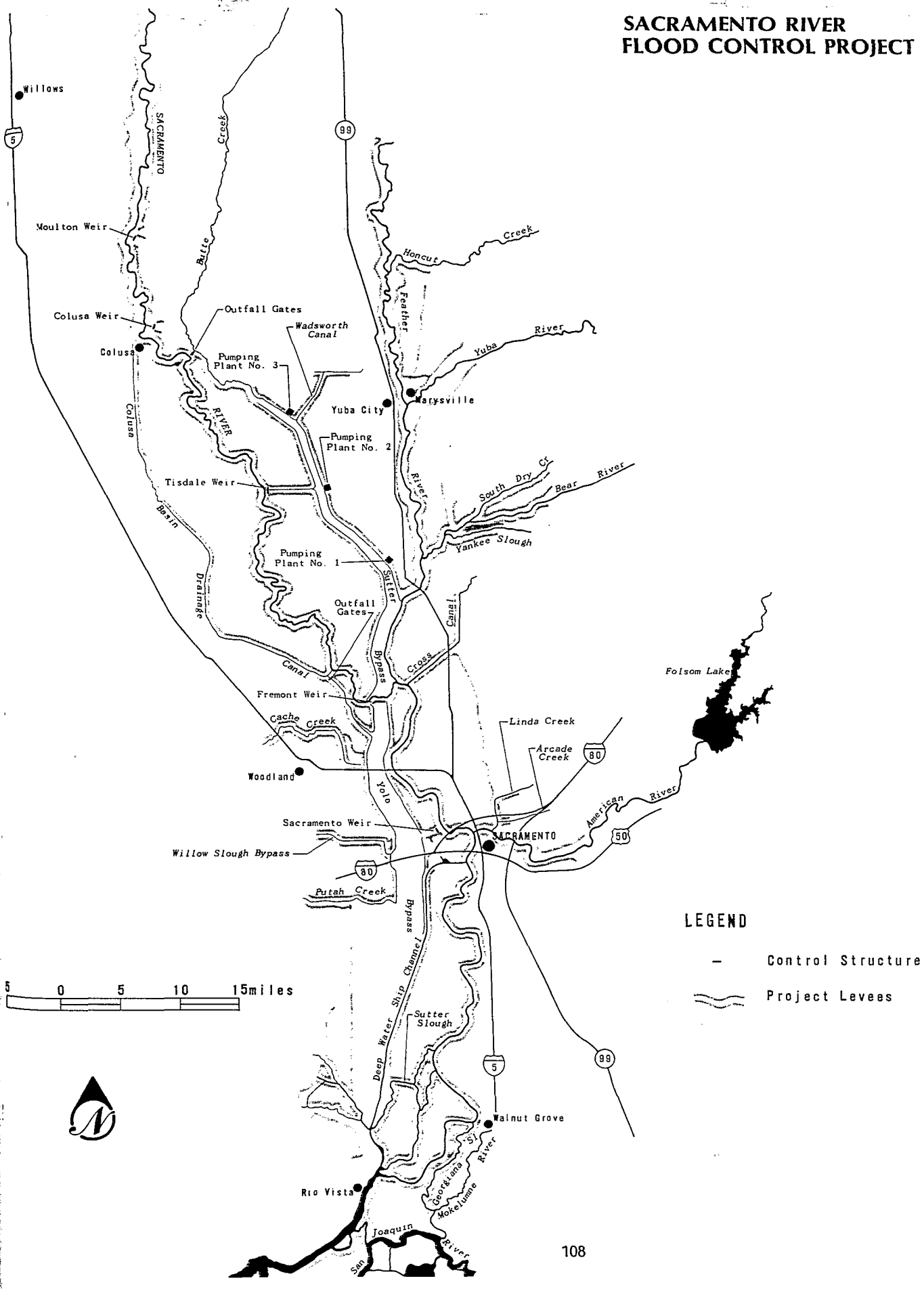
During major floods, the containment of floodflows in leveed channels on the valley floor is possible because the initial surges of runoff are detained in foothill reservoirs. The leveed streamways, enlarged channels, and bypass floodways could not contain major floodflows without the intercepting action of the upstream reservoirs, and full benefits of the reservoirs cannot be realized unless specific downstream channel capacities are provided and maintained. Reservoir operation is coordinated, not only among the various storage projects involved, but also in terms of downstream channel and floodway carrying capacities. Thus, each element is part of an integrated system and its proper functioning is dependent on various other elements.

Total first cost of the project, the active portion of which was completed in 1968, was about $163,800,000. Of this, $68,800,000 was Federal cost and $95,000,000 was the local interest share. Operation and maintenance of all completed project facilities are the responsibilities of local interests.

[1]Project works extend into the Delta-Central Sierra Area.

Sacramento Weir, Sacramento Bypass, and part of Yolo Bypass in summer (top) and during a major flood (bottom)

SACRAMENTO RIVER FLOOD CONTROL PROJECT



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Sacramento River and Major and Minor Tributaries

Improvements on the Sacramento River and certain of its tributary streams and waterways were authorized to supplement the Sacramento River Flood Control Project. The improvements authorized are summarized as follows:

New levees in Lower Butte Basin and along the Sacramento River from Moulton Weir upstream to Ord Bend.

New levees and/or channel improvement work on Antelope Creek; Chico and Mud Creeks and Sandy Gulch; Butte and Little Chico Creeks; Cherokee Canal; and Elder, Deer, Thomes, and Willow Creeks.

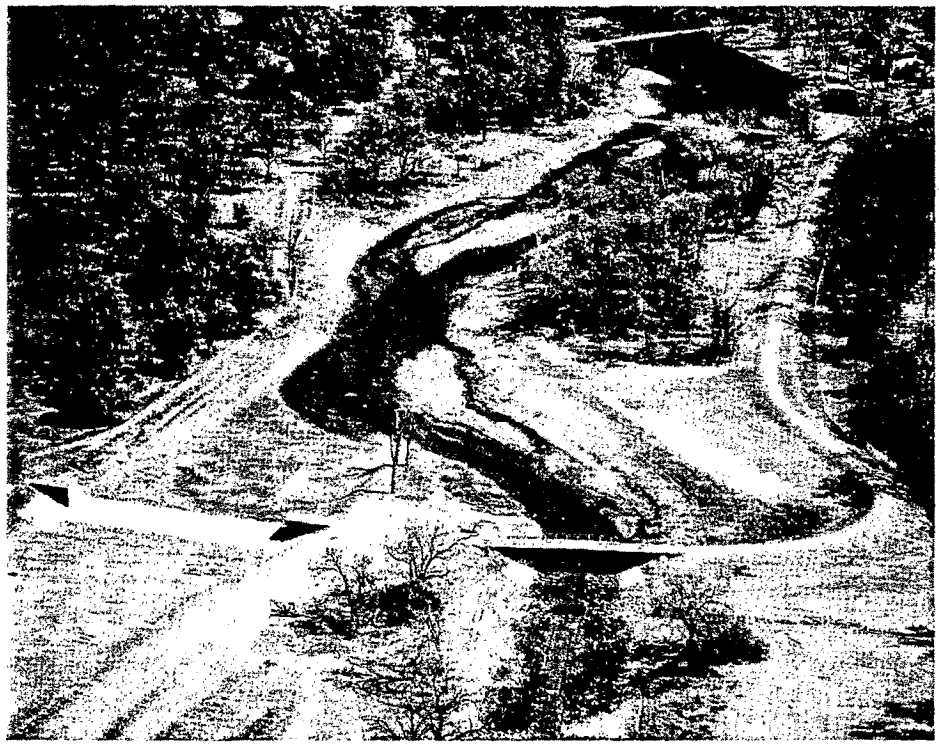
Enlargement of existing levees along Sutter, Tisdale, Sacramento, and Yolo Bypasses, and along the Sacramento River from the present levee terminus upstream to near Chico Landing.

Revetment as required to protect bypass levees from erosion.

A new weir at Chico Landing, extension (widening) of Moulton Weir, and a bypass through Upper Butte Basin.

Authorized improvements on Butte Creek, Chico and Mud Creeks and Sandy Gulch, Elder Creek, Deer Creek, and Cherokee Canal have been completed, and some bypass levee revetment work has been done. In total, about 72 miles of channel work and 107 miles of levee construction have been completed. The remaining authorized improvements are inactive or deferred. Active elements remaining are scheduled for completion in 1982.

The completed project works assist in providing flood protection to all major cities along the river system and to 880,000 acres of prime agricultural lands. Estimated cost of the project is $18,000,000, of which $11,900,000 would be Federal cost and $6,100,000 would be the local interest share.



Sandy Creek Diversion, Sacramento River and Major and Minor Tributaries Project

Sacramento River Bank Protection

The Sacramento River Bank Protection Project is a long-range, phased program for construction of bank erosion control work and setback levees on the main stem Sacramento River and various tributary and distributary waterways. The project is needed to maintain the capability of the Sacramento River Flood Control Project to continue to furnish design protection. It also reduces need for emergency levee repair, periodic dredging, and loss of land due to bank erosion.

Phase I construction consists of 430,000 lineal feet of bank protection work and necessary levee setbacks at selected erosion sites. Phase II construction will comprise 405,000 lineal feet of similar work. Basic

recreation facilities will be provided at selected locations. Phase I work was started in 1963 and completed in 1974. Public use facilities comprising boat launching ramps, parking areas, and access roads have been provided at three locations. Local interests operate and maintain these facilities and have provided for water supply, sanitation, and picnicking or camping. Other sites where recreational use potential exists will be considered in the future. Phase II construction was started in 1975 and is scheduled for completion in 1988. Overall, the project is about 45 percent complete. Completed units are transferred to the state for operation and maintenance.

The cost of Phase I work was $40,700,000, of which $26,600,000 was the Federal portion and $14,100,000 was the non-Federal share. Cost of Phase II work is estimated at about $48,100,000. Cost for work beyond Phase II has not been established.

Bank protection work requires construction activity that can adversely affect wildlife habitat and the natural beauty of a particular riparian area. To minimize these effects, trees, shrubs, and other vegetation are preserved where practicable, and scarred construction sites are reseeded or replanted.

Bank Protection along the Sacramento River

Sacramento River, Chico Landing to Red Bluff

The Sacramento River, Chico Landing to Red Bluff Project comprises extension and modification of the Sacramento River Flood Control Project. It provides for bank protection and channel improvement work (principally clearing and snagging) along the river in Butte, Glenn, and Tehama Counties, and, as a requirement of local cooperation, for flood plain regulation from Chico Landing to Keswick Dam. The purpose of the flood plain regulation is to assure floodway areas that will safely carry maximum flood control releases from Shasta Lake. Tehama County has adopted a suitable flood plain zoning ordinance. In Butte and Glenn Counties, the requirement for flood plain zoning was satisfied by state designation of a primary floodway along the river, and by county adoption of ordinances that safeguard a secondary floodway. All assurances of local cooperation for the project are considered satisfied because the floodway designated by the state extends to Keswick Dam.

Project works improve flow characteristics along the river, help stabilize the main channel by preventing erosion, and reduce the amount of eroded material normally transported downstream. It is estimated that the project will save 50-60 acres of agricultural land per year by preventing erosion of 500,000-600,000 cubic yards of material, of which around 200,000 cubic yards would eventually have to be dredged from navigation and flood channels downstream. Bank protection work is performed in a manner that insures preservation of riverfront esthetics and wildlife habitat.

Approximately 68,000 lineal feet of bank protection work at 29 sites has been completed. Project completion is indefinite pending identification of sites under extended authority afforded by the Water Resources Development Act of 1974. Estimated cost of work to be completed under prior authorization is $11,550,000—$10,600,000 Federal and $950,000 non-Federal expenditure.

FLOOD DAMAGE PREVENTION STUDIES

Northern California Streams

An authorized investigation of all streams in Northern California flowing into the Pacific Ocean, including the Sacramento River and its tributaries, has been divided between the San Francisco and Sacramento Districts. San Francisco District will study and report on coastal streams and Sacramento District will study and report on interior streams. A number of individual studies and reports will be made within the framework of the comprehensive investigation.

Recurring floods; growing water demands for municipal, industrial, and agricultural uses; and various other water resources development problems in the Sacramento River Basin testify to the need for continuing comprehensive study as well as detailed study of specific priority problems on an individual basis. In this connection, an interim study of erosion problems along Stony Creek downstream from Black Butte Dam was completed in 1976. The study showed that, under then existing conditions, there was no feasible solution to the erosion problem. Interim study of tributaries joining the Sacramento River from Red Bluff to Shasta Dam was carried on from 1971 to 1976. At that time, the study indicated that additional water supply and additional flood control along the Sacramento River were potentially feasible. Lakeport Lake, the Middle Creek Improvement Project, and the Cottonwood Creek Project were authorized on the basis of interim investigations and reports. Work on a comprehensive report is continuing, but completion of all work contemplated under the study authorization is indefinite. In recent years, study effort has been directed toward solving the remaining water resources development problems in the Cache Creek Basin. Discussion of that study effort follows:

Cache Creek Basin Cache Creek drains a portion of the eastern slope of the Coast Ranges in Lake and Yolo Counties. The basin is naturally divided into upper and lower drainage areas that comprise Clear Lake and tributaries and Cache Creek and tributaries, respectively. The upper basin is dominated by the Clear Lake depression. Cache Creek originates at the east end of Clear Lake, flows southeasterly through Cache Creek Canyon and across the valley floor, and discharges into the Sacramento River via the Yolo Bypass. Major problems comprise flooding along the rim of Clear Lake due to inadequate flood carrying capacity of the outlet channel, and transported sediment that, if no action is taken, will be deposited in the Yolo Bypass and downstream navigation channels. A report on proposals to enlarge the Clear Lake outlet and provide an additional 50 years of sediment storage capacity in an existing settling basin at the terminus of Cache Creek has been completed. It is in the process of review and transmittal to Congress.

Sacramento River and Tributaries, Bank Protection and Erosion Control

Investigation of erosion and bank protection problems along the Sacramento River from Collinsville to Shasta Dam, a distance of over 300 miles, and along the lower reaches of the principal tributary streams, was authorized in 1970. Local interests believe that, among other contributing factors, operation of upstream reservoirs has worsened natural erosion problems, and have requested assistance in providing remedial measures. Due to greatly increased use of the river by recreational boaters, erosion by wave wash has substantially increased. Measures to stabilize stream channels, reduce bank erosion, and preserve riparian vegetation will be considered. The study was started in 1976. Basic data have been collected and a detailed plan for conducting the study is under preparation. It is expected that the study and report will be completed in 1982.

Upper Putah Creek

A study to determine the feasibility of flood protection, including multiple purpose storage projects, in the Putah Creek drainage upstream from Lake Berryessa was completed in 1977. A negative report was prepared because no economically feasible project was found.

SMALL FLOOD-CONTROL PROJECTS

North Fork Pit River at Alturas

A small flood-control project comprising 2 miles of channel improvement work on the Pit River at Alturas was started in 1969 and finished in 1972. Its purpose is to convey floodflows safely through the city. Completed at a cost of $1,225,000 ($905,000 Federal and $320,000 non-Federal expenditure), the project reduces average annual flood damage in the Alturas area by about $80,000. The improved channel is maintained by local interests.

Hat Creek, Shasta County

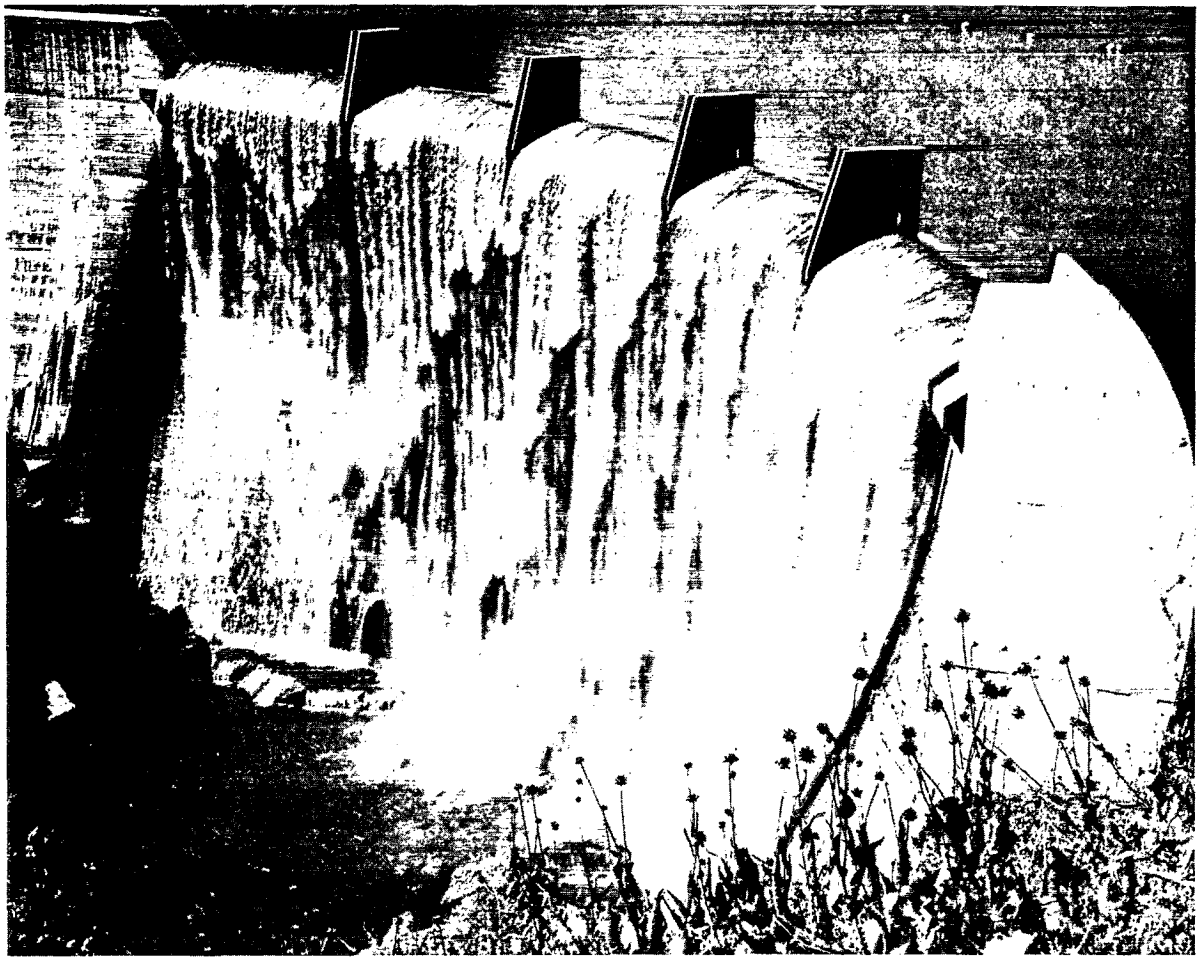
A detailed project report for a small flood-control project on Hat Creek was authorized in 1976. The plan of improvement indicated by a reconnaissance study involved a concrete diversion structure with gated conduit to pass low flows, stream channelization, a diversion channel approximately ¼ mile long, and a new highway bridge over the diversion channel. Detailed project studies showed that the project was not feasible.

DEBRIS CONTROL FACILITIES

Improvements to control hydraulic mining debris in the Sacramento River Basin have been constructed under two authorizations, viz., Sacramento River and Tributaries (Debris Control) and Treatment of Yuba River Debris Situation—Restraining Barriers. Two of four debris storage projects contemplated under the first-named authorization have been built. The remaining two projects (Ruck-a-Chucky Dam on the Middle Fork American River and Dog Bar Dam on the Bear River) were deauthorized in 1977 on the basis that debris control is no longer needed. Discussion of existing debris control facilities follows:[1]

Harry L. Englebright Lake

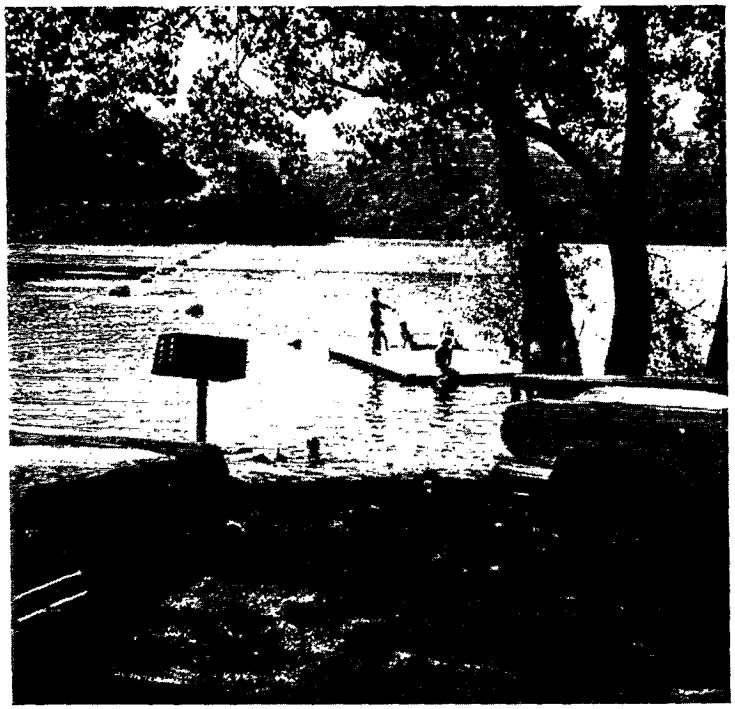
Harry L. Englebright Lake, originally known as Upper Narrows Reservoir, is on the main stem Yuba River about 20 miles northeast of Marysville. The dam is a concrete arch structure 260 feet high and 1,142 feet long. Completed in 1941 at a Federal cost of $3,912,000, the project has a debris storage capacity of 118,000,000 cubic yards. When hydraulic mining was in progress, the mining companies paid the Federal Government on the basis of the volume of material excavated in their mining operations. The Pacific Gas and Electric Company and the Yuba County Water Agency pay for the value of falling water for power generation at two plants downstream from the dam.



H.L. Englebright Dam

[1]Refer to "Sacramento River Flood Control Project," p. 106, this chapter, and "Regulation of Hydraulic Mining," p. 194, Chapter 16, for some historical information on hydraulic mining.

Public use facilities have been provided jointly by the Federal Government and a local concessionaire. The lake is extremely popular for boating and other water-oriented recreational activities.

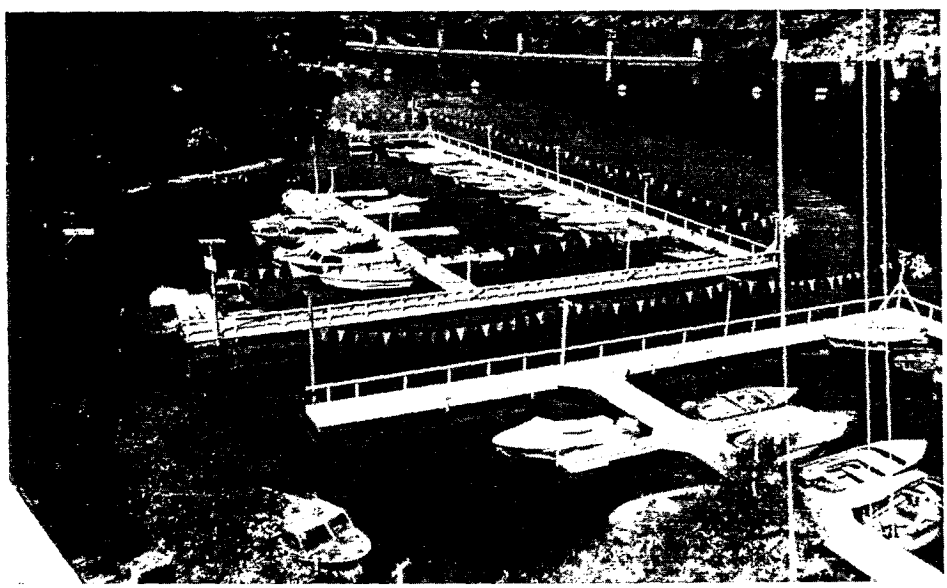


Swimming area, Englebright Lake

North Fork Lake

North Fork Lake is on the North Fork of the American River about 5 miles northeast of Auburn. The dam is a concrete arch structure 155 feet high and 620 feet long that provides a debris storage capacity of 26,000,000 cubic yards. It was completed in 1939 at a total Federal cost of $700,000. Auburn Reservoir, a multiple purpose project being built by the Bureau of Reclamation, will eventually submerge North Fork Lake.

Recreational development and public use administration of the lake area are responsibilities of a local agency under license to the Federal Government. The lake is popular for boating, swimming, fishing, and other water-oriented recreational activities.



Marina at North Fork Lake

Yuba River Restraining Barriers

Improvements to control movement of hydraulic mining debris along the lower Yuba River were completed in 1935. Built at a cost of $361,000, these works are located about 10 miles east of Marysville. They consist of Daguerre Point Dam, which forms a storage basin for debris, and training walls and other regulatory works downstream from the dam. The training walls, which total about 15 miles in length, confine flows to narrow channels to prevent stream meander and downstream movement of old debris deposits from flood plain areas. Thus, project works prevent debris from being carried downstream and into the navigation channels of the Feather and Sacramento Rivers. Construction, operation, and maintenance costs for project facilities are shared equally by the Federal and state governments.

Hydraulic mining at Malakoff Mine (also known as "Malakoff Diggings"), Nevada County (Bancroft Library photograph)

7 DELTA-CENTRAL SIERRA AREA
(Sacramento District)

PROJECT INDEX

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[1]Number following project name denotes Congressional District.

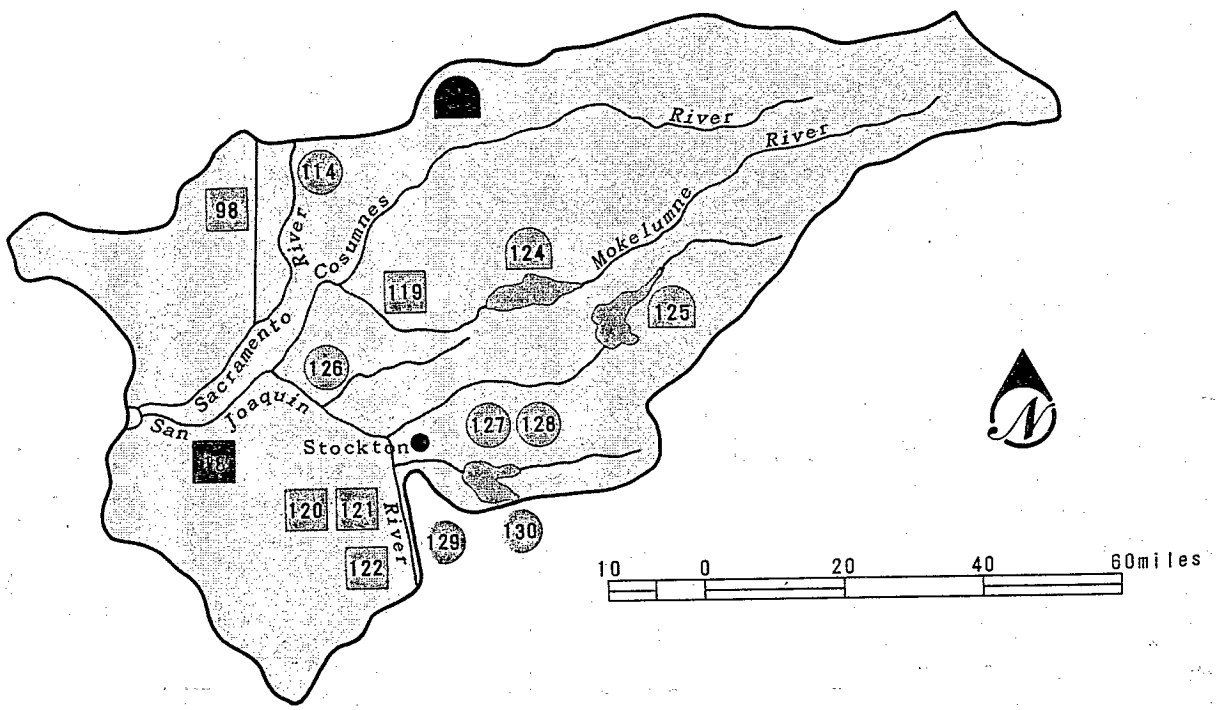
LEGEND

TYPE OF PROJECT

- Navigation
- Multipurpose
- Flood Control

STATUS OF PROJECTS

- Completed
- Under Construction
- Authorized, Not Started



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Extending from Sacramento on the north to Stockton on the south, and from the crest of the Sierra Nevada on the east to the foothills of the Coast Ranges on the west, the Delta-Central Sierra Area is situated in the central portion of the Central Valley. The area is about 120 miles long and 60 miles wide, and covers approximately 5,000 square miles. The Delta islands occupy the western portion. This low-lying tidal region comprises about 500,000 acres of highly productive farmland. Land surfaces in the Delta range from just below sea level in the central portion to just above sea level along the periphery. The principal waterways are the lower reaches of the Sacramento and San Joaquin Rivers. The Sacramento River drains a small portion in the northwesterly sector of the area, and the San Joaquin River and certain of its tributaries (the Cosumnes, Mokelumne, and Calaveras Rivers) drain the remainder. Cache Slough is the most significant waterway joining the Sacramento River in the Delta-Central Sierra Area.

Climate of the Delta-Central Sierra Area is characterized by hot, dry summers and mild winters with relatively light precipitation in valley floor areas, and by warm, dry summers and cold winters with heavy rain and snow in the mountain areas. Average annual precipitation varies with elevation, ranging from less than 10 inches on the valley floor to over 90 inches in the Sierra Nevada. Temperatures on the valley floor normally range from winter lows near freezing to summer highs of about 110 degrees. Temperatures in the Sierra Nevada portion of the area range from below zero in the winter to about 80-90 degrees in the summer.

Diversified agriculture and related manufacturing and industrial activities such as food processing and fabrication of agricultural machinery are the dominant economic activities in the Delta-Central Sierra Area. However, production of natural gas, clay and clay products, limestone, sand and gravel, and lumber and forest products are also significant economic activities. Highly developed Federal, state, and local road systems afford ready access to all parts of the area and adjoining regions. Air and rail lines and the Stockton and Sacramento Deep Water Ship Channels also serve the area. Its present population, 444,000, is expected to increase to over 600,000 by the year 2000.

A number of water-related problems affect the Delta-Central Sierra Area. Flood problems are increasing as residential and industrial developments continue to expand into flood plain areas. As noted, the Delta was reclaimed from swamp. In its undisturbed state, it was interlaced by many streams and sloughs and covered by dense growths of tule and other marsh-type vegetation. More than half of the Delta was awash with ordinary tides. High tides would submerge a much greater portion, and flood outflow from the Sacramento and San Joaquin Rivers could overflow the entire Delta, particularly when flood crests, high tide, and strong onshore winds occurred concurrently. A fundamental flood problem in the Delta results from the fact that for every square mile of land reclaimed, there is 1 square mile less flood plain to contain the volume of the rising tide and outflow from the rivers of the Central Valley. Further, the substructure of much of the Delta is overlain by a 20- to 50-foot thick layer of peat soil, which is ideal for agriculture but very poor as foundation or building material for levees. Peat soil dried out and exposed to air constantly oxidizes and subsides. As tracts subside, water pressure in adjoining channels may become too great for levees to withstand and a section may fail. Also, levees are continually being eroded by stream outflow, tidal flow, and wave wash from winds and boat wakes. Increasing levee fill creates compression that may force underlying materials to rupture into the adjoining waterway or toward the land side of the levee. If one tract is flooded and its levees lost, the levees protecting an adjacent tract become more vulnerable to the forces of waves and wind.

Water supply in the Delta-Central Sierra Area is ample, but there are problems of water quality, especially in the Delta where irrigation return flows and industrial waste discharges are lowering water quality. Also, Delta waters are subject to salinity intrusion. These water quality, pollution, and salinity problems will continue and become more acute unless corrective measures are taken.

NAVIGATION PROJECTS

Middle River and Connecting Channels

Located in the complicated network of tidal channels in the southwesterly section of the Delta, the Middle River Project comprised dredging Middle River, Latham Slough, and Empire and Turner Cuts to provide navigation channels 9 feet deep and 100 feet wide. Project work was started and completed in 1937 at a total Federal cost of $8,300. In 1977, commercial traffic on project waterways totaled 3,200 tons of sand, gravel, and crushed rock.

Mokelumne River

Improvement of the Mokelumne River for navigation was completed in 1885 at a Federal cost of $8,500. At New Hope Landing, this stream divides into North and South Forks, which reunite about 4 miles above the mouth in the San Joaquin River. Navigation improvements consisted of removal of obstruction and dredging shoals along the main stream (and along both forks) from the mouth upstream to the mouth of the Cosumnes River. Controlling depths range from 2 feet at the head of navigation to 12 feet at the mouth of the river. About 35 miles of navigable channel, now used extensively by pleasure craft, are provided by the project. In 1977, waterborne commerce totaled 11,100 tons of sand, gravel, crushed rock, and nonmetallic mineral products.

Old River

Old River is the most westerly branch of interconnecting tidal channels into which the San Joaquin River divides in crossing the Delta. Navigation improvements comprised widening and deepening the lower 35 miles of Old River and similar work in certain adjoining waterways. About one-third of the authorized work has been completed. Existing commerce does not indicate need for completing the work not yet started. Improvements now complete (Federal cost, $23,000) adequately meet the commercial navigation needs of the area. Annual dredging is required to maintain project channel depth and width.

Old River and adjoining waterways also carry floodflows and are used extensively for recreational boating. In addition, they carry water in transit from the Sacramento River to the Delta-Mendota Canal, a unit of the Central Valley Project, and to the California Aqueduct, a unit of the State Water Project. In 1977, waterborne commerce on Old River totaled about 38,000 tons mostly consisting of sand, gravel, and crushed rock.

Sacramento River Deep Water Ship Channel

The Sacramento River Deep Water Ship Channel extends through the northwesterly sector of the Delta-Central Sierra Area. It is discussed in conjunction with the Sacramento Basin because the terminal facilities and tributary trade area are in that basin. (See page 95.)

San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels)

As noted in Chapter 3, the John F. Baldwin and Stockton Ship Channels Project comprises modification of five existing navigation projects, one of which is in the Delta-Central Sierra Area and four are in the San Francisco Bay Area. For this reason, the entire project is discussed in the chapter on the Bay Area. (See page 31.)

San Joaquin River, Stockton Deep Water Ship Channel, and Burns Cutoff

In general, the project for navigation on the San Joaquin River provides for:

A deep draft channel from Suisun Bay to Stockton, a distance of about 40 miles. Controlling depth, 30 feet.

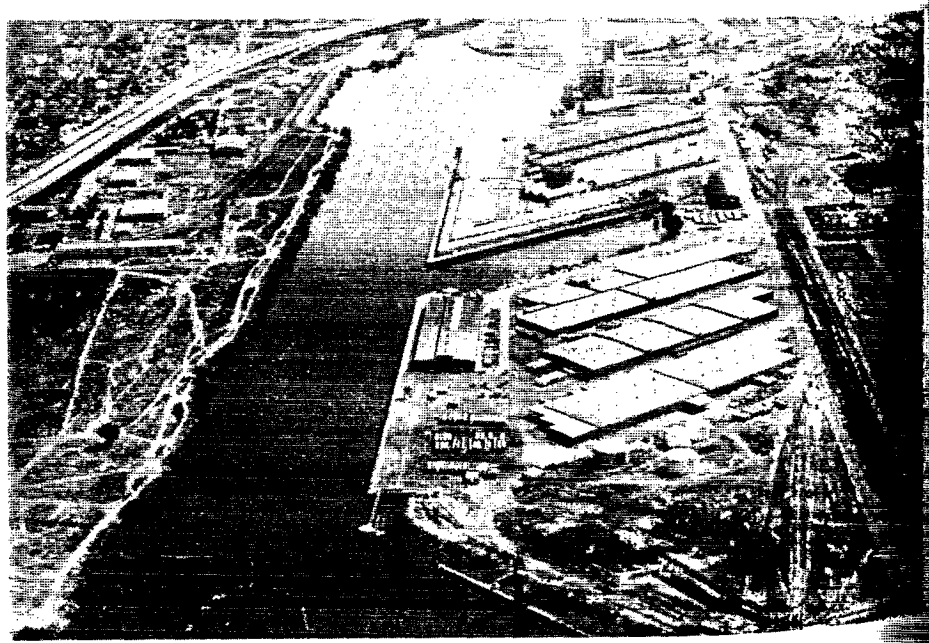
Shallow draft channels from Stockton upstream to Hills Ferry, a distance of about 85 miles. Controlling depths, 6 feet at Stockton, 3 feet at head of navigation.

Passing, turning, and settling basins, and levee reconstruction.

Various other improvements and modifications required to maintain project integrity and improve its capability to serve waterborne commerce.

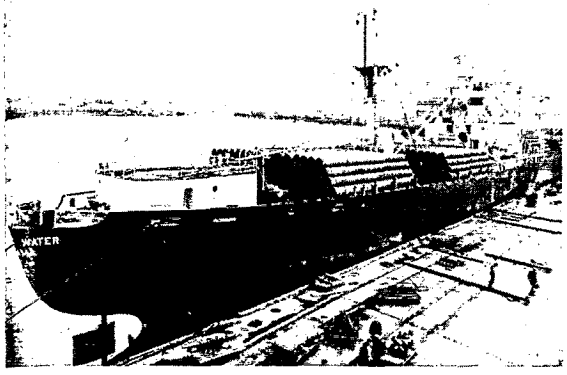
Of $8,200,000 spent for project works, $5,800,000 was Federal and $2,400,000 was non-Federal expenditure. Modification of the project is planned as part of the John F. Baldwin and Stockton Ship Channel Project. (Refer to page 31.)

Except for certain improvements authorized in 1950, which are not now of interest to the project sponsors, the project is complete and in operation, principally serving the southern half of the Central Valley. Commerce on project waterways was 3,500,000 tons in



Port of Stockton

1977 and averaged about 4,800,000 tons for the 10-year period 1968-1977. Cargo handled by the Port of Stockton in 1977 totaled approximately 1,500,000 tons, of which 1,100,000 tons were foreign shipments and 400,000 tons were domestic.



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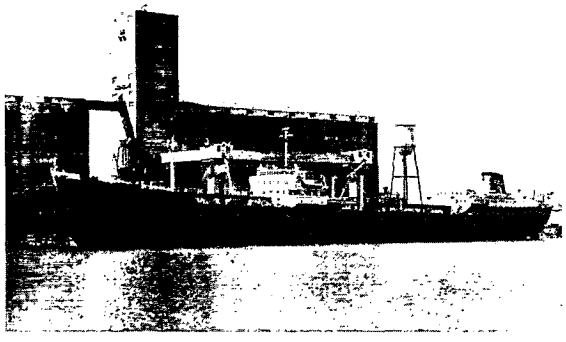
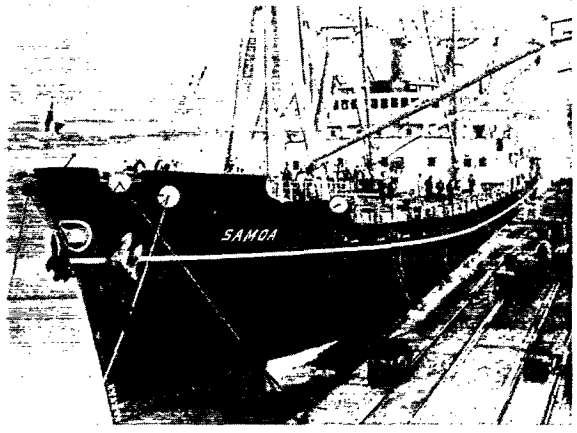


Hubert Miller Photo



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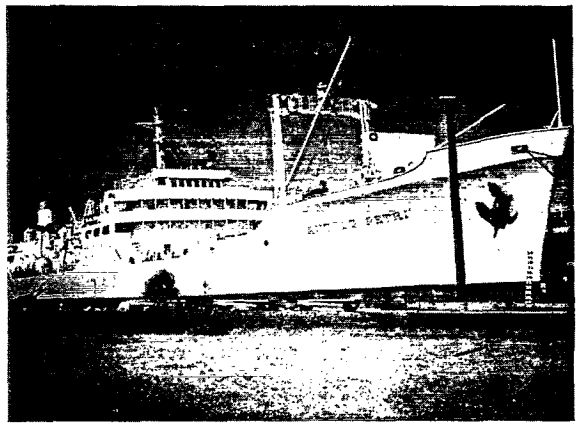


Olympius Organization Photo

Typical deep draft vessels, Stockton Deep Water Channel and Port of Stockton (Photos courtesy Port of Stockton)

MULTIPURPOSE PROJECTS

Morrison Creek Stream Group

Morrison Creek Stream Group includes Morrison Creek, Elder and Laguna Creeks (the principal tributaries), and a number of small tributary streams. The stream group drains into the Delta by way of Beach and Stone Lakes, Snodgrass Slough, and the Mokelumne River.

The project authorized for construction comprises a dam and 11,000 acre-foot reservoir at the Vineyard site on Elder and Laguna Creeks, a diversion to carry Morrison Creek runoff to the reservoir, 26 miles of levee and 66 miles of channel improvement work, and a 7,800 acre flood retardation basin in the Beach and Stone Lakes area. Flood control, recreation, and fish and wildlife enhancement benefits would be afforded by the reservoir. Nature-oriented recreation opportunities would be provided by a trail system along various creeks and by developments in the flood retardation basin, which would also be developed for fish and wildlife management. Adverse environmental impacts from the project are judged minimal and would be offset by positive effects. One of the principal objectives of the project plan is to preserve the natural greenbelt qualities of the area, and to make the area accessible to the public. With the rapid urbanization of the Sacramento area, it is important to preserve marsh and grassland habitat, which was once widespread in the Central Valley. It should be noted that most benefits from this project would accrue to the Sacramento metropolitan area, which is largely situated in the Sacramento River Basin.

Project operation involves a 9,000 acre-foot flood control reservation in the reservoir. The remaining 2,000 acre-feet of storage capacity would be used for general recreation, fish and wildlife, and sediment storage. First cost of the project is estimated at $108,500,000, of which $68,500,000 would be Federal cost and the remainder would be local interest cost for lands and relocations allocated to flood control. Local interests would also share costs allocated to recreation and fish and wildlife developments, and either be responsible for or share costs of operation and maintenance of certain other project facilities. Funds have not yet been appropriated to begin preconstruction planning.

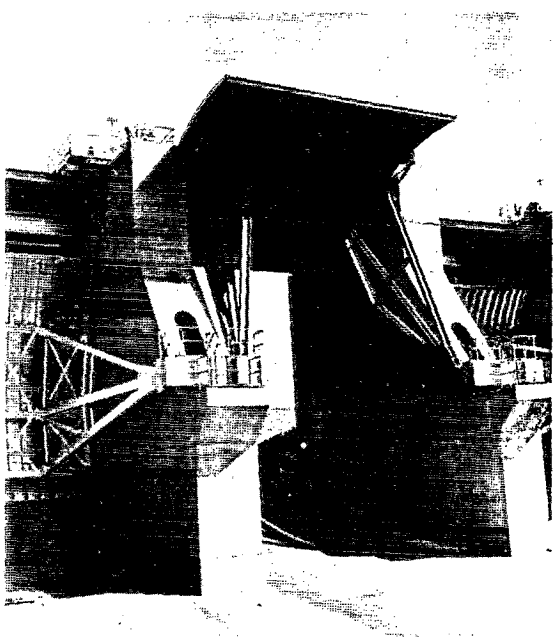
New Hogan Lake

New Hogan Lake is on the Calaveras River about 28 miles northeast of Stockton. The project consists of an earth and rockfill dam 1,960 feet long and 200 feet high, four auxiliary dikes, and a reservoir with a gross storage capacity of 325,000 acre-feet, 165,000 acre-feet of which are reserved for flood control purposes. Construction of the dam was started in 1960 and the project became operational in 1964. It replaces an older storage project owned and operated by the City of Stockton for water conservation and partial flood protection of the city. New Hogan Lake provides a high degree of protection to Stockton and its rapidly growing suburbs, to about 46,000 acres of agricultural land, and to important rail and highway transportation facilities. In addition, the project provides about 40,000 acre-feet of new water annually for irrigation in an area where the present supply is inadequate and overdraft pumping is depleting the ground water.

Federal cost of the project was $15,900,000, including about $544,000 for basic recreation facilities. Local interests contributed land valued at about $550,000 (in 1964). Also, local interests are responsible for first construction costs and annual operation and maintenance costs allocated to the water conservation function.

New Hogan Dam

New and "Old" Hogan Dams



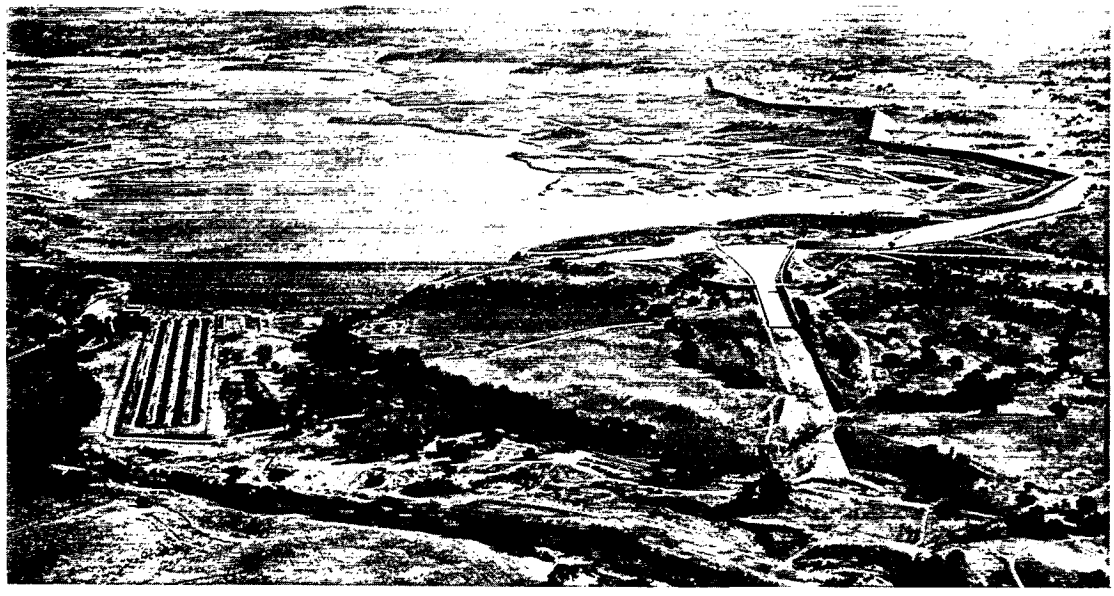
Radial outlet gate, New Hogan

COOPERATIVE PROJECT

Camanche Reservoir

Camanche Reservoir, a multiple purpose partnership project on the Mokelumne River about 15 miles northeasterly of Lodi, was built by the East Bay Municipal Utility District as a major element of its water supply system for Oakland and adjoining areas. Completed in 1964, the project cost $36,700,000. Of this, the Federal Government contributed $10,112,000 for the flood control function.

Camanche Dam is an earth and rockfill structure 171 feet high and 2,450 feet long. It impounds a 431,500 acre-foot reservoir, 200,000 acre-feet of which are reserved for flood control. Six gravel and earthfill dikes were required at low spots along the reservoir perimeter. The project is operated for flood control according to rules prescribed by the Corps of Engineers. In conjunction with three upstream storage projects, Camanche Reservoir affords flood protection to Lodi, Woodbridge, and Thornton, and to 69,000 acres of agricultural lands. During floods that occurred in 1964 and 1968-69, it prevented damages estimated at $2,000,000. Project water areas afford extensive opportunities for water-oriented recreation activities based on facilities provided by concessionaires. Camanche Reservoir is very popular for fishing.



Camanche Dam and Reservoir

FLOOD CONTROL PROJECTS

Farmington Project

Farmington Dam is the principal element of the Farmington Project, which provides flood protection to a 58,000 acre rural and suburban area southeasterly of Stockton. The dam creates a flood detention reservoir on Littlejohns Creek about 3.5 miles east of the community of Farmington. It is an earthfill structure 58 feet high and 7,800 feet long that, during floods, temporarily impounds up to 52,000 acre-feet of floodwater. Other project elements comprise a diversion channel to direct excess flow from Duck Creek to Littlejohns Creek, channel improvement work on selected streamways downstream from Farmington Dam, cutoff dikes to prevent escape of floodwater into the Calaveras River system, and a small diversion dam to confine floodflows to the main channel of Littlejohns Creek.

Completed in 1951, Farmington Dam is operated and maintained by the Corps of Engineers. Local interests are responsible for operation and maintenance of the channel improvements, embankments, and diversions, which were completed in 1955.

Federal construction cost for project facilities was about $3,700,000. Local interests furnished needed rights-of-way and utility relocations at an estimated cost of about $320,000.

Bear Creek Channel, San Joaquin County

Located along the south channel of Bear Creek from Jack Tone Road near Lockeford to Disappointment Slough, a Delta channel that joins the San Joaquin River, the Bear Creek Channel Project comprises 41 miles of low levees and 24 miles of channel improvement work. The project protects 30,000 acres of highly developed orchards, vineyards and croplands; suburban areas of Stockton, main highways and railroads; and industrial installations. Project construction was started in 1963 and completed in 1967 at a Federal cost of about $3,200,000. Local interests provided needed lands, rights-of-way, and utility alterations at an estimated cost of $3,700,000, and operate and maintain the completed project.

A section of the Bear Creek Channel Project

Lower San Joaquin River and Tributaries

The Delta-Central Sierra Area segment of the San Joaquin River extends from the mouth of the Stanislaus River downstream to Suisun Bay. Lower San Joaquin River and Tributaries Project improvements in the area consist of levee construction and rehabilitation along the San Joaquin and Old Rivers, French Camp Slough, and Paradise Cut. The project is discussed in its entirety in the chapter on the San Joaquin Basin because most of the improvements are in that hydrographic area. (See page 133.)

Mormon Slough, Calaveras River

The Calaveras River is a distributary stream west of Bellota where a bifurcation structure directs flow to northern and southern branches. The northern branch, Calaveras River, flows westerly across the valley floor to join the San Joaquin River just west of Stockton. Very little flow enters this branch except during the summer when diversions are made for irrigation and ground water replenishment. The southern branch, Mormon Slough, carries most of the flow. Its course extends southwesterly from Bellota. Historically, Mormon Slough passed through Stockton to join the San Joaquin River a few miles downstream from the mouth of the Calaveras River. Ultimately, however, the lower end of the slough was improved as the harbor terminus of a deep draft navigation channel along the San Joaquin River. To prevent siltation of the harbor area, Mormon Slough was dammed east of Stockton and a diverting canal built to carry flow back to the Calaveras River. This navigation project—which was known as "Stockton and Mormon Channels (Diverting Canal)"—was built in the early 1900s and included a levee along the left side of the canal to afford some flood protection to Stockton. Also, Calaveras River was enlarged downstream from the lower end of the diverting canal to carry the increased volume from diverted floodflows.

The purpose of the Mormon Slough, Calaveras River Project was to increase the capacity of Mormon Slough and the diverting canal to carry flood inflow originating downstream from New Hogan Lake as well as maximum flood control releases from that project. Improvements provided to achieve this purpose consisted of channel enlargement along Mormon Slough and the diverting canal; bank protection work on the north bank at the mouth of the Calaveras River; and levees along the north bank of the diverting canal, both banks of lower Mormon Slough, and along the south bank of Potter Creek, a tributary to Mormon Slough. Completed in 1970, the cost of these improvements was $5,900,000,

which was shared equally by the Federal Government and the local interests concerned.

The project protects Stockton and adjoining suburban areas and provides for the most efficient flood control operation of New Hogan Lake. Since it also serves to prevent siltation in the deep draft harbor in Stockton, the older navigation project has been discontinued.

Sacramento River Flood Control Project

Most of the comprehensive flood control project affording protection along the Sacramento River and the lower reaches of its major tributaries is in the hydrographic area designated "Sacramento Basin." In the Delta-Central Sierra Area, project elements comprise levees along the river, the lower end of the Yolo Bypass, and around certain Delta islands. See pages 106-108 for detailed discussion and a project map.

FLOOD DAMAGE PREVENTION STUDY

Sacramento-San Joaquin Delta

The nature of the Delta of the Sacramento and San Joaquin Rivers is described in the introductory portion of this chapter, and the water resources development problems inherent in this vast area reclaimed from tidal swamp are exemplified in that description. A principal purpose of this study is to determine the extent of Federal interest in preserving and improving the many miles of Delta levees. Some specific problems that must be addressed in the study include:

Improving protection to islands where urbanization is occurring.

Levee rehabilitation throughout the Delta, considering unstable peat foundations.

Possibly closing some Delta channels to navigational uses and passage of floodflows to reduce levee maintenance.

The implications of transporting fresh water from north to south across the Delta.

Recreational boating per se and development of water oriented retirement communities.

With respect to flood problems, it must be noted that levee failures resulted in damages of $9,000,000 and $12,000,000, respectively, in 1969 and 1972. Inundation of the entire Delta would cause damage estimated at more than $100,000,000.

This study has been suspended and resumed several times since it was originally started in 1949. The State of California urgently needs a report on Federal participation in saving and improving Delta levees. The study includes a separately authorized investigation of recreation in the Delta. Presently scheduled for completion in 1980, the consolidated investigation is active and continuing.

SMALL FLOOD-CONTROL PROJECT

Duck Creek, San Joaquin County

Duck Creek, a minor tributary to the San Joaquin River by way of Walker and French Camp Sloughs, is situated in and easterly of southern Stockton. Prior to its improvement, floodflows exceeded channel capacity along the lower reaches of the stream once each 5 years on the long-term average. A small flood-control project on Duck Creek was completed in 1967. It consists primarily of 14 miles of channel improvement work to increase flood carrying capacity along a total reach of 20 miles. Project cost was $1,300,000, one-half of which was the Federal share. During rainfloods that occurred in the Central Valley in 1969, the Duck Creek Project prevented damage estimated at $200,000.

8 SAN JOAQUIN BASIN
(Sacramento District)

LEGEND

TYPE OF PROJECT

- Navigation
- Multipurpose
- Flood Control

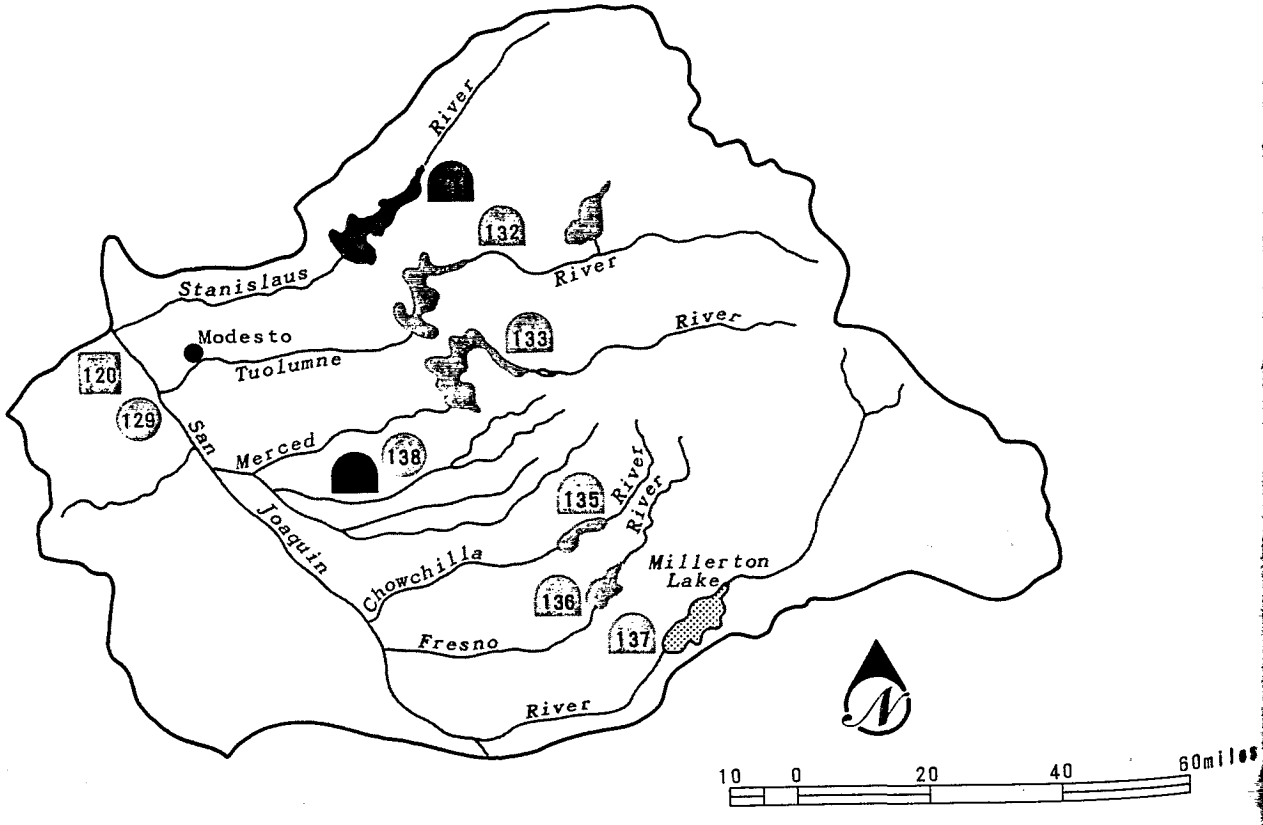
STATUS OF PROJECTS

- Completed
- Under Construction
- Authorized, Not Started

PROJECT INDEX

Number	Name[1]	Page
NAVIGATION		
120	San Joaquin River, Stockton Deep Water Ship Channel and Burns Cutoff (4, 7, 14)	124
MULTIPURPOSE		
131	New Melones Lake (14)	127
132	Tuolumne River Reservoirs (Cooperative Project) (14)	132
133	New Exchequer Dam and Reservoir (Cooperative Project) (15)	131
134	Merced County Streams Project (15)	126
135	Buchanan Dam (H. V. Eastman Lake) (15)	124
136	Hidden Dam (Hensley Lake) (15)	125
137	Millerton Lake (Friant Dam) (Cooperative Project) (15)	131
FLOOD CONTROL		
129	Lower San Joaquin River and Tributaries (14, 15)	133
138	Merced County Stream Group (15)	126

[1]Number following project name denotes Congressional District.



DESCRIPTION

The San Joaquin Basin is centrally situated in California. It extends generally from near Stockton on the north to near Fresno on the south, and from the Sierra Nevada on the east to the Coast Ranges on the west. The basin is about 110 miles long and 95 miles wide, and comprises a land and water area of about 11,000 square miles.

The climate of the basin is characterized by hot, dry summers and mild winters with relatively little precipitation in valley floor areas, and by warm, dry summers and cold winters with heavy rain and snow in the mountainous areas. Average annual precipitation varies from about 5 inches in the southern part of the valley floor to over 70 inches in the Sierra Nevada. Temperatures normally range from winter lows below zero in mountain areas to summer highs of about 115 degrees on the valley floor.

Highly diversified agricultural activities and related manufacturing and industrial activities dominate the economy of the San Joaquin Basin. Mining and lumbering are significant in the Sierra Nevada. Irrigation development began in the subregion in the 1870s. Agriculture is dependent on irrigation and irrigated acreage continues to increase at a rate of about 10 to 15 percent per decade. Population of the basin, presently about 500,000, is projected to increase to about 720,000 by the year 2000. Highly developed Federal, state, and county road systems afford ready access to all parts of the basin and to adjoining areas. The region is served by air and rail lines and the Stockton Deep Water Ship Channel.

The San Joaquin River, the principal stream, originates in glacial lakes in the Sierra Nevada. It flows southwesterly to the vicinity of Mendota, then northwesterly to its mouth in Suisun Bay. The principal tributaries to San Joaquin River are the Stanislaus, Tuolumne, and Merced Rivers. A number of minor tributaries, most of which are dry during the summer, join the river from the east and west. Average annual runoff of the river and its major tributaries is estimated at about 6,000,000 acre-feet. Snowmelt from the Sierra Nevada generally maintains flow in the major streams through most of the summer. The basin, particularly the valley floor portion, is subject to floods that occur during the late fall and winter months, primarily as a result of prolonged general rainstorms, and to floods that occur during the spring and early summer months, primarily as a result of unseasonable and rapid melting of the winter snowpack in the Sierra Nevada. Generally, rainfloods are more severe than snowmelt floods.

Although flood control structures reduce floodflows and resulting damage, flood problems still exist in some areas. The problems are especially serious along the streams of the Merced County Stream Group. In terms of present and potential damage, streambank and land erosion pose significant threats, especially in the lower-elevation tributary watershed and in the valley areas where intensive agricultural development exists.

NAVIGATION PROJECT

San Joaquin River, Stockton Deep Water Channel and Burns Cutoff

The major part of the navigation project on the San Joaquin River is in the Delta-Central Sierra Area and the project is discussed in more detail in the chapter on that area. (See page 117.) In the San Joaquin Basin, project works comprise a shallow draft channel from the mouth of the Stanislaus River upstream to the head of navigation at Hills Ferry, a distance of 55 miles (controlling depth, 3 feet, April through June). Project works, completed many years ago, consisted of snagging, removal of obstructions, and construction of wing dams to stabilize channel location.

MULTIPURPOSE PROJECTS

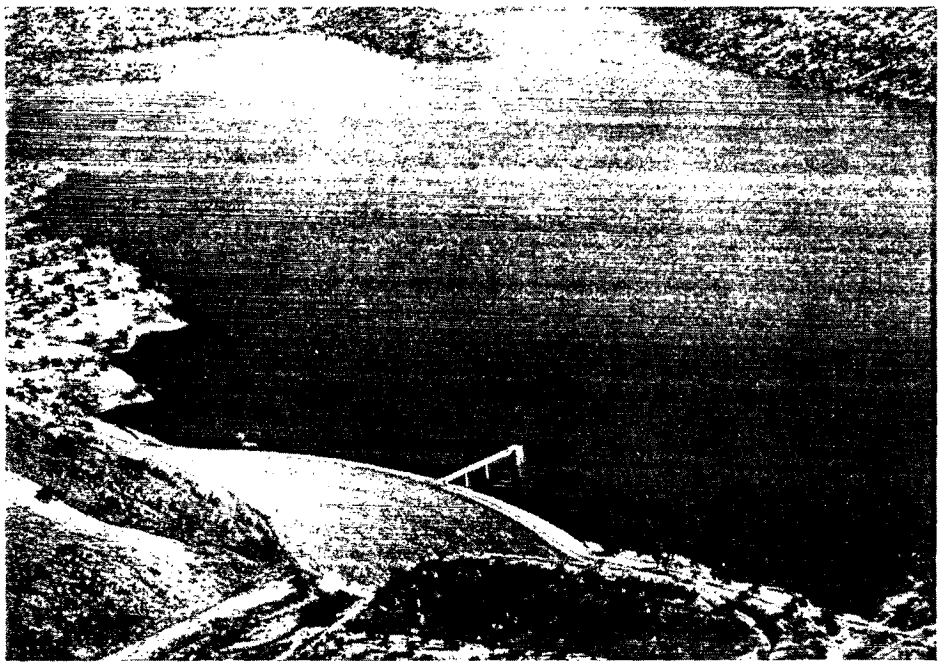
Buchanan Dam (H. V. Eastman Lake)

H. V. Eastman Lake, which is impounded by Buchanan Dam, is on the Chowchilla River 16 miles northeasterly of Chowchilla. Completed in November 1974, the dam is an earth and rockfill structure 205 feet high and 1,800 feet long. H. V. Eastman Lake, with a gross storage capacity of 150,000 acre-feet, serves flood control, recreation, fish and wildlife, and irrigation functions. In the vicinity of Chowchilla, the project includes about 20 miles of channel improvement work and levee construction on Ash and Berenda Sloughs. These waterways are distributary channels of the river. Related channel enlargement work was done by the state under its flood control project for the San Joaquin River.

Federal cost of the project was $27,450,000. Local interest cost for land, easements, rights-of-way, and relocations required for downstream channel work was $1,600,000. Repayment for the water conservation function in the project is integrated with the Central Valley Project.

Operation of the 45,000 acre-foot flood control reservation in H. V. Eastman Lake affords protection to Chowchilla and 110,000 acres of rural area along the Chowchilla River and its distributaries, and assists in controlling floods on the San Joaquin River. Also, the project improves the quality of Chowchilla River water by lessening turbidity and sediment load usually associated with uncontrolled floodflows, permits greater recharge of ground water, and provides a new source of irrigation water for the water-deficient Chowchilla River Service Area.

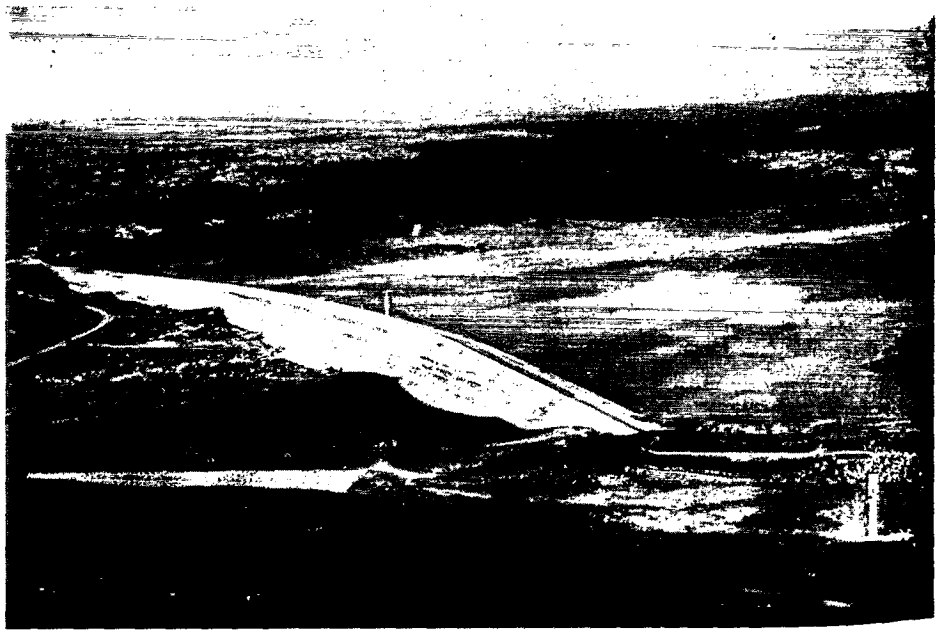
Public use facilities at H. V. Eastman Lake include boat launching ramps, camp sites, and picnic areas. A 1,500 acre land and water area is dedicated to fish and wildlife management, and a warm-water lake fishery is an important project feature.



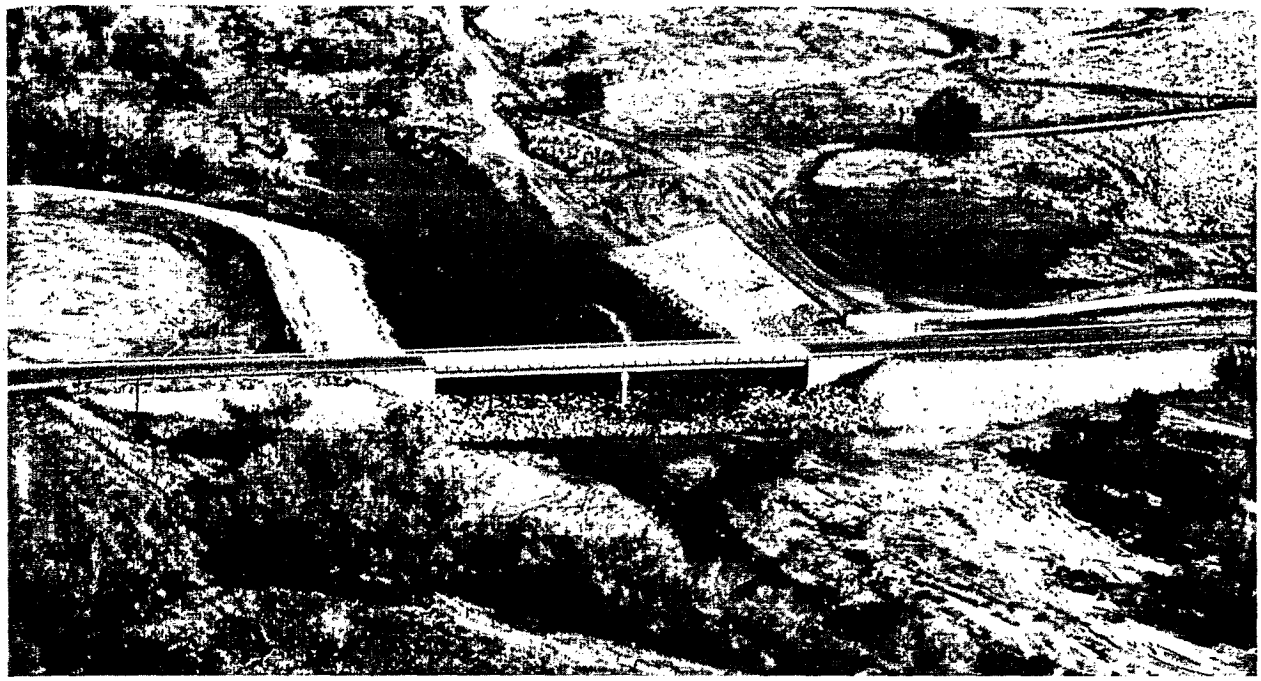
Buchanan Dam (H. V. Eastman Lake)

Hidden Dam (Hensley Lake)

Started in May 1972 and completed in November 1974, Hidden Dam and Hensley Lake serve flood control, irrigation, recreation, and fish and wildlife functions. The project is located on the Fresno River 15 miles northeasterly of Madera. Hidden Dam is an earthfill structure 163 feet high and 5,730 feet long. Storage capacity of Hensley Lake is 90,000 acre-feet, of which 65,000 acre-feet are reserved for flood control operation during the rainflood season. The project also includes 13 miles of channel improvement work upstream from the river crossing of Chowchilla Canal, which is approximately 16 miles west of Madera.



Hidden Dam (Hensley Lake)



Channel improvements on the lower Fresno River are part of the Hidden Dam Project

Channel improvement work west of the Chowchilla Canal was done by the state as part of its flood control project for the San Joaquin River.

Federal cost of the Hidden Dam (Hensley Lake) Project was $30,600,000. Local interest cost for land, easements, rights-of-way, and relocations required for downstream channel improvement work was $1,200,000. Repayment for water conservation function in the project is integrated with the Central Valley Project.

Operation of the project affords protection to Madera and 145,000 acres of rural area along the Fresno River, and assists in controlling floods on the San Joaquin River. Also, the project provides an average annual supply of about 24,000 acre-feet of new water for irrigation, and improves the water quality of the Fresno River by reducing turbidity and sediment load usually associated with uncontrolled floodflows. Flood control releases and delivery of irrigation water via the river allow greater recharge of ground water.

Recreation facilities provided as part of the Hidden Dam Project include boat launching ramps, picnic areas, and camp sites. About 320 acres of project land are devoted to wildlife management, and the lake provides a warm-water fishery.

Merced County Streams Project

The Merced County Streams Project would modify and extend the existing Merced County Stream Group Project, a single purpose improvement comprising:

Flood retention dams on Burns, Bear, Owens, and Mariposa Creeks;

Black Rascal and Owens Diversion Canals (Black Rascal Creek to Bear Creek and Owens Creek to Mariposa Creek, respectively); and

Channel improvements on streams in the vicinity of Merced.

The dams (all low, earthfill structures) and reservoirs are in the low foothills about 15 miles easterly of Merced and the diversion canals are west of the dams. Flood retention capacity of the project, which was completed in 1957, is 33,300 acre-feet. It protects Merced, several other smaller towns and farm communities, 136,000 acres of agricultural lands, and important rail and highway routes. Also, the project retards flood inflow into the San Joaquin River. The Corps of Engineers maintains the dams and reservoirs and local interests maintain the channel improvements. Cost of the existing project was $1,800,000 Federal and $1,200,000 local interest.

As authorized, the Merced County Streams Project expands the existing project by:

Providing three new water storage facilities (Castle Lake on Canal Creek, Haystack Mountain Dam on Black Rascal Creek, and Marguerite Dam on Deadman and Dutchman Creeks);

Enlarging the four existing dams and reservoirs and modifying the single purpose function of Burns and Mariposa Dams; and

> Providing 52 miles of levees and channel improvement work on lower Bear, Mariposa, and Deadman Creeks east of the Eastside Bypass, a unit of the state flood control project for the San Joaquin River.

Under the new project, three of the water storage facilities would be for flood control only, two for flood control and recreation, one for flood control and irrigation, and one for all three functions. It would increase total storage capacity from 33,300 to 126,700 acre-feet, increase the area afforded flood protection, provide an average annual supply of 7,300 acre-feet of new water for irrigation, and increase opportunities for water-oriented recreation. By way of the Eastside Bypass, the Merced County Streams Project would be tied into the state project for flood control on the San Joaquin River.

Phase I General Design Memorandum studies have resulted in a reduction of project scope and deferral of certain project features until justified by detailed economic studies. Specifically, the Phase I General Design Memorandum contains proposals for reducing total storage capacity from 126,700 to 55,600 acre-feet, deferring enlargement of Owens Dam, and deferring construction of Marguerite Dam and enlargement of Mariposa Dam (and the irrigation function planned for these improvements). Also, channel work on Mariposa and Deadman-Dutchman Creeks would be deferred. Local interests have requested that lake recreation be deleted from the project. However, trail-oriented recreation facilities will be provided in conjunction with levee construction and channel improvement work. Estimated cost of the proposed plan of improvement, which is under review, is approximately $50,800,000 ($41,500,000 Federal and $9,300,000 non-Federal). Preconstruction planning for the project is scheduled for completion in 1980.

New Melones Lake

Water storage projects on the Stanislaus River were contemplated very early in the development of irrigation and flood control in the Central Valley of California. In fact, water storage for irrigation in the Stanislaus River Basin was considered by settlers as early as 1854, and a flood damage reduction function for irrigation reservoirs was recognized in the early 1870s. A report published in 1874 states that irrigation in the foothill regions of the Sierra Nevada would be different from the direct diversion method of the valley floor in that:

> The water will come from the Sierra Nevada Mountains. Large storage-reservoirs will . . . be constructed in the gorges and valleys of the mountains and the water will be brought down from them in ditches, pipes, and flumes . . .

* * * * * * * * * * *

> Extensive irrigation will assist in . . . [reclaiming overflowed and swamp lands on the valley floor], for the water of irrigation, and particularly that stored for future use, will be held back during floods, when these lands are liable to damage, and will escape [to the groundwater] by percolation, or be let into the rivers . . . after the floods are over, when it can do no injury.[1]

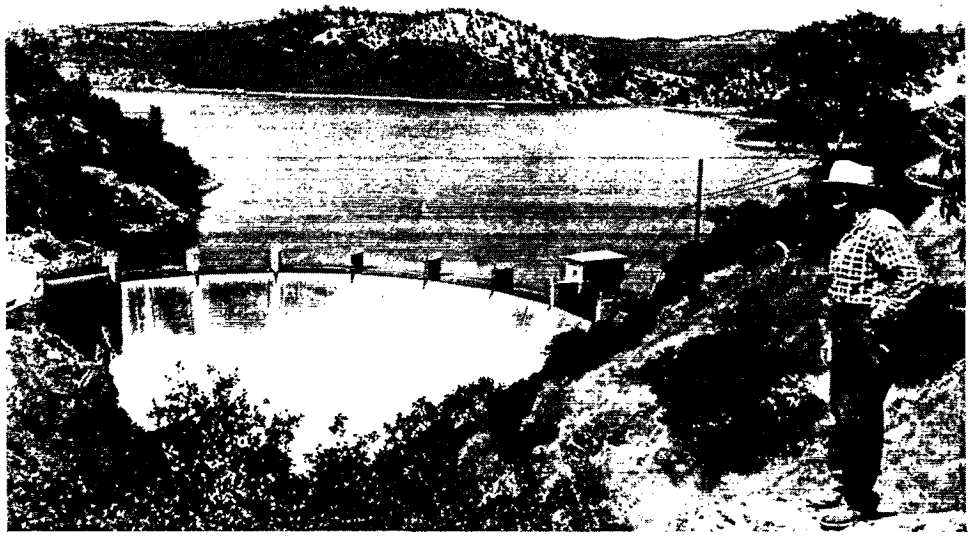
By the turn of the century, small storage projects for hydroelectric power generation were being built in the Stanislaus River system and, in 1912, Goodwin Dam was built for irrigation diversions. This dam is about 10 miles downstream from the original Melones Dam. Actually, Goodwin Dam and a 3½-mile canal replaced an upstream dam and canal built for mining purposes in 1853 and acquired for irrigation use in the late 1880s. In the early 1900s, however, continuing growth of agriculture along the Stanislaus River, and the minimal storage capacity of Goodwin Dam, quickly demonstrated need for a larger dam. Explorations begun in 1918 ultimately led to construction of old Melones Dam by the Oakdale and South San Joaquin Irrigation Districts during the period 1925-27. The project comprised a concrete arch structure 183 feet high and 590 feet along the crest, and a 26,000 kilowatt Pacific Gas and Electric Company powerplant downstream from the dam. Under a 40-year financing and operating agreement made in 1925, the power company controlled the dam from November through February and the irrigation districts controlled it from March through October. Maintenance of the dam was divided equally between the power and irrigation interests. Although used primarily to regulate streamflow for irrigation and power generation, the project sometimes had an effect in reducing floodflows. Such effect, however, was wholly incidental.

Systematic studies of water resources in the Central Valley were made by the state and other interested agencies in the early decades of the 1900s. Among other findings, these studies (particularly those made in the interest of flood control) disclosed that additional storage capacity was needed on the Stanislaus River. A map dated 30 October 1930 in House Document 191, 73d Congress, 1st Session,[2] shows the original Melones Project as "an existing reservoir, present capacity to be increased." In a 1931 report[3] published by the California Division of Water Resources, the Melones Project is included as a unit of the State Water Project to be increased in capacity to

[1]Ex. Doc. No. 290, 43d Cong., 1st Sess., **Report of the Board of Commissioners on Irrigation of the San Joaquin, Tulare, and Sacramento Valleys of the State of California**, G.P.O., Washington, D.C., 1874, p. 39.

[2]Report entitled **Sacramento, San Joaquin, and Kern Rivers, California**. It was completed in 1932.

[3]Bulletin No. 29, **San Joaquin River Basin.**



Melones Dam (Photo courtesy Oakdale Irrigation District)

1,090,000 acre-feet, with 204,000 acre-feet reserved for flood control. The dam specifically proposed at that time was a concrete gravity structure 460 feet high, about 1,150 feet long at the crest, and located about 2/3 of a mile downstream from the old dam. A 68,000 kilowatt powerplant downstream from the dam was selected as the economic power installation. In 1933, a New Melones Project as just described was authorized by the California Legislature as a low priority unit of the California Central Valley Project.

A Federal project on the Stanislaus River was originally authorized by Congress in 1944. At that time, the project plan comprised a concrete arch dam 355 feet high and 918 feet long at the crest. Storage capacity was 450,000 acre-feet (340,000 acre-feet for flood control) and the dam site was the same as that selected in 1931. Future raising of the dam to provide 1,100,000 acre-feet of storage was contemplated. The existing powerplant was to continue in use by means of a special penstock outlet. In the late 1940s, however, a common conclusion from studies made by the State of California, the Bureau of Reclamation, and the Corps of Engineers was that 1,100,000 acre-feet of multiple-purpose storage (350,000 acre-feet for flood control) should be provided in one step, and that a new powerplant of 41,000 kilowatts capacity be built because the old powerplant could not economically be adapted to the higher head created by the larger dam. The higher dam would rise 482 feet above streambed. Later studies indicated that a 62,000 kilowatt powerplant was feasible. Joint studies made by the Bureau of Reclamation and the Corps of Engineers in 1960-61 showed that a project of 2,400,000 acre-feet would be economically justified and would provide for full development of the Stanislaus River. This project was authorized by Congress in 1962. A 150,000 kilowatt powerplant, later increased to 300,000 kilowatts capacity, was also authorized at that time. Comparative studies showed that an earth-rockfill structure was less expensive than a concrete structure. Accordingly, the multiple-purpose project started in 1966 and now nearing completion comprises an earth-rockfill embankment type dam 625 feet high and 1,560 feet long. It will be the second highest fill structure in the United States. A flood control reservation of 450,000 acre-feet will be provided as part of the 2,400,000 acre-foot gross storage capacity of the lake. In addition to flood control, the project will meet needs for power generation, irrigation supply, water quality control, recreation, enhancing the existing lake and downstream fishery, and environmental mitigation measures. Maintaining the capacity of the Stanislaus River to at least 8,000 cubic feet per second from Goodwin Dam downstream to the San Joaquin River is also a feature of the project and a Federal responsibility. The powerplant, a two-unit installation, is on the right (north) bank immediately downstream

from the dam. Afterbay storage for reregulating power releases will be provided in Tulloch Reservoir[1], which is about 8 miles downstream from the powerplant. Old Melones Dam will be submerged by New Melones Lake.

Federal cost of the project is estimated at $339,000,000. On completion, the project will be transferred to the Bureau of Reclamation for operation and maintenance in conjunction with other units of the Central Valley Project. Flood control operation will be prescribed by the Corps of Engineers. Completion of major project features and power on the line is scheduled for 1979, and overall project completion is scheduled for 1981. The dam was "topped out" on 28 October 1978.

New Melones Lake has some controversial environmental aspects, the chief one involving loss of a popular 14-mile reach of whitewater that will be inundated by the new lake. The controversy arose when a large number of individual letters and petitions expressing opposition to the project and support for the whitewater were directed toward the California Secretary of Resources in 1971 and toward the President in 1971-72. In 1972, the Environmental Defense Fund and the Sierra Club entered suit in the U.S. District Court on the contention that the environmental statement was inadequate. However, in 1973, the Ninth Circuit Court of Appeals ruled the environmental statement in compliance with the National Environmental Policy Act, and the Supreme Court refused to hear a further appeal. A statewide initiative to preserve the whitewater under state law was rejected in the general election of 1974. Although the original environmental statement was found adequate, a court-ordered supplemental environmental statement was prepared by the Bureau of Reclamation to include the impact of use of project's irrigation supply, and project construction was delayed during preparation of the supplement. Delays occasioned by these activities were found to be very costly in terms of price level escalation. For example, delay in the award of the main dam contract (successful low bid $83,200,000 received in October 1972) resulted in withdrawal of the bid. Readvertisement after a delay of 14 months resulted in a low bid of $107,700,000, an increase of $24,500,000 over the original low bid.

In 1974, State Water Resources Control Board Decision Number 1422 imposed many conditions on operation of the New Melones Project. Among other things, it effectively served to protect the controversial whitewater reach. In a July 1978 ruling on a suit brought by the United States to prevent the decision from taking effect, the Supreme Court found in favor of the state, but directed a further review by the lower courts to determine whether Decision 1422 contains conflicts that must give way before specific laws passed by Congress. As of 1 January 1979, this issue remained to be resolved.

A summary of the potential benefits expected from the New Melones Project follows:

Flood Protection Operation of New Melones Lake during major floods will reduce floodflow downstream to 8,000 cubic feet per second, thus protecting about 35,000 acres of highly developed agricultural land along the Stanislaus River. In conjunction with other projects, New Melones will materially aid in reducing floods along the lower San Joaquin River and in the Delta, thereby helping to protect an additional 235,000 acres of highly productive and intensively cultivated agricultural lands; urban, suburban, and industrial areas; military installations; and transportation facilities.

Irrigation An irrigation supply of 210,000 acre-feet of new water annually can be provided by New Melones Lake to relieve current and predicted shortages. If any of this new water is surplus to local needs, it will be available to serve other water-deficient areas of the San Joaquin Valley. Most of the water released for irrigation, as well as for other project purposes, will also be used for power generation.

Hydroelectric Power The 300,000 kilowatt hydroelectric powerplant at New Melones will generate more than 400,000,000 kilowatt-hours of pollution-free energy annually. This would satisfy the domestic electrical requirements of about 200,000 people. About 30,000,000 gallons of oil would be required to produce equivalent energy in an oil-burning steam plant.

Water Quality Operation of New Melones Lake for flood control, irrigation, power, and recreation demands, and to achieve specific water quality and fishery objectives, will improve the existing flow characteristics of the Stanislaus and San Joaquin Rivers. Under preproject conditions, agricultural and other pollutants caused water quality problems during periods of low flow. Releases from the project will be made to maintain adequate dissolved oxygen in the Stanislaus River and to limit total dissolved solids in the San Joaquin River. High peak winter flows will be reduced and more consistent year-round sustained flow will be afforded by the project.

Fish and Wildlife New Melones Lake will restore a declining salmon fishery by protecting and preserving spawning gravels and by providing releases to maintain high quality flow in the lower river. The characteristics of the lake will be favorable to establishing cold and warm water game fish species. A trout fishery will be established below Goodwin Dam to take advantage of the colder water from the lake and improved flow conditions due to operational releases. About 2,100

[1]One unit of the Tri-Dam Project, a power and irrigation development completed in 1968 by the Oakdale and South San Joaquin Irrigation Districts. As indicated, Tulloch Reservoir is on the main stem Stanislaus River downstream from New Melones Lake. The remaining units, Donnells and Beardsley Reservoirs, are on the Middle Fork.

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New Melones Dam Project, December 1978. The original Melones Dam appears just over the crest of the new dam.

New Melones Project spillway excavation

acres of land in the lake area will be managed specifically for fish and wildlife purposes. Wildlife habitat restoration will consist of selected clearing, planting wildlife food crops, developing waterholes, and installing protective fencing. About 5,000 acres of easement area will be provided for fish and wildlife and protection of spawning areas and riparian vegetation along the lower reaches of the river.

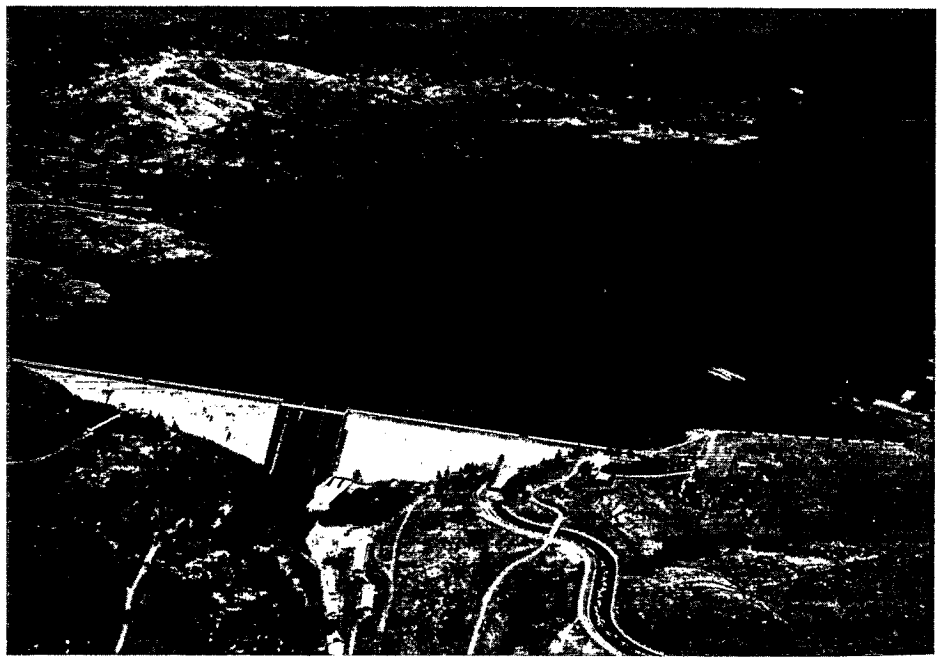
Recreation About 3,000 acres of landscaped recreation areas that will include campgrounds, picnicking facilities, launching ramps, access roads, and parking lots are planned for the new lake. Opportunity for all water-oriented activities will be available. Annual recreation use is expected to exceed 800,000 user-days within 3 years of initial lake operation. Based on projected population growth and observation of recreation at other projects, public use of New Melones Lake is ultimately expected to reach 3,000,000 user-days annually. Access for fishing and other activities along the lower river will also be provided. To support increased boating and related activities (and to supplement three existing public parks), eleven new recreation areas are planned for construction at intervals along the river. A 4-mile course for kayaks is proposed for the canyon upstream from Knights Ferry. This will partially compensate for loss of whitewater reaches when the lake is filled to its 2,400,000 acre-foot capacity. Annual recreation use of the river is expected to grow from an initial 200,000 to about 400,000 user-days ultimately.

It is recognized that loss of the whitewater reaches upstream is significant to whitewater enthusiasts, and although complete mitigation may not be possible, studies are being made to determine whether additional whitewater mitigation is feasible.

COOPERATIVE PROJECTS

Millerton Lake (Friant Dam)

Completed in 1949 by the Bureau of Reclamation, Friant Dam impounds 520,200 acre-feet of water primarily for conservation purposes. Both the Friant-Kern and Madera Canals originate at this project. Operation for flood control under Section 7, 1944 Flood Control Act, affords flood control reservations of 170,000 and 390,000 acre-feet, respectively, during the rain and snowmelt flood seasons.



Friant Dam and part of Millerton Lake

New Exchequer Dam and Reservoir

New Exchequer Dam and Reservoir, a multiple purpose project on the Merced River about 25 miles northeast of Merced, was built by the Merced Irrigation District. Completed in 1966, the project consists of a concrete-faced rockfill dam 480 feet high and 1,200 feet long at the crest, and a reservoir (Lake McClure) with a gross storage capacity of just over 1,000,000 acre-feet. The original dam was incorporated into the upstream toe of the new rockfill structure, which increased storage at the site by nearly fourfold and afforded 400,000 acre-feet of space for flood control. A powerplant with an installed capacity of 80 megawatts and provisions for future expansion to 125 megawatts is located at the dam. A 9 megawatt powerplant is located at the afterbay, which is 6 miles downstream.

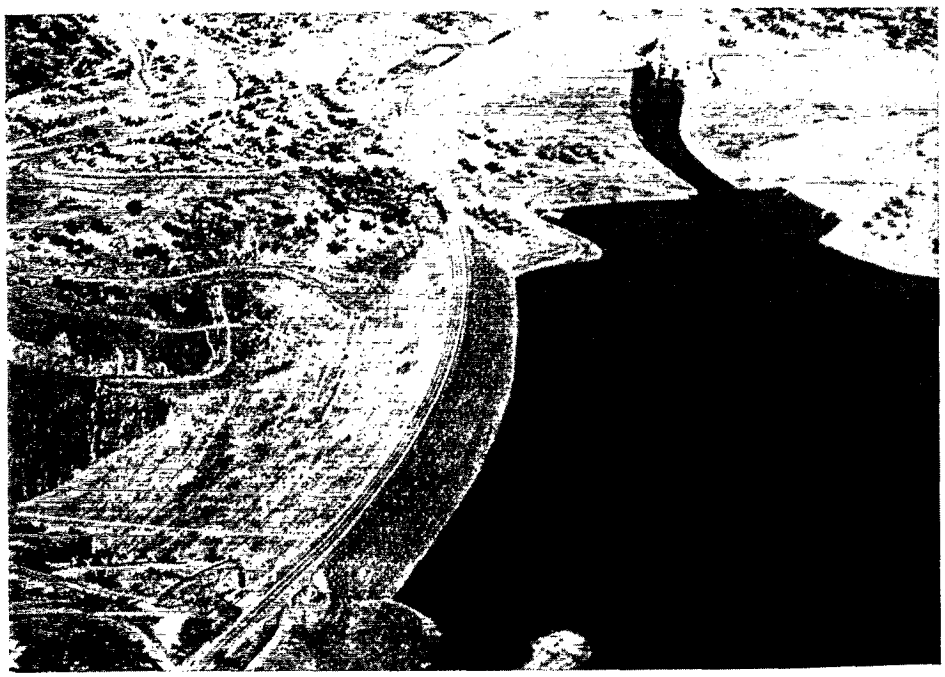
A number of small communities and 50,000 acres of agricultural land in the Merced River flood plain are provided flood protection by New Exchequer Dam. It also significantly assists in reducing flood damage along the lower San Joaquin River and in the Delta, and helps meet increasing demands for irrigation water and electrical energy.

Cost of the project, exclusive of power and recreation facilities, was $28,900,000, of which $10,900,000 was Federal expenditure for the flood control function. Merced Irrigation District operates the project for flood control according to rules and regulations developed by the Corps of Engineers.

New Exchequer Dam

Tuolumne River Reservoirs

Flood control storage on the Tuolumne River was provided under a cooperative agreement entered into by the Federal Government, the City and County of San Francisco, and the Turlock and Modesto Irrigation Districts. Under the initial phase of the agreement, the Federal Government provided financial assistance to the local interests in building Cherry Valley Reservoir on Cherry Creek, a major upstream tributary of the Tuolumne River. In return for this assistance, Cherry Valley Reservoir was operated in conjunction with Lake Eleanor, Hetch Hetchy Reservoir, and old Don Pedro Reservoir to provide partial flood protection on an interim basis. Under the final phase of the agreement, the local interests built New Don Pedro



New Don Pedro Dam

Reservoir with further financial assistance from the Federal Government and provided 340,000 acre-feet of storage space to be operated for flood control according to rules and regulations established by the Corps of Engineers.

Completed in 1971, New Don Pedro Reservoir provides substantial flood protection to Modesto, to a number of rural communities, and to about 8,000 acres of agricultural lands along the lower Tuolumne River. In conjunction with the San Joaquin River levees and other storage projects, it helps protect about 140,000 acres of agricultural lands along the San Joaquin River and in the Delta, a number of military installations, and industrial and suburban areas in the vicinity of Stockton.

FLOOD CONTROL PROJECT

Lower San Joaquin River and Tributaries

Improvements for flood control along the San Joaquin River and its tributaries provided for Federal facilities on the San Joaquin River downstream from the Merced River, Federal facilities in the lower reaches of the Stanislaus and Tuolumne Rivers, and for State of California facilities upstream from the mouth of the Merced River. More specifically, Federal project work consisted of constructing or improving levees, removing accumulated snags, protecting streambanks where required, and acquiring flowage easements necessary to assure project channel capacities. Facilities provided by the state comprised levee construction along the river at the upstream and downstream ends of the project reach, approximately 50 miles of leveed bypass, numerous control and drop structures, and construction of several major bridges. A general map of Federal and state project works is shown on page 134.

Both the Federal and state portions of the project were closely coordinated to assure project effectiveness and design complementary to flood control storage projects on the Stanislaus, Tuolumne, and upper San Joaquin Rivers. Thus, the project affords an effective system of levees and storage that protects urban and suburban areas in the vicinity of Stockton and about 140,000 acres of highly productive agricultural lands along the river and in the Delta. During rain and snowmelt floods that occurred in 1968-69, the project prevented an estimated $20,700,000 damage, of which $10,750,000 was attributable to the Federal portion and $9,950,000 was attributable to the state portion.

Work on the Federal portion of the project was started in 1956 and completed in 1972 at a cost of $13,100,000. Local interest cost for work above the mouth of the Merced River (completed in 1968) and for cooperation in the Federal portion downstream was about $30,000,000. Operation and maintenance of all project improvements are local responsibilities.

Levees along the San Joaquin River

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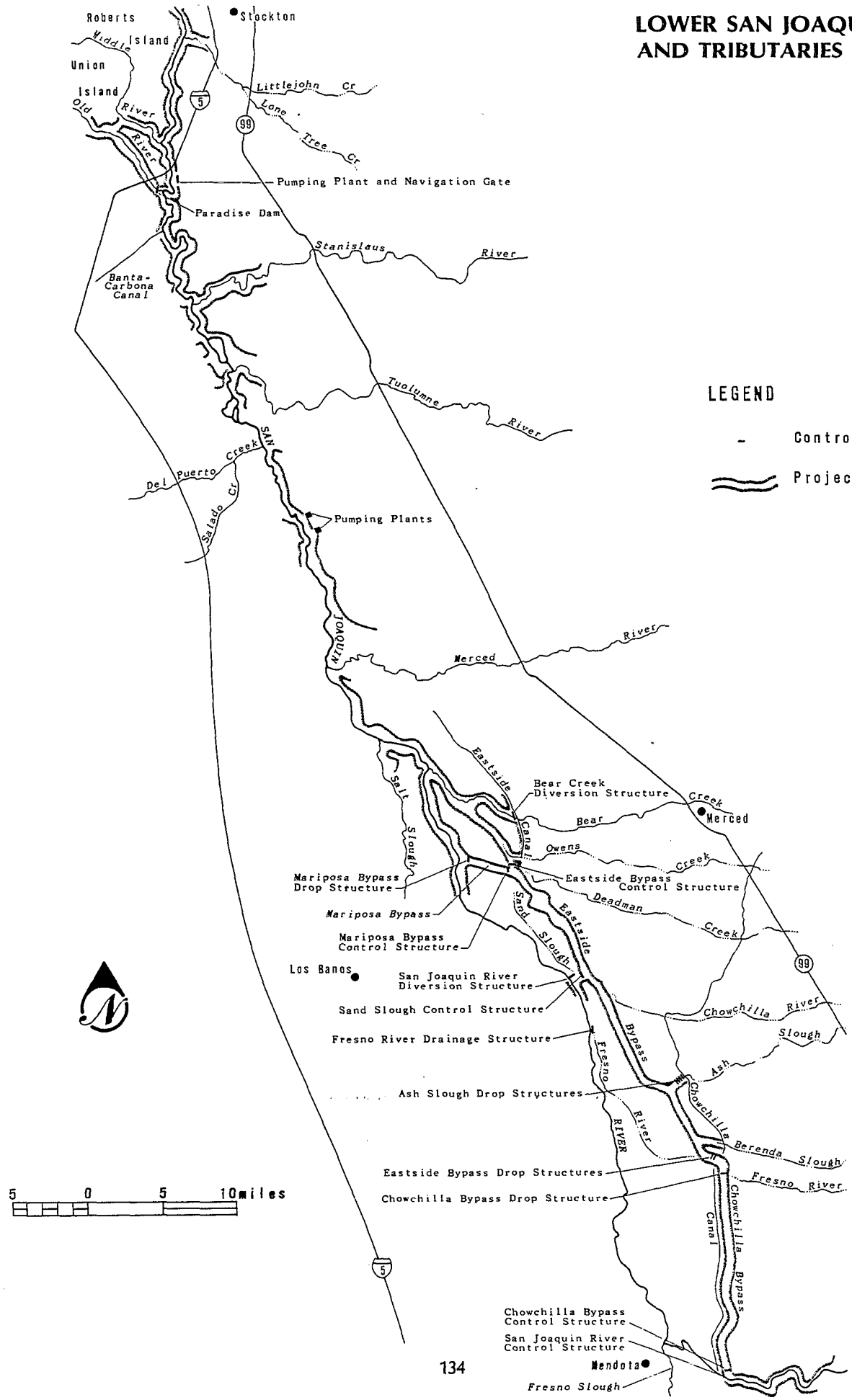

FLOOD DAMAGE PREVENTION STUDIES

San Joaquin River Basin

Comprehensive study of water resources problems and needs of the San Joaquin River Basin was authorized in 1964 and has been in progress since 1968. The study area encompasses part of the Delta-Central Sierra Area and all of the San Joaquin and Tulare Lake Basins. Problems of flood control, irrigation, municipal and industrial water supply, power, recreation, fish and wildlife, and water quality are being considered. The California Water Plan (prepared by the California Department of Water Resources in 1957) and a more recent joint Federal-state plan (California Framework Study) serve as guides for project formulation and study coordination. This basin study has been approached on the basis of problem priority and a number of interim studies and reports are contemplated. For convenience, all study elements are discussed here although the sub-study area may be partly or wholly in another of the hydrographic areas adopted for this booklet. Discussion of ongoing and recent study activities follows:

Redbank and Fancher Creeks (Tulare Lake Basin) Existing flood control and drainage improvements protecting the Fresno-Clovis metropolitan area are inadequate to provide the needed degree of protection for this rapidly growing area. Flood damage is increasing due to urbanization of agricultural lands adjoining the metropolitan complex. An interim study showed that a flood detention dam on Fancher Creek, three flood detention basins, and enlargement of the existing Big Dry Creek Dam would comprise a feasible solution to the problem. A report on these improvements submitted to higher authority in June 1977 was returned for additional information early in 1978. It was resubmitted in December 1978.

Kern River — Isabella Lake (Tulare Lake Basin) The purpose of this study is to develop a plan for basin-wide development of water resources. Major areas of study consist of providing hydroelectric power generation at Isabella Dam or at some other site upstream, and enlarging Isabella Lake for increased recreational use capability and other purposes. Alternative plans addressing the study objectives are being inventoried and assessed. Work on the study, suspended from 1966 to 1973, is again in progress and scheduled for completion in 1981.

Lower San Joaquin River (Delta-Central Sierra Area and San Joaquin Basin) An interim study of measures to regain project design flow channel capacity and protect existing project levees from about river mile 40 to river mile 120 has been under way since 1975. Work completed includes identifying and analyzing alternative plans that considered bank protection, raising levees, setback levees, new levees, and channel clearing, taking into account water quality, recreation, and fish and wildlife. Work on this interim study has been terminated because Federal interest could not be found in potential project improvements.

New Hogan Fishery (Delta-Central Sierra Area) During years of above average water supply, operation of the New Hogan Project induces a king salmon fishery in the lower Calaveras River. The salmon are prevented from establishing a stable population due to periods of low water supply. The purpose of this study, which is to be started in 1979, is to determine whether it would be feasible to enhance the downstream fishery by modifying the existing project operation, or by providing additional water supply by enlarging New Hogan Lake or developing new storage capacity upstream.

San Joaquin Basin Comprehensive (Delta-Central Sierra Area, San Joaquin Basin, and Tulare Lake Basin) An inventory and assessment of basin-wide water resources development problems is continuing. Completion of the comprehensive report is unscheduled.

9 TULARE LAKE BASIN
(Sacramento District)

PROJECT INDEX

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MULTIPURPOSE		
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141	Success Lake (17)	141
142	Isabella Lake (18)	138
FLOOD CONTROL		
143	Big Dry Creek Dam and Diversion (17)	143
144	Kern River-California Aqueduct Intertie (Small Flood-Control Project) (18)	143

[1]Number following project name denotes Congressional District.

LEGEND

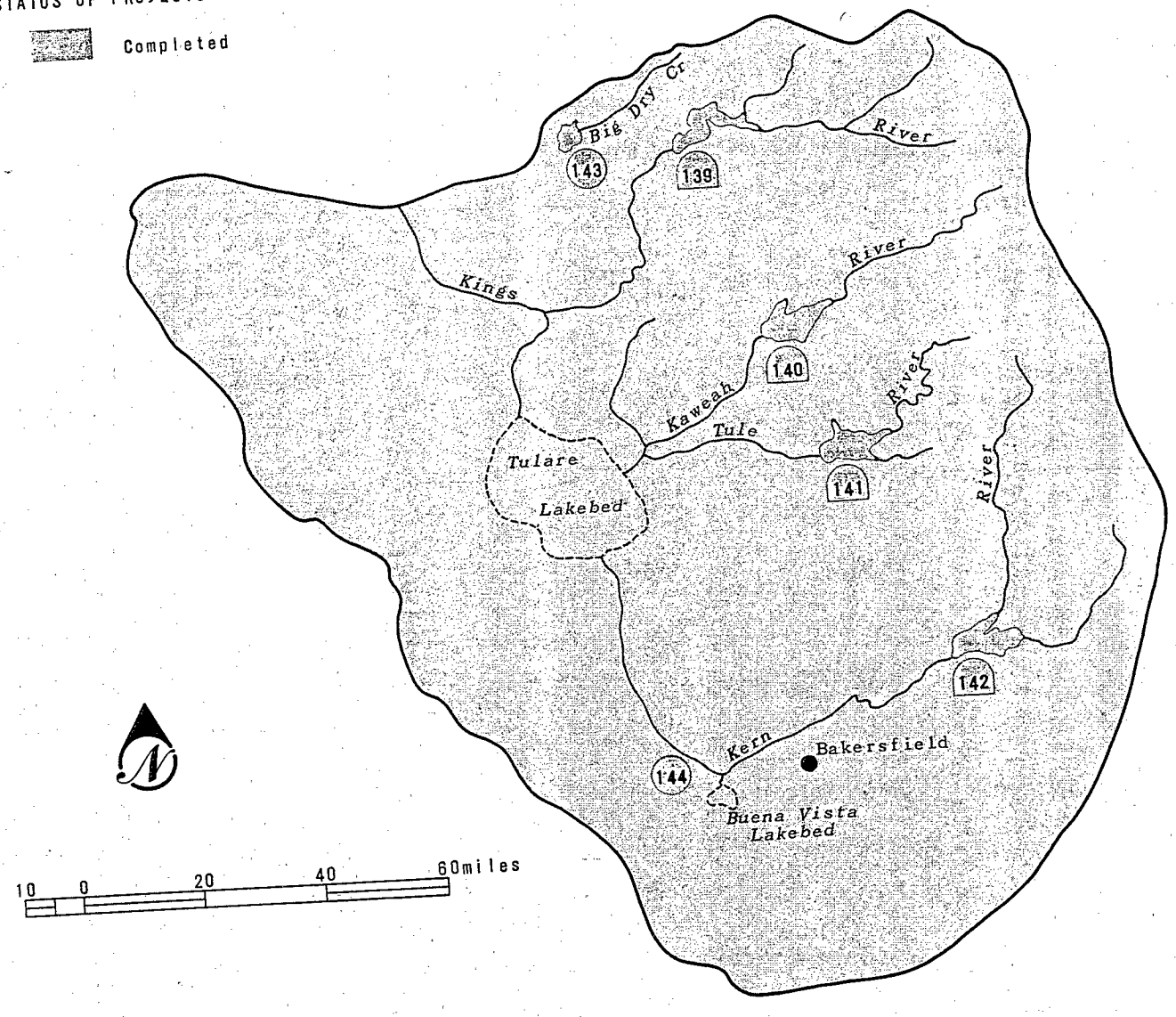
TYPE OF PROJECT

Multipurpose

Flood Control

STATUS OF PROJECTS

Completed



DESCRIPTION

Tulare Lake Basin comprises the southern end of the Central Valley. It is bounded by the Sierra Nevada on the east, the Tehachapi Mountains on the south, and by the Diablo and Temblor subranges of the Coast Ranges on the west. On the north, it is separated from the San Joaquin Basin by a low, transvalley ridge formed by the coalesced alluvial cones of the San Joaquin and Kings Rivers. Historically, a large shallow lake lay south of the barrier ridge.

The major streams draining the Tulare Lake Basin—which covers approximately 12,500 square miles—are the Kings, Kaweah, Tule, and Kern Rivers. These streams rise in the Sierra Nevada and, except for Kings River North, a distributary channel of the Kings River, terminate in ancient lakebeds located in the lowest areas of the basin floor. Although now reclaimed and used for agriculture, these sump areas are known as Tulare and Buena Vista Lakes. Minor streams flow to the basin floor from the Tehachapi Mountains and Coast Ranges, and drain the foothill regions between the major streams flowing from the Sierra Nevada. Most of the minor streams are dry in summer. Melting snow usually sustains flow in the major streams during the summer months. As indicated, the basin has no effective outlet to the sea.

Climate of the Tulare Lake Basin is characterized by hot, dry summers and mild winters with little precipitation in the mountain areas to the south and west and on the basin floor, and by warm, dry summers and severe winters with heavy rain and snow in the Sierra Nevada. In general, precipitation decreases from north to south and southwesterly across the basin. Average annual amounts vary from about 6 inches in the dry southwest sector to 50 inches in the northeast sector. In the higher elevations of the Sierra Nevada, precipitation usually occurs as snow and a deep snowpack accumulates. The basin is subject to rainfloods in late fall and winter, and to snowmelt floods during late spring and early summer. On the basin floor, streambank and other types of flood induced erosion result in average annual land loss damage estimated at $200,000. In general, however, the Tulare Lake Basin is water deficient and development of water supply for irrigation and municipal and industrial uses has resulted in an overdraft of ground water and almost complete conservation of surface water. Prior to extensive irrigation development and reclamation of lakebed areas, floodwater periodically filled the basin floor area and flowed over the ridge defining the basin on the north. The last such overflow occurred in 1878 and the recurrence of such an event is not likely under present conditions of river control and irrigation development. It should be noted that floodwaters now reaching the ancient terminal lakebed areas may remain on the ground until pumped away for irrigation or evaporated, thus taking highly productive agricultural lands out of production for as long as 3 years.

Population of the Tulare Lake Basin, currently about 1,100,000, is projected to increase to 1,500,000 by the year 2000. Irrigated agriculture based on highly fertile soils is the dominant element of the basin's economy. About equally important, however, is extraction of petroleum and natural gas. Mining and lumbering are significant in rural areas and light manufacturing is increasing in importance in and around urban centers. The basin is served by Federal, state, and county highways; by main line and branch line railroads; and by commercial airlines.

MULTIPURPOSE PROJECTS

Isabella Lake

Isabella Lake is located at the junction of the north and south forks of the Kern River about 35 miles northeast of Bakersfield. Completed in 1953 at a Federal cost of $22,000,000, the major elements of the project consist of a main earthfill dam 185 feet high and 1,725 feet long and, in an adjacent saddle, an auxiliary earthfill structure 100 feet high and 3,257 feet long. The dam and its auxiliary impound a lake with a gross capacity of 570,000 acre-feet, of which 325,000 acre-feet are reserved for operation to control rainfloods. The total capacity may be operated to control snowmelt floods.

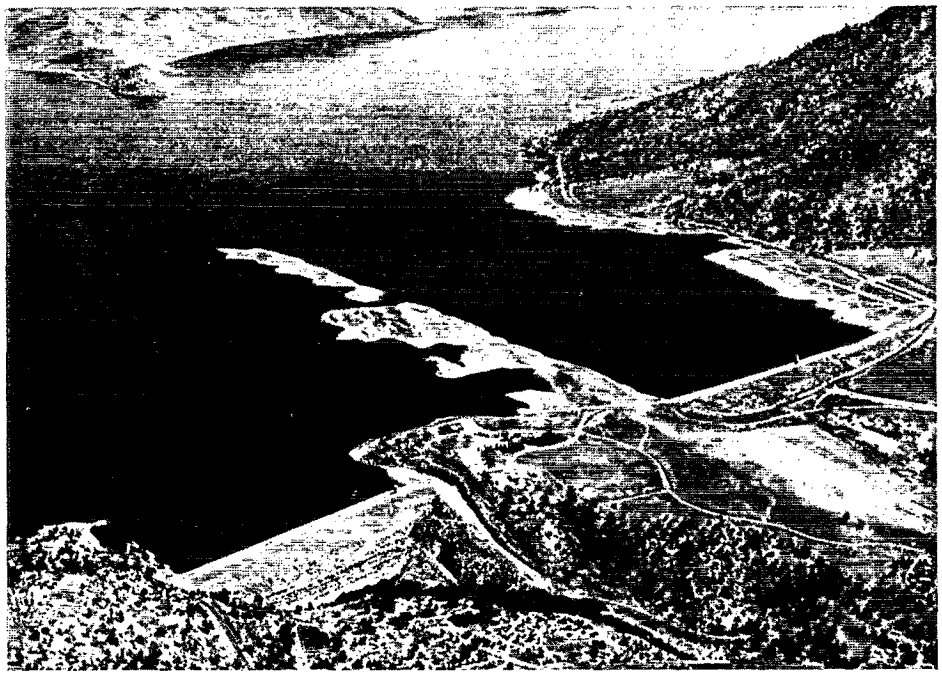
Bakersfield and about 350,000 acres of agricultural lands and oil fields are protected by Isabella Lake. In conjunction with other multipurpose projects in the basin, the project contributes to protecting 260,000 acres of cropland in the Tulare Lake area.

Isabella Lake provides an average annual supply of 50,000 acre-feet of water for irrigation, and affords a means to regulate the irrigation supply. Local interests have paid for the conservation function of the project and are responsible for a portion of the annual operation, maintenance, and replacement costs.

Although there are no power facilities at Isabella Dam, existing downstream powerplants benefit incidentally from the regulation of streamflow. Borel Powerplant (Southern California Edison Co.), which is downstream from Isabella Lake, was originally supplied by a diversion on the north fork and a canal from the diversion to the headworks of the powerplant. The diversion and a section of the canal, which crossed the site of the auxiliary dam, were inundated by Isabella Lake. By means of a unique installation—generally unseen because it is under water on the lake side of the auxiliary dam—the powerplant can be supplied by way of the old diversion when the lake is very low, or directly from the lake when the lake level is above the minimum required.

Isabella Lake offers extensive opportunities for varied water-oriented recreation activities and is an extremely popular fishery for warmwater species.

Almost $2,000,000 has been spent for launching ramps, campgrounds, picnic areas, marinas, access roads and parking areas, and water supply and sanitary systems. An investigation with the objective of developing a basin-wide water resources development plan for the Kern River, including consideration of increasing the recreation use capability of Isabella Lake, is in progress. (See page 135.)



Main dam (left) and auxiliary dam, Isabella Lake

Pine Flat Lake and Kings River Project

Improvements for flood control and other purposes on the Kings River consist of Pine Flat Lake in the foothill region, and channel improvement work along the river and certain of its distributaries on the valley floor. Pine Flat Dam, completed in 1954, is located about 25 miles east of Fresno. It is a concrete gravity structure 429 feet high above streambed and 1,820 feet long at the crest. The lake has a capacity of 1,000,000 acre-feet, all of which may be used to control snowmelt floods. A total of 260,000 acre-feet of storage space is reserved for operation to control rainfloods. On the valley floor, channel improvement work was done along the main stem Kings River, Clarks Fork, Crescent Bypass, and Kings River North. Completed in 1976 at a cost of $2,400,000, the channel improvements comprise 35 miles of levee construction or rehabilitation; 60 miles of intermittent channel clearing; and modification of Army Weir, a structure that controls flow in Kings River South. Local interests operate and maintain these facilities, which are needed to assure proper division of floodflow among the several distributary channels, and to provide the channel capacity necessary to carry flood control releases reflecting optimum flood control operation of Pine Flat Lake.

Pine Flat Dam cost $39,100,000. Local interests must reimburse $14,300,000 to the Federal Government for costs allocated to irrigation. The lake improves irrigation supply on about 720,000 acres of agricultural land in the Kings River and Tulare Lake areas by providing an average of 165,000 acre-feet of water annually, and by affording better regulation of the irrigation supply. The lake also serves as an afterbay for reregulating releases from upstream power projects. Provisions for future installation of power generating facilities were included in the design of Pine Flat Dam.

About 80,000 acres of rich agricultural lands along the lower Kings River are protected by Pine Flat Lake, which, together with other storage projects in the basin, assists in flood damage reduction on 260,000 acres of cropland in the Tulare Lake area. In conjunction with flow control structures on the valley floor, the lake contributes to flood damage reduction along the San Joaquin River.

Eight recreation areas have been jointly developed at Pine Flat Lake by the Corps of Engineers, Fresno County, and the U.S. Forest Service. Campgrounds, picnic areas, boat launching ramps, marinas, an observation area, access roads and parking areas, and water supply and sanitary systems have been provided to afford extensive opportunities for all types of water-oriented recreational activities.

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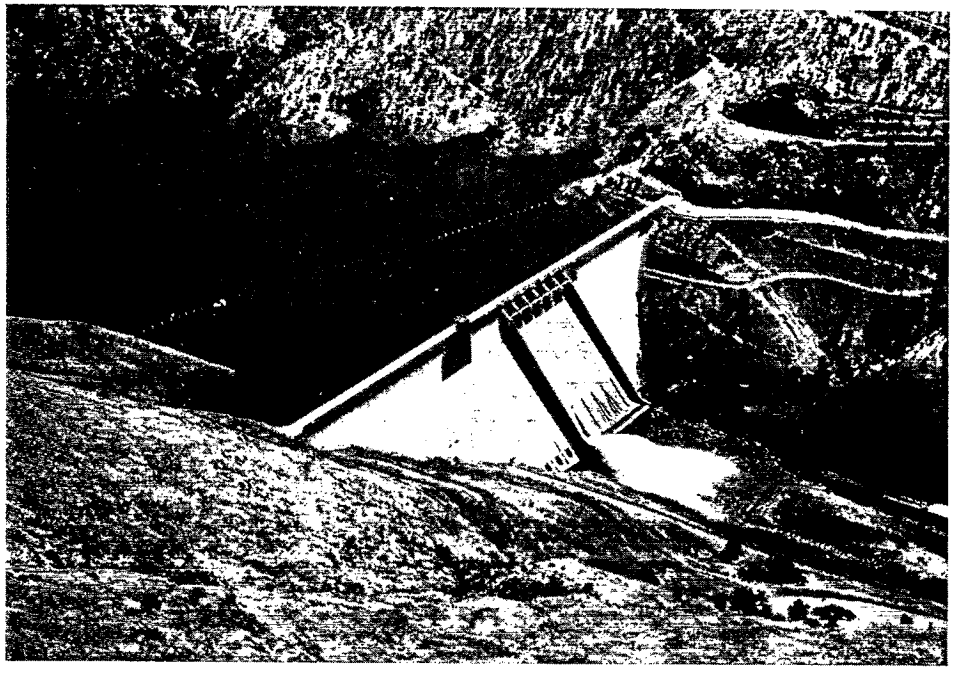

Pine Flat Dam

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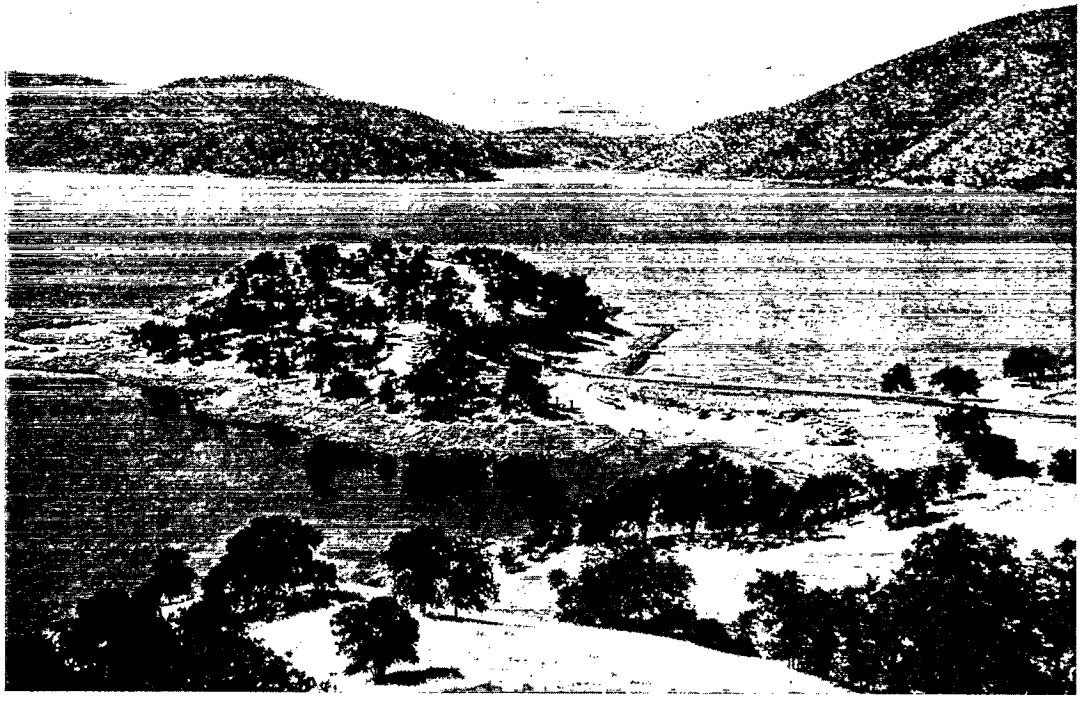
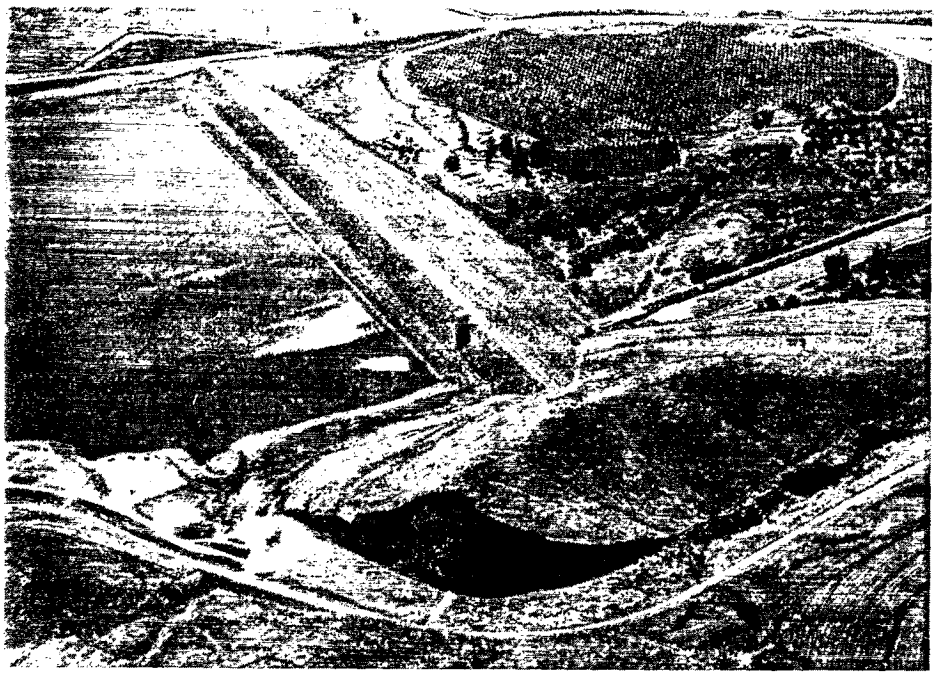


Island Park Recreation Area, Pine Flat Lake

Success Lake

Success Lake is on the Tule River about 6 miles east of Porterville. The project consists of an earthfill dam 142 feet high and 3,490 feet long, an auxiliary earthfill dike 42 feet high and 7,650 feet long at a low spot in the lake periphery, and a reservoir with a gross storage capacity of 85,000 acre-feet. Flood control operation of the project provides for use of the entire storage capacity of the lake as well as for use of downstream channels, irrigation canals, and other locally owned facilities to dispose of excess floodwaters by spreading to replenish the ground water or overirrigate.

Completed in 1961 at a cost of $14,300,000, the project provides flood protection to Porterville and to about 60,000 acres of agricultural lands along the Tule River. In conjunction with other multipurpose projects in the basin, Success Lake contributes to protecting 260,000 acres of cropland in the Tulare Lake area. It also provides an average annual supply of 27,000 acre-feet of water for irrigation, and affords a means to regulate irrigation supply. Local interests are responsible for construction and annual operation and maintenance costs allocated to irrigation. The Corps of Engineers administers the project area for public recreation use and, in conjunction with Tulare County and its concessionaires, has developed five recreation areas.

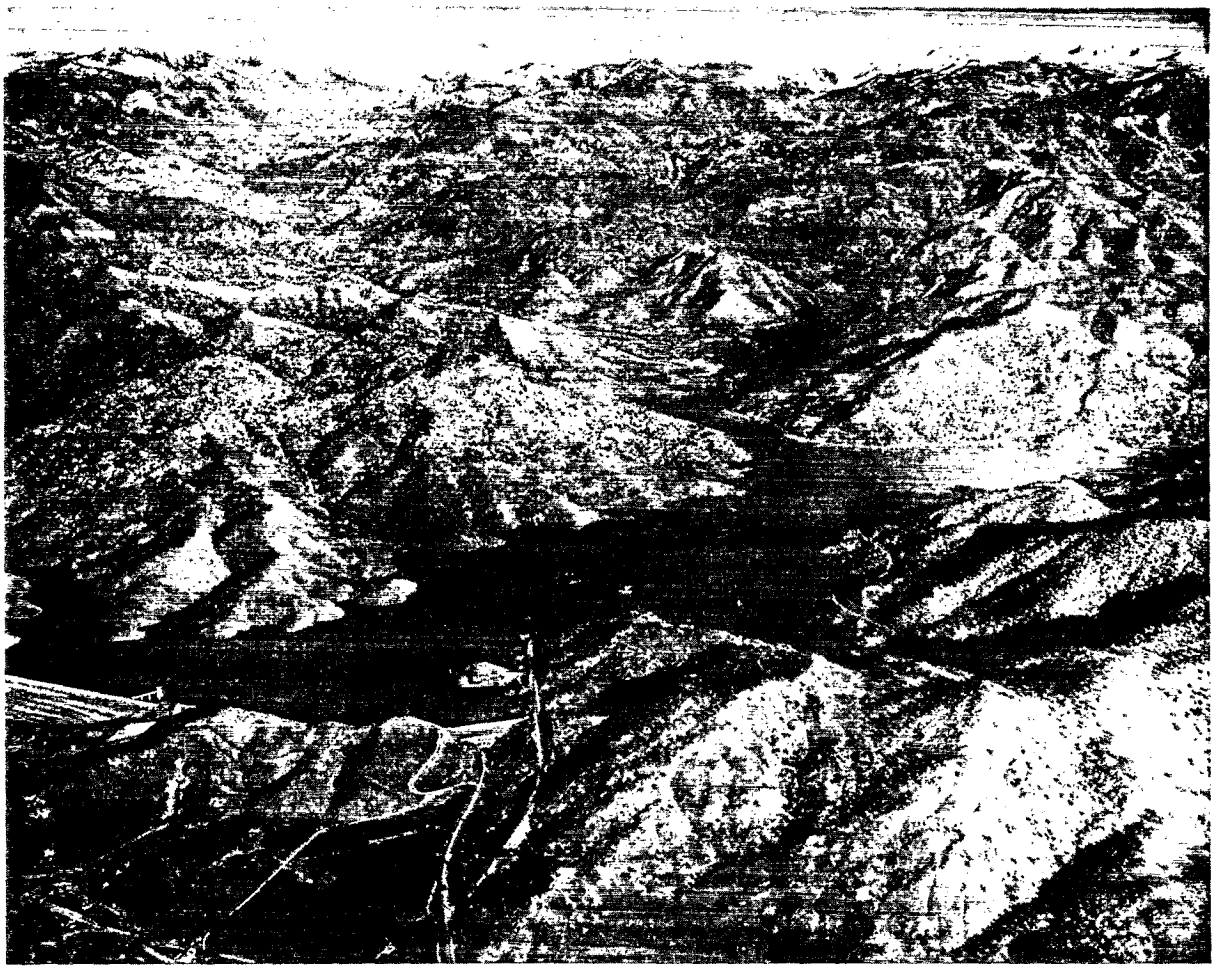


Success Dam

Spillway flow at Success Dam, December 1966

United Aerial Survey

Terminus Dam (Lake Kaweah)



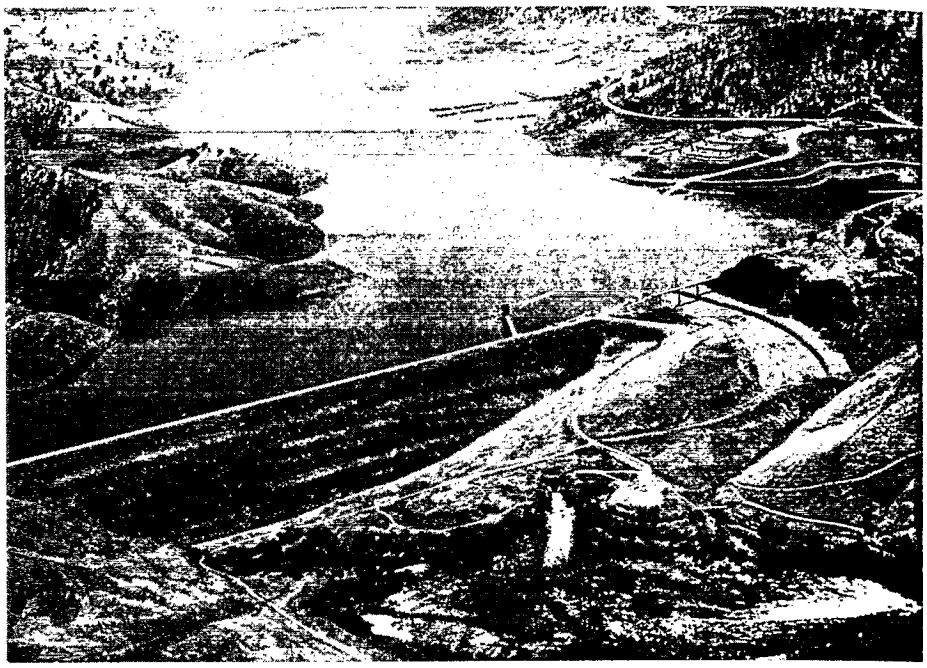
United Aerial Survey

The ideal foothill setting of Lake Kaweah

Completed in 1962, Lake Kaweah serves flood control, irrigation, and recreation functions. The project is located on the Kaweah River 20 miles east-northeasterly of Visalia. It consists of Terminus Dam, which is an earthfill structure 250 feet high and 2,375 feet long; an auxiliary dam 130 feet high and 870 feet long in an adjacent saddle; and a reservoir with a gross storage capacity of 150,000 acre-feet, all of which may be used for flood control. Flood control operation of the project also contemplates use of downstream channels, irrigation canals, and other locally constructed facilities for disposition of excess floodwaters by spreading to replenish the ground water or to overirrigate.

Federal first cost of the project was $19,300,000. Local interests are responsible for construction and annual operation and maintenance costs allocated to irrigation, and for maintenance of the locally constructed spreading works.

Visalia and about 126,000 acres of agricultural land along the Kaweah River are provided a moderate level of flood protection by Lake Kaweah. In conjunction with other multipurpose projects in the basin, it helps protect 260,000 acres of cropland in the Tulare Lake area. The project improves local irrigation supply by providing 55,000 acre-feet of water annually, and by affording an efficient means of regulating the irrigation supply. Administration of the project area for public recreation use is the responsibility of the Corps of Engineers. Four recreation areas have been developed jointly by the Corps of Engineers, Tulare County, and Tulare County concessionaires.



Terminus Dam and Lake Kaweah

FLOOD CONTROL PROJECT

Big Dry Creek Dam and Diversion

Fresno, Clovis, and adjoining suburban areas are afforded flood protection by the Big Dry Creek Dam and Diversion Project. This improvement comprises an earthfill detention dam and reservoir (flood retention capacity, 16,250 acre-feet) on Big Dry Creek, a diversion canal to carry floodflows from Dog Creek to Big Dry Creek and thence to the reservoir, and a diversion channel from the reservoir to Little Dry Creek and the San Joaquin River. Completed in 1948 at a cost of $1,400,000, the project is located about 10 miles northeast of Fresno. Its operation and maintenance are the responsibilities of local interests. Non-Federal cost of the project (for rights-of-way and utility relocations) was about $370,000. A flood damage prevention study report that includes a recommendation for enlarging Big Dry Creek Dam has been submitted to higher authority. (See page 135.)

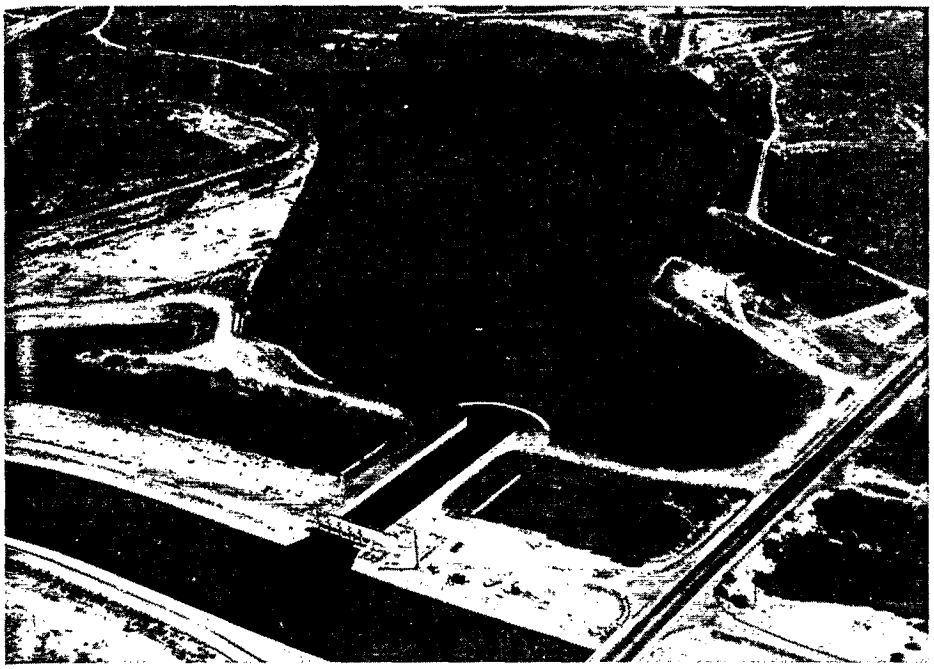
FLOOD DAMAGE PREVENTION STUDIES

The Tulare Lake Basin is part of the study area for an ongoing comprehensive investigation of water resources problems and needs of the southern Central Valley. Specific Tulare Lake Basin problems being studied consist of flood control for the Fresno-Clovis metropolitan area and possibly enlarging Isabella Lake and providing for hydroelectric power generation in the upper Kern River Basin. These studies are discussed in more detail in conjunction with the comprehensive investigation. (See page 135.)

SMALL FLOOD-CONTROL PROJECT

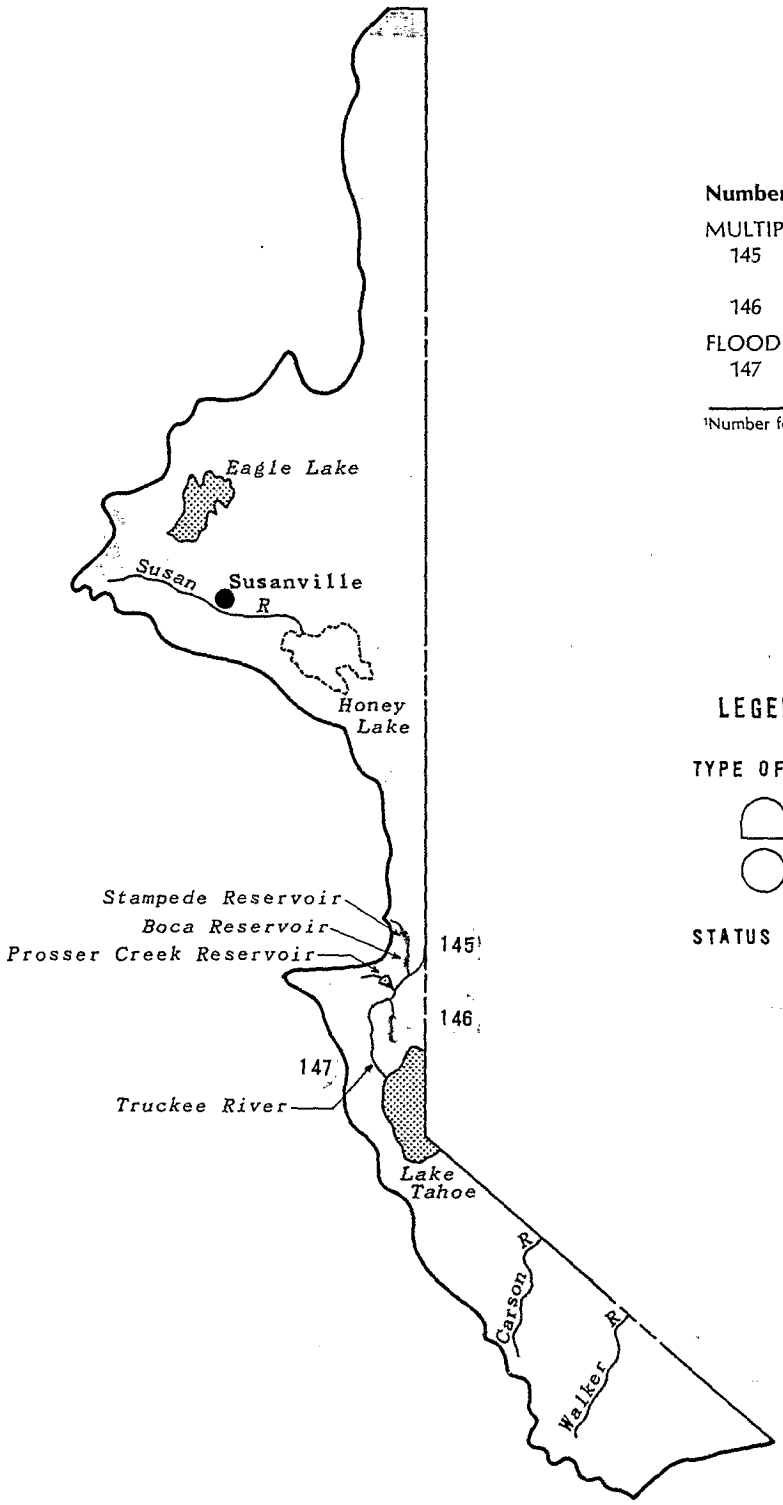
Kern River-California Aqueduct Intertie

A small flood-control project comprising a sedimentation basin and a gated 3,500 cubic foot per second gravity flow connection between the Kern River and the California Aqueduct was completed in 1977 at a cost of $1,500,000. Located in the vicinity of Buena Vista Lake approximately 20 miles southeast of Bakersfield, the project provides for diverting snowmelt floodflows from the Kern River into the Aqueduct for beneficial use in southern California.



Kern River Intertie

10 NORTH LAHONTAN TERRITORY
(Sacramento District)



PROJECT INDEX

Number	Name[1]	Page
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145	Truckee River Reservoirs (Cooperative Project) (1)	147
146	Martis Creek Lake (1)	146
FLOOD CONTROL		
147	Truckee River Improvement (1)	147

[1]Number following project name denotes Congressional District.

LEGEND

TYPE OF PROJECT

Multipurpose

Flood Control

STATUS OF PROJECTS

Completed

10 0 20 40 60miles

C-104209

DESCRIPTION

The North Lahontan Territory is situated in eastern and northeastern California. It extends from the Oregon border on the north to about Bridgeport, Mono County, on the south. The Sierra Nevada, Cascade Range, and Warner Mountains form its western boundary, and it is arbitrarily delimited by the California-Nevada boundary on the east. Physiographically, the territory is the western edge of the Great Basin, a vast landlocked region extending from the eastern cordillera of California to the Wasatch Range of the Rocky Mountains. The territory covers about 6,100 square miles and includes the Madeline Plains; Surprise Valley; and the California portions of the Susan, Truckee, Carson, and Walker Rivers. These streams have no outlets to the sea and terminate in lakes or playas that are remnants of ancient Lake Lahontan.

Page

147
146

147

Terrain of the territory presents sharp contrasts and includes the steep, forested eastern slopes of the Sierra Nevada, desert-plateau country, and flat valley lands. Climate varies widely due to differences in topography, elevation, and exposure to moisture-bearing winds. Some portions of the area receive as much as 50 inches of precipitation per year; more desert-like areas in the rainfall shadow of the mountains to the west receive as little as 4-6 inches per year. In general, the lowlands have short, hot summers; long, cold winters; and wide ranges in daily temperature. In mountain areas, summers are short and mild, and winters are long and severe. Average annual runoff for the territory is about 1,500,000 acre-feet.

Most of the territory is sparsely populated. Its present population of about 60,000 (largely concentrated in the Lake Tahoe Basin) is expected to increase to about 110,000 by the year 2000. Except for the Lake Tahoe area, where the recreation-entertainment industry comprises the economic base, the territory is largely dependent on agriculture (mainly production of livestock and forage crops), lumbering, and mining. Main line railroads and several important Federal and state highways traverse the territory east-west, and a major Federal highway traverses it north-south. South Lake Tahoe is the only city to which airlines maintain scheduled flights.

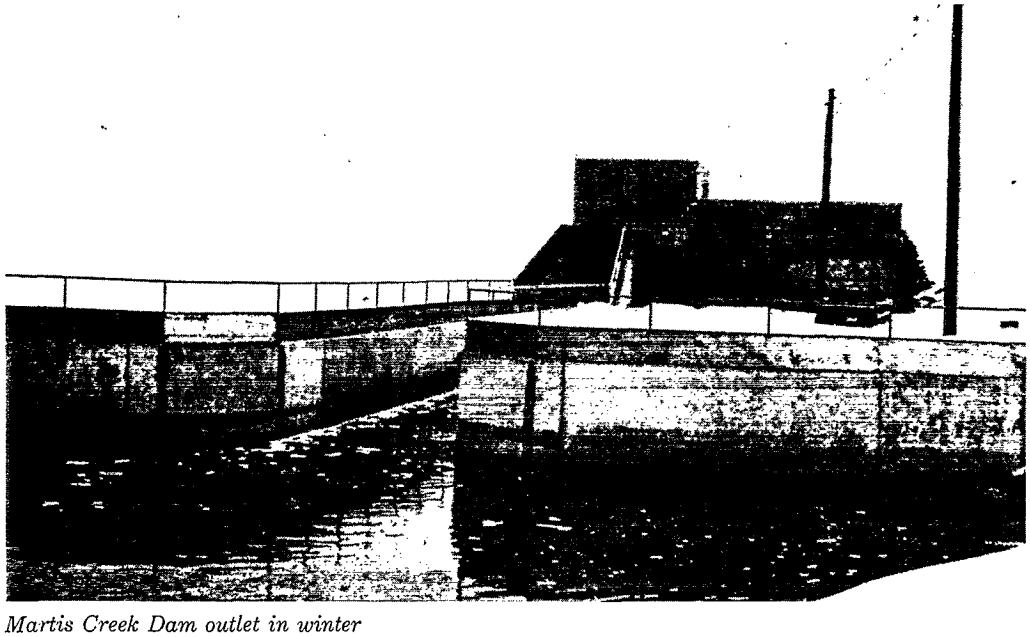
Floods in the territory are usually the result of general rain in late fall and winter, but may also result from intense local rainstorms in spring and early summer. In addition to inundation, floods in the North Lahontan Territory characteristically cause land damage, including severe bank and channel erosion. The Susan River, streams in Surprise Valley, and streams tributary to Lake Tahoe have critical erosion problems. This is a particularly serious condition around Lake Tahoe where streamside areas are undergoing urban development. In part, the high intensity rainfall and rapid runoff that may result from summer thunderstorms compounds flood problems of the territory.

MULTIPURPOSE PROJECT

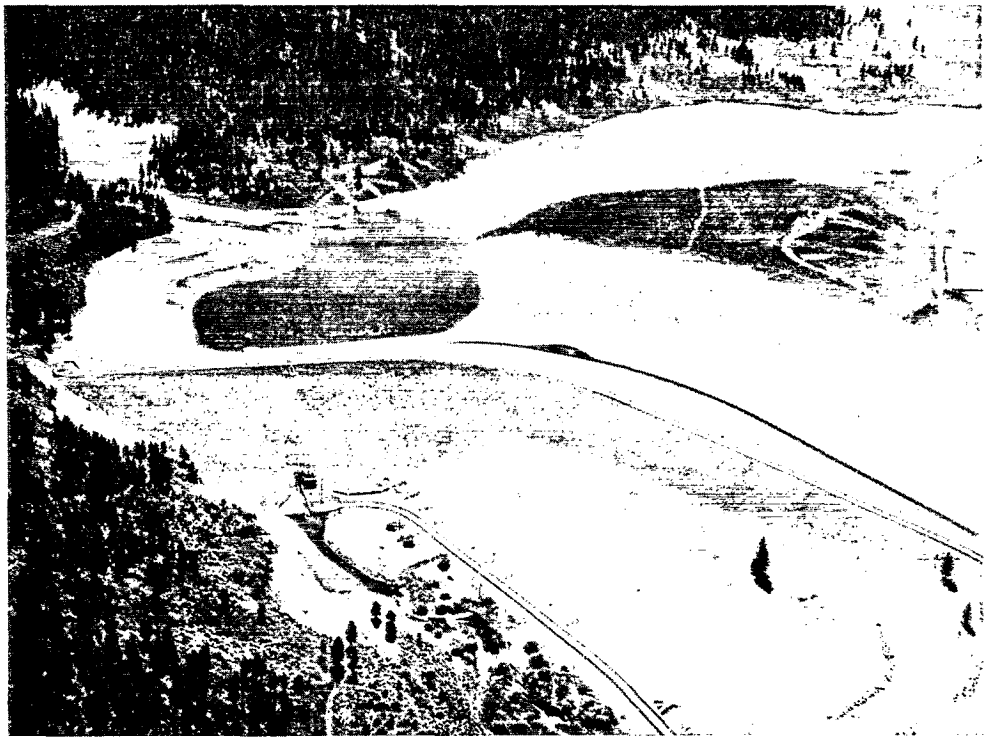
Martis Creek Lake

Martis Creek is a tributary to the Truckee River. Martis Creek Lake is located about 2 miles above the mouth of the creek and 4 miles easterly of the community of Truckee. Started in 1967 and completed in 1974, the major element of the project is an earthfill dam 113 feet high and 2,670 feet long. Storage capacity of the lake, which serves flood control, recreation, and (future) water supply functions, is 20,400 acre-feet.

60miles



Martis Creek Dam outlet in winter



Martis Creek Dam

Martis Creek Lake is an important unit of the comprehensive plan for flood protection in the Truckee River Basin. Its principal purpose is to reduce floodflows in the Truckee River through Reno, which is about 30 river miles downstream (northeasterly) from the project. For proper project functioning, about 1 mile of channel improvement work was required along the river in Reno. These improvements consisted of modifying and extending existing floodwalls to provide a flow capacity of 14,000 cubic feet per second through the city. Martis Creek Lake, the channel work in Reno, and three U.S. Bureau of Reclamation Section 7 projects in the basin combine to afford Reno a fairly high degree of flood protection, and a moderate degree of protection along all reaches of the Truckee River from the mouth of Martis Creek downstream to the terminus of the river in Pyramid Lake. A picnic area and campground administered by the Corps of Engineers have been provided at Martis Creek Lake, which is popular for fishing.

Federal cost of Martis Creek Lake was about $8,500,000. Local interest cost for associated channel improvement work in Reno was about $100,000. Local interests must maintain the improved channel, including removal of bed load material and debris following floods, to assure the carrying capacity of 14,000 cubic feet per second.

COOPERATIVE PROJECT

Truckee River Reservoirs

There are three Section 7 projects in the North Lahontan Territory. These are Boca and Stampede Reservoirs on the Little Truckee River, and Prosser Creek Reservoir on Prosser Creek. Built by the Bureau of Reclamation primarily for irrigation, these projects aggregate about 300,000 acre-feet of storage, 50,000 acre-feet of which may be operated for flood control. They are operated in conjunction with Martis Creek Lake primarily to reduce the flood hazard to Reno.

FLOOD CONTROL PROJECT

Truckee River Improvement

Flood control improvements authorized under this project are located in California and Nevada. This discussion, however, is limited to those in California where authorized project works consist of discontinuous channel improvements between Lake Tahoe and Truckee, and enlarging the stream channel for a short distance downstream from the Lake Tahoe outlet structure.

During late spring and early summer, high stages in Lake Tahoe frequently damaged lakeshore resorts and residences, damaged piers and beaches, and reduced beach area available to visitors. Increasing the capacity of the outlet channel permits greater releases from the lake, thus reducing shoreline damage from high lake stages. It also permits better control of lake stage during periods of high wind, and affords flexibility in the control of peak snowmelt runoff from the Truckee River Basin. Project works in California and Nevada were designed to function as integral parts of the basin-wide plan of improvement for flood control.

Federal cost of improving the outlet channel, which was completed in 1960, was about $225,000. Associated local interest cost was about $20,000 for needed land, right-of-way, and utility relocations. The discontinuous channel improvement work between Lake Tahoe and Truckee has been deferred indefinitely at the request of the State of California.

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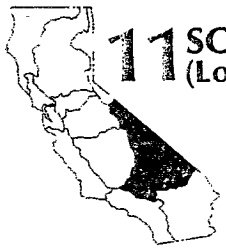
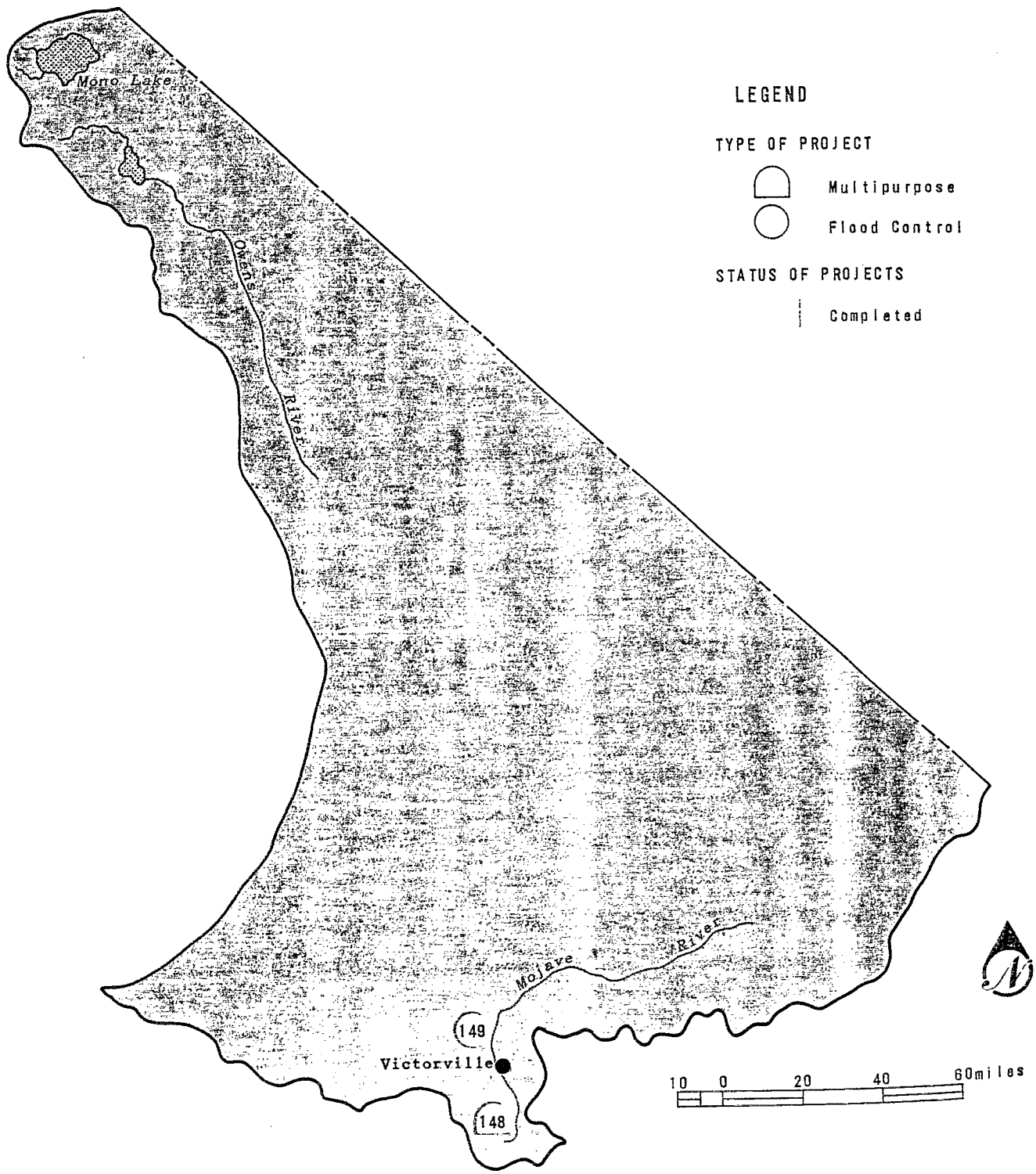


11 SOUTH LAHONTAN TERRITORY
(Los Angeles District)



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FLOOD CONTROL		
149	Oro Grande Wash Channel, Victorville (Small Flood-Control Project) (37)	152

[1]Number following project name denotes Congressional District.

DESCRIPTION

The South Lahontan Territory is a sparsely inhabited, strikingly beautiful area of desert and mountains. Situated along the California-Nevada border, it includes the eastern portion of Los Angeles and Kern Counties, all of Inyo County, and parts of San Bernardino and Mono Counties. The territory is characterized by great contrasts: the highest and lowest spots in the continental United States—Mount Whitney and Death Valley—pristine lakes in the high, heavily timbered Sierra Nevada, and miles of dry, alkaline flats in low desert areas. Annual precipitation ranges from about 2 inches in desert areas to about 50 inches in the high mountains. The principal streams in the territory include the Mojave, Amargosa, and Owens Rivers, and Big Rock, Little Rock, Furnace, and Bishop Creeks.

Two types of storm may produce floods in the territory: the occasional winter storm that may last as long as 4 days, and sudden, short-duration thunderstorms that can occur anytime from spring through fall. Thunderstorms produce high intensity rainfall that constitutes a severe but lesser threat than winter rainstorms.

Barstow, Bishop, Lancaster, Palmdale, California City, Ridgecrest, and Victorville are the major uban centers of the South Lahontan Territory. Agriculture, mining, defense activities related to flight testing and research, and recreation—particularly in Death Valley and the Mono Lake-Owens Valley areas—are the major economic activities. Population is projected to increase from about 260,000 in 1978 to 470,000 in the year 2000. Land use is changing as agricultural and unused lands are developed for residential, commercial, and industrial uses. Major improvements for flood control have not been warranted in the territory because development has been so limited. With changing land use and increasing population, however, existing flood problems will magnify and new problems will develop. Erosion problems are proportional to flood problems and less than 50 of 23,500 miles of streamway are improved with limited capacity levees and rectified channels. Also, about 50 miles of streambank stabilization work has been done. It is estimated that 3,600 miles of streamway are subject to erosion.

Although projects now existing or under study will prevent some of the flood damage expected in the future, additional levee and channel projects and flood detention structures are needed to control floodflows and provide flood carrying capacity. Flood plain management must also become a significant part of urban and rural planning in the territory. Water supply, always a problem in this largely desert region, is being augmented by the State Water Project. Any flood control plans developed by the Corps of Engineers would also provide for conservation of floodwater to replenish the underground supply, which is being overdrawn in Antelope Valley and the

miles

Mojave River Basin. Also, any proposals by the Corps of Engineers would recognize the need to protect the fragile desert and mountain ecology of the territory.

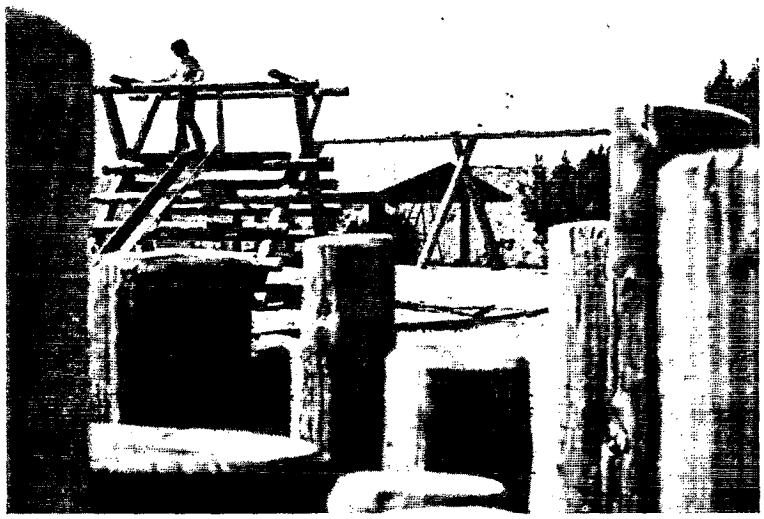
MULTIPURPOSE PROJECT

Mojave River Dam

Mojave River Dam is a rolled earthfill structure on the Mojave River about 14 miles upstream from Victorville. It is 2,200 feet long and 200 feet high at the crest, and can impound 89,700 acre-feet of floodwater. The dam protects Victorville and Barstow, about 19,000 acres of agricultural lands, and important surface transportation facilities. It also provides incidental water conservation benefits by controlling peak flood inflow to sustained outflows that recharge the ground water basin downstream. Cost of the project was $18,100,000 Federal and $290,000 non-Federal expenditure.

Recreation facilities available in the project area include a camping-picnicking area, a trailer camp, natural areas, an equestrian area, and an overlook that affords a view of the project as well as the surrounding desert. By using materials such as rough-sawn lumber, used railroad ties, boulders, and slump stone, the Corps has attempted to develop the project areas in accord with the surrounding environment and the history of the area. Measures taken to beautify the project included protecting existing ground cover, shrubs, and stands of trees, and planting other indigenous species.

Mojave River Dam provides flood protection to Victorville and Barstow



Rustic recreation areas at Mojave River Dam reflect the character of the region

FLOOD DAMAGE PREVENTION STUDY

Antelope Valley Streams

An investigation of streams in Antelope Valley was started in 1970. Its purpose is to determine the need for flood control, water conservation, and related improvements in a rapidly developing area that includes Palmdale, Lancaster, and Edwards. The population of this once-rural valley was about 140,000 in 1978. It is expected to increase to about 250,000 by the year 2000 due to spillover from the Los Angeles metropolitan area. This will substantially increase potential loss from future floods in the valley.

During the 1969 floods, three lives were lost and damage totaled $2,200,000. Roads and railroads, bridges, power and telephone facilities, and residential, business, and agricultural properties were damaged. Multipurpose reservoirs in foothill areas, debris basins, channel improvements on the valley floor, and flood plain management measures are being examined. The investigation is scheduled for completion in 1981.

SMALL FLOOD-CONTROL PROJECT

Oro Grande Wash Channel, Victorville

A small flood-control project on Oro Grande Wash was completed in 1969 at a cost of $1,500,000, of which $500,000 was provided by local interests. The project consists of inlet levees and a 1.25 mile concrete channel extending from the southeast limits of Victorville to the Mojave River. Victorville, which lies in the natural swale of Oro Grande Wash, is afforded protection by the project.

In constructing Oro Grande Wash Channel, esthetic as well as economic factors were carefully considered. Consequently, the upper part of the project (2,150 feet of open channel) is between city streets, thus permitting development on each side of the channel and along the streets. One segment in this reach skirts a park, but has only minimal effect on park activities. About 4,290 feet of project channel, the lower portion, is underground and does not interfere with any city activities. During floods that occurred early in 1978, the improvement prevented damage estimated at $600,000.

Oro Grande Wash Channel provides a reasonable degree of flood protection to Victorville. It does not, however, provide protection against all floods. The populace of Victorville knows that damage would result from a very large flood. Although the occurrence of such a large flood would be extremely rare, it is a definite hazard and could cause extensive damage to residential, commercial, and public properties in the overflow area. At the present time, study of this problem is not authorized.

12 COLORADO DESERT (Los Angeles District)

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154	Tahchevah Creek Detention Basin and Channel Improvements (37)	154
155	Tahquitz Creek Project (37)	155

[1]Number following project name denotes Congressional District.

LEGEND

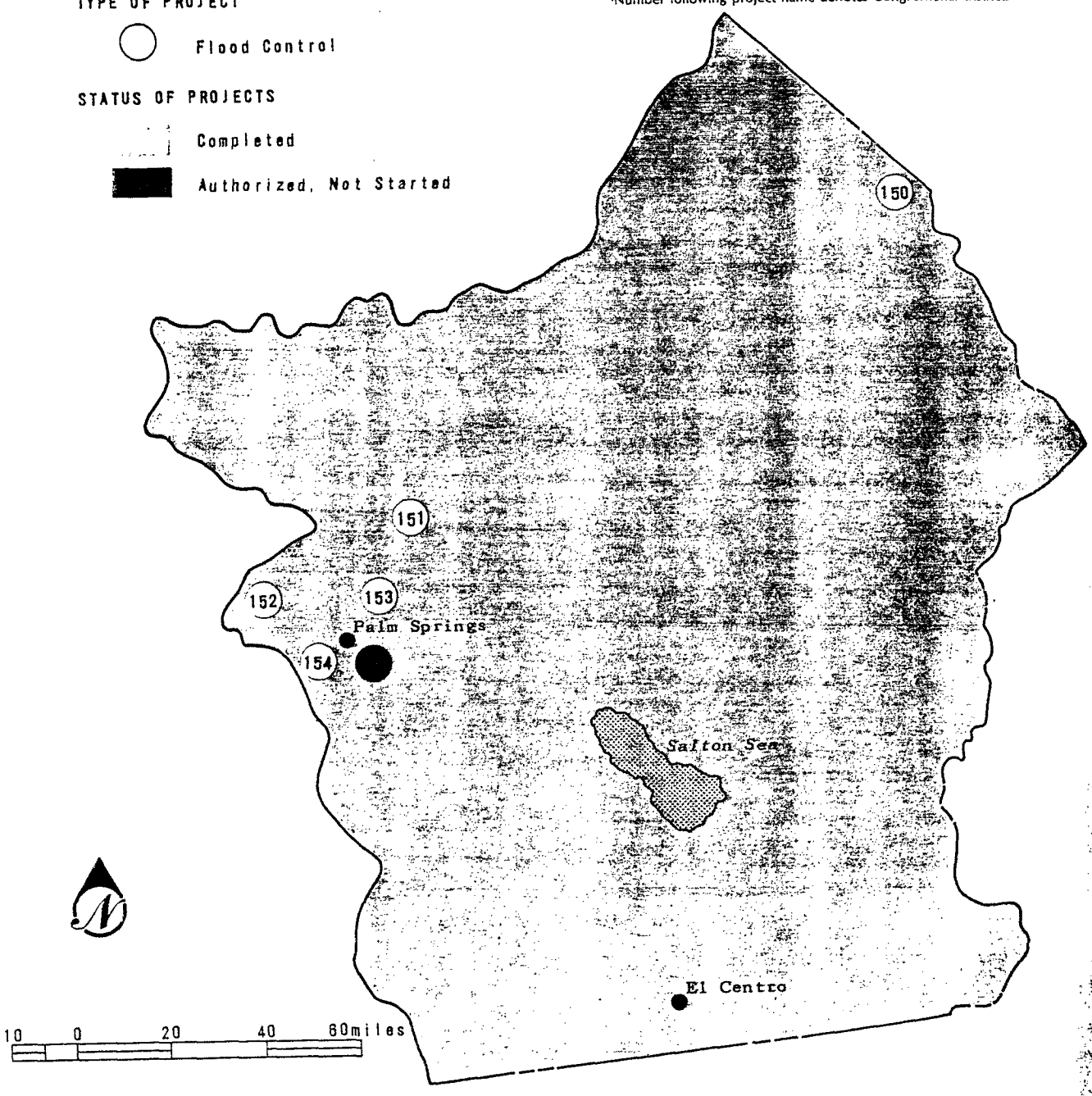
TYPE OF PROJECT

Flood Control

STATUS OF PROJECTS

Completed

Authorized, Not Started



DESCRIPTION

The southeastern corner of California is occupied by the Colorado Desert. In California, this region consists of a number of closed basins, numerous low mountain ranges, and all of the tributary drainage of the Colorado River. High mountains border the region on the west. About half the Colorado Desert area is valley and mesa land and the remainder is mountainous. Its arid climate is typified by short, mild winters and exceptionally hot, dry summers with extremely low humidity. There is, however, marked contrast between day and night temperatures during all seasons of the year. Three-fourths of the annual precipitation—2½ to 5 inches in the valley and mesa lands to as much as 40 inches in the highest mountain areas in the western portion—occurs from December through April. Snow frequently occurs in the high mountain areas.

The major streams in the Colorado Desert are the Whitewater, Colorado, New, and Alamo Rivers. All of these streams except the Colorado drain into the Salton Sea. The New and Alamo Rivers are old overflow channels of the Colorado River that flow north from Mexico and now carry only wastewaters from irrigated lands in the Imperial Valley (California) and Mexicali Valley (Mexico). None of the streams directly tributary to the Colorado River has perennial flow. In general, very little streamflow occurs in the subregion except at high elevations in the winter and spring months and in the desert valleys immediately after rainstorms. Most damaging floods result from general winter storms originating over the North Pacific Ocean. These storms occasionally last as long as 4 days and result in rainfall over large areas. Some damaging flooding results from intense rainfall accompanying tropical hurricanes that originate off the west coast of Mexico and move north of their usual path to pass over Southern California. Thunderstorms may result in short-duration high-intensity rainfall over small areas either independently or in conjunction with general storms.

The economy of the Colorado Desert is based principally on irrigated agriculture in the Imperial, Coachella, and Palo Verde Valleys, which are noted for citrus fruits, dates, table grapes, and off-season vegetables. The long growing season permits as many as three crops in 2 years in some localities. In winter, the mild, dry climate makes the desert an outstanding resort area that attracts visitors from many parts of the world. Palm Springs is considered to be one of the most fashionable desert winter resorts in the United States. Desert Hot Springs and Twentynine Palms are also popular wintering areas. Other urban centers are Banning, Blythe, Brawley, Calexico, Calipatria, and Needles. Population of the region, about 280,000 in 1978, is projected to increase to about 430,000 by the year 2000.

Although some areas in the Colorado Desert are protected by flood control improvements, flood problems exist where improvements are lacking, or where existing measures are inadequate. With about 2,000 miles of a total of 15,400 miles of streambank subject to erosion, and 160 miles severely eroded, bank stabilization is a serious problem. Land erosion from the steeper areas of watersheds results in serious sediment deposition problems in the valleys.

FLOOD CONTROL PROJECTS

Tahchevah Creek Detention Basin and Channel

A 945 acre-foot capacity flood detention basin and related improvements on Tahchevah Creek in Palm Springs were completed in 1965. Specifically, the basin is formed by an earthfill embankment about 2,000 feet long and 43 feet high at the mouth of Tahchevah Creek Canyon in west-central Palm Springs. An underground conduit extends from the embankment downstream to near the junction of Tahchevah and Baristo Creeks, and an open concrete channel extends from the conduit to Baristo Creek. The cost of these improvements was $2,800,000, which was shared equally by the Federal Government and the local interests. Palm Springs and part of the Agua Caliente Indian Reservation are protected by the project.

Tahchevah Creek Detention Basin

Tahquitz Creek Project

Authorized in 1965, the Tahquitz Creek Project would provide for a 645,000 cubic yard capacity debris basin at the mouth of Tahquitz Creek Canyon in the southwest section of Palm Springs, and for a channel from the debris basin downstream to the junction of Tahquitz Creek and Palm Canyon Wash. This project would protect residential, commercial, and public property in Palm Springs. Preconstruction planning has been completed, but the project is classified "inactive" because the debris basin would be on tribal lands and it is opposed by the Agua Caliente Band of Mission Indians. The future of the project is uncertain.

FLOOD DAMAGE PREVENTION STUDY

Whitewater River

A flood damage prevention study of the Whitewater River from Banning downstream to the Salton Sea has been under way intermittently since its authorization in 1937. Its purpose is to determine whether additional improvements for flood control are justified on the basis of current and expected future development in the study area, which extends for 70 miles along the river and covers a tributary area of 1,950 square miles. Flood damage in the Whitewater River Basin has exceeded a total of $38,000,000 since 1965. Population of the study area, about 130,000 in 1978, is expected to increase to about 195,000 by the year 2000.

Existing improvements comprise Tahchevah Creek Detention Basin and Channel, Chino Canyon Improvements Project, and Banning Levee. The Tahquitz Creek Project is authorized, but currently classified "inactive." Major problems to be examined as part of this study include protection of agricultural lands in the lower basin, protection of rapidly growing desert communities along the river and its tributaries, ground water recharge that may result from controlling floodflows, and provision of facilities for water-oriented recreation. Single and multiple purpose reservoirs, debris basins, levees, and channel improvements are being considered in developing a comprehensive plan. The study is scheduled for completion in 1981.

SMALL FLOOD-CONTROL PROJECTS

Banning Levee

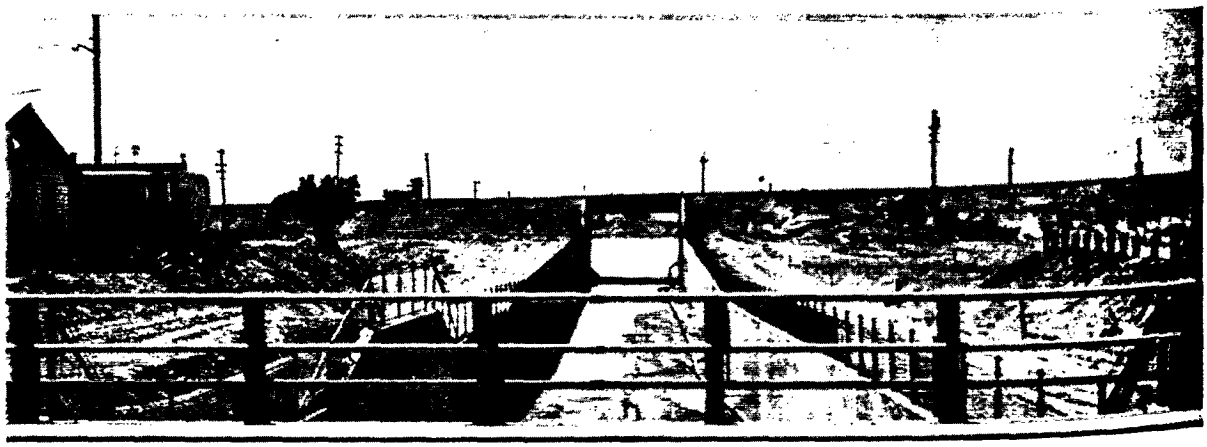
Completed at a Federal cost of $98,000 in 1965, the small flood-control project at Banning consists of 0.4 mile of revetted levee along the right side of the San Gorgonio River at Banning. Local interests provided lands, easements, and rights-of-way at an estimated cost of $20,000. Since its completion, the levee has prevented damage estimated at $145,000.

Chino Canyon Improvements

The Chino Canyon Improvement Project protects about 9,000 acres of residential, commercial, and public property in Palm Springs. Completed in 1972, the project consists of 3.4 miles of levee, 1.6 miles of excavated channel, and 11 directional groins, all located on the right bank of the Whitewater River and on the alluvial cone of Chino Canyon. Cost of the project was $1,150,000, of which $820,000 was Federal and $330,000—including a $10,000 cash contribution—was non-Federal expense. In 1978, the project prevented flood damage estimated at $1,700,000.

Needles, San Bernardino County

A small flood-control project to protect Needles from floods on "S" Street and Sidewinder Washes was completed in 1973. Project improvements, which are on "S" Street Wash, consist of two inlet levees, concrete channel, unlined diversion channel, diversion levees, and two deflection levees. The cost of project improvements was $1,760,000, of which $978,000 was Federal and $782,000 was local interest expense.



Part of the Needles small flood-control project

Quail Wash Levee

Quail Wash Levee prevents Quail Wash floodflows from flowing westerly through the community of Joshua Tree. Completed in 1961, the project consists of 1½ miles of levee with grouted stone revetment. Federal cost of the improvement was $213,000. Local interest cost for lands, easements, and rights-of-way was $39,000.

13 FLOOD PLAIN MANAGEMENT SERVICES

INTRODUCTION

Despite the outlay of billions of tax dollars for flood control structures, the Nation continues to be confronted with an ever-increasing annual bill for flood damage, as well as the need to spend untold amounts during flood emergencies and for recovery in post flood periods. The threat floods pose to human life cannot be expressed in terms of dollars. The dilemma of the continuing threat to life, mounting flood damage, and ever-increasing costs for flood control structures results from the fact that lands subject to flooding—the flood plains—are encroached upon more rapidly than flood control works can be built. Further, future floods greater than those for which most projects can economically be built can reasonably be expected. During the past 10-15 years, this dilemma has led to recognition of an approach to flood damage reduction that involves control over the use of flood plain lands, separately or in combination with control of floodwaters. This approach is known as "flood plain management."

Flood plain management implies identifying the nature of flood hazards, and using that basic information to protect lives and to prevent or minimize flood damage by conventional measures, nonconventional measures, or combinations of these approaches. Conventional measures are corrective in nature and involve control of floodwater by dams, levees, or other structures. Nonconventional measures are preventive in nature and involve control over the use and development of flood plain lands by zoning ordinances, building codes, subdivision regulations, and other related measures such as flood proofing, temporary and permanent flood plain evacuation, tax adjustments, and flood insurance. The power to control the uses of flood plains rests with local governments. Exercise of this power is not only the prerogative of local government, it is its responsibility.

The Flood Plain Management Services Program of the Corps of Engineers originally developed in response to local need for information and assistance in guiding development of flood plains in a way that would minimize future flood hazards and damage, but permit optimum use of flood prone lands. Under the program, the Corps of Engineers prepares flood plain information reports, provides technical assistance and guidance, conducts related research on various phases of flood plain management, and plans long range flood plain management activities. The program also provides for flood hazard evaluations of specific sites when an improvement is to be federally built, federally financed, or involved in a federally administered program, or when disposal of Federal land and improvements is involved.

FLOOD PLAIN INFORMATION REPORTS

Flood plain information reports are prepared at the request of local interests to delineate flood problems in specific communities or along specific stream reaches in suburban and rural areas. In carrying out previously assigned responsibilities for flood control, the Corps of Engineers has gathered much data on flood hazards and historical floods. These data may be assembled as they relate to the community or area under study. When necessary, additional land surveys may be made, additional research on floods conducted, and new hydrologic studies undertaken to develop data needed for a flood plain information report. A typical report includes maps or mosaics, flood profiles, charts, tables, photographs, and narrative material on the extent, depth, and duration of past floods, and similar data on large floods that may reasonably be expected in the future.

In total, over 100 flood plain information reports for areas in California have been or will be completed. These reports are summarized by hydrographic area as follows:

North Coastal Basins

Eel River, Stafford to Holmes
Freshwater Creek, Eureka Area
Lake Earl, Lake Talawa, and lower Smith River
South Fork Eel River:
    Phillipsville to Garberville
    Weott to Meyers Flat
Trinity River, Lewiston Lake to Junction City
Van Duzen River, Poverty Flats Area

San Francisco Bay Area

Alamitos-Calero Creeks, Santa Clara County
Coyote Creek, Santa Clara County
Fisher Creek, Santa Clara County
Green Valley, Dan Wilson, and Suisun Creeks, Solano County
Guadalupe River. Santa Clara County
Penitencia Creek, Santa Clara County
Rush Creek, Marin County
Sonoma Creek Basin, Sonoma County

Central Coastal Basins

Aptos Creek, Santa Cruz County
Carmel River, Monterey County
City of Santa Barbara Streams
Corralitos Creek, Santa Cruz County
Llagas Creek (Unit I), Santa Clara County
Montecito Streams
San Benito River, San Benito County

San Felipe Lake (Unit II), San Benito County
San Felipe Lake and Pacheco Creek (Unit I), San Benito County
San Lorenzo River-Boulder and Bear Creeks, Santa Cruz County
San Luis Obispo Creek and Tributaries
San Luis Rey River
Santa Ynez River:
    Cachuma Dam to Buelton
    Lompoc to the Ocean
Soquel Creek, Santa Cruz County
Uvas-Carnadero Creek, Santa Clara County

South Coastal Basins

Agua Hedionda Creek, San Diego County
Aliso Creek, Orange County
Buena Vista Creek from Vista to the Ocean
Calleguas and Conejo Creeks, Camarillo
Calleguas Creek:
    From Somis to the Ocean
    In the Vicinity of Moorpark
Escondido Creek, San Diego County
Laguna Canyon, Orange County
Las Chollas Creek, San Diego County
Los Penasquitos Drainage Area, San Diego County
Lower Santiago Creek, Orange County
Rose and San Clemente Canyons, San Diego County
Salt Creek, Riverside County
San Antonio Creek, Ventura County
San Diego Creek and Peters Canyon Wash, Orange County
San Jacinto River from San Jacinto to Railroad Canyon
San Juan Creek including Arroyo Trabuco and Oso Creek, Orange County
San Marcos Creek, San Diego County
San Timoteo Creek, San Bernardino County
Santa Ana River from Imperial Highway to Prado Dam, Orange County
Santa Clara River:
    From Saticoy to the Ocean
    In the Vicinity of Piru
    In the Vicinity of Santa Paula
    In the Vicinity of Sespe
Spring Valley Creek, San Diego County
Sweetwater River and Coyote Creek, San Diego County
Ventura River, Ventura County
Wilson and Wildwood Creeks, San Bernardino County
Keys Canyon, San Diego County
Moosa Canyon, San Diego County
Otay River, San Diego County
Point Mugu Naval Weapons Center, Ventura County
Upper Peters Canyon Wash, Orange County
Upper San Diego Creek Tributaries, Orange County

Sacramento Basin

Antelope Creek, Secret Ravine and Tributaries, Rocklin
American River Flood Plain
Big Valley Streams, Kelseyville
Churn Creek, Enterprise
Clover Creek, Stillwater Creek, and Stillwater Creek Tributaries, Loomis Corners
Cow Creek, Palo Cedro
Dry Creek and Tributaries, Roseville
Feather River, Nicolaus
Feather and Yuba Rivers, Marysville-Yuba City
Morrison Creek Basin
North Yuba and Downie Rivers, Downieville
Northeastern Sacramento County Streams
Sacramento River and Cottonwood and Battle Creeks, Cottonwood-Bend Area
Sacramento River, Anderson and Olinda Creeks, and Spring Gulch, Anderson
Sacramento River, Redding
Snodgrass Slough Flood Plain

Delta-Central Sierra Area

Alamo and Ulatis Creeks
Cosumnes River Basin
Northeast Stream Group (Calaveras River; Mormon Slough; and Bear, Mosher, and Paddy Creeks), Stockton
Southwest Stream Group (San Joaquin and Calaveras Rivers, Bear and Lower Mosher Creeks, and Disappointment and Fourteen Mile Sloughs), Stockton
Southeast Stream Group (Duck, Littlejohns, and Lone Tree Creeks), Stockton
Southwest Stream Group (San Joaquin River, Mormon Channel, Duck Creek, and Walker and French Camp Sloughs), Stockton

San Joaquin Basin

Fresno River and Cottonwood, Root, and Little Dry Creeks, Vicinity of Madera

Tulare Lake Basin

Deer Creek and White River, Earlimart
Kaweah River, Three Rivers
Kern River:
    Bakersfield
    Kernville
Kings River, Sanger
Sand and Cottonwood Creeks and Lower Kaweah River, Visalia
Sandy Creek, Taft and Ford City
Tule River, Springville
Numerous streams along the west side of the San Joaquin Valley were investigated in 1965 to develop flood damage data, hydrologic data, and information on the extent of flood plains. Most of the streams studied were in the Tulare Lake Basin. This study was requested and funded by the State of California to acquire data for use in the design and construction of the California Aqueduct and the Westside Freeway (Interstate 5). The streamcourses studied in detail were: Arroyo Robador; Bitterwater, Santiago, San Emigdio, Pleito, and Pastoria Creeks; streams near Lost Hills; and streams in Buena Vista Valley (Tulare Lake Basin); Del Puerto Creek (San Joaquin Basin); and Corral Hollow Creek (Delta-Central Sierra Area).

FLOOD PLAIN MANAGEMENT SERVICES

North Lahontan Territory

Trout and Bijou Creeks, South Lake Tahoe
Truckee River, Tahoe City
Truckee River and Martis Creek, Truckee
Upper Truckee River, South Lake Tahoe

South Lahontan Territory

China Lake Naval Weapons Center, Kern County
China Lake Tributaries, Ridgecrest, Kern County
El Mirage and Copper Dry Lakes, San Bernardino County
Mojave River:
Vicinity of Barstow
Vicinity of Victorville

Colorado Desert

New River in the Vicinity of Brawley
San Gorgonio River and Smith Creek, Riverside County
San Gorgonio Tributaries (except Smith Creek), Riverside County

TECHNICAL ASSISTANCE AND GUIDANCE

The Corps of Engineers stands ready to provide technical assistance and guidance to Federal, state, and local agencies in the interpretation and application of data in flood plain information reports. This includes providing additional data pertinent to but not published in flood plain information reports, assisting in preparing flood plain regulations, suggesting viable floodways, and evaluating the effects of such floodways. Technical assistance also includes furnishing generalized information on corrective and preventive flood damage reduction measures.

The Corps of Engineers will assist and guide Federal, state, and local agencies in the decision making process where flooding and flood hazards are involved. This may include making special evaluations to provide information needed to decide wisely about the location of public buildings, other publicly owned facilities, subdivision developments, or other improvements where there is a Federal interest. Similar information is furnished to individuals and business interests if data are readily available from files. In California, responses have been made to approximately 7,000 requests for technical assistance and guidance.

GUIDANCE MATERIALS AND RESEARCH

The Flood Plain Management Services Program includes research studies to improve methods and procedures for flood damage prevention and abatement, and the preparation of guides and pamphlets on flood proofing, flood plain regulations and the economics thereof, flood plain occupancy, and other related approaches to flood damage prevention. The guides and pamphlets are for use of state and local governments, private citizens, and Federal agencies in planning and taking action to reduce flood damages or damage potential.

Research efforts related to the program are conducted by or under the close direction of the Chief of Engineers. The research effort includes studies of and means for illustrating alternative ways of coping with flood damages for the benefit of the growing number of local, state, and Federal officials concerned with flood problems. This requires investigation of the applicability and potential combinations of alternative methods of flood damage reduction, and study of the acceptability of various alternative or complementary measures. These activities are closely coordinated with related research programs of other Federal agencies and the various states.

Among other publications, booklets on flood proofing, corrective and preventive alternatives in flood damage reduction, generalized and illustrated guidelines to flood damage reduction, and how to obtain flood plain management services have been published under the guidance and research phase of the Flood Plain Management Services Program. These booklets may be obtained from any Division or District Office upon request.

FLOOD PLAIN MANAGEMENT PLANNING

Comprehensive flood damage prevention planning leading to sound flood plain management at all levels of government is the basic objective of the Flood Plain Management Services Program. The Corps of Engineers, working with and through the proper agencies, provides engineering, technical assistance, and guidance. Through close contacts and understanding, Federal, state, and local officials are brought fully into planning actions and appropriate consideration is given to alternative or supplementary measures. Thus, the planning effort considers flood control structures, flood proofing, flood forecasting, zoning, subdivision regulations, building codes, local policies, and other elements to find the best solution to a given flood problem.

EXPANDED FLOOD PLAIN INFORMATION STUDY

As described earlier, a traditional flood plain information study report includes illustrative and narrative materials on the depth, extent, and duration of past floods in a given locality, and similar data on large floods that may reasonably be expected in the future. Essentially, the report and its illustration are a static representation because the traditional studies are based on existing conditions in the area studied and do

not consider the impacts of possible future land use changes on flood characteristics. Definition of flood stages and flooded areas for existing conditions is an essential first step in solving flood problems, but this does not furnish all the answers needed in a comprehensive flood plain management program. Some of the problems not covered by traditional studies are:

The impact of future urban development on frequency and depth of downstream flooding.

The effects of added fill or other flood plain encroachment on flood stages and flood damage.

The effects of future land use changes, both on and off the flood plain, on water quality, wildlife habitat, and other environmental factors.

The expanded flood plain information study addresses these and many other problems relating to the impacts of future land use changes on flood plain characteristics. It defines existing hydrologic, economic, and environmental conditions, and evaluates the effects of a wide range of future land use changes that logically might occur. The study methodology involves coding land use, topographic, soil classification, hydrologic, and other factors into computerized data files, and use of computer programs for computation, analysis, and the return of specific information for display or further use. Thus, a computerized planning tool that can be used to evaluate the impact of proposed changes in land use is made available to state and local planning agencies.

An expanded flood plain information study has been authorized for Sonoma Creek Basin, Sonoma County. It is discussed in Chapter 15. Other expanded studies in California may be authorized.

THE NATIONAL FLOOD INSURANCE PROGRAM

Until a few years ago, insurance against flood losses was available but prohibitively expensive. Now, however, flood insurance in flood prone communities is available at very reasonable rates under the National Flood Insurance Program. A cooperative effort of the Federal Government and the private insurance industry, the program is administered by the Federal Insurance Administration, Department of Housing and Urban Development. In return for making low cost federally subsidized insurance available for property in flood plains, the program places certain obligations upon communities wishing to participate. They are required to adopt and enforce land-use and other control measures that will guide new development in flood prone areas so that flood damage is avoided or reduced.

The role of the Corps of Engineers in the Flood Insurance Program is making hydrologic and hydraulic studies necessary to establish actuarial flood insurance premium rates that reflect the flood hazard. The findings of the hydrologic and hydraulic studies are reported to the Federal Insurance Administration together with maps, other illustrations, information on historical floods, and information on floods that may be expected in the future. Flood insurance study reports made by the Corps of Engineers for places in California are summarized by hydrographic area as follows:

North Coastal Basins

Klamath Townsite

San Francisco Bay Area

Berkeley
Concord
Cotati
Foster City
Fremont
Guerneville
Hayward
Healdsburg
Livermore
Marin County
Martinez
Mill Valley
Napa County
Novato
Oakland
Palo Alto
Petaluma
Pleasant Hill
Pleasanton
Richmond
Rohnert Park
San Pablo
Santa Rosa
Sonoma
Sonoma County
South San Francisco
Sunnyvale
Union City
Vallejo
Walnut Creek

Central Coastal Basins

Arroyo Grande
Grover City
Lompoc
Pismo Beach
San Luis Obispo
San Luis Obispo County
Santa Barbara
Santa Barbara County
Santa Maria

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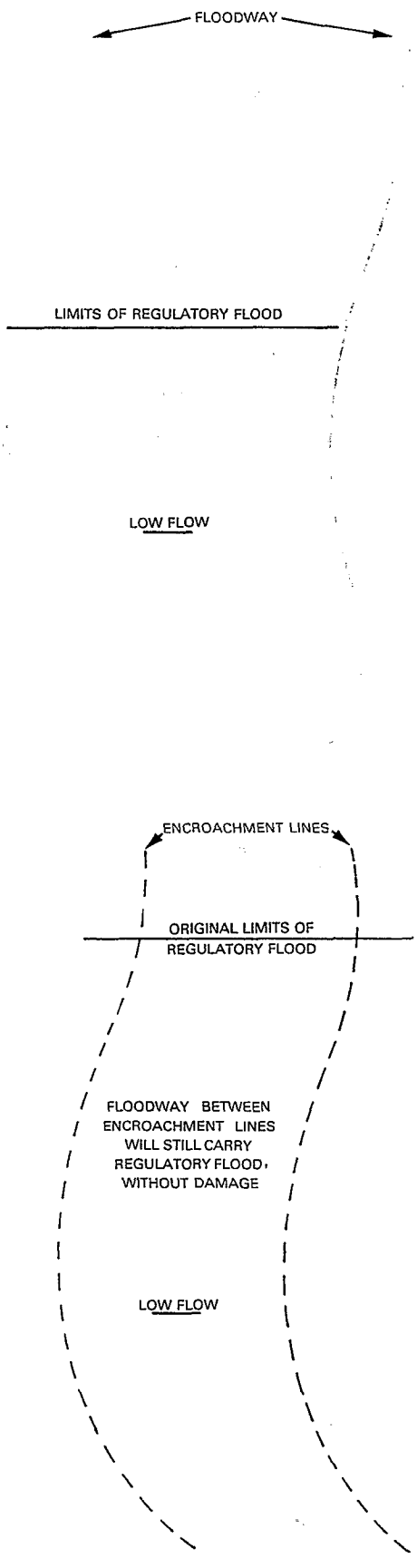
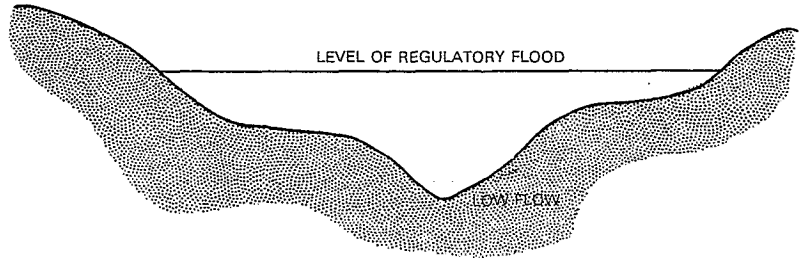
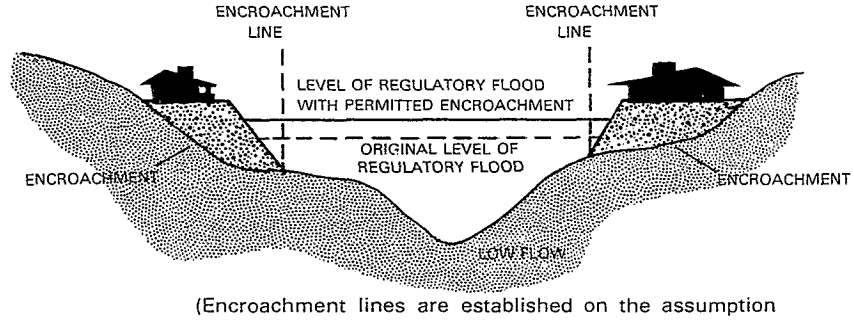
Designated Floodways and Encroachment Lines—
One approach to flood damage reduction.



NATURAL FLOOD PLAIN WITHOUT ENCROACHMENTS



FLOOD PLAIN WITH ENCROACHMENTS

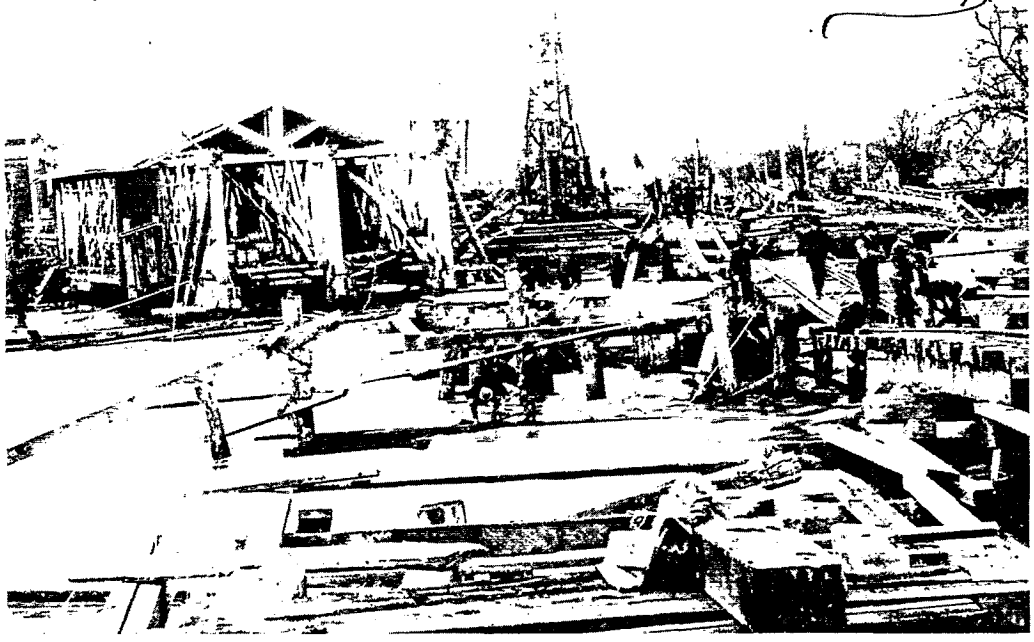


(Encroachment lines are established on the assumption that the area landward will be ultimately developed in such a way that it will not be available to convey floodflows. It is further assumed that the hydraulic efficiency of the floodway between encroachment lines is preserved by periodic removal of undesirable vegetation and by not permitting it to become a dumping ground. Between periods of high flows, the land between encroachment lines could be used for a parkway with hiking trails, bike trails, and flood resistant rest stops.)

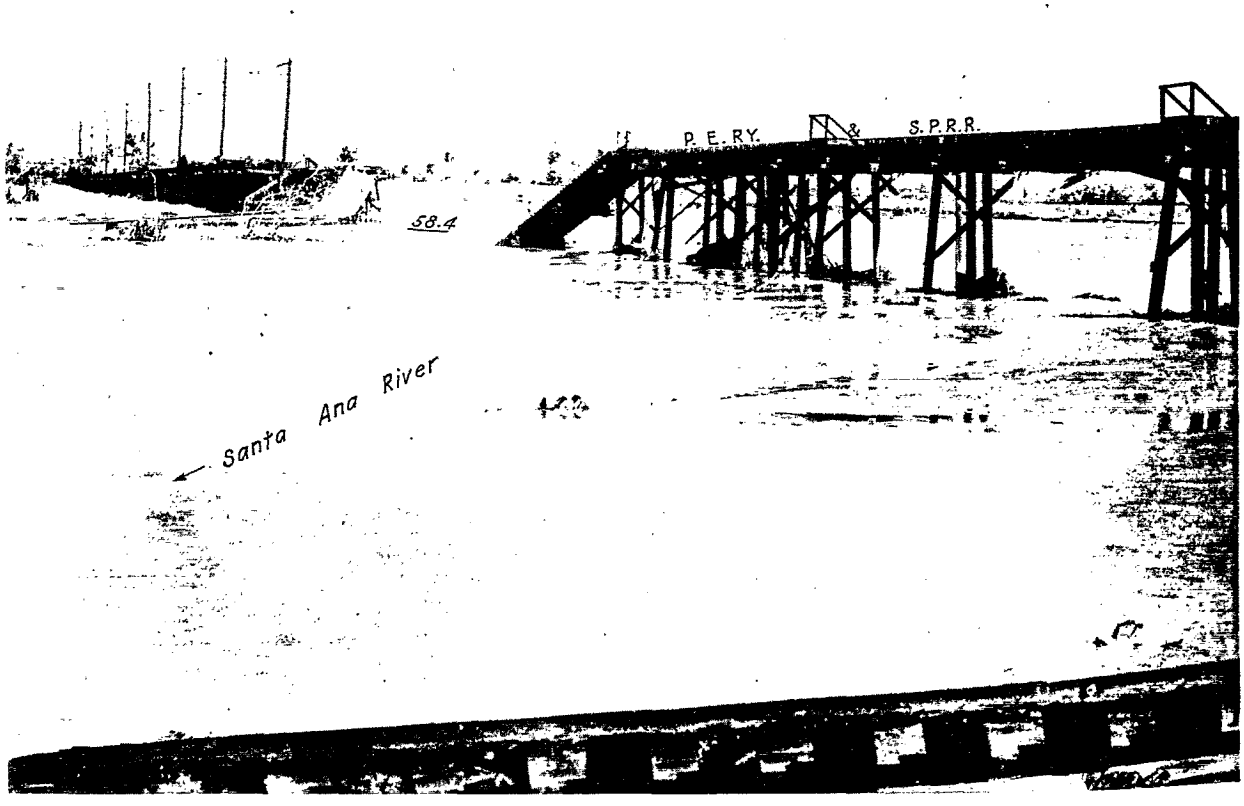
The corner of Court and School Streets, Visalia, January 1890 (Photo from collection of George W. Stewart, courtesy Visalia Times-Delta)

Floodwater in central Stockton, March 1907 (Covello Photos, Stockton)

1907 Flood. Damage done to old Bridge and new Bridge under Construction. Between Marysville & Yuba City

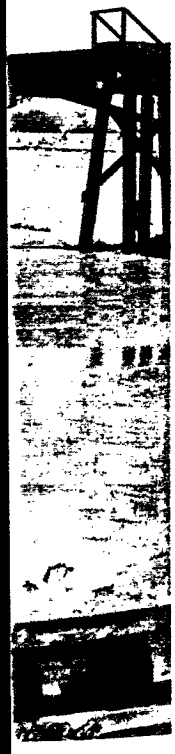


Wreckage from the 1907 flood, Marysville-Yuba City

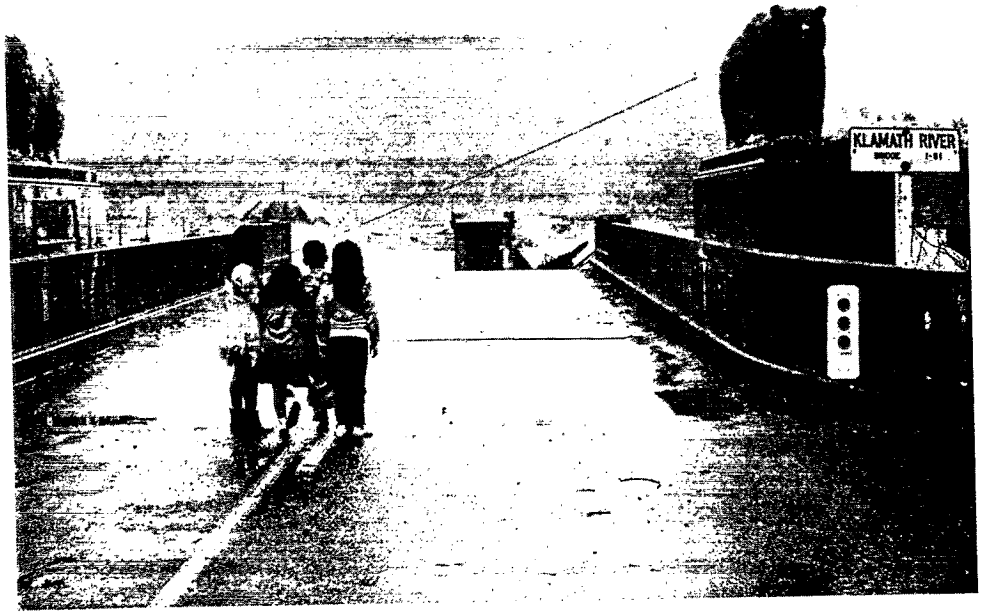


Santa Ana River, 1938 flood

Break in east levee, San Joaquin River south of Stockton, December 1950



Flooding in Santa Cruz, December 1955 (Photo courtesy California Department of Water Resources)

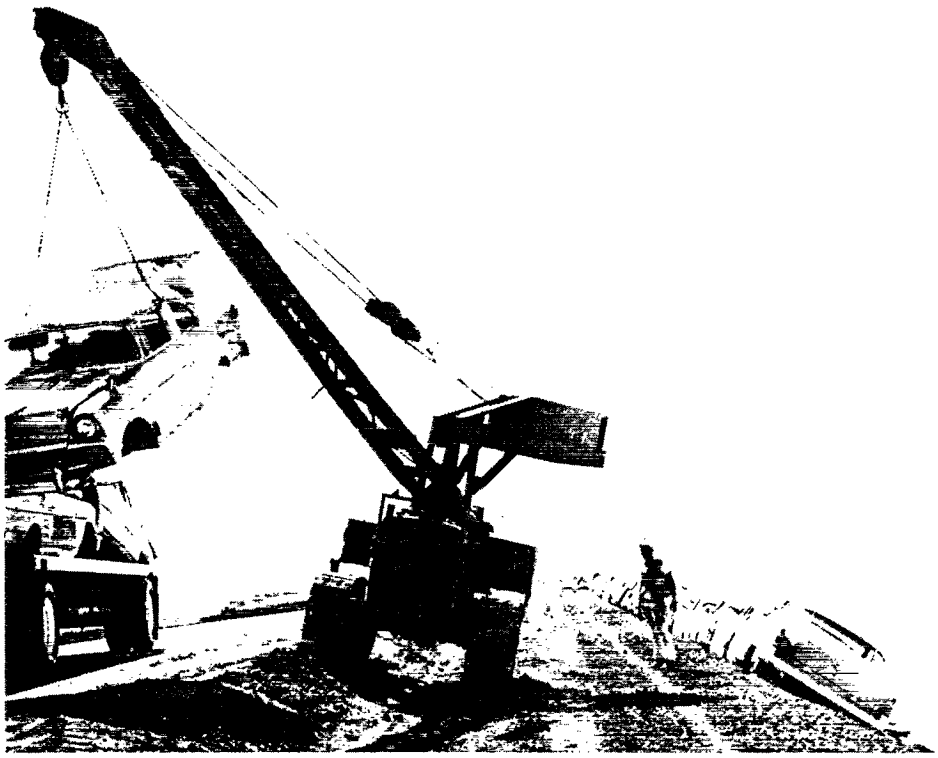


Highway 101 bridge at Klamath, December 1964

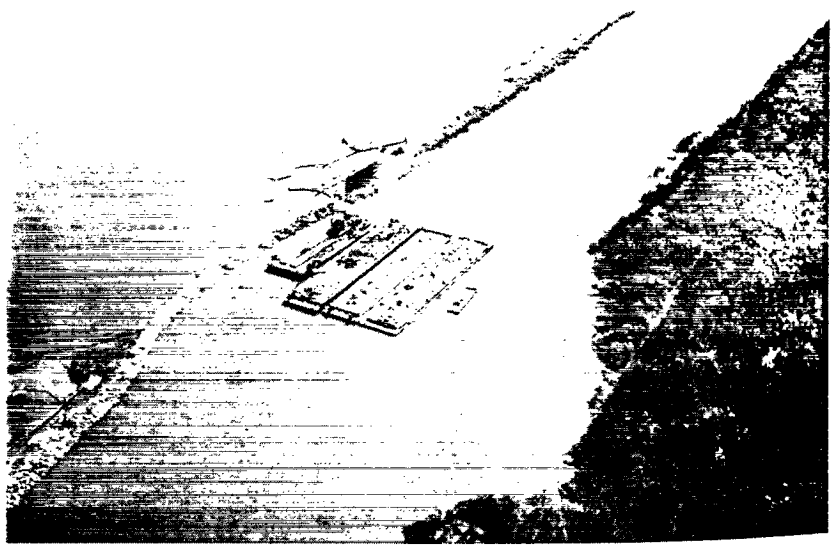
Rain and snowmelt floodwater, Tulare Lake Basin, 1969 (Corcoran Journal photograph)

Floods have claimed an unknown but substantial number of lives in California and caused several billion dollars' damage. They have also caused uncounted personal financial losses and, at all levels of government, imposed staggering financial burdens for flood fighting and recovery. Although flood control works have been very effective, flooding and flood losses continue to occur because some areas do not have protective works, it is economically infeasible to provide protection against extremely large floods, and nonstructural flood plain management measures have not been extensively implemented. Some pictures of typical and atypical flood fighting and other emergency activities follow.

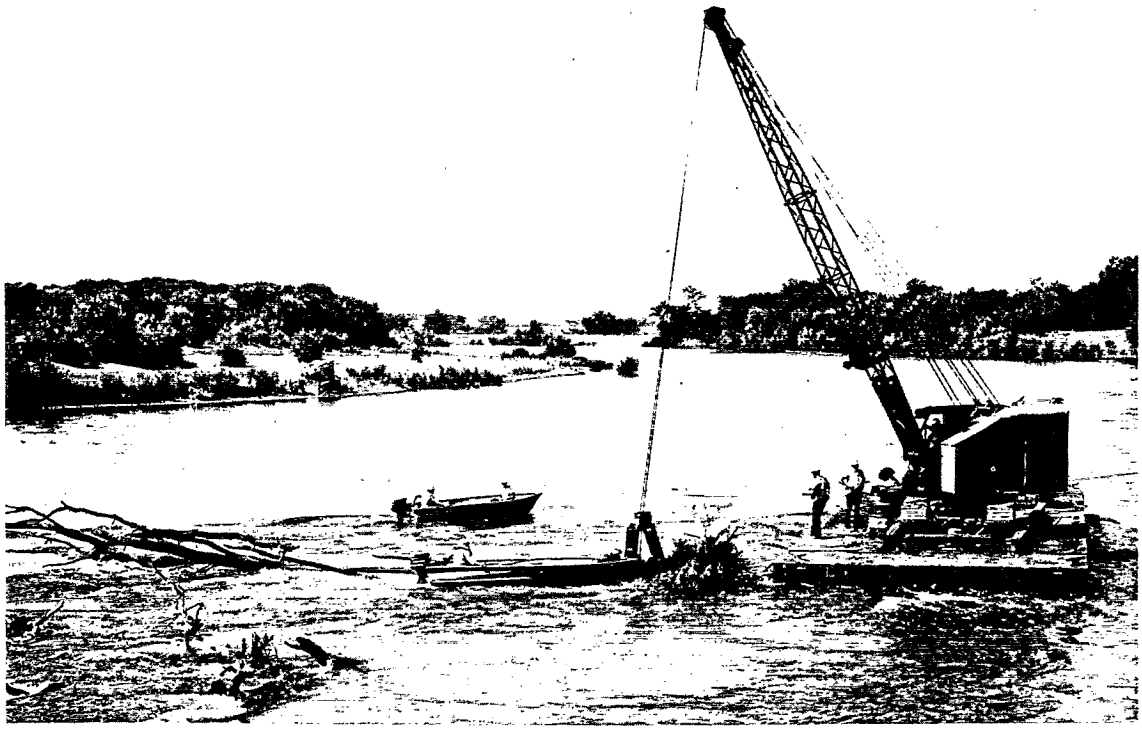
Reinforcing levees threatened by waves or high velocity flow is frequently required during floods



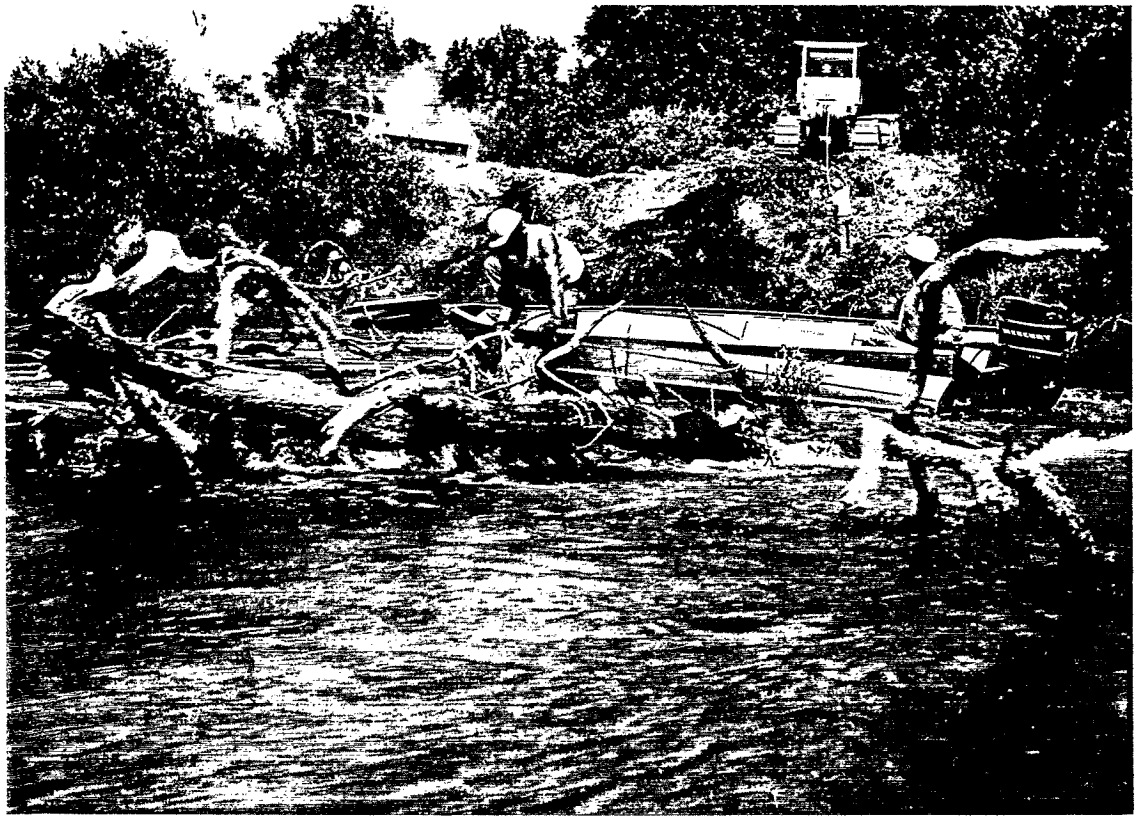
Placing junk cars to reduce wind generated wave damage, Tulare Lake, 1969



Restoring the San Joaquin River levee break that resulted in the inundation of Andrus Island and Isleton, 1972



Typical snagging and clearing operations in the interest of shallow-draft navigation on the Sacramento River



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EMERGENCY WORK, 1978

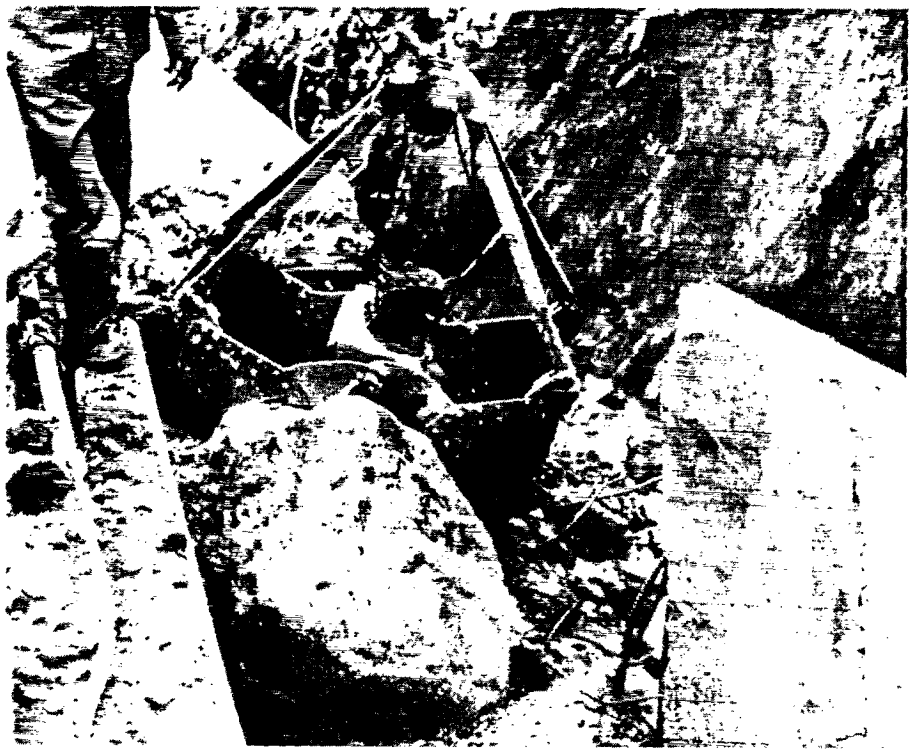
Emergency work in California in 1978 was largely localized in Southern California where major storms on 8-10 February and 3-5 March resulted in widespread flooding, mudflows, and heavy surf conditions. Precipitation approached 10-12 inches at some locations in the South Coastal Basins during both storm series. At one location, it was 13 inches in a single 24-hour period during the February storm. Existing flood control facilities in the Los Angeles River Basin and elsewhere prevented most potential damage, but the full brunt of the storms was felt in areas where flood control facilities are lacking or only partly completed.

The Corps of Engineers assisted local emergency efforts with personnel and equipment in San Bernardino, Riverside, and Ventura Counties. At the Foothill Boulevard Bridge across Cucamonga Creek (San Bernardino County), floodflows were kept in the channel by reinforcing the banks as fast as high velocity flow was able to eat them away. Flood fighting along Cucamonga Creek was again needed in March. In 1969, a breakout that overtopped Foothill Boulevard Bridge left 10 feet of debris and sediment in its wake.

In Riverside County, heavy churning flow in Murietta Creek threatened the levees but was successfully contained. Near Corona, a flood fight on Temescal Creek was lost as high velocity floodflows carried rock away as fast as it could be placed. The operation had to be abandoned and areas nearby were damaged. Other flood fighting took place on the Whitewater River in Palm Springs and in Massacre Canyon on the San Jacinto River.

The most serious situation in Ventura County was in Fillmore where the city was threatened and eventually damaged by overflow from Sespe Creek. Eventually, the creek split the city and forced evacuation of half its people. This task was doubly difficult because the town had been cutoff from the outside by road damage. At Santa Paula, the completed (lower) portion of an authorized flood control channel was entirely filled with debris during the night of 8-9 February. An effort was made to restore carrying capacity, but the March storm resulted in more flood fighting. The largest single expenditure for flood fighting and emergency advance preparation ($365,000) was at Santa Paula. Completion of the authorized flood control channel, which would have prevented the damage that occurred and need for the emergency expenditure, had been halted by an injunction. Other flood fights in Ventura County were carried out along the Ventura River at Casitas Spring, Oak View, and Meiners Oaks. These were unsuccessful, but damage was largely limited to wastewater treatment plants.

Substantial damage occurred along Big Tujunga Wash where heavy rain and rapid runoff created mudflows and mudslides. The area drained by Big Tujunga Wash is very steep, and a large part of the watershed was



Flood borne boulders brought severe damage during the February and March 1978 floods

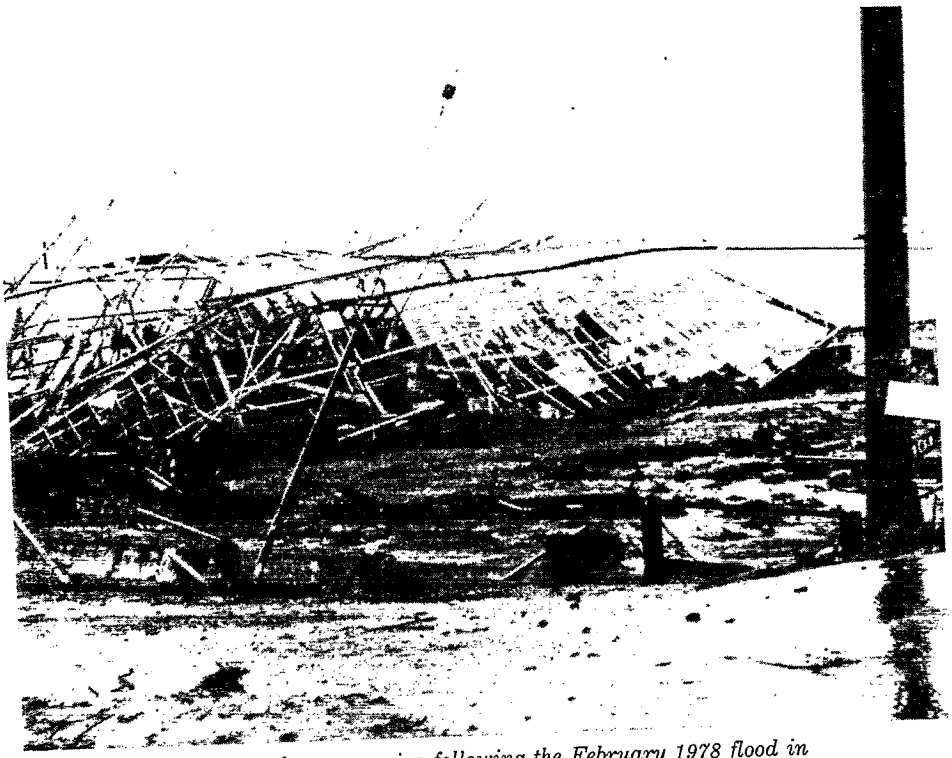
A house in Big Tujunga Wash literally covered by flood borne debris

burned in a major wildfire in 1976. Regrowth had been retarded by 2 years of drought. When the drought started to break in January 1978, a series of heavy — but not damaging — storms saturated the watershed and primed it for maximum runoff and production of debris. In the February storm, debris basins built far up the tributary streamways quickly filled, and water carrying vast quantities of sand, gravel, rocks, and boulders poured down the wash. Trees and brush, and (in populated areas) cars, buildings, and other manmade objects increased the mass of debris being carried downstream.

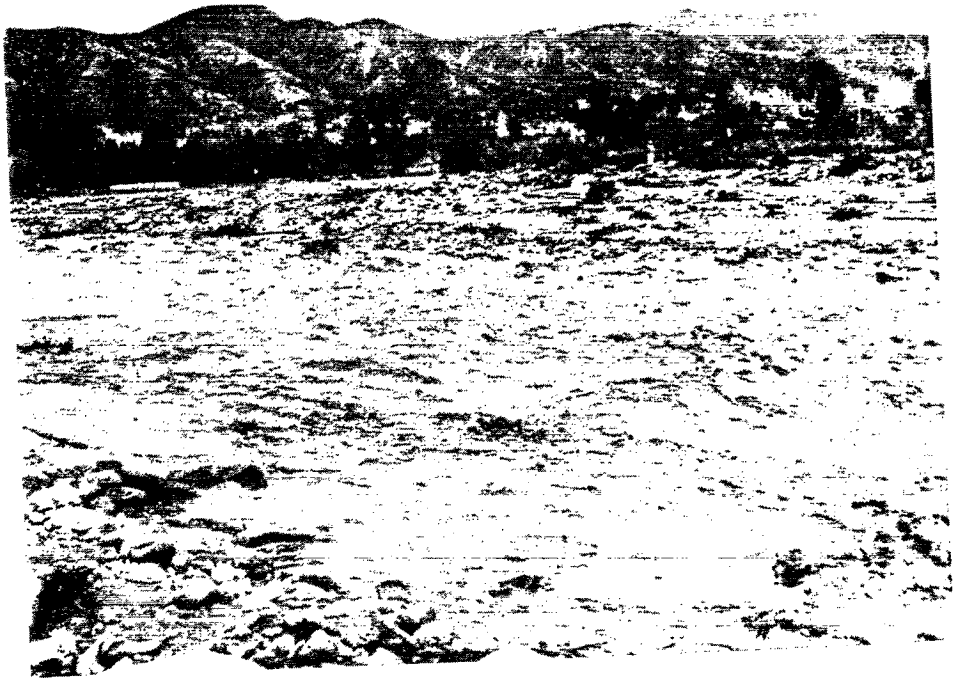
Both the February and March storms were accompanied by high winds and damaging wave action in some coastal areas. In the March storm, the most dramatic damage was at Malibu where there was severe damage to beachfront homes. Requests for assistance were not received in this particular emergency, but the Corps probably could not have helped because the area is privately owned.

In total, $2,645,000 was spent for emergency operations as a result of the 1978 floods. The Federal Disaster Assistance Administration was supported with 6 Corps of Engineers' people in the Ventura County Emergency Center and 17 in Los Angeles. All of the support people were not from the Los Angeles District. Some came from the Sacramento, San Francisco, Tulsa, Galveston, and Little Rock Districts. Support work consisted of directing emergency restoration of damaged facilities.

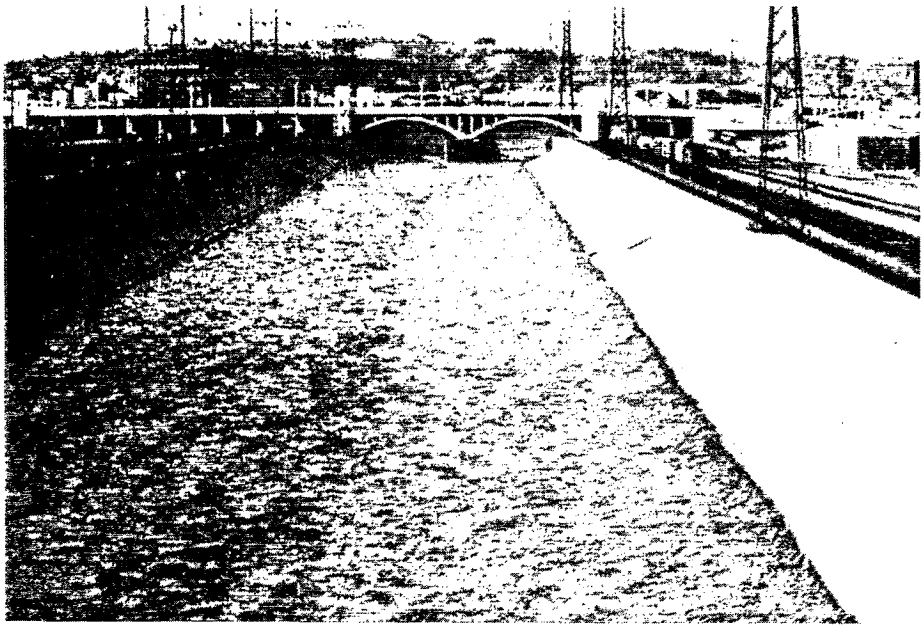
Flood fighting along Murietta Creek was successful and riverbank residents were protected



About half of this greenhouse remains following the February 1978 flood in Ventura County



Big Tujunga Wash, March 1978



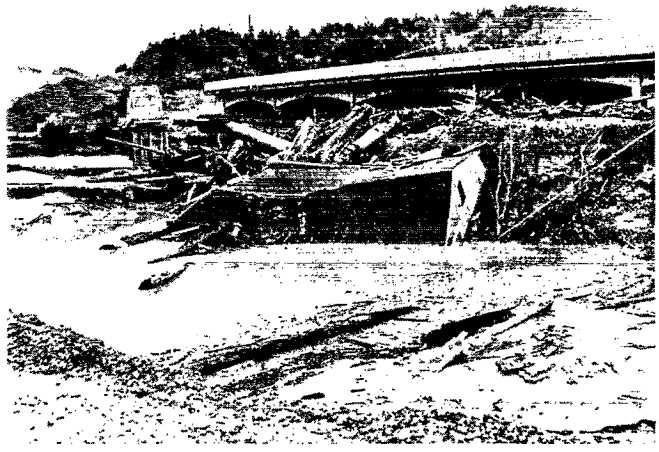
The Los Angeles River is usually a trickle. During the flood producing storms of February and March 1978, peak flows over 75,000 cubic feet per second were measured near Long Beach.

OTHER REPRESENTATIVE EMERGENCY WORK

Since all of the emergency work done by the Corps of Engineers in California cannot be covered in this booklet, the following discussion of some selected past flood episodes is considered representative.

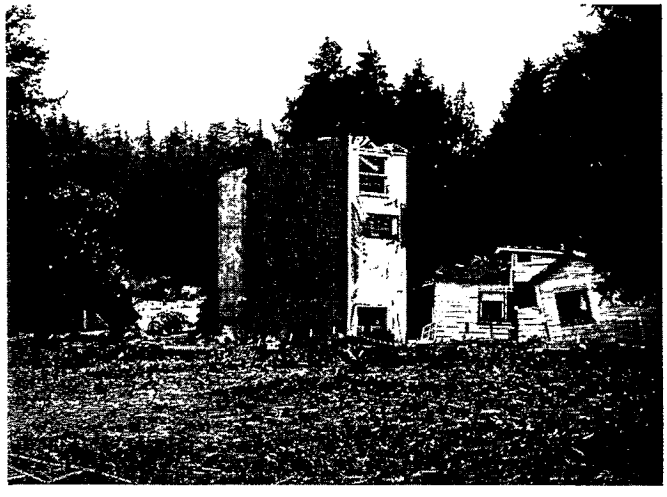
December 1964-January 1965 Floods: North Coastal Basins One of the most severe floods known in the North Coastal Basins occurred in December 1964-January 1965. This flood, which was of unprecedented intensity for so large an area, resulted from an extremely unfavorable combination of unusual storm patterns, above-freezing temperatures at high elevations in the tributary watersheds, and intense prior precipitation.

In the Eel River Basin, 24 lives were lost, entire communities demolished, and hundreds of miles of roads and highways badly damaged. In Mendocino and Humboldt Counties alone, 70 road bridges were destroyed or damaged. About 100 miles of track and much rolling stock of the only railroad serving the area were lost. Entire herds of dairy cattle and large numbers of other livestock were drowned. The lumbering industry suffered enormous losses. In total, 233,000 acres were flooded and $184,000,000 damage occurred.

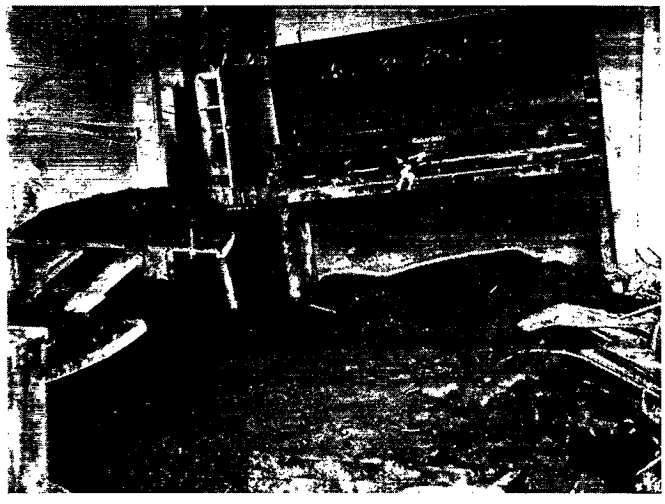


Rio Dell area

Klamath Glen



Pepperwood



Fortuna home

About 10,000 people were assisted by disaster relief agencies or military personnel. The Carrier "Bennington" was sent from Southern California to provide helicopters, medical supplies, and emergency rations. Extensive aerial relief and rescue operations under hazardous flying conditions were carried out. The San Francisco District mobilized for emergency operations and activated a flood emergency center in Eureka with field offices in Yreka and Crescent City. Flood fighting and rescue operations, snagging and clearing, levee repair, and bank protection work cost $5,400,000. Rehabilitation work under the Office of Emergency Preparedness (antecedent agency to the Federal Disaster Assistance Administration), was done at 530 sites and at a cost of $16,700,000.

Rohnerville area

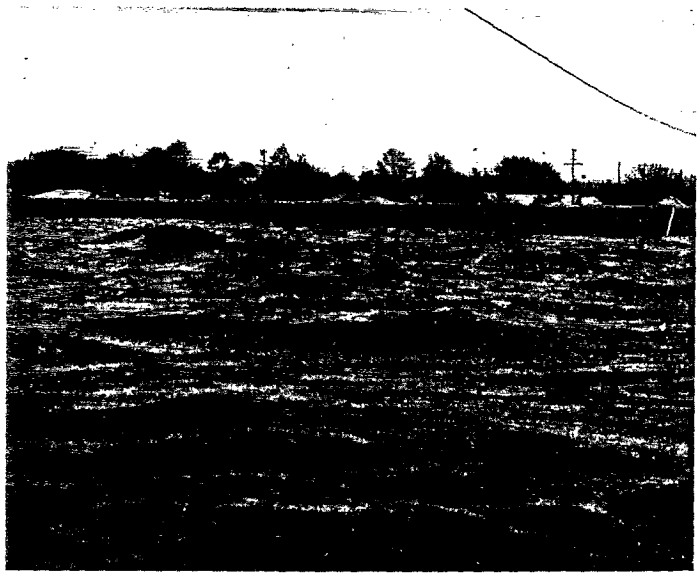
January and February Floods, 1969: South Coastal Basins Devastating floods struck the South Coastal Basins in January and February 1969. In most areas affected, these floods were the most damaging known. Earlier floods may have been equal in magnitude of flows, but they were far less damaging because they occurred when the area was not extensively developed. The 1969 floods took the lives of over 100 people, including 57 in Los Angeles County alone. Many died in mudslides triggered by floodflows. Over 10,000 people had to be evacuated and many thousands were isolated in foothill and mountain canyons. Damage to homes, commercial and industrial properties, agricultural areas, transportation facilities, public utility systems, and recreational improvements was widespread and severe. Seven counties were declared disaster areas. Flood damage totaled about $157,900,000.

During the floods, flood control officials of the affected counties coordinated flood fighting and rescue activities and directed the efforts of thousands of volunteer workers. Among other emergency activities, the Los Angeles District directed the operation of the existing complex of flood control reservoirs and channels in a manner that ensured optimum flood control as well as water conservation.

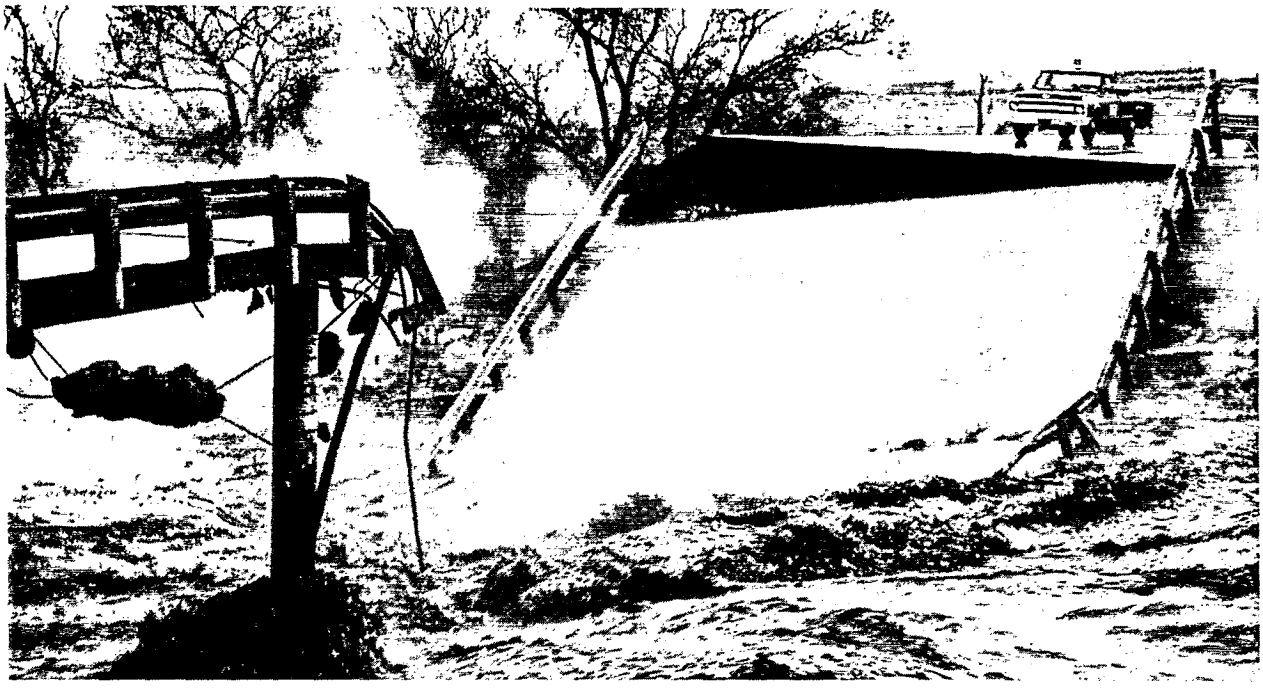
Major types of recovery work included removing mud, silt, and other flood debris from stream channels, debris basins, roads, streets, and beaches; repairing and restoring levees and revetments; rectifying stream channels; rehabilitating reservoir areas; repairing and restoring public utilities, especially water and sanitary systems; and repairing and reconstructing roads and bridges. Costs for emergency recovery totaled about $11,300,000 under national disaster recovery authorities and $7,700,000 under continuing emergency work authorities of the Corps of Engineers.

The Santa Clara River levee prevented $55,000,000 flood damage during the 1969 floods. The damaged levee was repaired in a round-the-clock operation during the flood.

Santiago Creek, February 1969. A new record flow occurred during the flood.



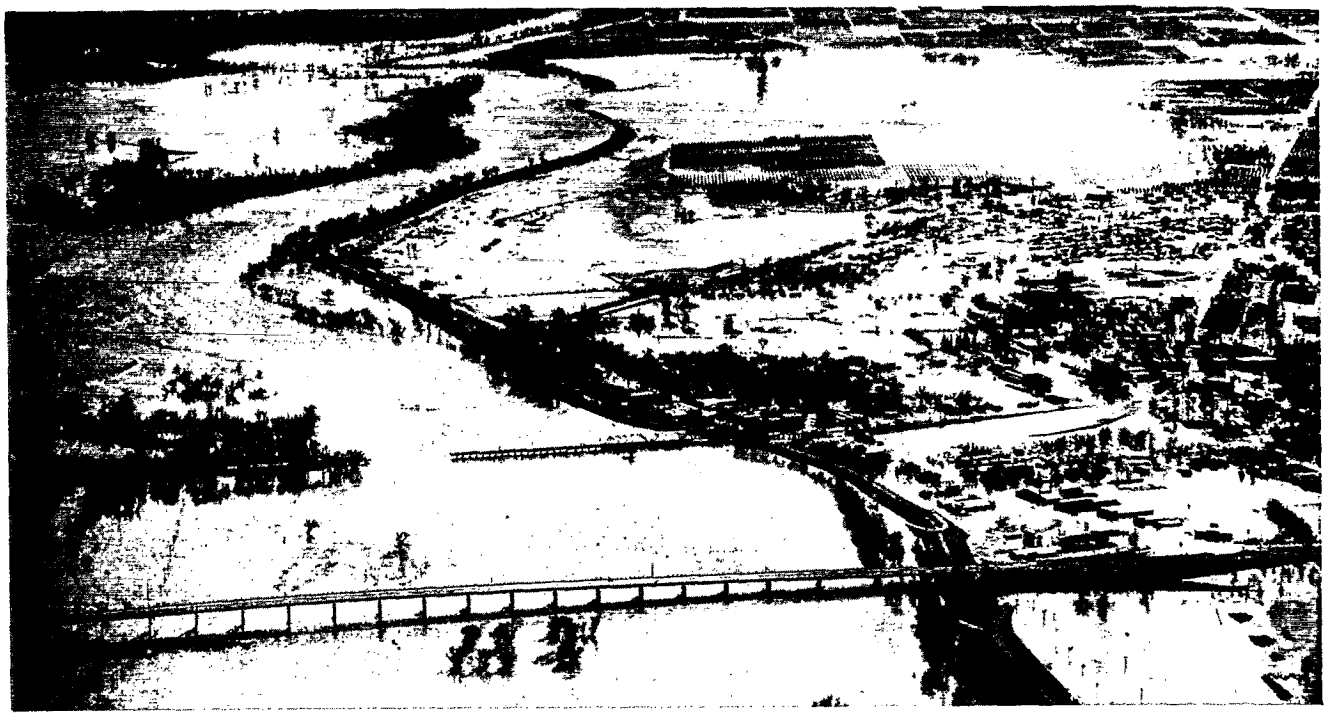
A record peak flow, Los Angeles River Channel, February 1969



The Van Buren Boulevard Bridge in Riverside was destroyed by the February 1969 flood (Photo courtesy of the Riverside Flood Control and Water Conservation District)

Flooding in the principal commercial district of Corona

December 1955 Floods: Sacramento Basin The most widespread and destructive floods in the recorded history of the Sacramento Basin occurred in December 1955. These floods resulted from an unprecedented 30 inches of rain in 12 days over large areas of tributary watersheds and substantial snowmelt that added to flood runoff. High tides and persistent high-velocity onshore winds aggravated flood conditions in the lower part of the basin. Although flooding occurred along every major river and creek, catastrophic damage occurred along the Feather River. Around midday on 23 December, the east levee failed about 1 mile south of the community of Nicolaus. About 25,000 acres comprising approximately 100 farms and ranches were flooded, and around 400 people had to be evacuated. Two people lost their lives in the floodwater, which continued to flow through the break for 34 days. At Shanghai Bend, just south of Yuba City, the west levee failed at 12:10 a.m. on the 24th. Outflow from the break flooded almost all of Yuba City. Because the flooding occurred so quickly and in the middle of the night, 38 people were lost. Of 3,100 homes flooded, 45 were swept completely away and 31 were totally demolished. Around 12,000 people were evacuated from the city for periods ranging from a few days to several months.



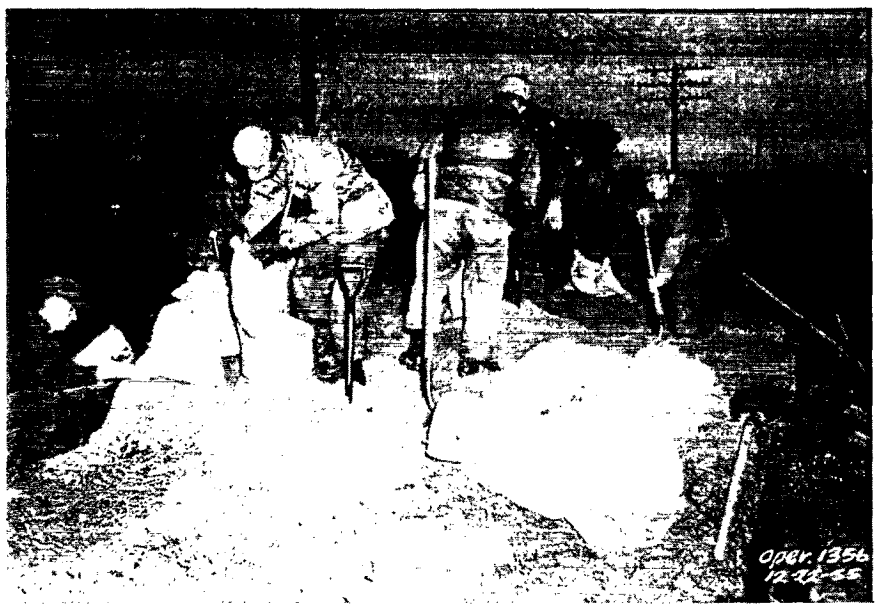
Yuba City, December 1955

Marysville (population 12,500) is situated at the mouth of the Yuba River directly across the Feather River from Yuba City. The community is encircled by levees that had been seriously weakened by sustained high flows. At the peak of the flood, water was coming through the levees at a number of locations, and they probably would have failed if the Shanghai Bend break had not relieved the pressure. Extensive flood fighting by many citizens and hundreds of airmen from nearby Beale Air Force Base, and emergency use of Air Force vehicles, significantly contributed to saving Marysville, which had been completely evacuated as the flood threat worsened.

In total, 100,200 acres were flooded and damage amounted to approximately $51,500,000 along the Feather River. In the Sacramento Basin, 363,000 acres were flooded and damage exceeded $65,000,000. Cost of flood fighting, other emergency operations, and repair and restoration under continuing Corps of Engineers authorities totaled $8,000,000, including $4,800,000 for restoring levees along the Feather River. Under national disaster recovery authorities, the Corps of Engineers acted as the engineering and construction agency in the expenditure of $3,340,000 for removing debris, restoring levees, reestablishing channels of uncontrolled streams, and rebuilding public utilities.

Emergency repair and restoration of levees in the Marysville-Yuba City area following the December 1955 flood substantially contributed to protecting those cities during December 1964 when combined flow in the Feather and Yuba Rivers posed the most disastrous flood threat ever known in that locality.

Closing the floodgate at the D Street Bridge, Marysville, December 1955



Flood fighting at the northern approach to Marysville, December 1955

ge, Marysville,

Homes destroyed by the December 1955 flood, Yuba City. Many homes were completely swept away.

SPECIAL APPLICATIONS OF EMERGENCY WORK AUTHORITIES

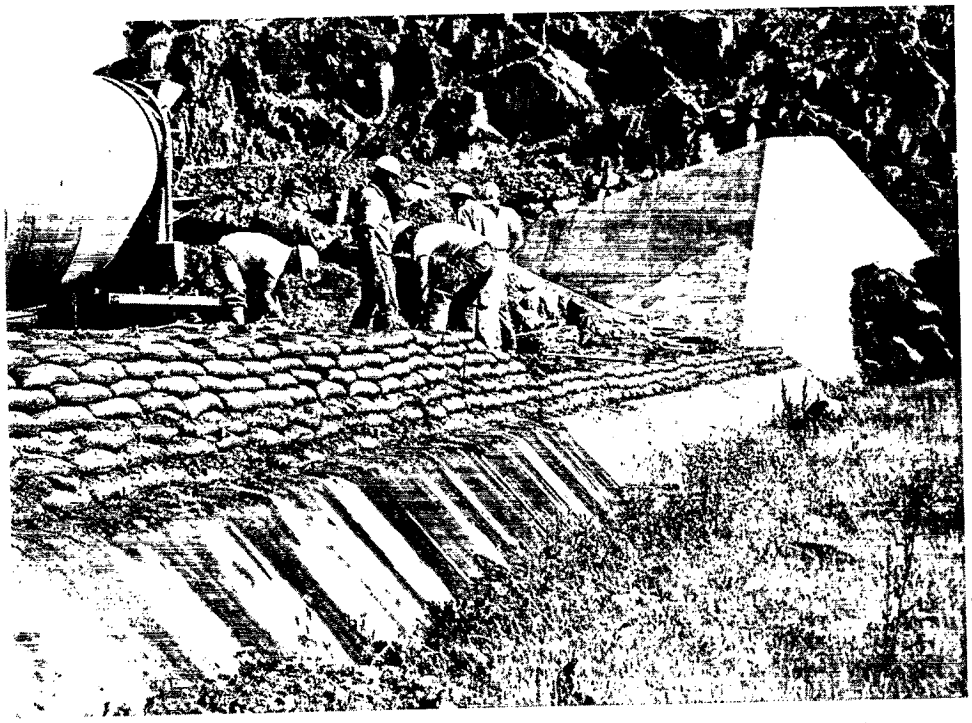
Operation Foresight In early 1969, California was one of 26 states where serious snowmelt flooding during spring and early summer was predicted. In a letter dated 1 March 1969, the Director of the Office of Emergency Preparedness (OEP) notified the Secretary of the Army that:

> The President has directed that all feasible steps within the authorities of the Federal agencies be taken to prepare for floods which threaten to occur in various parts of the country because of the unusual snowpack conditions which now exist.

Special reference was made to continuing authorities of the Corps of Engineers, which previously had been used primarily during and after flood emergencies. The President urged "aggressive use of these authorities under present conditions." Work under the program, which the OEP named Operation Foresight, was undertaken in the Central Valley, in Owens Valley, in the Klamath River Basin, and on the north slope of the San Bernardino Mountains.

Operation Foresight work consisted mainly of rectifying channels; raising, strengthening, repairing, and protecting levees; and constructing new levees. Other work included constructing a temporary 63,000 acre-foot floodwater detention basin, constructing about 800 acres of temporary percolation ponds, and emplacing sack-concrete spillway barriers to temporarily increase the capacity of two flood control reservoirs.

It is estimated that advance preparations under Operation Foresight reduced potential snowmelt flood damage by $12,500,000. Cost of the work was more than $4,000,000, of which 80 percent was paid by the Federal Government.



Placing a sack concrete barrier across the spillway at Terminus Dam as part of "Operation Foresight"

Wildfires in Southern California, 1970 Widespread fires that burned in nine Southern California counties in September, October, and November 1970 left large areas extremely vulnerable to mudslides and flood damage. These fires, which blackened over 380,000 acres, were the worst known in Southern California to that time. The largest single fire covered almost 90,000 acres in the Sweetwater River Basin, San Diego County. Immediately following the fires, extensive work was undertaken under national disaster recovery authorities to prevent mudslides and flooding with the onset of winter rains. The work done comprised clearing stream channels; clearing, repairing, and modifying existing debris barriers; constructing new debris barriers and check dams with spillways and outlets; and clearing burned and fallen timber. Cost of the remedial work was $5,750,000.

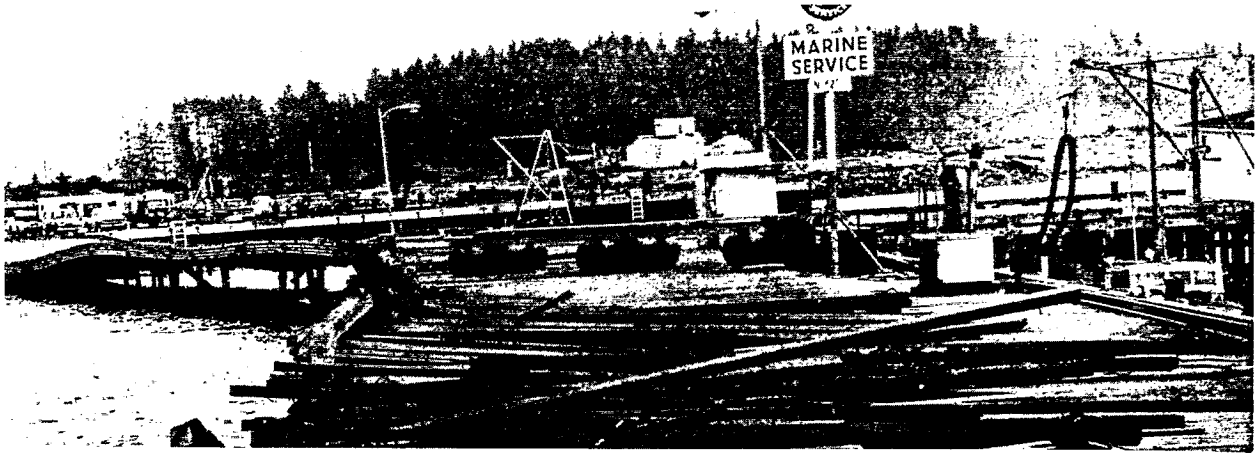
San Fernando-Sylmar Earthquake At 6:02 a.m., Tuesday, 9 February 1971, an earthquake that registered 6.6 on the Richter scale struck the San Fernando-Sylmar area in metropolitan Los Angeles. Within an hour, the Corps of Engineers dispatched a contractor and many engineers to the area where two main buildings of the Veterans Administration Hospital had collapsed. Sixty patients and staff were buried, and the search for victims was a complicated and dangerous task. Huge pieces of wreckage had to be removed without disturbing the mass, and twisted debris had to be cut with concrete saws. Although the death toll reached 45, the searchers had the satisfaction of bringing 15 people out of the wreckage alive.

A few miles away, the earthfill dam at Van Norman Reservoir had sustained major damage during the quake and 80,000 people immediately below the dam were in imminent danger. Corps of Engineers and Los Angeles Department of Water and Power personnel worked desperately to draw the reservoir down to a safe level. Eleven pumps, including a huge dredge pump powered by a diesel engine that once drove a submarine, were hooked up for dewatering. Fortunately, the dam held during the dewatering operation.

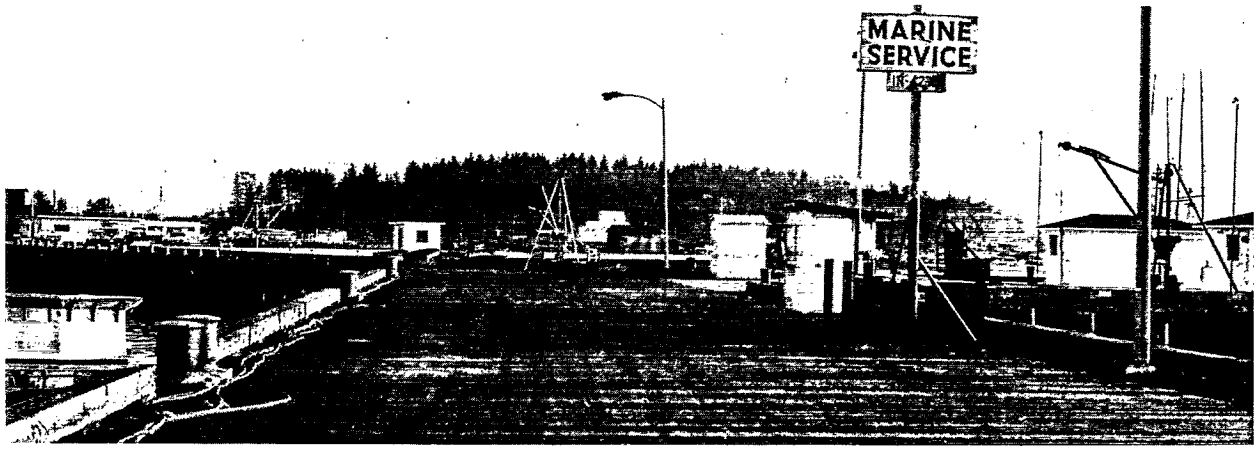
Under disaster recovery authorities, the Corps of Engineers provided water to the badly damaged City of San Fernando; repaired water and sewer systems, streets, flood control facilities, and public buildings; and demolished and cleared away damaged structures that were public dangers. Damage from the earthquake totaled more than $500,000,000 and the cost of emergency and recovery operations exceeded $28,000,000.

Corps workers rescued 15 people from the wreckage of the Veterans Administration hospital at Sylmar. Forty-five people died.

Crescent City Tsunami A giant earthquake that registered 8.5 on the Richter scale occurred in the seabed 300 miles off the coast of Alaska on 27 March 1964. The earthquake devastated the City of Anchorage, and the tsunami (great sea wave) it generated reached the coast of Northern California on 28 March. At Crescent City, the tsunami was of such magnitude that the wall of water rushing landward gathered the water in the shallow draft harbor and then submerged the central part of the town. Damage was estimated at $11,000,000. The city and harbor were declared a disaster area on 3 April. Restoration work included cleanup and repair of streets and roads, repair of the storm drain system, emergency demolition of damaged structures, debris removal, and repair of docking facilities. Emergency restoration work cost $700,000.



A major pier at Crescent City Harbor before and after restoration following the 1964 tsunami

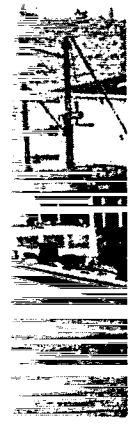


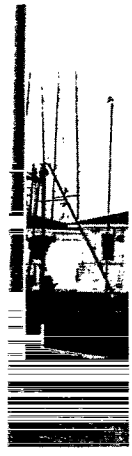
EMERGENCY WORK UNDER SPECIAL CONGRESSIONAL PROVISIONS

In the 1940s, when severe beach erosion threatened the destruction of homes in the Surfside area, a special provision to correct the situation was included in Public Law 80-122 (Second Urgency Deficiency Appropriations Act, 1947). In the fall of 1947, 1,220,000 cubic yards of material dredged from the U.S. Naval Weapons Station outer basin were deposited between the Navy breakwaters. The beach was widened to 400 feet at the upcoast end and to 300 feet opposite the entrance to Surfside. Cost of the work was $250,000.

From 22 September through 1 October 1964, wildfires that raged on a 10-mile front destroyed 67,000 acres that included residential property, many public facilities, and U.S. Forest Service lands in or adjoining Santa Barbara and the communities of Montecito, Summerland, Goleta, and Carpenteria. With the beginning of winter rains, the communities faced the threat of flooding and debris flows from runoff moving unchecked from the exposed hillsides. Special authorization of advance corrective measures to prevent impending damage from flooding and mudflows was included in Public Law 88-635 (Supplemental Appropriations Act, [Fiscal Year] 1965). Corrective work undertaken included construction of six debris basins and rectification of 15 miles of stream channel at a cost of $860,000. Under continuing emergency work authorities, an additional $106,000 was spent in November for flood fighting and repair work in the fire-stricken areas.

In October 1971, fires that burned unchecked for 10 days devastated 16,100 acres in an area extending from the foothills near Montecito and Carpenteria to the crest of the Santa Ynez Mountains. After 8 months without rain, the area was powder dry and the existing combination of fuel density and dry weather resulted in a "clean burn." That is, the area was essentially denuded of vegetation, and the potential for debris flow, rock slides, and mudflows increased to extreme levels with the onset of winter rains. Special provisions for advance flood suppression activities in the devastated areas were included in Public Law 92-184





(Supplemental Appropriations Act, [Fiscal Year] 1972). At a cost of $1,400,000, work done included constructing nine debris barriers and eight grade stabilizers; clearing and shaping existing channels; and removing fire debris from Sandyland Slough (the collection outlet for Santa Monica and Franklin Creeks), Carpenteria State Park, and Carpenteria. Winter rainstorms generated floods in December and, under continuing authorities, an additional $100,000 was spent for flood fighting and debris removal.

SUMMARY

Continuing emergency work authorities of the Corps of Engineers provide for the following broadly classified activities: removal of obstructions and clearing and snagging operations in the interest of navigation, and for flood fighting, rescue, repair, bank protection work, and clearing and snagging in the interest of flood control. The cost of emergency work in California under continuing authorities and special Congressional authorizations is summarized by hydrographic area as follows:

Hydrographic Area	Cost
North Coastal Basins	$ 7,980,000
San Francisco Bay Area	3,600,000
Central Coastal Basins	11,300,000
South Coastal Basins	58,700,000
Sacramento Basin	17,816,000
Delta-Central Sierra Area	4,465,000
San Joaquin Basin	5,235,000
Tulare Lake Basin	5,924,000
North Lahontan Territory	305,000
South Lahontan Territory	1,065,000
Colorado Desert	4,100,000
Total	$120,490,000

Under national disaster recovery authorities, the cost of repair, rescue, and restoration work done, supervised, or otherwise participated in by the Corps of Engineers during major emergency situations in California is summarized as follows:

Disaster	Cost
December 1955-January 1956 Floods	$ 2,520,000
Failure of Baldwin Hills Dam, December 1963	1,251,000
December 1964-January 1965 Floods	24,280,000
December 1966 Floods	3,469,000
January-February 1969 Floods	27,173,000
January 1970 Floods	3,393,000
September-November 1970 Wildfires	5,750,000
San Fernando-Sylmar Earthquake, February 1971	28,000,000
Andrus Island Levee Failure, June 1972	2,560,000
February and March Floods, 1978	2,645,000

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15 SPECIAL ACTIVITIES

SPECIAL INVESTIGATIONS

Special investigations involve unusual problems and may not be confined to natural river basins or political subdivisions. They are usually carried out in cooperation with other Federal agencies, various state agencies, and the local interests concerned. The depth of study and scope of special investigations can vary widely and may range from regional to single-project coverage. On-going special investigations in California are:

Eel River Basin (San Francisco District) A special investigation of the water, land, and environmental resources of the Eel River Basin and adjacent areas was authorized in 1974 and started in 1976. Its purpose is to develop water resources management plans that will promote, through contributions to economic stability and environmental quality, the general welfare of the people of the basin.

In general, the development, management, conservation, and environmental enhancement of the water and related land resources of the basin will be considered in conjunction with local, state, and other interested Federal agencies. Specifically, and among other things, the areas of study will include flood control, streamflow augmentation, water quality, municipal and industrial water supply and interbasin water exchange, sedimentation problems and streambank and shoreline erosion, recreation, and protection of unique natural and historical areas. Alternative plans that will include the social, economic, administrative, and engineering factors involved will be prepared for consideration by those most directly concerned.

A plan for conducting the investigation has been completed and it is expected that a report will be completed around the middle of 1982.

Humboldt Harbor and Bay (San Francisco District) Humboldt Bay is the only major landlocked anchorage on the California coast north of San Francisco. Although physically smaller than San Francisco Bay, Humboldt Bay has similar environmental characteristics.

A special investigation of the Humboldt Bay region was begun in 1976. Its purpose is to determine optimum economic, environmental, and social uses of the bay and its environs. The investigation will include, but not be limited to, examining present land use patterns, determining the extent of various government jurisdictions and their impact on land use, examining the suitability of land and water resources for single and multiple purpose uses, and developing other data needed to provide the basis for sound and integrated planning at local, regional, state, and Federal levels. A completion date for the investigation has not been established.

San Francisco Bay Area (In-Depth Study) (San Francisco District) A special in-depth investigation of San Francisco Bay and all tributary deep water ports was authorized in 1967. Its objective is to develop guidelines for alternative regional navigation facility plans that fully consider competing uses of Bay Area resources. The study will include evaluating the relationship between future waterborne commerce passing through the study area and the necessary facilities to support that commerce. It will also include evaluating the interrelationship between waterborne and other modes of transportation serving the San Francisco Bay system and its hinterland areas. Among more specific objectives, extensive research and study will be devoted to establishing:

The impact of technological advances on trends in waterborne commerce.

The economics of present and estimated future waterborne commerce with particular reference to use of supersize bulk transport vessels and tankers.

The impact—on regional and national economies—of new and expanded heavy industry resulting from improved facilities and operations for waterborne commerce.

The adequacy of regional shipping capacity in defense mobilization.

The feasibility and extent of Federal participation in expanding and improving facilities for waterborne commerce.

A number of pressing navigation problems exist in the San Francisco Bay Area and effort under the in-depth study is currently being concentrated in preparing an interim report on improving **Richmond Harbor.** During the past decade, commerce in Richmond Harbor has about doubled. Due to current demand and to planned development in bulk, general cargo, and containerized shipments, the principal harbor channel is judged inadequate. Deepening a turning basin at the inner harbor to 40-50 feet, and providing a 40-50 foot controlling depth throughout the harbor development south and east of Richmond Long Wharf are under detailed study. A report on this phase of the in-depth study is projected for completion in 1979. An interim report favorable to deepening and widening the outer channels of **Oakland Harbor** was completed in 1977 and is in process to Congress. Also, as part of the in-depth study, the existing **Redwood City Harbor** will be examined in detail to evaluate increasing channel depth to more than 30 feet in order to allow fully loaded deep draft vessels to enter the harbor at all tidal stages. The effect of increased harbor usage on

the environment will also have to be closely examined. The Redwood City environment will also have to be closely examined. The Redwood City Harbor phase of the in-depth study is presently inactive. Completion of the overall study is scheduled for completion in 1981.

San Francisco Bay and Sacramento-San Joaquin Delta Water Quality and Waste Disposal (San Francisco District) Authorized by the 1965 Flood Control Act, this special investigation covers the 12-county area encompassing San Francisco, San Pablo, and Suisun Bays and the delta of the Sacramento and San Joaquin Rivers, all of which are influenced by the ebb and flow of the tides and runoff from about 50,000 square miles of tributary drainage area. The east and west shorelines of San Francisco Bay are extensively urbanized and industrialized as are much of the southerly shores of San Pablo and Suisun Bays. The northerly shorelines have scattered urban centers, agricultural areas, and extensive marshlands that support waterfowl migrating along the Pacific Flyway. The Delta region is devoted almost exclusively to agriculture. The specific objectives of the special investigation are to:

Determine the Federal interest in measures for waste disposal and water quality control in the area under study, and

Examine the environmental, social, and economic impacts of water quality and waste disposal management.

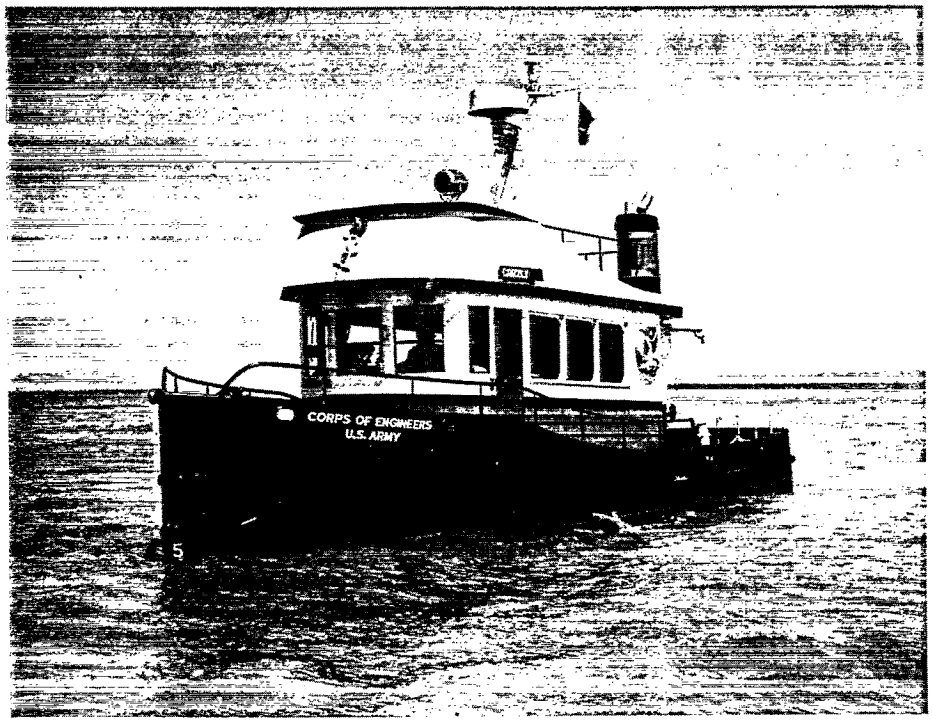
A report entitled "Land Application Alternatives for Wastewater Management" has been completed. It was accomplished as a joint effort of the State Water Resources Control Board, the Environmental Protection Agency, and the Corps of Engineers. Specific tasks completed in making the report involved developing alternatives for disposal of treatment system solid waste by land application; developing alternatives for wastewater reclamation and use as related to land application procedures; and evaluating alternatives in terms of national economic development, environmental quality, social well-being, and regional development. A plan of study is being prepared on the second phase of the investigation, which will address water quality. Specific areas of study contemplated include:

The circulation of contaminants in San Francisco Bay,

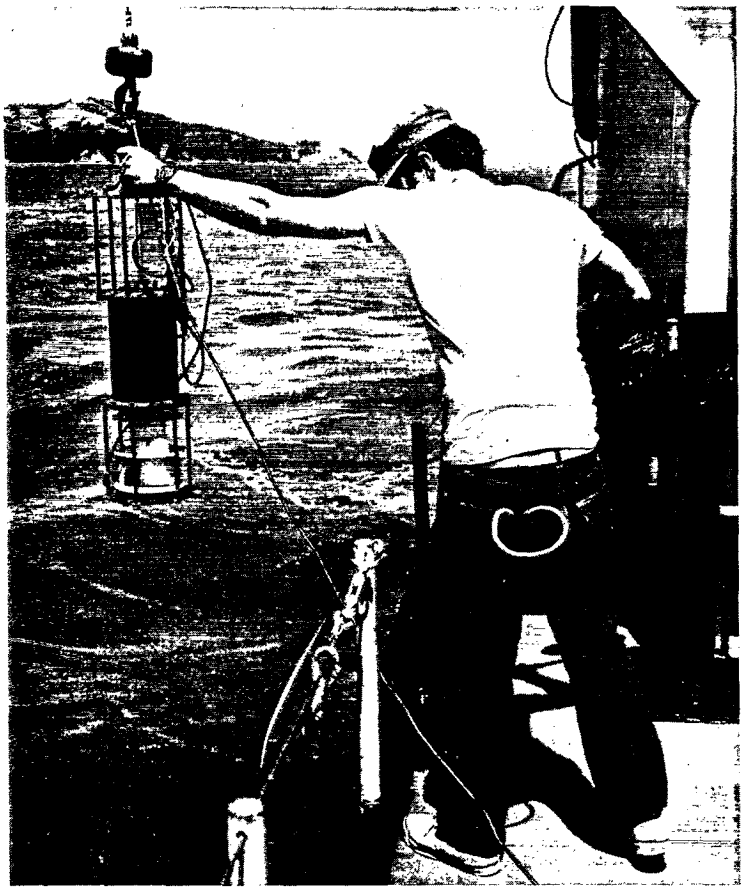
The role of suspended sediments on levels of contaminants, and

The availability of contaminants to organisms as changing salinity levels vary sediment concentrations.

The date of completion of this phase of the overall study is indefinite.



Corps of Engineers Survey Boat "Grizzly" on San Pablo Bay



Water sampling for hydrologic survey of San Francisco Bay

Coast of California, Protection Against Storm and Tidal Waves (San Francisco and Los Angeles Districts) The Pacific coast is subject to destructive wind and wave action during the winter-spring storm season (November through April). Tidal waves generated by seabed earthquakes as far away as the Pacific Ocean off Asia periodically strike the California coast. These great waves create extreme hazard to human life and coastal properties, and to ships and boats in coastal waters. A special investigation of storm and tidal waves along the Pacific coast from Canada to Mexico was authorized by the 1965 Flood Control Act. Its purpose is to examine the feasibility of protective measures and consider the advisability of restrictive zoning and warning systems. However, the investigation is currently inactive and its reactivation is unlikely. Originally, several individual reports (the first of which was to be on the Crescent City area) were planned in making the investigation.

Harbors for Light Draft Vessels—Coast of California[1] (San Francisco and Los Angeles Districts) Investigation of a chain of harbors for refuge and other purposes along the California coast was authorized by the 1945 and 1946 River and Harbor Acts.

In the northern coastal reaches of California, conditions hazardous to small boats can rapidly develop due to dense fog, ground swells from distant storms, or from sudden intense local storms. Along the southern reaches, there are only a few harbors of refuge within safe sailing distances of one another. The lack of harbors of refuge is of particular significance to the fishing industry, which is vital to the economy of numerous coastal communities. Each year, the popularity of recreational boating along the California coast increases. However, the economic potential of recreational boating cannot be realized unless adeqate harbor facilities are available.

At present, study of the coastal reach south of Cape San Martin has been deferred. Study emphasis is being placed on Moss Landing Harbor, which is on Monterey Bay (Central Coastal Basins area) about 80 miles south of San Francisco. This harbor is close to important fishing banks and in an area considered the major seaside recreational center of northern California. The existing harbor, completed in 1947, is now overcrowded and judged inadequate for present needs. Enlargement of the existing Federal portion of the lagoon is under consideration. A proposed small-craft

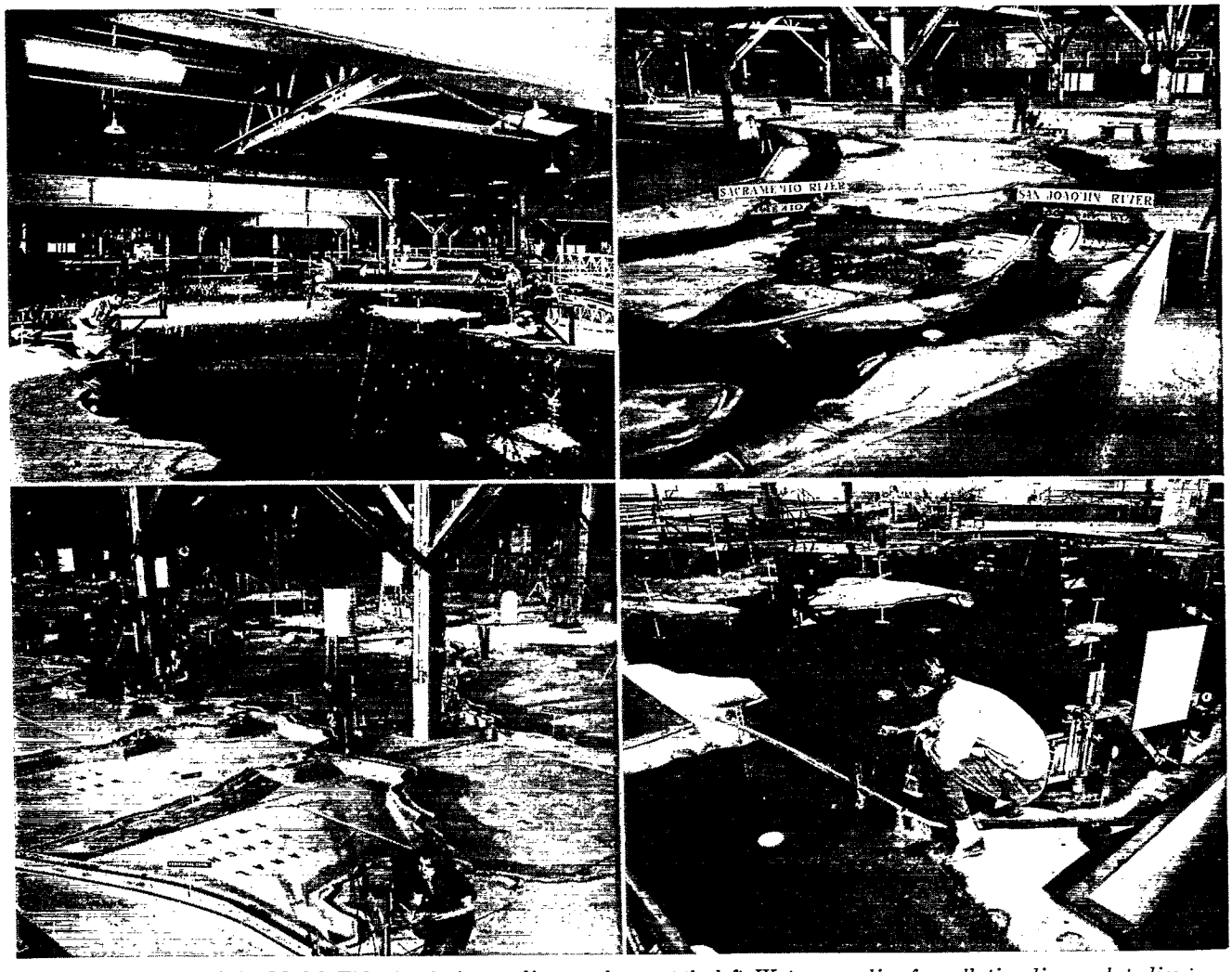
[1]This study is not a special investigation. It is included in this section of the booklet because it affects the coastlines of all coastal hydrographic areas.

harbor on the San Mateo County coast in the vicinity of Pacifica (San Francisco Bay Area) will also be investigated. A systems analysis that treats the entire northern coastal reach as a unit was completed in 1971. Completion of the entire study is indefinite. Interim reports for the Moss Landing and Pacifica studies are contemplated.

SAN FRANCISCO BAY-DELTA MODEL

In conjunction with a special investigation of San Francisco Bay (now completed), a scale hydraulic model of San Francisco Bay was built to verify analytical solutions and solve problems not subject to analytical solution. Completed in 1957, the model was extended to include the Delta in 1969 so the complex water resources problems of that region could be more easily studied. The model reproduces the rise and fall of the tides, flow and currents of water, mixing of fresh and salt water, and deposition of sediment. Important model studies of shoaling and sedimentation using radioisotopes have been conducted in cooperation with scientists from the University of California.

Located at the Corps of Engineers Operations Base in Sausalito, the model is open to visitors from 9 a.m. to 4 p.m. Monday through Friday (except for holidays) and on selected Saturdays. Design work to include a Corps of Engineers Regional Visitor Center at the model site has been completed. Exhibits will cover Corps of Engineers history and mission, and offer means for better understanding of the complex ecology of San Francisco Bay. Completion of the Center is scheduled for late 1979.



Overviews of the Bay-Delta Model. Tide simulation studies are shown at the left. Water sampling for pollution dispersal studies is shown in the lower right, and the western apex area of the Delta appears in the upper right.

URBAN STUDIES

As described in more detail in Chapter 1, urban studies are conducted primarily to provide input—from various areas of Corps of Engineers expertise—to local urban planning efforts. On-going urban studies in California are:

Alameda Creek (Upper Basin) (San Francisco District) The upper Alameda Creek Basin encompasses Livermore and San Ramon Valleys. These areas, which include the cities of Livermore and Pleasanton and the communities of Dublin and San Ramon, were originally a shallow lake now reclaimed by a system of drainage ditches along streamways that crossed the ancient lakebed. Arroyos Mocho, de la Laguna, Los Positos, and Del Valle; Tassajara, San Ramon, and Alameda Creeks; and the Chabot and Alamo Canals are the principal waterways involved.

During the last 20 years, population in the upper Alameda Creek Basin increased almost fivefold and land use rapidly changed from predominantly agricultural to residential and other urban patterns. Existing public facilities are incapable of meeting the needs of the present population. This problem has focused attention on environmental concerns. Local planning agencies are establishing social and environmental goals based on public input, knowledge of available resources, and needs for environmental preservation.

Earlier study effort has been directed toward storm water runoff and nonstructural solutions to abate storm runoff pollution. Flood control, water supply, water quality, water-oriented recreation, and fish and wildlife enhancement are other major study components that must be addressed. Study emphasis in 1979 will be on flood plain management. The results of this phase of the study were published in 1978. The report will describe all work done, including the earlier studies of surface runoff. It is expected that the overall study will be completed in 1981.

Salinas River—Salinas-Monterey Metropolitan Area (San Francisco District) Priority planning issues in the Salinas-Monterey Metropolitan Area include water supply, flood control, water quality and disposal of wastewater, and supplementing the state water quality plan for the Salinas River Basin. Major studies of ground water (the principal source of water supply) and regional water resources management will be undertaken. A primary objective is to develop comprehensive water resources plans consistent with local land use planning.

Study effort has been concentrated on developing a ground water model and land application alternatives for treated wastewater. A reconnaissance-type report on flood control, water supply, and water quality control was completed in 1978. The Association of Monterey Bay Area Governments and the Environmental Protection Agency participated in developing the water quality control findings. Final reports are expected by the end of 1979. Among other things, they will include the findings of:

Various water quality control studies.

Ground water model tests.

Reanalysis of the authorized channel improvement and bank protection project for the Salinas River.

An analysis of multiple purpose storage in the Salinas River Basin.

Comprehensive investigations of water supply in Santa Cruz and Monterey Counties.

EXPANDED FLOOD PLAIN INFORMATION STUDY

The concept of expanded flood plain information studies is discussed in Chapter 13. Although only one such study (as described below) has been undertaken in California, authorization and completion of others is expected.

Sonoma Creek Basin, Sonoma County (San Francisco District) An expanded flood plain information study of the Sonoma Creek Basin has been in progress since 1976. The area under study comprises the entire basin, a roughly rectangular shaped watershed about 22 miles long (on its north-south axis) and 7 miles wide. Sonoma Creek is tributary to San Pablo Bay, the main northerly body of the San Francisco Bay system. In general, the upper portion of the basin is rural except for small, scattered clusters of residential and commercial development. The middle sector contains the more populated areas, including Sonoma and its environs. The lower part of the basin is primarily agricultural. Rapid residential, commercial, and light industrial development is occurring in the middle sector. From the north, expansion of the metropolitan area of Santa Rosa is beginning to spill into the upper portion of the Sonoma Creek Basin. Continuing development in this area can cause hydrologic changes, especially in runoff characteristics, that would be most noticeable in the middle portion. In a reclaimed tidelands area along San Pablo Bay, there is pressure to develop lands in agriculture or in their natural state to commercial, industrial, and possibly residential uses.

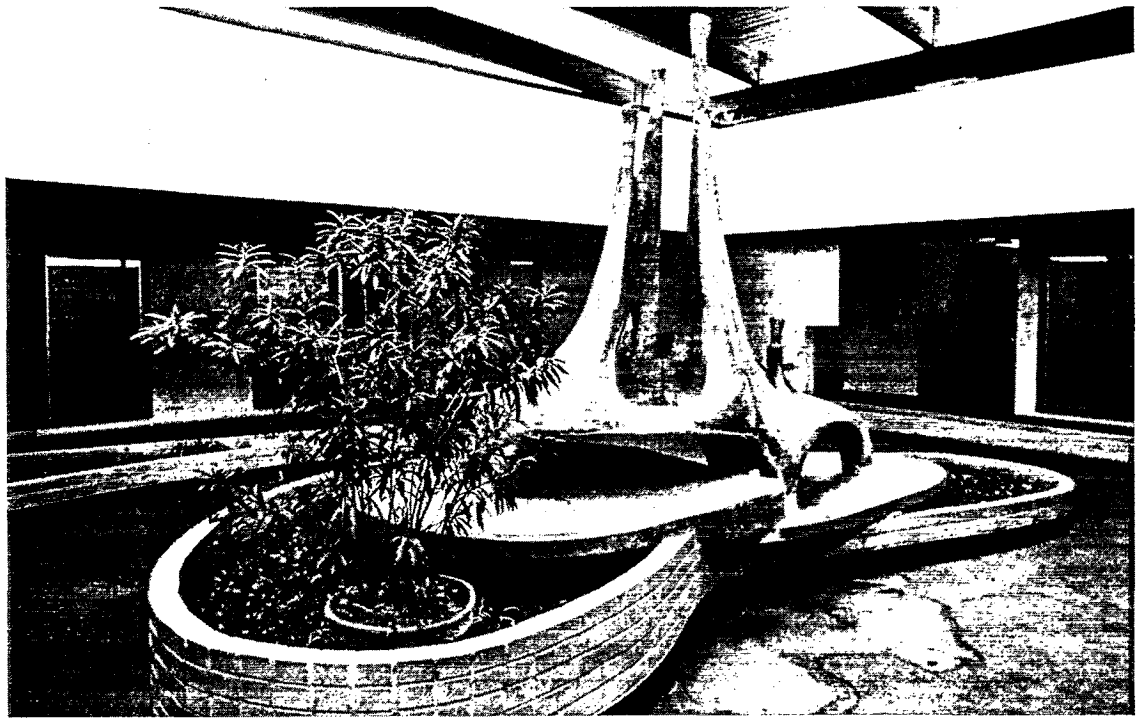
The study objective is to provide information useful to Federal, state, and local officials in making planning decisions that emphasize the implications of basin-wide development. Detailed hydrologic and generalized environmental investigations of the entire basin will be made to evaluate the effects of land use changes. Economic evaluations will be concentrated on areas of high flood damage potential. Computer

techniques are used to manage and manipulate basic data for map-making and presenting information in table form. In essence, computerized geographic files are used to evaluate the effects of alternative land use patterns on the hydrologic, economic, and environmental characteristics of the basin.

Data bank files have been completed and the analysis and evaluation of future land use schemes started. Preliminary reports and completion of the study are expected in 1979.

HYDROLOGIC ENGINEERING CENTER

The Hydrologic Engineering Center, an organizational unit of the Office of the Chief of Engineers, was established to improve the hydrologic engineering capability of the Corps of Engineers. Its staff includes 24 engineers and computer scientists of varying specializations. The Center's basic purpose is to assist engineering and planning personnel in applying advanced computer technology to current problems of investigating, planning, designing, and operating water projects. This involves evaluating and adapting available computer programs or developing new programs, teaching the use of these programs, and assisting in their application. A library of around 40 programs is maintained by the Center. Corps offices use these programs on Government-owned computers at Lawrence Berkeley Laboratory (Berkeley, CA) or on commercial computers in Seattle. The Center uses remote terminals and telephone lines to communicate with these and other computer facilities. Basically, the Center's mission may be separated into three broad areas of activity—applied research, training, and field office assistance.



Foyer of the Hydrologic Engineering Center, Davis, California

Research needs devolving from the Corps' role in developing and managing the Nation's water resources have increased rapidly due to growing competition for water resources, increasing complexity of water projects, and the far-reaching effects of changing land use and water management policies. Evaluation of these complex and interrelated factors presents major problems that the Center seeks to solve by developing systematic analytical methodologies tied to the most advanced computer capability available. The research effort is intended to bridge the gap between the academic community and practicing planners and hydrologic engineers.

Direct motivation for research projects comes from the actual problems confronting Corps field offices. Most of the Center's research effort is oriented toward developing or improving computer programs designed to solve these field problems. The resulting computer programs are generalized and may be applied to similar problems nationwide.

Ongoing research projects include developing programs to:

Determine the hydrologic effects of urbanization and changing land use.

Simulate operation of multipurpose reservoir systems.

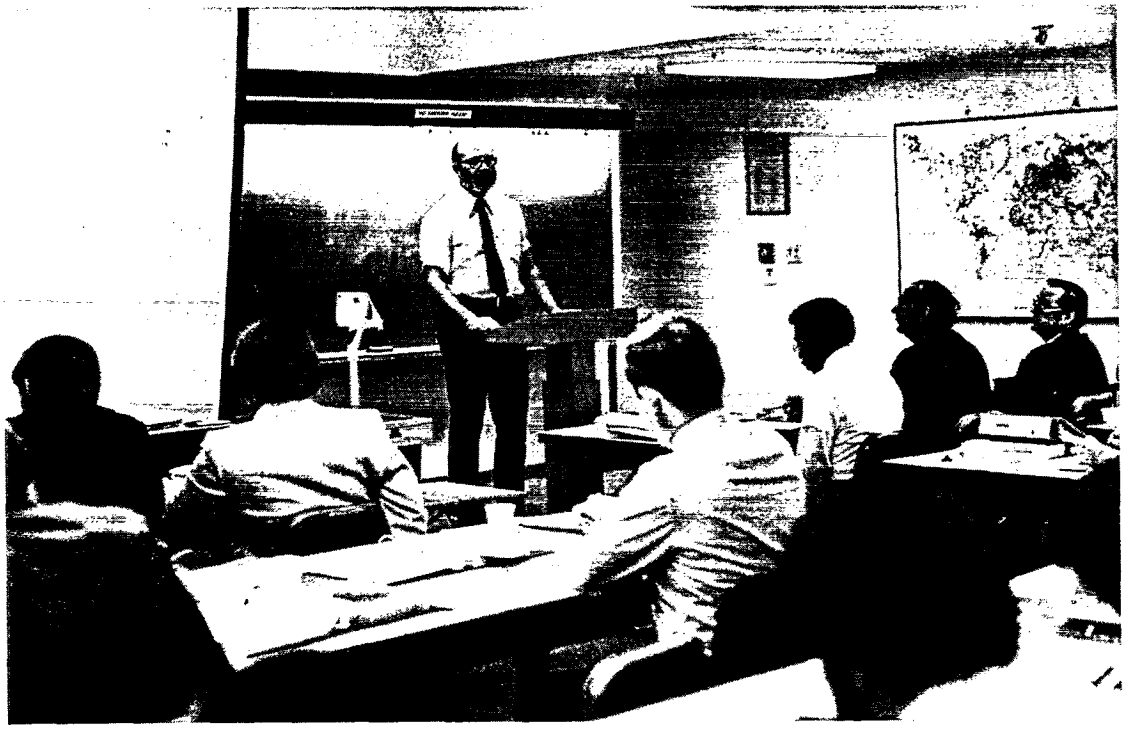
Forecast floodflows during flood emergencies.

Evaluate water quality and sediment movement in flowing streams, reservoirs, and estuaries.

Research to improve the technological capability for the Corps to undertake the nationwide inspection of dams (see page 18) and a nationwide study of hydroelectric power has been assigned to the Center on a high priority basis.

The main thrust of the Center's training program is toward practical application, and a substantial part of the training effort is devoted to instruction in applying computer techniques to the actual water resources development problems being encountered by planners and engineers. The program includes formal training courses, technical seminars, and special training of individuals.

Twelve formal training courses in hydrologic engineering and planning subjects are usually held each year, frequently with people from other agencies in attendance. The courses cover current techniques and methods, and emphasize practical applications as well as the limitations of new developments and the findings of recent research. Selected lectures are videotaped for distribution. Each year, a few special courses may be conducted to meet the needs of specific Division and District offices, particularly in using computer programs developed by the Center. Training course manuals, training documents on the solution of hydrologic engineering problems, and seminar proceedings are published and distributed as part of the training effort.



The Hydrologic Engineering Center classroom

The work of the Hydrologic Engineering Center is of particular interest to the world community of developing nations, which frequently lack technological and other capabilities needed to develop water resources for irrigation, power, flood control, and municipal and industrial uses. The Center has extended its expertise to these and other nations by conducting international workshops, conducting UNESCO sponsored training in Asia and South America, and by participating in activities of the World Meteorological Organization and the UNESCO International Hydrological Program. Over 50 engineers from more than 20 countries have participated in month-long workshops on computer applications in hydrologic analyses. As its contribution to the International Hydrologic Decade (a worldwide effort to rapidly advance water science during the period 1964-1974), the Center prepared a 12-volume report on methods and criteria for planning and designing water projects in regions where little specific hydrologic data are available. In October 1978, an international meeting on methods of computation for the hydrologic aspects of water projects was held at the Center. Engineers from Argentina, Ghana, Holland, Japan, Norway, Poland, Russia, Spain, and West

Germany participated as did representatives of the World Meteorological Organization and other international agencies concerned with water resources development.

Aiding and guiding field offices in applying computerized solutions to water resources development problems is the primary objective of the field office assistance program. A corollary benefit from this activity is that it gives the Center an opportunity to judge its own effectiveness and points out new areas of research and training needs. The Center has an intensive program for developing and implementing analytical methods and techniques for use in making expanded flood plain information investigations. (See page 159.) Emphasis is being given to developing methodology to formulate and evaluate alternatives in land use planning, and to developing computer programs to integrate hydrologic data, flood damage estimates, project and other benefits, costs, and other factors important in managing flood prone and adjacent lands. Methodologies and techniques developed or refined by the Center are being used by about a dozen Corps offices in conducting expanded flood plain information investigations as pilot studies.

Three United Nations Fellows from the Central Water Commission, India, reviewing computer printout with Hydrologic Engineering Center staff members.

Engineers from Brazil and India were recent trainees at the Center

16 CORPS OF ENGINEERS PARTICIPATION IN CIVIL WORKS

GENERAL

Through its Civil Works Program, the Corps of Engineers has been the principal water resources development agency of the Federal Government since 1824. This program is carried out in accordance with directives from Congress, and is supervised by the Chief of Engineers under the direction of the Secretary of the Army. Work is accomplished in close cooperation with other Federal agencies concerned, and with interested state and local authorities, to provide beneficial improvements desired by the citizens of the communities and areas most affected.

The Civil Works Program is directed toward the development of water resources in a way that will lead to the satisfaction of all water-related requirements—both immediate and long-range. These include navigation, flood control, major drainage, water supply for irrigation and municipal-industrial uses, regulation of hydraulic mining debris, hurricane flood protection, water quality control and wastewater disposal, hydroelectric power, shore protection and beach stabilization, water-oriented recreation, enhancement of fish and wildlife resources, and the preservation of esthetic and ecological values. Special emphasis is being placed on flood plain management in support of a national effort to reduce flood losses through appropriate local regulation of the use of flood prone areas.

The basic authority for Corps of Engineers participation in the development of water resources lies in the commerce clause of the Constitution, which gave Congress the power "to regulate commerce with foreign nations, and among the several states, and with the Indian tribes." Under this authority, during the 1820s, Congress assigned the Corps of Engineers the responsibility for projects dealing with navigation on the Ohio and Mississippi Rivers. In 1936, Congress expanded this basic authority to include nationwide responsibility for flood control, and, subsequently, to include the many related aspects of comprehensive water resources development.

The National Environmental Policy Act of 1969 established a policy that encourages productive and enjoyable harmony between man and his environment, promotes efforts to prevent damage to the environment, stimulates the health and welfare of man, and enriches the understanding of ecological systems and natural resources. Under Section 102 of that act, every recommendation for a Federal project must include a detailed statement on:

The environmental impact of the proposed action.

Adverse environmental effects that cannot be avoided should the proposal be implemented.

Alternatives to the proposed action.

The relationship between local, short-term use of the environment and the maintenance and enhancement of long-term productivity.

Any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

The coordination of the proposal with interested Federal, state, and local agencies.

Well aware of the complexities associated with water as a natural resource and its essentiality to all living things, the Corps of Engineers has recognized the need for including environmental analysis and planning as an integral factor in water resources studies and project formulation. The Corps was a member of the President's Water Resources Council Special Task Force for developing the role of the environment in solutions to water problems. At District level, the Corps has established environmental units staffed with biologists, ecologists, oceanographers, foresters, sanitary and civil engineers, recreation specialists, and others who contribute the expertise of their educational disciplines to environmental considerations.

In project planning, the basic objective is to provide for the best use, or combination of uses, of regional water and land resources to meet foreseeable needs. To achieve this basic objective, Corps planners give specific consideration to four planning objectives set forth in the 1970 Flood Control Act. These are, to insure the enhancement of:

Regional economic development.

The quality of the total environment and its protection and improvement.

The well being of the people.

The national economic development.

In other words, Corps planners in cooperation with local interests must arrive at rational, well considered decisions on what constitutes the best plan among alternative or competing plans for the use of water and related land resources.

Preparing plans for water resources development is a team job. Many Federal, state, and local agencies are involved to insure plans have proper balance, meet all important needs, and are generally acceptable. In planning a specific project, the Corps must assure that the final decision is made in the best overall interest and takes into consideration the need for flood control, navigation and associated facilities, the cost of eliminating or minimizing adverse effects, and:

Air, noise, and water pollution.

Destruction or disruption of manmade and natural resources, esthetic values, community cohesion, and the availability of public facilities and services.

Adverse employment effects and tax and property value losses.

Injurious displacement of people, businesses and farms.

Disruption of desirable community and regional growth.

Consideration of nonstructural (preventive) alternatives in the investigation, planning, and design of Federal projects involving flood control is required under the 1974 Water Resources Development Act. Nonstructural alternatives to flood control projects such as dams and levees do not lessen the magnitude of flooding or reduce the extent of areas flooded. They do, however, reduce the damaging effects of floods through control of the uses and development of flood plains.

Coordination of project proposals is another essential element of water resources development planning. Coordination with all Federal, state, and local agencies concerned, and with interested local groups, is carried on during all stages of planning to:

Obtain and exchange information on problems under study to insure that all useful data available are considered and basic research is not duplicated.

Insure balanced development among the plans of other agencies and of local groups concerned by considering all pertinent facts on their plans and views.

Develop feasible plans or programs that will make the best possible use of the natural resources involved.

Every Corps of Engineers project must be specifically authorized by Congress except for certain work that may be authorized by the Public Works Committees or by the Chief of Engineers. As indicated, a large volume of legislation governs the activities of the Corps of Engineers in carrying out the Civil Works Program. Information on selected authorities follows.

NAVIGATION PROJECTS

Beginning with an act approved 24 May 1824, investigations and improvements for navigation and related purposes have been authorized by a series of River and Harbor Acts, and basic policies and procedures have been established by these laws. The 1920 River and Harbor Act expanded the Federal policy on navigational improvements and established general requirements for local cooperation where the benefits are mainly local in nature. Subsequent acts have further clarified and expanded the Federal policy, and have authorized many specific navigation projects. Any special conditions and requirements pertaining to a specific project are included in the authorizing act. Section 117 of the 1968 River and Harbor Act permits the Corps of Engineers to maintain navigation channels in excess of authorized project depths when such depths were provided for defense purposes and also serve essential needs of general commerce. Section 6 of the Water Resources Development Act of 1974 provides that the cost of the operation and maintenance of the general navigation features of certain small boat harbors shall be borne by the Federal Government.

REGULATION OF HYDRAULIC MINING

After its beginning in 1853, hydraulic mining became a highly important activity in California. However, it resulted in large deposits of silt, sand, and gravel in the main waterways of the Sacramento and San Joaquin Valleys. This debris was deposited in such large quantities that it greatly impaired the usefulness of these channels for navigation and flood-carrying purposes. Widespread agitation about these detrimental effects finally resulted in a United States Circuit Court decree prohibiting uncontrolled deposition of hydraulic mining debris. This decree was issued in 1884, and in the next few years practically all mines operating without means of restraining debris were closed. Due to the importance of hydraulic mining, Congress in 1893 created the California Debris Commission (as an organizational element of the Corps of Engineers) to regulate hydraulic mining activities. The act creating the Debris Commission permitted resumption of hydraulic mining under conditions that would prevent debris from entering navigable waters or otherwise causing damage. In general, the law requires that prospective hydraulic mine operators provide debris-restraining facilities considered satisfactory by the California Debris Commission, or agree to make appropriate payment for debris storage in debris control reservoirs built by the Federal Government.

In addition to its continuing regulatory functions, the California Debris Commission acts as a construction agency in the building of Federal debris control facilities. These works retain hydraulic mining debris in foothill regions and prevent its deposition in main stream channels.

FLOOD CONTROL PROJECTS

In the 1880s, the Corps of Engineers was authorized to construct levees for flood control along the lower Mississippi River. In 1917, under the authority of Public Law 367, responsibility for flood control work along the entire Mississippi River and for a limited amount of

work on the Sacramento River was assigned. This was the first authorization of flood control improvements outside the Mississippi River Valley. Responsibility for the nationwide flood control program was assigned to the Corps of Engineers in Section 1 of the 1936 Flood Control Act, which established Federal policy on flood control as follows:

> . . . it is the sense of Congress that flood control on navigable waters or their tributaries is a proper activity of the Federal Government in cooperation with States, their political subdivisions, and localities thereof . . .

Many specific projects have been authorized for construction, and completed projects have been extended or otherwise modified, under a series of Flood Control Acts since 1936, and basic procedures and policies have been shaped by these laws. Authorizing acts usually do not carry appropriations for undertaking the projects authorized. Therefore, funds for engineering, design, and construction must be provided by subsequent appropriations acts.

Section 7 of the 1944 Flood Control Act provides that operating rules and regulations for flood control space in any reservoir built in whole or in part with Federal funds is the responsibility of the Corps of Engineers. Projects for which operating rules and regulations have been developed are referred to as "Section 7 Projects."

The Small Reclamation Project Act of 1956, as amended, established a program under which non-Federal interests can obtain loans for small reclamation projects. In cooperation with the Bureau of Reclamation, the Corps of Engineers assists in analysis and evaluation of proposed projects when flood control is a function.

Under the authority of the Watershed Protection and Flood Prevention Act of 1954, as amended, the Soil Conservation Service constructs dams and other facilities in headwater areas for a variety of purposes including flood control. The Corps of Engineers cooperates with the Soil Conservation Service in carrying out this program.

Federal participation in the cost of partnership projects must be specifically authorized by Congress in a Flood Control Act. The Federal contribution is determined by detailed cost allocation studies and reflects the flood control accomplishment to be realized. It excludes costs for other functions as well as the Federal expenditures for studies and administration of funds. Partnership projects are operated for flood control according to rules and regulations established by the Corps of Engineers.

SHORE PROTECTION PROJECTS

The 1930 River and Harbor Act authorized Corps of Engineers investigation of shore processes and beach erosion problems in cooperation with the states. Later authorizations (1946, 1956, 1962, and 1968) permitted Federal assumption of up to 50 percent of the construction cost for protecting certain public beaches, up to 70 percent of the construction cost for protecting certain public shore parks or conservation areas, and limited contribution toward the cost of protecting privately owned shore areas. Non-Federal interests in all cases must assume all remaining costs and meet certain other requirements of local cooperation.

Shore protection projects must be specifically authorized by Congress, except for small projects or construction, operation, and maintenance of improvements costing less than $1,000,000, which may be authorized by the Chief of Engineers if needed to prevent or mitigate shore damage from Federal navigation works.

Section 54, Water Resources Development Act of 1974, authorized a 5-year demonstration program to disseminate information on low-cost means of solving shoreline erosion control problems.

PROJECTS APPROVED BY THE PUBLIC WORKS COMMITTEES

Section 201 of the 1965 Flood Control Act, as amended by the 1976 Water Resources Development Act, authorizes the Secretary of the Army, acting through the Chief of Engineers, to construct, operate, and maintain single- and multiple-purpose water resources development projects involving, but not limited to, navigation, flood control, or shore protection if the Federal cost is less than $15,000,000. Such projects must be approved by resolutions adopted by the Public Works Committees of the Senate and House of Representatives, and are subject to the same requirements of investigation, coordination, and local cooperation as projects that must be authorized by the full Congress.

PROJECT DEAUTHORIZATION

Section 12 of the Water Resources Development Act of 1974 provides a procedure for deauthorization of projects that have not received appropriations for 8 years. In general, the procedure requires that both Houses of Congress be provided a list of projects no longer considered for continued authorization. Prior to submission of the list, the views of interested Federal agencies and the Governors of the affected states must be obtained, and the Congressional Representative concerned must be notified. A project on the list becomes deauthorized after 180 days of continuous session unless one of the committees on public works adopts a resolution to the effect that the project will continue in an authorized status.

INVESTIGATIONS AND REPORTS

Preauthorization investigations of most water resources development projects are made under specific authorizations of Congress included in River and Harbor and Flood Control Acts, or in resolutions of the House or Senate Public Works Committee. Authority to reevaluate completed water resources development projects when physical, economic, or social conditions have changed materially since project construction is contained in the 1970 Flood Control Act. The 1958 Fish and Wildlife Act provides authority to investigate modifying structures and operation of projects completed before August 1958, or acquiring lands in the interest of conserving fish and wildlife resources. Mitigation of shore damage due to navigation improvements may be investigated and reported upon under authority of the 1968 River and Harbor Act. Special investigations are made pursuant to legislative actions or congressional resolutions. The Urban Studies Program grew out of pilot wastewater management planning studies directed by Congress in 1970. Although those studies were single purpose, it was apparent that solving wastewater problems on a regional basis provided opportunities to solve other urban water resources problems. Beginning in 1973, funds have been provided for urban studies, which are specifically authorized by resolutions adopted by the House or Senate Public Works Committee.

RECREATION

Outdoor recreation is recognized by the Corps of Engineers as a tangible and important function of water resources development, and it is given the same consideration as other needs and potentialities in the planning of water resources development projects. Authority to participate in recreational developments was provided by Section 4 of the 1944 Flood Control Act as amended by the 1946, 1954, 1960, and 1962 Flood Control Acts. Under these continuing authorities, the Corps of Engineers constructs, operates, and maintains public park and recreational facilities at water resources development projects under its control, and may permit construction, operation, and maintenance of such facilities by local interests.

Recreation facilities for public use are generally provided through cooperative efforts of the Corps of Engineers and a non-Federal agency, and when appropriate, by private interests on a concessionaire basis. The 1965 Federal Water Project Recreation Act, as amended by the Water Resources Development Act of 1974, authorized the Corps of Engineers to participate and cooperate with states and local interests in developing the recreational potential of any Federal water project. Under these authorities, the Federal Government assumes responsibility for major recreational development provided that non-Federal public bodies agree in advance to administer project land and water areas for recreation or fish and wildlife enhancement, and to bear not less than one-half the separable project costs allocated to recreation and one-quarter of the costs allocated to fish and wildlife enhancement.

FLOOD PLAIN MANAGEMENT SERVICES PROGRAM

The Corps of Engineers program to assist and guide others in the prudent use of flood plains is discussed in detail in Chapter 13. Authority to conduct the program was provided by Section 206 of the 1960 Flood Control Act (as amended by the 1966 and 1970 Flood Control Acts and the Water Resources Development Act of 1974). The program must be carried out in consonance with Executive Order 11988, which is a significant policy initiative tying together the need to protect lives and property with the need to restore and preserve natural and beneficial flood plain values. Adopted on 24 May 1977, the order establishes a new general policy that requires agencies to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of flood plains, and to avoid the direct or indirect support of flood plain development whenever there is a practicable alternative.

CONTINUING SPECIAL AUTHORITIES

Small Projects

Small navigation, flood control, and shore protection projects may be approved by the Chief of Engineers on the basis of reconnaissance-type investigations and subsequent detailed project reports. The allotments for small projects, which are made by Congress on a lump-sum nationwide basis, cannot exceed $30,000,000 for small flood control projects or $25,000,000 each for small navigation and small shore protection projects during any one year. No more than $2,000,000 (Federal cost) can be allowed for any single small navigation or small flood control project, and no more than $1,000,000 can be allowed for a single small shore protection project. However, $3,000,000 may be allowed for a small flood control project if it will protect an area declared a major disaster area in the 5-year period preceding the date of project approval.

Small navigation projects are constructed under the authority of Section 107 of the 1960 River and Harbor Act, as amended by the 1965 and 1970 River and Harbor Acts and the 1974 and 1976 Water Resources Development Acts. Authority to investigate and construct small flood control projects is contained in Section 205 of the 1948 Flood Control Act, as amended by the 1950 and 1962 Flood Control Acts and the 1974 Water Resources Development Act. Small shore protection projects are undertaken pursuant to the provisions of Section 3 of "An Act Authorizing Federal Participation in the Cost of Protecting the Shores of

Publicly Owned Property" (13 August 1946), as amended principally by the 1962, 1965, and 1970 River and Harbor Acts.

Emergency Work

Congress has provided continuing authority for the Corps of Engineers to do emergency work for flood control and navigation, or for general recovery from disasters. Emergency flood control and navigation work projects need not be specifically authorized, but, just as projects requiring specific authorization, they must be economically and environmentally feasible. Emergency work for flood control may be undertaken under three general authorizations as follows:

Bank Protection (Section 14, 1946 Flood Control Act, as amended): Within the limit of available funds, the Corps of Engineers is authorized to spend up to $250,000 annually in a single locality to construct emergency bank protection works to prevent flood damage along shorelines or to highways, bridge approaches, and other public works endangered by bank erosion. Public works within the meaning of the authorization are Federal, state, and local facilities, or facilities of non-profit organizations serving the general public.

Snagging and Clearing (Section 208, 1954 Flood Control Act, as amended). Within the limit of available funds, the Corps of Engineers is authorized to spend up to $250,000 annually on any single tributary to remove accumulated snags and other debris, and to clear and straighten channels in navigable streams and tributaries thereof when, in the opinion of the Chief of Engineers, such work is advisable in the interest of flood control.

Flood Fighting, Rescue, and Repair (Public Law 84-99 and antecedent legislation). Within the limit of available funds, the Corps of Engineers is authorized to engage in flood fighting and rescue operations and to repair or restore flood control works threatened or destroyed by floods. Repair or restoration of flood control works includes strengthening or otherwise modifying damaged or threatened flood control structures to ensure adequate functioning. Operation Foresight activities were conducted under the authority of Public Law 84-99.

Emergency work in the interest of navigation is undertaken under two general authorizations:

Removal of Wrecks and Obstructions (Public Law 55-189). The Corps of Engineers is authorized, within the limit of available funds, to investigate wrecked vessels and other obstructions to navigation, and to ensure removal at the expense of the owner or, under certain specific conditions, at the expense of the Federal Government.

Snagging and Clearing (Section 3, 1945 River and Harbor Act). Within the limit of available funds, the Corps of Engineers is authorized to remove accumulated snags and other debris and to protect, clear, and straighten channels in navigable harbors and navigable streams and tributaries thereof when, in the opinion of the Chief of Engineers, such work is advisable in the interest of navigation or flood control.

Authority to engage in disaster recovery activities at the request of the Federal Disaster Assistance Administration is provided by Public Law 93-288 (Disaster Relief Act of 1974) and antecedent legislation—Public Laws 81-875, 89-769, 91-79, and 91-606, and Executive Order 10427.

INITIATION, AUTHORIZATION, AND CONSTRUCTION OF CORPS OF ENGINEERS PROJECTS

Water resources development projects cannot be initiated by the Corps of Engineers. Actually, local interests initiate, the Corps investigates, Congress authorizes, and the Corps plans and constructs the project authorized. The major steps in processing a project are summarized as follows:

Local interests inform their Senator or Representative of a water resources problem affecting their area or of a water resources project they feel is needed, and request that a Federal study of the problem or project be made. A study may be authorized by the Senate or House Public Works Committee, or in separate legislation.

When the study is authorized, the Chief of Engineers assigns it to the appropriate Division Engineer, who refers it to a District Engineer for accomplishment. After receipt of the directive and funds, the District Engineer begins the required engineering, economic, and environmental analyses, as well as the necessary coordination with local interests and other agencies. An initial public meeting is held to advise local people of the nature and scope of the investigation and to ascertain their views on problems, needs, and the types of improvements desired.

After careful consideration of the desires and needs of local people and detailed study of data obtained through field and office investigations (and assuming there is a positive potential solution to the problem under study), the District Engineer develops alternative plans of improvement. Planning workshops, citizens advisory committees, or similar methods of citizen involvement in planning are arranged by the District Engineer to insure that alternative plans of improvement for an area are developed as a joint effort by Corps planners and affected citizens. The

District Engineer presents the alternative plans at a second public meeting to obtain the opinions of local people on which plan best satisfies community needs. Sufficient public meetings are held to insure that all viewpoints are considered before the District Engineer formulates a definite plan.

On the basis of systematic analysis of problems and the best overall plan for their solution, and the views expressed by local citizens, the District Engineer prepares a project feasibility report and an environmental impact statement. The draft feasibility report is reviewed by state and Federal agencies and citizens groups, and their comments are included in the report and in the final environmental impact statement.

When a plan of improvement is selected, local interests must indicate their support of the proposed plan and their intent to meet the requirements of local cooperation. These assurances must be in the form of a formal document from an agency of local government that is empowered to represent the area concerned and to incur public debt. These data and the recommendations of the District Engineer are included in the report. A recommendation by the District Engineer for structural improvements is largely dependent upon local acceptance of the project proposed and its justification on the basis of economic, environmental, and social considerations.

The Division Engineer reviews the report, adds his recommendations, and transmits the report and the environmental impact statement to the Chief of Engineers. The report and the statement are referred to the Board of Engineers for Rivers and Harbors for review. All interested parties receive a public notice summarizing the findings and recommendations of the District and Division Engineers and informing them that they may present their views on the matter to the Board of Engineers for Rivers and Harbors within a specified period of time.

The Board of Engineers for Rivers and Harbors reviews the environmental impact statement and the reports of the District and Division Engineers, and carefully considers any additional information received from interested parties. The Board prepares its report, including recommendations, and transmits it to the Chief of Engineers. Upon receipt of the recommendations of the Board, the Chief of Engineers prepares the report for submittal to Congress. Interested Federal agencies and Governors of affected states are given opportunity to comment on the recommendations of the Chief of Engineers. After full consideration of these comments, the Chief of Engineers submits the report to the Secretary of the Army, who obtains the views of the Office of Management and Budget before transmitting the report to Congress. The environmental impact statement is sent to the Environmental Protection Agency.

The House and Senate Committees on Public Works may hold hearings on the report findings to formulate a bill including authorization of the recommended project. If the project is included in a Flood Control or River and Harbor Act, adoption of the act constitutes project authorization. Funds for construction must be provided by separate congressional action.

Often, a number of years may elapse between project authorization and appropriation of funds. Thus, it is necessary for the District Engineer to reevaluate the authorized project in the light of current economic, environmental, and social factors. At an initial public meeting, he presents the authorized project plan and alternatives to that plan, and solicits comments on the adequacy of the authorized plan under current conditions. If required, he requests local interests to appoint a citizens advisory committee and conducts planning workshops in his reanalysis of the situation to either reaffirm or reformulate the desired plan. These studies are identified as Phase I, General Design Memorandum.

After detailed analysis of all reasonable alternatives, the District Engineer holds a second public meeting to determine the public consensus. Based on public reaction and local recommendations, the District Engineer selects the plan that he considers best fulfills the needs and desires of the people, and updates the environmental impact statement on file with the Environmental Protection Agency. He then presents the plan at a final public meeting, where all interested parties are given full information as to why the recommended project plan was selected instead of the alternative plans considered and are invited to submit their views and comments on the selected plan. When the interested parties generally are in agreement that the plan selected is the optimum plan, the District Engineer forwards the Phase I General Design Memorandum and the updated environmental impact statement through the Division Engineer to the Chief of Engineers, who in turn transmits the report and statement to the Board of Engineers for Rivers and Harbors for approval.

When these documents are approved, the District Engineer begins detailed project design studies of the structures necessary to meet the objectives selected in the reaffirmed or reformulated plan in the Phase I General Design Memorandum. A second report (Phase II General Design Memorandum) is then prepared. When approved, it constitutes the beginning of the end of the planning process, for the District Engineer can now prepare plans and specifications, advertise and award a construction contract, and actually begin project construction. When the construction contract is advertised, another public meeting is held to inform local interests and others of proposed construction activities.

HOW LOCAL INTERESTS SHARE IN FEDERAL PROJECTS

The cost of a Federal water resources development project is usually shared by local interests as specified

in the authorizing legislation. The local share is not the same for every project because each project is separately and specifically authorized. However, the local share would usually include several of the following:

Providing lands, easements, rights-of-way, utility relocations, disposal areas, miscellaneous harbor and related improvements, supplemental dredging and jettywork, and a cash contribution.

Operating and maintaining the completed improvements, maintaining and preserving channel capacities, and preventing any future encroachment on project channels.

Adjusting water rights claims resulting from operation of the improvements.

Holding and saving the United States free from damages resulting from construction and operation of the improvements.

Paying all or a portion of project costs allocated to irrigation, municipal and industrial water supply, recreation, fish and wildlife enhancement, and any costs for facilities especially beneficial to local interests.

The best method for meeting the requirements of local cooperation in any water resources project is for local interests to be represented by a legal sponsoring agency. Such an agency should be a governmental unit or some type of special district with the necessary legal authority and financial ability to meet the requirements of local cooperation specified. If an agency suitable to project sponsorship does not exist, local interests should take action to establish one. If the authority to form a sponsoring agency is not available, local interests should take action to obtain state, county, or local enabling authority.

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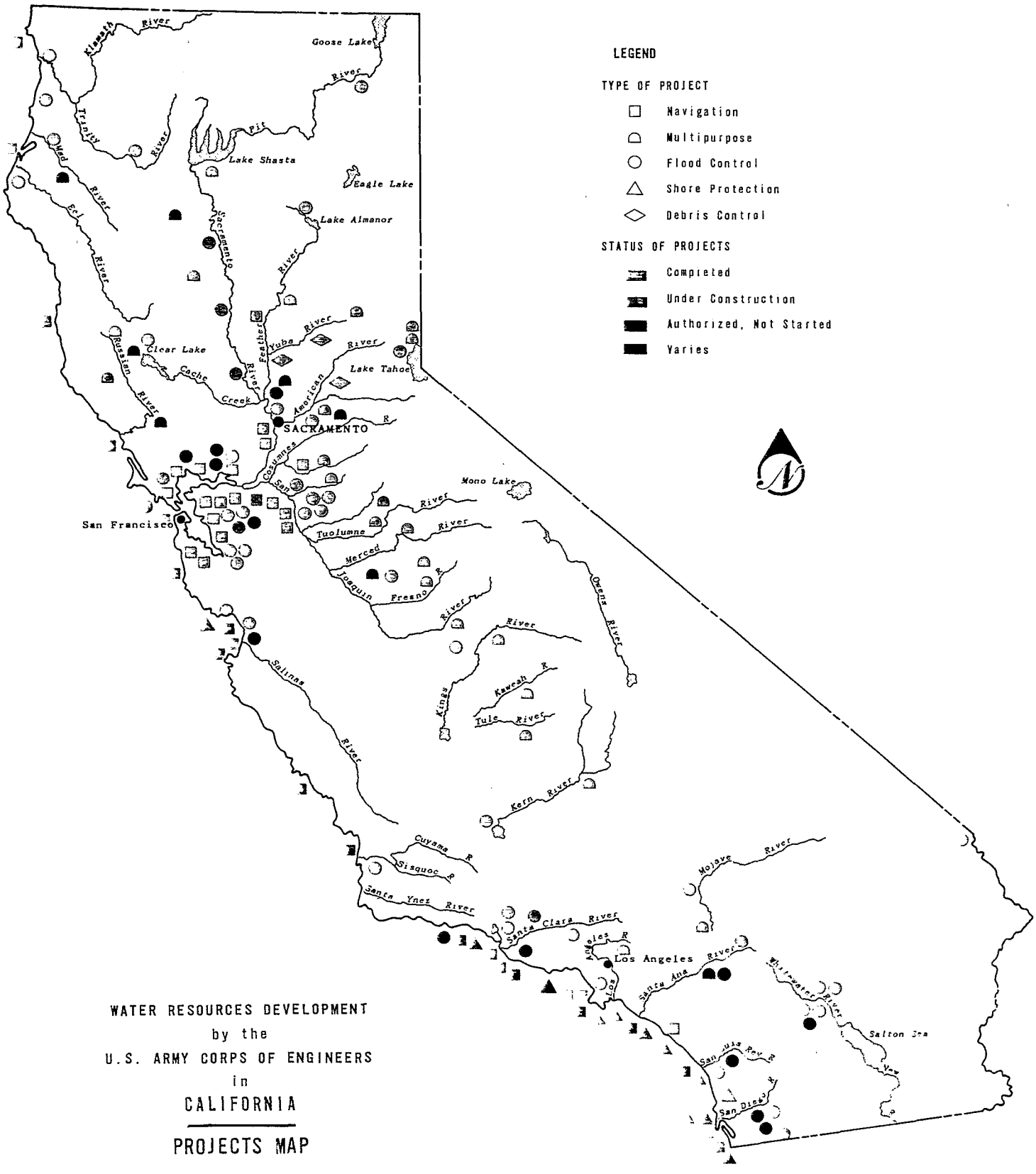

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