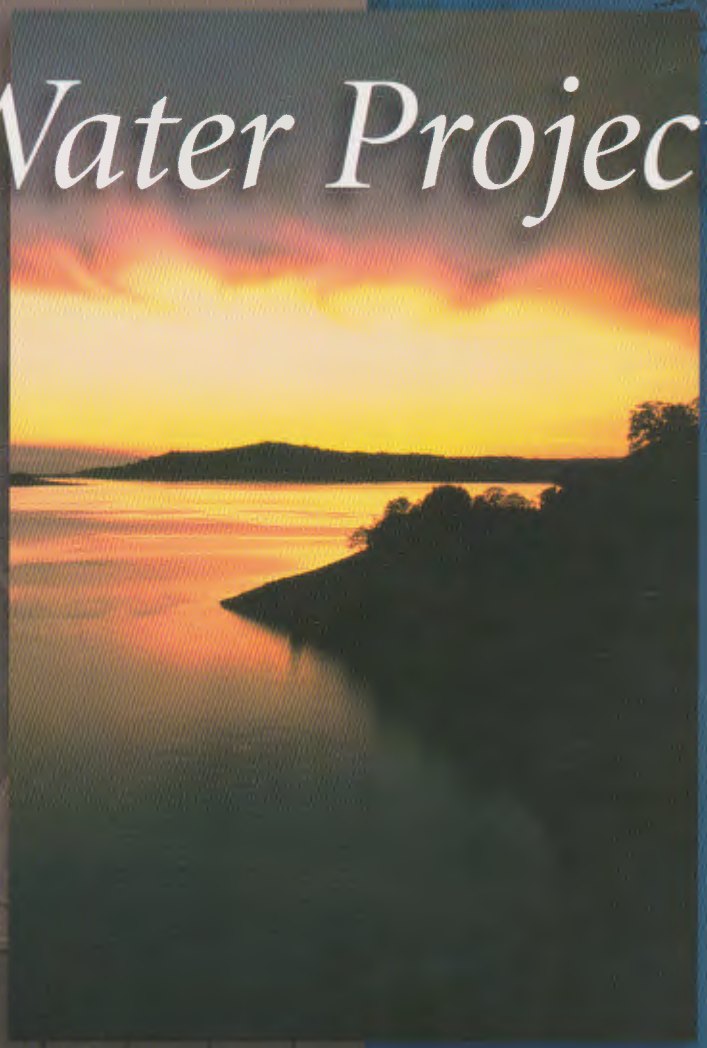
DWR NEWS SPECIAL EDITION

CALIFORNIA *State Water Project*



PAST

PRESENT

FUTURE

"**TO MANAGE THE WATER RESOURCES** *of California, in cooperation with other agencies, to benefit the State's people and protect, restore, and enhance the natural and human environments.*"

Mission Statement

This revised **DWR News** special edition on the State Water Project , originally released in 2000, marks the Department's 50th year of service to the people of California; 1956 - 2006.

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PROLOGUE

Originally released in 2000, this publication was revised in honor of the Department's 50th anniversary. The Department was created to oversee, plan, design, construct, maintain, and operate the State Water Project. Learn why the Project struggled for passage, how it was constructed over miles of hilly terrain, and what future plans are in store.

THE PAST

California started as a land, populated mainly by native Indians and Spanish missions. But the Gold Rush in 1849 changed the quiet frontier and focused attention on the significance of water in the State's development. The rush of people, industries, and agriculture soon pushed regional supplies to their limits, and a state water project was sought to solve the problem. However, decades would pass before such a system was conceived and approved, and construction begun.

THE PRESENT

Today's State Water Project is highlighted with its benefits, the contracting agencies that paid for its construction and pay for its operations and maintenance, its financing, and recent events that changed how the system's water supply is allocated and how operations have changed. This section also explains how environmental regulations have changed construction of additional facilities and how the Department is dealing with an aging system.

THE FUTURE

The SWP has faced many challenges within the last 50 years, but what does the future hold? To ensure communities' water supplies, SWP deliveries must be complemented by regional water management and alternative management strategies such as conservation and reclamation. The Project's Oroville facilities await a new operating license. Future SWP operations also depend on fixing the Delta's water quality and levee problems to protect the region that serves as the hub of California's water system.

PROLOGUE

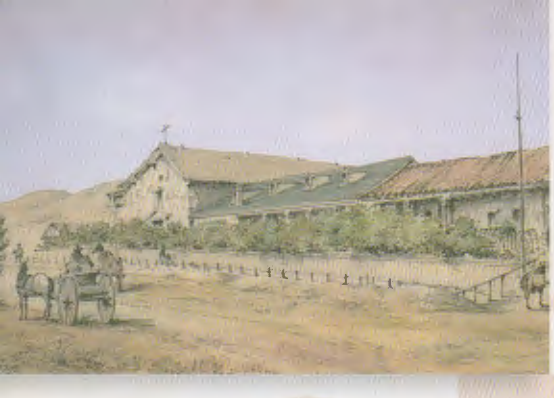
Originally published in 2000, this special edition on the State Water Project has been updated to commemorate the Department of Water Resources' 50th year of service to the people of California.

On July 5, 1956, the Legislature passed a bill creating the Department of Water Resources to plan, design, construct, and oversee the building of the nation's largest state-built water development and conveyance system. Talented men and women accomplished this enormous task during a time when slide rules were the engineers' main tools and computers were just beginning their evolution into modern versions.

The publication brings to light the history of the Project's long struggle for passage and events that encouraged its construction; the SWP's present facilities and the contracting agencies that pay for its operations and maintenance; and the projects and policies that will affect California's water future.

In 2001, the American Society of Civil Engineers recognized the State Water Project as one of the greatest engineering achievements in the 20th century. With facilities extending from Lake Oroville in Butte County to Lake Perris in Riverside County, its operations serve 23 million people and irrigate one million acres of farmland. Water is delivered to counties in Northern California, the Bay area, San Joaquin Valley, the Central Coast, and Southern California. The project has helped California sustain its status as the nation's number one food producer and the world's eighth largest economy.

After 50 years of outstanding service to the people of California, those who contributed to this tremendous legacy can look back with pride at a job well done. A new generation of water managers are continuing the Department's commitment to excellence - knowing that with professional skill and strong leadership, DWR can meet the water challenges of today and tomorrow.



Before gold was discovered, there were no substantial settlements, only missions (like the San Jose mission shown here) and ranches along the coast.

BEFORE GOLD WAS DISCOVERED *at Sutter's Mill in 1848, California was "virgin" land. As described by S.T. Harding in his 1960 "Water in California," there were no substantial settlements, only missions and ranches along the coast and a few early pioneers like John Sutter. The streams ran uncontrolled, and during the wet seasons, large areas became wetlands filled with thousands of waterfowl and other wildlife.*

Attracting Forty-niners from all over the world, the Gold Rush would soon change the new state's pristine nature, including the way its water resources would be viewed and used. Miners built hundreds of miles of flumes and ditches to divert water so it could be used to sluice out the gold. In the following years as the precious metal became more difficult to find, frustrated miners turned to farming, using California's brimming aquifers to irrigate their crops. Local water systems were built in the early part of the 20th century to bring water to cities that were developing into booming metropolitan centers like San Francisco and Los Angeles.

THE Past

Gold seekers flocked to California, increasing its population and water needs.

Hydraulic mining was used to break down hillsides to search for gold. Flumes (far right) conveyed water used to sluice out the precious metal.

Local water systems were built in the early part of the 20th century to bring water to cities that were developing into booming metropolitan centers like San Francisco (left, Market Street) and Los Angeles.

WATER INVESTIGATIONS BEGIN

The first investigation of California's water resources began in 1873 when President Ulysses S. Grant commissioned an investigation by Colonel B. S. Alexander of the U.S. Army Corps of Engineers. Alexander's report, completed the following year, surveyed the Central Valley's irrigation needs and recommended systematic development of the Sierra watersheds.

The State followed with its own study in 1878 when the State Engineer's office was created and filled by William Hammond Hall. His comprehensive study, conducted most intensely between 1878-83, produced an impressive body of work that included drainage and river channel investigations with recommendations for flood control and navigation improvements on the Sacramento, Feather, Yuba, and Bear rivers and in the Sacramento-San Joaquin Delta. Irrigation surveys contained maps; climatic, geographic, geologic, and hydrologic data; soil profiles; well inventories; and summaries of irrigation practices. Also under his direction, a permanent system of more than 200 stream gauges was installed. Overall, Hall's report concurred with the Alexander report that the waters of the Central Valley should be developed for the benefit of the state.

The concept of a statewide water development project was first raised in 1919 by Lt. Robert B. Marshall of the U.S. Geological Survey. He proposed transporting water from the Sacramento River system to the San Joaquin Valley then moving it over the Tehachapi Mountains into Southern California. His proposal led to the first plan for a State-operated water project.

THE Past

An early water extraction rig.

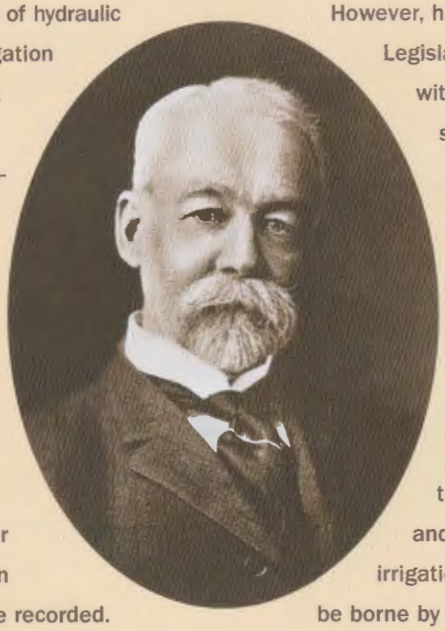
William Hammond Hall

FIRST STATE ENGINEER

During the Civil War, William H. Hall served under the U.S. Engineering Corps. His education and experience as a field engineer, draftsman, and hydrographer eventually led to his appointment as the first State Engineer in 1878. He had $100,000 to do a comprehensive study that would improve navigation and drainage on the Sacramento and San Joaquin rivers, determine the effects of hydraulic mining, and assess the irrigation needs of the Central Valley.

The most intensive years of research were conducted from 1878–1883. His survey team, working from boats, gauged and sounded large portions of the Sacramento, Feather, and American rivers. They installed an extensive system of permanent river gauging stations. Irrigation acreage and practices were recorded.

Their efforts were summarized in five progress reports to the Legislature from 1878–1882. Impressive in their detail and quantity, the data was presented in extensive tables, maps, and narratives with cost analysis.



During his term as State Engineer, Hall built a number of navigation improvement projects for river commerce, gathered information eventually used to end hydraulic mining, proposed an integrated flood control system for the Sacramento Valley, compiled an abundance of data on irrigation, and called for long-range water planning by the State.

However, his work suffered as the Legislature began providing him with less and less funding as some members questioned his methods and the validity of his investigations.

Hall's proposal to reform the state's system of water rights brought him the most opposition. He argued for public ownership, regulation, and control of the State's waterways and against public funding of irrigation works that he felt should be borne by private irrigation districts.

In 1888, Hall resigned his position after he went through criminal proceedings for misuse of State funds. He was exonerated and went on to continue his work as a private consulting engineer to the federal government, California irrigation districts, and projects in South Africa and eastern Europe.

1878–88

SWP DEVELOPMENT TIMELINE

1874 A report, commissioned by President Ulysses S. Grant to investigate the Central Valley's water resources, is completed. It proposes a Central Valley storage and distribution system.

1878 The Office of the State Engineer is established, with William Hammond Hall as its first appointee. He launches a comprehensive investigation which concludes that Central Valley water resources should be systematically developed.

1887 Wright Act is adopted. It permits the formation of irrigation districts.

1902 Congress passes the Reclamation Act, offering cheap land to those who drain swamplands and farm them. The act also creates the U.S. Bureau of Reclamation, charged with the reclamation of western lands.

1919 Lt. Colonel Robert Marshall of the U.S. Geological Survey publishes a plan that proposes Sacramento River water be impounded by reservoirs and delivered to the San Joaquin Valley and Southern California through canals for irrigation use.

Early irrigation canal

SWP

DEVELOPMENT TIMELINE

1921 The Legislature authorizes the Department of Public Works to conduct a statewide investigation of water resources.

1927 The Legislature passes a law that reserves the rights to divert surplus unappropriated water for future development according to a coordinated plan.

1929 The Division of Water Resources is established within the Department of Public Works. The Division is the predecessor of the Department of Water Resources.

The Legislature establishes a statewide program to collect snow survey data and determines that the Division of Water Resources would be the coordinator of the "California Cooperative Snow Surveys Program." Data are used to forecast runoff for water supply.

A dam safety program (now administered by DWR's Division of Safety of Dams) is established after the disastrous 1928 failure of St. Francis Dam.

1928 failure of St. Francis Dam.

1931 State Engineer Edward Hyatt makes a report to the Legislature on what he calls the State Water Plan. The plan discusses the physical and economic aspects of the proposed development, and provides for an exchange of water between northern and southern portions of the Central Valley.

A Visionary–

COLONEL ROBERT BRADFORD MARSHALL

He called his proposal "only a Big Job," knowing many would doubt its engineering and economic possibilities. But Colonel R. Bradford Marshall was dedicated to the vision of a statewide water system that would irrigate California's millions of acres lying unused.

By the time he left the U.S. Geological Survey after 30 years of service, Colonel Marshall knew California intimately. He came to California in 1891 as a surveyor and rose through the ranks rapidly to eventually be assigned responsibility for all Western states. And as he gathered data all over California, Colonel Marshall wondered why its residents did not use its abundant water supplies to irrigate acreage that could increase its population and its economy and produce "billions" of dollars worth of crops, making it "the world's greatest garden."

Colonel Marshall was known as a man who would not propose a plan for construction until he knew all the facts. He wrote in his report that "we have all the field data necessary to begin this work and could start construction tomorrow." Specific facilities were described such as a diversion dam across the upper Sacramento River above and near Redding with water flowing down two grand canals, one down each side of the Sacramento Valley.

He justified the project's costs, which would probably run in the "billions," with the jobs it would provide and the food it would produce to feed the hungry. Water user costs and hydroelectric sales would repay the expenses and provide for operations and maintenance.

When his proposal was unveiled in 1919 however, very few people took it seriously and had no interest in studying his maps in detail– although the press had reported on it favorably. Then Colonel Marshall retired to his farm in Patterson, knowing someday his plan would be recognized.

1919

THE Past

A STATE WATER PLAN IS PROPOSED

In 1931, State Engineer Edward Hyatt introduced a report identifying the facilities required and the economic means to accomplish the north-to-south water transfer. Called the "State Water Plan," the report took nine years and $1 million to prepare. To implement the plan, the Legislature passed the Central Valley Act of 1933, which authorized the project. A $170 million bond act was subsequently approved by the voters in a special December 19, 1933 election.

But in the midst of the Great Depression, revenue bonds were unmarketable so no funding could be found to begin construction of the Central Valley Project. The federal government took over the CVP as a public works project to provide jobs and its construction began in 1935. Today, the CVP provides water to parts of the Central Valley and Bay Area.

Central Valley Project

Today the Central Valley Project, operated by the federal Bureau of Reclamation, is one of the world's largest water storage and transport systems. Its 22 reservoirs have a combined storage of 11 million acre-feet, of which 7 million acre-feet is delivered in an average year. In comparison, the SWP's 20 major reservoirs can hold 5.8 million acre-feet, with annual deliveries averaging up to 3 million acre-feet.

CVP water irrigates more than 3 million acres of farmland and provides drinking water to nearly 2 million consumers. SWP deliveries are 70 percent urban and 30 percent agriculture, meeting the needs of 20 million Californians and about 1 million irrigated acres, respectively.

The CVP has long-term contracts with more than 250 contractors in 29 out of 58 counties; while 29 agencies have 50-year contracts with the SWP.

SWP DEVELOPMENT TIMELINE

1931 County of Origin law is enacted, protecting the water rights of counties in which the water originates and guaranteeing their rights for water needed for their future development.

1933 The Central Valley Project Act is passed by the State Legislature (and later that year by the voters) to begin construction of the project. However, with the start of the Great Depression, the State could not sell the bonds to fund the project. The federal government takes it over as a public works construction project, now known as the federal Central Valley Project.

How the State Reserved Water Rights for the SWP

The State's effort to acquire the rights to the water that the SWP now conserves and conveys began more than 70 years ago. In 1927, the California Legislature passed a law that gave the Department of Finance authority to file applications to reserve unappropriated water for future development according to statewide plans.

The Department of Finance filed a number of applications on July 30, 1927, the day after the law became effective, to establish water rights under the plans of that time for coordinated development of California's water resources. The applications were assigned to and are held by the State, the United States, or other agencies. Water rights permits were issued on many of these applications to implement plans for water projects: DWR for the SWP, the Bureau of Reclamation for the Central Valley Project, and other agencies for local projects.

Confluence of two important Northern California water resources: the Sacramento and Feather rivers

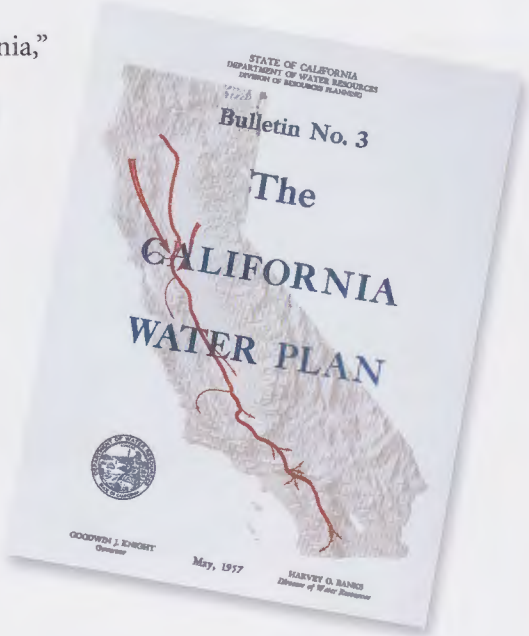
Continual growth of San Francisco (top) and Los Angeles (bottom) spurred their water officials to seek resources far from their boundaries.

THE Past

CALIFORNIA'S SECOND GOLD RUSH

California experienced a second economic "gold rush" after World War II ended in 1945. People flocked to the Golden State, attracted by its climate and lure of new jobs. Businesses and tract housing developments quickly multiplied, especially in larger metropolitan areas such as San Francisco and Los Angeles. The increased population and commerce made it clear to local water officials that their local water supplies alone would not meet their communities' future needs. Groundwater basins were also being rapidly depleted to irrigate the increasing acreage needed to grow food and fiber for a growing population.

In 1945, the California Legislature authorized an investigation of statewide water resources. The work, conducted by the Division of Water Resources (DWR's predecessor) of the Department of Public Works, led to the publication of three important bulletins: Bulletin 1 (1951), "Water Resources of California," a collection of data on precipitation, unimpaired stream flows, floodflows and frequency, and water quality statewide; Bulletin 2 (1955), "Water Utilization and Requirements of California," estimates of water uses and forecasts of "ultimate" water needs; and Bulletin 3 (1957), "The California Water Plan," plans for full practical development of California's water resources, both by local projects and a major State project to meet the State's ultimate needs.



SWP DEVELOPMENT TIMELINE

1945 The Legislature again authorizes an investigation of California's water resources. The Division of Water Resources leads these studies.

1950 A. D. Edmonston is appointed State Engineer. He retires in 1955.

State Engineer A. D. Edmonston

1951 Bulletin 1, "Water Resources of California," is published. It reports data on precipitation, unimpaired stream flows, flood flows and frequency, and quality of water statewide.

State Engineer A. D. Edmonston presents the first complete report on the Feather River Project. It contains plans for a multipurpose dam and reservoir with a power plant, afterbay dam and power plant on the Feather River near Oroville, a Delta Cross Channel (a peripheral canal), an electric power transmission system, an aqueduct to transport water from the Delta to Santa Clara and Alameda counties, and an aqueduct to transport water from the Delta to the San Joaquin Valley and Southern California.

The California Legislature authorizes the Feather River and Sacramento-San Joaquin Delta Diversion Projects. The Division of Water Resources continues its studies and surveys for the projects' construction and approval.

Core samples were taken to investigate the geologic nature of sites planned for project development.

The Division also completed studies that culminated in the Feather River Project presented to the Legislature in 1951 by State Engineer A. D. Edmonston. The initial proposal included a multipurpose dam and reservoir near Oroville complete with a power plant, an afterbay dam and power plant, a Delta Cross Channel (i.e., a peripheral canal), an electric power transmission system, an aqueduct to transport water from the Delta to Santa Clara and Alameda counties, and another aqueduct to carry water from the Delta to the San Joaquin Valley and Southern California. After additional surveys and investigations, the Division submitted a revised Feather River Project in 1955. The revised project added the San Luis Reservoir and proposed that San Benito County be served by the South Bay Aqueduct. The North Bay Aqueduct was included in the project in 1957.

Core sample extractions were vital to the SWP's planning, design and construction.

SWP Planning Passes Evaluation

AN INTERVIEW WITH STANLEY BARNES

Stanley Barnes remembers "taking the project study quite seriously." That project was the 1955 Feather River Project. His job, as a member of the Bechtel consulting team, was to determine the physical, engineering, and economic feasibility of the proposed system.

Just a few years out of graduate school but experienced from working on the Hetch Hetchy project, Barnes was one of about 20 engineers from Bechtel's water resources section assigned to the huge task.

"The whole project was a rush to complete, but we had competent, excellent engineers and consultants," Barnes says. Within three months the engineers had to examine the State Engineer's proposal to determine if there were sufficient information about the hydraulics, hydrology, geology, and other design requirements to make reliable cost estimates of the proposed project.

"We had to establish if the project could be paid for by the agricultural and urban users," he says.

Assumptions had to be made that regional conflicts and concerns would be settled and that the project would function as it was envisioned.

To complete the evaluation of "one of their most important water resources jobs," Bechtel Corporation engaged its own consultants on geology, economics, water demands, financial analyses, acquisitions, and relocation of facilities.

The project was declared sound in terms of engineering and economic aspects. Bechtel stated their estimates ran 3 to 9 percent higher than the State Engineer's on certain proposed routes, that the project could be funded by general obligation bonds and supported by the users, and that there was a demand for water equal or greater than estimated by DWR.

"Our figures were a little more conservative," says Barnes, "but what it amounts to is the Department did a good job in designing the project."

About eight years later, Barnes moved on to serve as the water manager for Boswell Company and from 1983-99 served on the California Water Commission. Both positions brought him back into contact with the Department. He sat on the board of directors of the State Water Contractors for Tulare Lake Basin Water Storage District and reviewed DWR projects as a Water Commissioner.

He is still active as a part-time consulting engineer.

Stanley Barnes

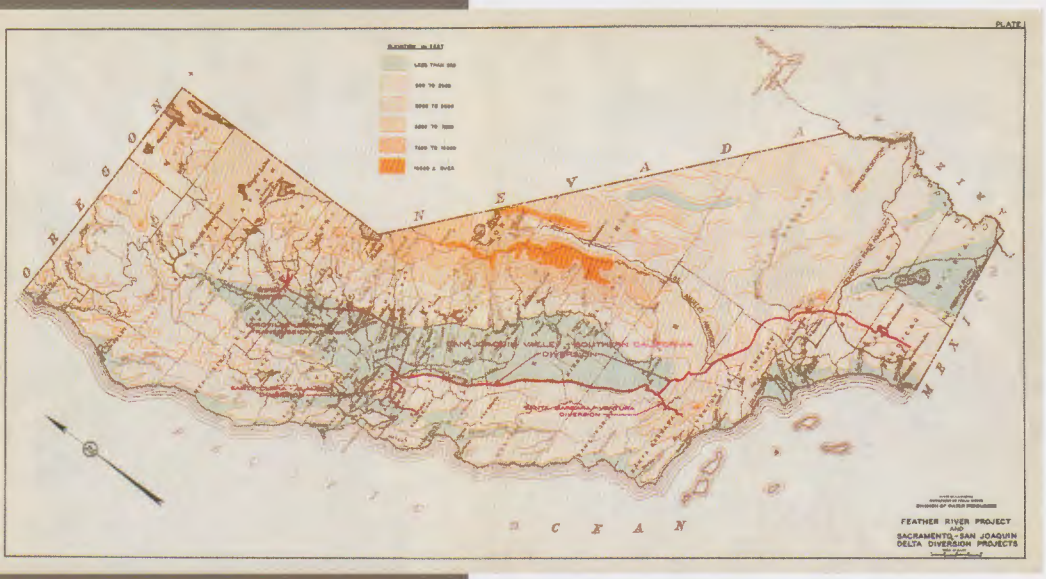
"The whole project was a rush to complete, but we had competent, excellent engineers and consultants," Barnes says.

SWP
DEVELOPMENT TIMELINE

1955 The Division submits another report to the Legislature on the proposed Feather River Project, which shows the project's engineering and financial feasibility and recommends legislative funding to begin construction. It proposes modifications that include adding San Luis Reservoir and having the South Bay Aqueduct also serve San Benito County.

THE STRUGGLE FOR PASSAGE

Approval of a state water project did not come easily. Such an immense project had never been constructed. Its costs and engineering feasibility were questioned. Parties in the State's north and south regions vehemently opposed the project. Northerners claimed the water was rightfully theirs and did not want their water flowing south, although the 1931 County of Origin Statute protected their future water needs. Southern California water agencies such as the Metropolitan Water District of Southern California argued that the project would be futile without guarantees that their counterparts in the north could not rescind supply agreements. MWD was also looking to meet its future needs via its share of water from the Colorado River.



The Legislature refers the report to Bechtel Corporation as an independent consultant. Bechtel concludes that the engineering concepts are sound, financial requirements manageable, and funding by general obligation bonds feasible.

Bulletin 2, "Water Utilization and Requirements of California," is released. It includes estimates of current water use statewide for all consumptive purposes and presents forecasts of probable ultimate water requirements, generally based on the capabilities of lands for development.

Some in Southern California also questioned whether the designated dollar amount would cover the entire cost of the project. They wanted specific details on every facility, and they wanted to know exactly what they would be paying for.

Delta and San Francisco Bay area residents wanted assurances that their waterways would be protected. That meant sufficient water flows to supply their urban, industrial, and agricultural needs and to maintain good water quality and habitat for fish and wildlife. With many of the Delta islands many feet below the water level, they also wanted their levees rehabilitated to protect them from flooding.

The San Francisco Chronicle was among the Project's strongest opponents and urged its readers to vote down the bond issue.

San Joaquin Valley farmers were among the strongest supporters of the project. A state project would not impose an irrigation acreage limit similar to federal Central Valley Project restrictions. They looked to surface water resources to relieve groundwater overdrafts that were causing them to drill deeper and deeper for water, raising costs and causing severe land subsidence in affected areas. Other voices raised in favor were the teamsters, steelworkers, construction workers, and engineers who would gain from public works projects.

Voices against the SWP included the California Labor Federation, which claimed it would benefit agribusiness and not the farmworkers whom they hoped to organize, and the State Grange and others who felt irrigation acreage limitations were vital to preserving small family farms.

San Joaquin Valley farmers were among the strongest supporters of the project. A surface water supply would help reduce groundwater overdrafts in the valley.

AREAS OF COMPROMISE

Special committees met through 1957, 1958, and 1959, attempting to draft a constitutional amendment that would satisfy everyone. That avenue proved futile. What the legislators devised was a series of laws tied to the main bill, called the Burns-Porter Act, after Senator Hugh Burns of Fresno and Assemblyman Carley Porter of Compton, the two key legislative leaders on water policy.

Northern counties were afraid the South would "steal" their water. Sacramento River above.

One of these laws, the Davis-Grunsky Act, assured northern counties that water would be available for future projects and $130 million of the $1.75 billion bond funding was earmarked for those projects. The County of Origin and Watershed of Origin acts were reaffirmed in the Burns-Porter Act and in SWP water supply contracts. Despite the affirmation of their water rights, Northern Californians were concerned that these contracts provided for additional water facilities if needed in the future, opening the possibility of more water going South.

For southern parties, the Burns-Porter Act contained most of the guarantees they sought, including contracts for firm water supplies that future legislatures could not change, sufficient funds to pay for the facilities to deliver water to Southern California, and funds to construct only the facilities specified in the act and no others. The act included additional facilities if needed though those remained vague.

Department of Water Resources and its Work

Before Governor Goodwin Knight called a special legislative session, which established the Department of Water Resources, California water issues were handled by many different agencies. On July 5, 1956, the California Department of Water Resources became responsible for the accumulation of data on the State's water resources and planning of their development and distribution.

Such data collection was not new to the Department. Its predecessor, the Division of Water Resources under the Department of Public Works, began initial investigations in 1921 into California's water resources.

Today, DWR continues collecting data on water supply and usage and forecasts future water needs. This information is published in the Department's Bulletin 160 series, which follows the tradition of Bulletins 1, 2, and 3, the last of which is the first California Water Plan. **Bulletin 160** is updated every five years.

Each year, the Department publishes **Bulletin 132**, which summarizes details of the preceding year's SWP operations.

Also available, although out of print, is the **Bulletin 200** series, "California's State Water Project." Published in 1974, the series consists of six volumes that cover the history prior to the approval of the SWP; the events leading to its approval; and the planning, financing, and procedures required to implement the project's plan. The volumes also document the planning, design and construction, and operations of SWP facilities. Each volume records in detail the geologic conditions and construction highlights for facilities completed by 1973. Each volume also contains photos and technical drawings of each facility.

Vol. I, "History, Planning, and Early Progress"

Vol. II, "Conveyance Facilities

Vol. III, "Storage Facilities"

Vol. IV, "Power and Pumping Facilities"

Vol. V, "Control Facilities"

Vol. VI, "Project Supplement," includes project management information system, right of way, relocations, project architecture, geologic and seismic investigations, Feather River Fish Facilities, Delta Fish Protective Facility, Operations and Maintenance facilities, visitor centers, archeology.

DWR maintains reference copies available for loan from its publications library in Room 338.

SWP DEVELOPMENT TIMELINE

The flood of 1955 breached levees at Yuba City and caused widespread destruction and more than 60 deaths.

A flood devastates Northern and Central California, impacting an area of about 100,000 square miles. Legislators respond by authorizing an emergency appropriation of more than $25 million to begin work on the Oroville site. Appropriations are made yearly until 1960 to fund Oroville relocations and to begin construction of the South Bay and California aqueducts in 1959.

1956 The Legislature creates the Department of Water Resources, replacing the Division of Water Resources, to oversee the development of California's water resources and the construction of the State Water Project.

Harvey O. Banks

Harvey O. Banks is appointed the first DWR Director. He serves until 1960.

SWP

DEVELOPMENT TIMELINE

1957 Work begins on preparing the site for **Lake Oroville** and **Oroville Dam** and is completed in 1961. Highway 70 and the Western Pacific Railroad are relocated.

The **North Bay Aqueduct** is authorized for construction as part of the California Water Plan.

"The California Water Plan," Bulletin 3, presents preliminary plans for full practical development of all the State's water resources to meet its ultimate water needs. It describes plans for local projects and State works needed for major transfers of water from areas of surplus to water-deficient areas.

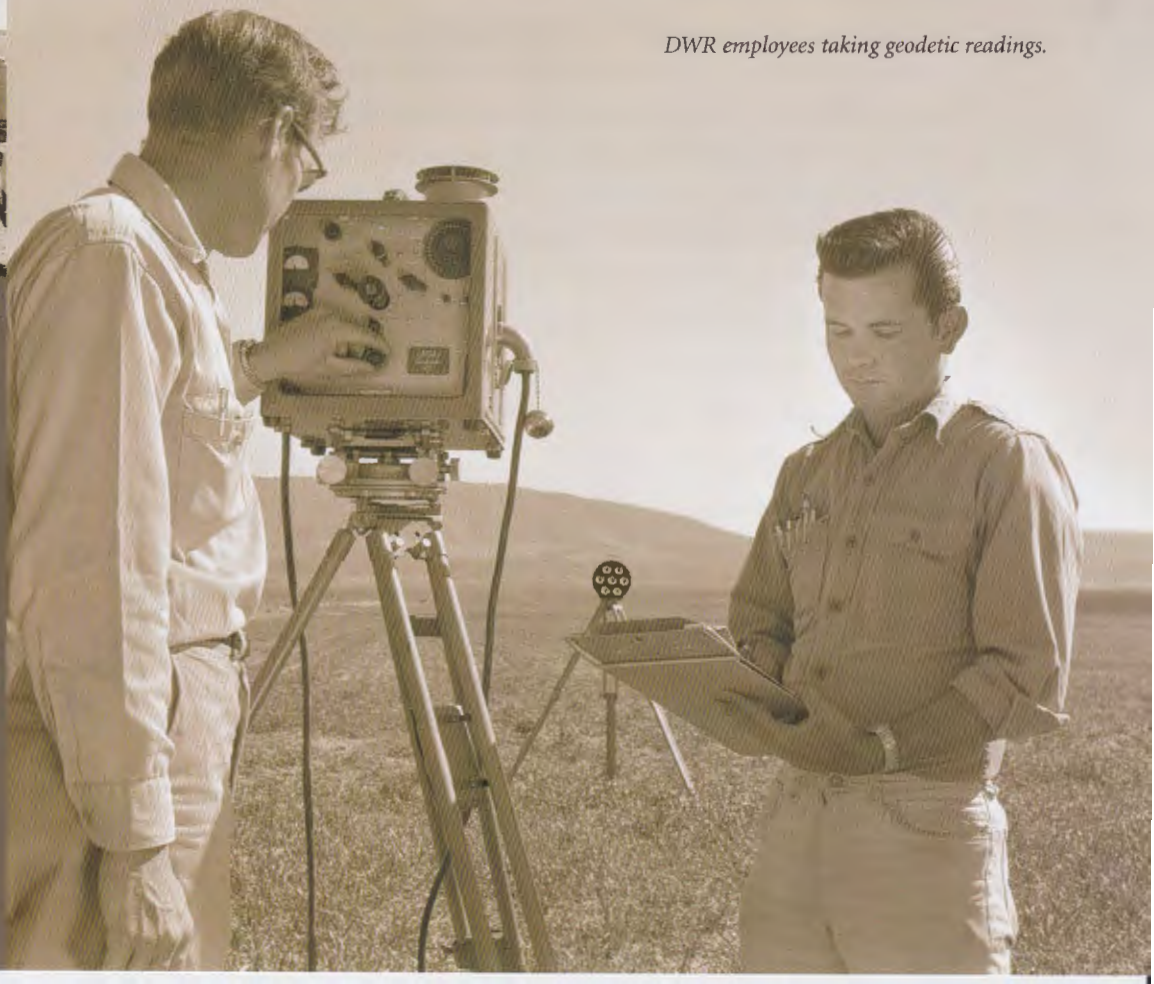
1958 **South Bay Aqueduct** construction starts, with all of its facilities completed by 1969.

South Bay Aqueduct Construction

Delta water users were placated by the Delta Protection Act of 1959, which protected their water uses and promised them good water quality for all purposes.

To reassure all parties that the project was achievable, two independent consulting firms were hired to study the engineering and economic feasibility of the project. Less than a month before the November election, Charles T. Main, Inc. endorsed the engineering and Dillion, Read &Co. did the same with the financing. However, because they believed future inflation would limit the State's ability to complete the project's construction, cost-cutting measures were suggested. DWR engineers began reviewing the plans, scaling back the project, reducing certain facilities, and eliminating others.

DWR employees taking geodetic readings.



THE Past

DWR Staffs Up

The year was 1959 when John Silveira, former DWR Deputy Director, joined the ranks of the recently established Department of Water Resources. Work would soon begin in earnest on what "was to be the biggest, the longest, the highest and maybe several other 'ests' that had ever been attempted before as a single project anywhere in the United States or, for that matter, in the world," he remembers.

He witnessed DWR's growth from 760, 250 of whom were assigned to Design and Construction, in 1956 to 1,900, of whom 600 were D&C staff, during the period leading up the 1960 passage of the Burns-Porter Act. Construction on the South Bay and California aqueducts was already in progress.

Many of the new staff were raw recruits from colleges across the country. They came "in abundance" and awaited assignments that "would allow them to put their mark on this vast undertaking," although sometimes their inexperience would display itself. He recalls that one young engineer, when asked to design an enclosure for an irrigation pump relocation, included in his design instructions to use corrugated metal siding for the enclosure with specific reference to a page in the 1962 Sears Roebuck Farm Catalogue.

These young recruits however were guided by more experienced professionals hired to oversee various aspects of the project. Consulting review boards were also established for each major area of activity including earth dams, tunnels, power and pumping plants, plus earthquake analysis.

The overriding driving force behind the construction of the SWP was its operational reliability. "It was recognized that each purveyor of water would have responsibilities to customers with investments at risk that made operational reliability of the project's water delivery system an imperative," Silveira says. "That requirement become an integral part of the design equation."

Basic criteria were established such as protection of water quality, allowance for specific emergencies, partial or complete power failure and its effect on the aqueduct, and operational limitation on the plants in keeping with related transmission systems. Information was gained from studying systems of the Bureau of Reclamation and the Metropolitan Water District of Southern California.

When construction of the system was at its peak DWR staff numbered about 4,480 with 2,250 in D&C. In 1965, as many as 50 major construction contracts were underway simultaneously, says Silveira. "It was an exciting time for the Department and myself."

When major design work for SWP facilities north of the Tehachapi Crossing was completed, Silveira left for New York to join a private engineering firm that did work primarily overseas. During that time, he traveled extensively to countries in Central America, South America, the Middle East, the Far East, and Africa, working on various water, power and agriculture development projects. For four years, he lived in Iran heading a number of projects including the construction of a hydroelectric dam and transmission project and a major irrigation system.

John Silveira

In 1989, Silveira came full circle and returned to DWR. Two years later, he was Deputy Director in charge of the operations and maintenance, design and construction, energy generation, and right-of-way for the State Water Project.

...Work would soon begin in earnest on what "was to be the biggest, the longest, the highest and maybe several other 'ests' that had ever been attempted before as a single project anywhere in the United States or, for that matter, in the world," Silveira remembers.

How Governor Edmund G. Brown, Sr., Won Financing Approval for the SWP

Governor Brown at Oroville groundbreaking ceremony.

When Governor Brown took office in 1958, he was convinced that California's growth depended on developing new water resources. According to Norris Hundley in "The Great Thirst," that vision dictated passage of legislation to fund the SWP. Hundley says Governor Brown was an activist and won over needed legislators by granting two major concessions. Those were the Davis-Grunsky Act with money for local projects mainly in the North and an amendment in the bill that stipulated the water contracts could not be changed by the Legislature as long as the bonds were outstanding.

Many others credit Governor Brown with the passage of the Burns-Porter Act. DWR Director Ron Robie said at a 1999 SWP history seminar that it was Brown's "large commitment and strong leadership, which gave water a high priority" in California's infrastructure.

Governor Brown and then-DWR Director Harvey O. Banks campaigned tenaciously for the act and against antagonists who disparaged the passage of the State's largest bond issue at the time.

To honor their leadership, major SWP facilities bear their names: Governor Edmund G. Brown California Aqueduct and the Harvey O. Banks Delta Pumping Plant.

When Governor Brown took office in 1958, he was convinced that California's growth depended on developing new water resources.

TODAY'S STATE WATER PROJECT IS BORN

The Burns-Porter Act, formally known as the California Water Resources Development Bond Act, was placed on the November 1960 ballot. It was Proposition One on the list, but even days before the election its chances for passage were unpredictable. Heated and continuous negotiations were still ongoing, with MWD withholding its endorsement until days before the election. The *San Francisco Chronicle* strongly opposed the proposition. California's North-South regional rivalry was a strong factor in the election.

On November 8, the Burns-Porter Act was narrowly approved by the slim margin of 173,944 votes from about 5.8 million ballots counted. Only one northern county supported the proposition–Butte County, site of Oroville Dam. But one fact was certain, construction was soon to begin on what is now the nation's largest state-built water and power development and distribution system, which would change the face and future of a once virgin land.

Governor Edmund G. Brown discusses the State Water Project with key government officials.

SWP DEVELOPMENT TIMELINE

1959 Governor Edmund G. Brown, Sr., is elected. His leadership and promotion of legislation to build a state water project help pass the Burns-Porter Act.

The Legislature reaffirms its acceptance of the California Water Plan and enacts legislation, the California Water Resources Development Bond Act, known as the Burns-Porter Act. It authorizes funding, $1.75 billion in general obligation bonds subject to approval by the voters, to assist in funding of immediate construction of the State Water Facilities and later construction of specified additional works. The project becomes widely known as the State Water Project.

Work begins on **Frenchman Dam and Lake,** completed in 1961, and on **Bethany Reservoir,** completed in 1967.

Frenchman Dam and Lake

THE Past

SWP
DEVELOPMENT TIMELINE

1960 In the November election, the $1.75-billion bond act is narrowly approved by voters.

The Metropolitan Water District of Southern California signs the first water supply contract with the state for supplemental water supplies from the SWP. Today 29 agencies have long-term contracts for SWP deliveries.

Congress authorizes construction of the **San Luis Unit** of the CVP, which is to be jointly owned and operated with the SWP.

Gianelli Pumping-Generating Plant

Davis-Grunsky Act is enacted as part of the State Water Project. It provides funds for local water projects, particularly in Northern California.

Construction begins on **South Bay Pumping Plant** and **Patterson Reservoir**, completed in 1969 and 1962; respectively.

Work also starts on the **California Aqueduct** from San Luis Canal to Edmonston Pumping Plant and ends in 1971.

THE Past

CONSTRUCTION BEGINS

Construction on the Oroville site actually began even before the passage of the Burns-Porter Act. A $25 million emergency appropriation was passed in 1957 after a record late 1955-early 1956 flood, which devastated Northern and Central California. Statewide, 64 deaths were recorded, mainly in Sutter County and Yuba City, and more than $200 million of property damage.

In May 1957 work began on the construction of two tunnels on the Western Pacific Railroad relocation to clear the site for the dam and reservoir. Appropriations continued year to year for the relocations and to begin building the South Bay and California aqueducts in 1959.

(Top) The Mother Orange tree, the first in Northern California, was relocated from the reservoir site. (Right) Photo shows position of dam on the Feather River. (Far right) Construction started in 1961 on Diversion Tunnel No. 1, which was 4,400 feet long and 35 feet in diameter. The two tunnels helped save the city of Oroville during a 1964 flood.

SWP DEVELOPMENT TIMELINE

After the legislative passage of the Burns-Porter Act and the voters' approval of the bond issue, construction started in earnest, with facilities built from north to south. To reduce costs, some facilities were built in stages with additional units or facilities added as demands increased.

Today, the SWP includes 20 primary storage facilities (with a gross capacity of 1,000 acre-feet or more); 17 pumping plants; 3 pumping-generating plants; 5 hydroelectric power plants; and more than 660 miles of canals, tunnels and siphons.

Look for construction dates (start and completion) of major State Water Project facilities included in the SWR Development Timeline, which also lists other events important to the Project.

1961 The Davis-Dolwig Act is passed. It directs the SWP to provide recreation and fish and wildlife enhancement and provides money from the General Fund for such purposes.

William E. Warne is appointed DWR Director. He retires in 1966.

William E. Warne

State and federal governments enter into an agreement to develop and construct the San Luis Joint-Use Facilities. The Bureau of Reclamation and DWR agree to coordinate operations of the CVP and the SWP, creating the foundation for the Coordinated Operations Agreement signed more than 25 years later.

A partially completed **South Bay Aqueduct** starts service to Santa Clara County and to Alameda County in 1965.

President John F. Kennedy and Governor Edmund G. Brown preside over the groundbreaking ceremony for the San Luis Complex.

Work starts on **Antelope Dam and Lake** and ends in 1964.

Antelope Facility construction

Davis-Dolwig Act

The Davis-Dolwig Act, enacted in 1961 together with the Burns-Porter Act, provided financing for SWP recreational facilities and fish and wildlife enhancement projects. The act declared that these projects are among the benefits of state water projects and benefit all people of California and should be paid via appropriations from the General Fund.

Banks Pumping Plant

SWP DEVELOPMENT TIMELINE

1963 A State Supreme Court ruling clears the way for DWR to sell revenue bonds to finance construction of additional facilities.

Thermalito Diversion Dam and Pool construction begins in 1963 and ends in 1968, also on **O'Neill Forebay**, ending in 1967. *(The Jack Edward O'Neill Forebay is named for a San Joaquin Valley pioneer farmer who worked for authorization of the San Luis Division of the federal CVP.)*

Thermalito Diversion Dam

Construction starts on **Banks Pumping Plant** *(shown left)* and is completed in 1969.

Four additional pumps are added to the original seven in 1986 for operational flexibility. *(The Harvey O. Banks Pumping Plant is named for DWR's first Director, 1956-60.)*

The first reach of the **California Aqueduct's** construction begins, ending in 1968 at the O'Neill Forebay *(The aqueduct's official name is Governor Edmund G. Brown California Aqueduct, for California's governor from 1959-66.)*

THE Past

Lake Oroville

Hyatt Power Plant

California Aqueduct

Engineering

Construction of the SWP was truly an engineering marvel. The Project crosses more than 600 miles of terrain, both mountainous and flatland. A water project of its magnitude had never been attempted before. A new, young generation of engineers, fresh out of college, was recruited to help the more seasoned staff tackle the challenges that lay ahead. The following is a sampling of these engineering accomplishments.

LAKE OROVILLE, the SWP's largest reservoir with a power plant, built in a cavern excavated under the dam, is impressive in its scope. Its earthfill dam stands 770 feet tall, the tallest in the nation, with a crest (top of the dam) 6,920 feet long. More than 80 million cubic yards of material were needed to build Oroville Dam – enough material to build a two-lane highway around the earth.

Engineers decided to build the earthfill embankment with materials readily available at the site. This feat required huge tools like a bucketwheel excavator with eight-1.8 cubic yard buckets. The excavator could scoop up rocks within its 30-foot path and unload the rocks onto a conveyor belt about three miles long. The belt moved the rocks into a system that fed 10 hoppers at a loading station. At the station, the hoppers loaded trains of 40 gondolas, pulled by double diesel electric locomotives.

The trains, loaded in 15 minutes, travelled some 12 miles to the gondola dumper, where the loaded gondolas were disconnected from the train and the engine moved into place to pick up an empty string of cars for a return trip. The dumper could seize two fully loaded gondolas at a time and turn them upside down, dumping their 220-ton load of rocks onto a half-mile conveyor belt that crossed the Feather River to a stockpile near the dam. Running 24 hours a day with the three pairs of locomotives, 45-50 trains were dumped every 24 hours, producing nearly 500,000 cubic yards of material each week.

HYATT POWERPLANT is located underneath the dam and lake. Its chamber was blasted from a metavolcanic rock formation and is large enough to hold almost two football fields. Miners drilled holes, loaded them with explosives, and blasted away the rock. Rock bolts or "structural steel framing" were used to hold the newly exposed rock. The bolts were anchored in place by an expansion anchor, tensioned to a specified stress, packed and sealed at the rock face, and finally grouted.

More than 80 million cubic yards of material were needed to build ***Oroville Dam*** *– enough material to build a two-lane highway around the earth.*

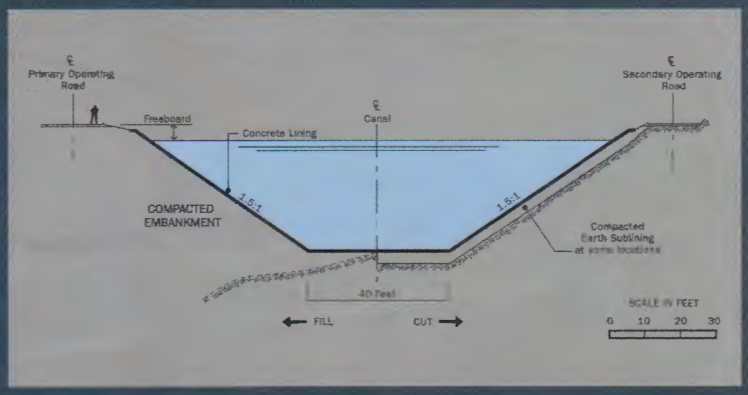
Challenges

Another major challenge was the building of the **CALIFORNIA AQUEDUCT.** Much of the aqueduct parallels the San Andres Fault Zone and crosses other major faults. More than 100 potential alignments were studied, and evaluations considered the seismic hazards the faults presented. Where the alignment crosses active faults, canal sections or pipelines are located near or at ground level to facilitate quick repair. Automatically controlled check gates were also installed upstream of these crossings to shut off flows if an earthquake ruptured the canal.

Also, approximately 200 miles of the aqueduct were to cross the westside of the San Joaquin Valley, where unconsolidated soil deposits were known to be prone to shallow subsidence. Once saturated, settlement of these unconsolidated soils would damage the unreinforced concrete lining planned for use in constructing the aqueduct.

Field test ponds in subsidence-prone areas produced as much as nine feet of subsidence. To solve this problem, hundreds of water-filled preconsolidation ponds were constructed along the alignment of the aqueduct to ensure that settlement occurred before canal construction. The ponds were kept filled for as long as six months.

California Aqueduct



Hundreds of water-filled preconsolidated ponds were constructed along the alignment of the aqueduct to ensure that settlement occurred before canal construction.

SWP DEVELOPMENT TIMELINE

1963 Work also begins on several joint-use facilities: **San Luis Reservoir** and **Sisk San Luis Dam,** with the reservoir filled in 1969 *(The B.F. Sisk San Luis Dam is named for U.S. Representative, 1955–79, who introduced legislation authorizing the San Luis Unit of the CVP.);*

the **Gianelli Pumping-Generating Plant,** ending in 1967 *(The William R. Gianelli Pumping-Generating Plant is named for former DWR Director, 1967–73 and Assistant Secretary of the Army for Civil Works, 1981–84.);*

the **San Luis Canal** *(a 102-mile portion of the California Aqueduct),* completed in 1968; and **Dos Amigos Pumping Plant,** completed in 1966.

San Luis Canal

1964 **Grizzly Valley Dam** and **Lake Davis** construction starts and is completed in 1967. *(Lake Davis is named for Lester Thomas Davis, California Assemblyman, 1947–1952, and Pauline L. Davis, California Assemblywoman, 1953–1972. Husband and wife were active in water matters. Mrs. Davis coauthored the Davis-Grunsky and Davis-Dolwig Acts.)*

Engineering Challenges

CONTINUED

The Pastoria Siphon connects Tunnels 2 and 3. A second barrel was added in 1982.

THE TEHACHAPI CROSSING presented another test of engineering ingenuity because the crossing would traverse or parallel several major faults including San Andreas, Pastoria, Garlock, and White Wolf. The simpler and more direct way would have been to drill a single tunnel at a lower elevation. But what if an earthquake struck, damaging the tunnel? It could take several months to reach the damaged areas and would leave Southern California without SWP water.

So engineers had four tunnels drilled at a higher elevation, near the top of the mountain range. The tunnels are connected by siphons and pipes with access sites for inspections and repairs.

*The **Tehachapi Crossing** presented another test of engineering ingenuity: the crossing crosses or parallels several major faults including San Andreas, Pastoria, Garlock, and White Wolf.*

Background photo: Carley Porter Tunnel construction

Project Awards

Oroville Dam

Construction of the SWP was truly a great engineering feat of its time. Here are some of the awards received by the Project:

1967 Oroville Dam was named by the California Society of Professional Engineers as one of the seven wonders of engineering in California for 1967.

1969 The American Society of Civil Engineers selected the SWP's Oroville Dam and Hyatt Powerplant as the "Outstanding Engineering Achievement of 1969."

1971 The National Society of Professional Engineers named the SWP as one of the nation's top 10 engineering achievements in 1971.

1971 The American Public Power Association's First Honor Award, the highest made, went to the Banks Delta Pumping Plant, and an Honor Award went to the Oroville-Thermalito hydroelectric power complex.

Banks Pumping Plant

Paving train for the California Aqueduct.

1972 The American Society of Civil Engineers selected the SWP for "The ASCE Outstanding Civil Engineering Award for 1972" for its contribution to the well-being of people and communities, the resourcefulness in planning and solving design problems, the pioneering use of material and methods, its innovations in construction, and in unusual aspects and aesthetic value.

This award is presented annually to the engineering project that best demonstrates the greatest engineering skill and represents the greatest contribution to civil engineering and to mankind.

2000 The American Society of Civil Engineers names the SWP as one of the 100 Greatest American Engineering Achievements of the last century.

SWP DEVELOPMENT TIMELINE

1964 Excavation begins on the underground **Hyatt Powerplant** at Oroville and is completed in 1967. *(Edward Hyatt Powerplant is named for the Division of Water Resources' State Engineer, Department of Public Works, 1927–50.)*

Work also starts on the **Thermalito Pumping-Generating Plant**, completed in 1969;

the **Santa Clara Terminal Reservoir**, ending in 1965;

the **Los Banos Detention Dam and Reservoir**, completed in 1965;

and the **Tehachapi Crossing**, completed in 1971. (The longest of four tunnels is named for California Assemblyman Carley V. Porter, 1949–72, co-author of the 1959 Water Resources Development Bond Act to help finance the SWP.)

1965 Construction begins on **Thermalito Forebay** and **Thermalito Afterbay**, both completed in 1968; Castaic Lake and Lagoon, completed in 1974.

Work also begins on **Little Panoche Detention Dam and Reservoir,** ending in 1966.

1966 Work begins on the **Feather River Fish Hatchery**, which first receives salmon and steelhead in 1967.

THE Past

Population increases have been the driving force behind increasing water needs.

WHEN THE SWP BEGAN OPERATIONS IN THE 1970'S, *the State's water needs were rapidly increasing. By 1963, California's population had surpassed New York's as the nation's most populous state. The State's temperate climate and opportunities attracted people from all over the world, seeking new careers and homes. Housing tracts developed rapidly in the suburbs around metropolitan areas.*

Irrigation water rapidly transformed agriculture into big business in California. For more than 50 years, the state has remained the nation's number one producer of farm products. Crops flourished in the arid but fertile soil of the San Joaquin Valley with irrigated water. Ranging from fruits to nuts to flowers, these crops filled both the nation's and the world's markets. SWP water also allowed farmers to supplement their local supplies and reduce their use of declining groundwater basins.

California's economy was booming as well. Industries moved or relocated to the Golden State, where the water supplies seemed plentiful. Metropolitan areas, especially in Southern California, expanded with imported water supplies.

THE Present

California is the nation's number one producer of agricultural products.


REDDING
OROVILLE
NORTH BAY AQUEDUCT
SACRAMENTO
SAN FRANCISCO
SOUTH BAY AQUEDUCT
CALIFORNIA AQUEDUCT
COASTAL BRANCH AQUEDUCT
SAN LUIS OBISPO
BAKERSFIELD
WEST BRANCH
EAST BRANCH
LOS ANGELES
RIVERSIDE
SAN DIEGO
LAS VEGAS
61
N
0 40 80
SCALE IN MILES
0 50 100
KILOMETERS

State Water Project Facilities

1. Antelope Dam and Antelope Lake
2. Frenchman Dam and Frenchman Lake
3. Grizzly Valley Dam and Lake Davis
4. Oroville Dam and Lake Oroville
5. Hyatt Powerplant
6. Thermalito Diversion Dam Powerplant
7. Thermalito Diversion Dam and Pool
8. Feather River Fish Barrier Dam and Pool
9. Feather River Fish Hatchery
10. Thermalito Forebay Dam and Forebay
11. Thermalito Pumping-Generating Plant
12. Thermalito Afterbay Dam and Afterbay
13. Barker Slough Pumping Plant
14. Cordelia Pumping Plant and Forebay
15. Napa Turnout Reservoir
16. Suisuin Marsh Salinity Control Gates
17. South Bay Pumping Plant
18. Patterson Dam and Reservoir
19. Del Valle Pumping Plant
20. Del Valle Dam and Lake Del Valle
21. Santa Clara Terminal Reservoir
22. Clifton Court Dam and Forebay
23. Skinner Fish Facility
24. Banks Pumping Plant
25. Bethany Dams and Reservoir
26. O'Neill Dam and Forebay*
27. Gianelli Pumping-Generating Plant
28. Sisk Dam and San Luis Reservoir*
29. Los Banos Detention Dam and Reservoir*
30. Dos Amigos Pumping Plant*
31. Little Panoche Detention Dam and Reservoir*
32. Las Perillas Pumping Plant
33. Badger Hill Pumping Plant
34. Devil's Den Pumping Plant
35. Bluestone Pumping Plant
36. Polonio Pass Pumping Plant
37. Tank Site 1
38. Tank Site 2
39. Tank Site 5
40. Buena Vista Pumping Plant
41. Teerink Pumping Plant
42. Chrisman Pumping Plant
43. Edmonston Pumping Plant
44. Tehachapi Crossing
45. Tehachapi Afterbay
46. Oso Pumping Plant
47. Quail Dam and Lake
48. Warne Powerplant
49. Pyramid Dam and Lake
50. Castaic Powerplant
51. Elderberry Forebay Dam and Forebay
52. Castaic Dam and Lake/Lagoon
53. Alamo Powerplant
54. Pearblossom Pumping Plant
55. Mojave Siphon Powerplant
56. Cedar Springs Dam and Silverwood Lake
57. Devil Canyon Powerplant
58. Santa Ana Pipeline
59. Perris Dam and Lake Perris
60. East Branch Extension
61. Reid Gardner Powerplant

* *Indicates joint-use facility*

SWP DEVELOPMENT TIMELINE

1967 The **West Branch** is started in 1967 and completed in 1982. Its facilities include **Oso Pumping Plant**, 1967-72; **Quail Lake**, 1967; **Warne Powerplant**, 1978-82, with a new unit added in 1983 (William E. Warne Powerplant is named for former DWR Director from 1961-66.); **Pyramid Dam and Lake**, 1969-73; **Castaic Dam and Lake and Lagoon**, 1965-74.

The first facility of the **East Branch**, **Pearblossom Pumping Plant** begins construction in 1967 and is completed in 1973. Other facilities include **Alamo Powerplant**, 1982-85; **Mojave Siphon Powerplant**, 1990-96; **Cedar Springs Dam and Silverwood Lake**, 1968-71 *(The lake is named for W. E. "Ted" Silverwood, a Riverside County resident and activist for the SWP.)*;

Devil Canyon Powerplant and afterbay, 1969-74, with a second afterbay added, 1992-95; **Santa Ana Pipeline**, 1969-73; and **Perris Dam and Lake**, 1970-74.

Perris Dam and Lake

THE Present

The Rise in Environmental Awareness

In 1962, Rachael Carson's book, "Silent Spring," stirred public awareness of the harmful consequences of human intervention in the environment. This consciousness began to rise and take shape in legislation as the State Water Project began its first deliveries in 1968. Here is a sampling of these environmental laws:

- **Endangered Species Act of 1973 (federal)** protects species and their critical habitat, and, in defining critical habitat, considers economic effects of such a designation. U.S. Fish and Wildlife Service and National Marine Fisheries Service share authority to list species, determine critical habitat, and develop recovery plans for listed species.

- **California Endangered Species Act 1970** applies to native species, was amended in 1984 to more closely resemble the federal act.

- **Section 404 of the Clean Water Act (1972)** protects wetlands and prohibits their alterations without a permit from the Corps of Engineers.

- **Clean Water Act (1972)** administered by Environmental Protection Agency, establishes a national commitment to restore and maintain national waters in "fishable,swimmable" quality.

- **California Environmental Quality Act 1970 and the National Environmental Policy Act 1970** Under these two acts, lead public agencies are required to prepare and submit for public review EIS (Environmental Impact Statements) or EIRs (Environmental Impact Reports) for major federal or state projects that could significantly affect the environment.

- **National Wild and Scenic Rivers Act (1968)** names rivers nationwide which were to be kept in their pristine natural state, unmarred by dams or power plants.

- **California Wild and Scenic Rivers Act (1972)** preserves about a quarter of the State's undeveloped water-mostly North Coast rivers- in their natural state, prevents construction of dams and other diversion facilities except to serve local needs on the entire Smith River, parts of the Trinity, Van Duzen, Eel, Klamath, Salmon, Scott, Feather and American rivers. In 1980, the federal government added further protections by including these rivers in the national wild and scenic rivers system.

The burrowing owl is a species of concern.

SWP BENEFITS

The multipurpose State Water Project delivers water supply to its contracting agencies, provides flood control, generates power, enhances fish and wildlife habitat, releases freshwater flows to control salinity intrusion into the Delta, and offers a variety of recreational opportunities.

WATER SUPPLY

The SWP's main purpose is water supply–to divert and store surplus water during wet periods and distribute it to 29 public agencies that contract for SWP water supplies. Spring snowmelt runoff captured and stored in Oroville, together with unstored runoff available in the Delta, constitute its major sources.

The Project's existing facilities can typically supply about 3 MAF. Their capacity to deliver full water supply requests in a given year depends of probabilities of rainfall, snowpack, runoff, water in storage, pumping capacity from the Delta, and regulatory constraints on SWP operations, especially in the Delta.

Of the contracted water supply, 70 percent goes to urban users and 30 percent to agricultural users. SWP water provides supplemental supplies to most of its contracting agencies' local surface water, groundwater, and imported water sources.

The SWP made its first deliveries in 1962 to the Alameda County Flood Control and Water Conservation District Zone 7 and the Alameda County Water District. In 1965, deliveries were made to the Santa Clara Valley Water District, where imported supplies were used to solve a land subsidence problem caused by long-term overdrafting of local groundwater basins. In 1968, service was extended into the central and southern San Joaquin Valley and part of the North Bay area; and by 1972, Southern California

SWP DEVELOPMENT TIMELINE

1966 Contracts are signed with major California utilities to supply power for SWP pumping and to supplement other sources.

Construction begins on **Del Valle Dam** and **Lake Del Valle** in 1966 and ends in 1968;

Phase I of the Coastal Branch, begins construction and is completed in 1968. It includes **Badger Hill** and **Las Perillas pumping plants;** and **Chrisman Pumping Plant,** completed in 1973. *(The Ira J. Chrisman Wind Gap Pumping Plant is named for a member of the California Water Commission, 1960–76; chairman 1967–76.)*

Chrisman Pumping Plant

DWR begins building **Skinner Fish Facility** in 1966, completing it in 1970 with operations beginning in 1968. A new building is built from 1991–92. The facility salvages an annual average of 15 million fish before they enter Banks Pumping Plant in the Delta. *(The John F. Skinner Fish Salvage Facility is named for a California Department of Fish and Game biologist who supervised the evaluation and improvements of the facility.)*

THE Present

SWP

DEVELOPMENT TIMELINE

1967 First SWP entitlement water delivered via the **South Bay Aqueduct** to Santa Clara Valley Water District.

William R. Gianelli is appointed Director and serves until 1973.

William R. Gianelli

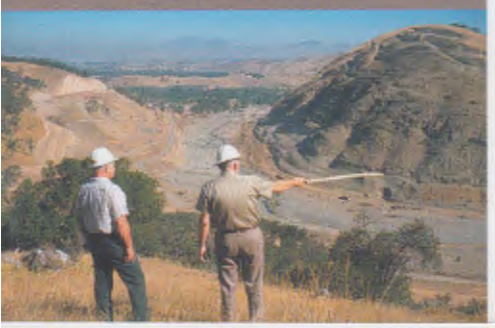
Oroville Dam's embankment is topped out at its height of 770 feet.

DWR signs 50-year contracts for sale of power from **Oroville-Thermalito facilities** to three major California utilities.

Construction begins on the **North Bay Aqueduct, Phase I,** (includes the Napa Turnout Reservoir) and is completed the next year.

Work also starts on **Del Valle Pumping Plant** and **Clifton Court Forebay,** both completed in 1969, and **Buena Vista, Teerink,** and **Edmonston** pumping plants, with the former two ending in 1972. Edmonston, completed in 1973, had all 14 units installed by 1984. *(The John R. Teerink Wheeler Ridge Pumping Plant is named for former DWR Director, 1973–75, and the A. D. Edmonston Pumping Plant for State Engineer, Division of Water Resources, 1950–55.)*

DWR employees survey the site of the Del Valle Pumping Plant.



areas began receiving their first deliveries. The Coastal Branch's completion in 1997 began deliveries to Central Coast communities.

Through 1999, the SWP has delivered more than 57 million acre-feet of water to its contracting agencies.

FLOOD CONTROL

Another Project function is to provide flood control in Northern California. Storage space is provided in Lake Oroville (750,000 acre-feet) and Lake Del Valle (38,000 acre-feet) to capture flood flows and protect areas downstream. Because flood control costs are paid by the federal government, the two reservoirs must reserve the flood control storage space from October to May. When high inflows occur during those months, water is temporarily held in the reservoir so releases can be made that are within the prescribed downstream channel capacity.

Water being released down Oroville Dam spillway.

Working Together

DWR's Division of Operations and Maintenance has the main responsibilities to maintain and operate the State Water Project, but all of the other major DWR divisions and offices contribute to the smooth and efficient functioning of the Project.

- **State Water Project Planning Office** develops water management strategies and proposed actions that ensure the ability of the SWP to meet future water needs. Also formulates environmentally acceptable projects to increase the Project's delivery reliability, conducts extensive hydrodynamic and hydrologic computer modeling, and plans improvements to the Sacramento-San Joaquin Delta.

- **Division of Land and Right of Way** clears the way for construction of SWP facilities. Staff conducts surveys; prepares property descriptions, maps, exhibits, and deeds needed to acquire, manage, lease, transfer, exchange, or sell all SWP lands; appraises land and easements; manages State property; and relocates, replaces or acquires facilities such as roads, pipelines, and telephone and power lines.

- **Division of Engineering** designs and constructs additions and alterations to the SWP (see sidebar, "The Repair Side.") Typical projects involve designing and overseeing the construction of dams, canals, pipelines, pumping and hydroelectric power plants, and associated roads and structures.

- **State Water Project Analysis Office** administers both water and power contracts for the Project. Staff negotiates and administers agreements to implement current water policy issues, coordinates project planning activities, secures power resources, facilitates water deliveries and transfers, and allocates $600 million in annual charges among 29 long-term water supply contractors.

- **Environmental Services Office** helps the Department comply with an array of State and federal environmental regulations that affect SWP operations and water development programs. Also negotiates solutions and develops measures to avoid or minimize adverse effects that may result from SWP activities or construction of a new facility, develops criteria for fish protective facilities, coordinates with other agencies on mitigation programs, and conducts various fish and wildlife studies.

- **Division of Flood Management** works closely with SWP flood control reservoir operations during floods to coordinate releases with other flood control reservoirs to keep flows within the capacity of downstream channels. The division is also responsible for many other flood fight projects and flood control projects.

- **Division of Safety of Dams** approves the design, construction, operation, alteration, repair, and maintenance of more than 1,200 nonfederal dams, including SWP dams, in California. Division staff examines existing dams; reviews plans and specifications for new dams and reservoirs; and inspects dam construction and alterations to assure dams will withstand earthquakes, floods and other potential hazards.

- **Division of Planning and Local Assistance** including four district offices in Red Bluff, Sacramento, Fresno, and Glendale, works with federal, State, and local agencies including the SWP contracting agencies on a variety of water resources management issues. These include water quality, water supply planning, water conservation, land and water use, groundwater management, water recycling, water transfers, and agricultural drainage. The Division also provides funding for local water conservation, groundwater recharge, and urban stream restoration projects.

- **Office of Water Education** educates the public about the importance of water and creates awareness of the Department's responsibilities and programs, including the SWP. OWE has brochures available on all major SWP facilities that are free to the public and loans videos on the SWP to interested parties.

Deregulation: Power Moves

When California's power-producing industry ventured into the realm of deregulation as the first state to do so on in 1998, so did DWR.

Before deregulation, electrical utilities (DWR became a bulk power entity in 1983) traded, bought, and sold electricity among themselves. Power generated was transmitted though a grid of electrical lines built by different utilities to move energy to and from locations.

Previously, utilities such as Pacific Gas and Electric and Southern California Edison would enter into agreements to pay for a certain amount of power during a certain period of time. Smaller energy-producers had no access to the transmission lines and were no match in the marketplace for the larger utilities. Price depended on time of day and availability.

During pre-deregulation times, prices were more predictable, except during shortages or emergencies. Utilities generally buy power in advance–from an hour to a day. So if DWR purchased 100 megawatts from PG&E for 6 p.m. that day, PG&E would produce power to meet all of its demands including the promised power to DWR and send it over their transmission lines to where it was needed. If they were not able to produce the amount needed to match demand with supply for that time period because one of their units shut down, the missing quantity would be supplied from the interconnected utilities and by PG&E at a later time.

With deregulation, new entities were created like the California Independent System Operator (now in control of utilities' transmission lines) and the California Power Exchange (which acts as a commodities marketplace). Prices are now more volatile and penalties exist for those who don't produce what they promised.

Because DWR is not under the jurisdiction of the Public Utilities Commission, it is not required to participate, but the Department wanted to be a starting player in deregulation. What this means to the Project is, based on the skill of its energy traders who are always in contact with the power market and other brokers, the Department can keep costs affordable for its contractors by selling power at top prices and buying it at bargain rates.

POWER

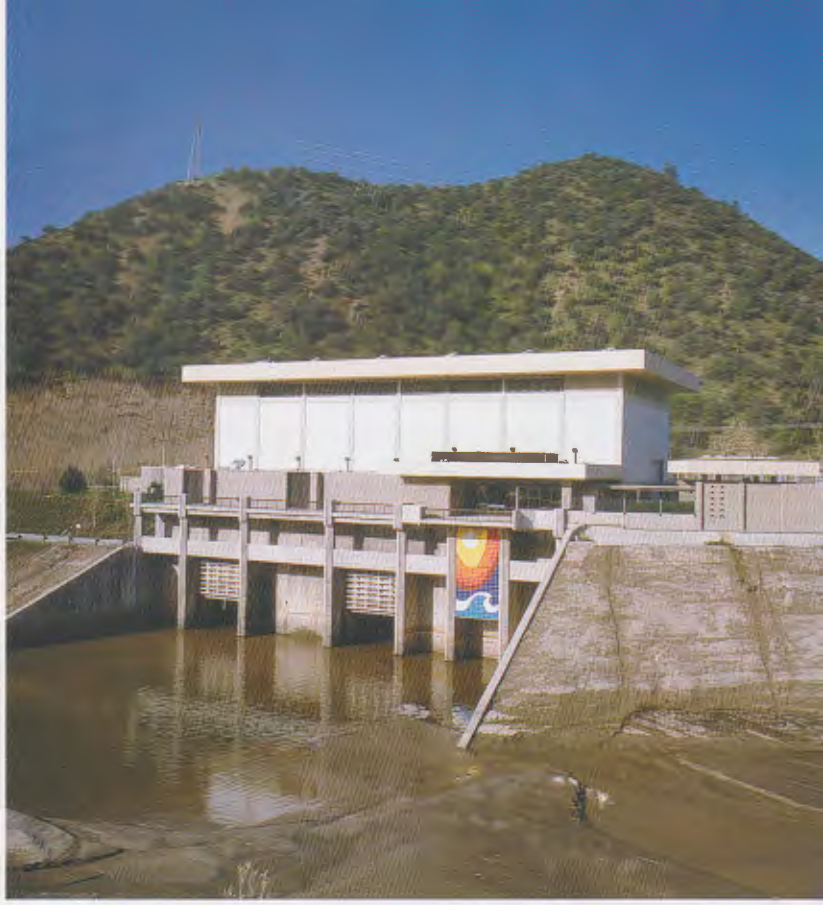
The SWP is the State's fourth largest generator of electricity and the single largest user of power. How much energy is consumed by Project facilities depends on contractor requests for water and the amount of water available for delivery and storage. Since 1984 power requirements have ranged from under 4 billion to over 8 billion kilowatthours.

Eight hydroelectric plants–three of which can also pump water–plus a coal-fired facility (DWR owns 67.8 percent of one unit) near Las Vegas, Nevada provide about two-thirds of the Project's power demands. Hyatt Powerplant, combined with Thermalito Diversion Dam Powerplant and Thermalito Pumping-Generating Plant, produce more than 2.4 billion kWh during a median water year. Other power recovery plants–Gianelli (a pumping-generating plant shared with the U.S. Bureau of Reclamation), Alamo, Devil Canyon, Warne, and Mojave Siphon–add to DWR's resources, making it about 5.9 billion kWh.

The rest of the Project's needs are met through a power exchange with Southern California Edison Company, and long and short-term purchases and agreements with other utilities, energy brokers, and power pools. Those include purchases from L.A. Department of Water and Power's Castaic Power Plant on the West Branch (constructed under an agreement between DWR and

the Los Angeles Department of Water and Power, but owned and operated by LADWP) and King River Conservation District's Pine Flat Powerplant.

DWR manages its loads (needs) and resources (generated power) through an extensive computerized network by which SWP operators can remotely control pumping units in its major plants. The SWP's flexibility in managing its pumping operations helps keep its costs down. Much of the pumping is done at night, or off-peak hours, when electrical costs are cheap. During daylight, or on-peak, hours, the Project generates power to sell at higher prices.



Warne Powerplant

When power resources are greater than SWP loads, the Department sells surplus power to help defray the net cost of water deliveries to its contracting agencies.

Thermalito Diversion Dam and Powerplant

Deregulation of California's electrical industry in 1998 changed the way DWR and major utilities exchanged and sold power. The Independent Services Operator, an entity established to monitor and control the transmission of power over the State power grid, created new opportunities for marketing power. These included the selling of ancillary services (power that's there when you need it) in an open market with the potential to sell power at higher prices to offset SWP water delivery costs.

The SWP's 4-Pumps Program

When Banks Pumping Plant was constructed, only seven of its 11 pumps were installed. In 1986, four additional pumps were installed, increasing the plant's capacity to pump and divert water during wet years for offstream storage and groundwater recharge. However, DWR was required to mitigate for additional fish loss anticipated by the increased pumping by funding programs to restore striped bass, steelhead trout, and chinook salmon populations.

DWR and the Department of Fish and Game signed the Delta Pumping Plant Fish Protection Agreement in 1986 to offset adverse fishery impacts caused by the diversion of water at the Banks Pumping Plant. The agreement is commonly known as the 4-Pumps Agreement because it was subsequently identified as mitigation for the additional four pumps. Among its provisions, the agreement provides methodology to estimate annual fish losses and mitigation credits, implements fish mitigation projects and associated funding sources, and evaluates potential fish mitigation projects for funding under the agreement.

The agreement established a $15 million lump sum program and an annual mitigation program, funded by DWR, to pay for such projects as improving salmon spawning habitat in the Sacramento River and San Joaquin tributaries, creating a law enforcement unit to combat poaching in the Bay Delta estuary and upstream into the Sacramento and San Joaquin river systems, stocking yearling striped bass, and expanding and modernizing Merced River Fish Hatchery. Some recently funded projects include fish screens in Suisun Marsh, fish screens and a ladder in Butte Creek at Durham Mutual Dam, a fish ladder in Butte Creek at Parrot-Phelan Dam, exchange of groundwater for surface water diversions in Mill Creek currently and Deer Creek within the next year, improvement of salmon spawning habitat on the Stanislaus, Tuolumne, and Merced rivers. Several of these projects primarily benefit spring-run salmon.

FISH AND WILDLIFE PROTECTION

Even before environmental laws began to require protective measures for fish and wildlife, the Department built facilities with the environment in mind. During the construction of Oroville Reservoir, a sloping intake structure was installed to allow for temperature-selective releases of water through Hyatt Powerplant. These releases are made for downstream fishery.

The reservoir also blocked returning salmon from their usual spawning grounds. To compensate for this loss, the Feather River Fish Hatchery was opened in 1967. Hatchery staff artificially fertilizes and raises more than 20 million fall-run and spring-run chinook salmon and steelhead trout annually. These fish are released in Lake Oroville and the San Francisco Bay Area. In 1999, the hatchery was expanded to accommodate more rearing areas and add a facility to treat a fungal disease that attacks young chinook salmon.

In the Sacramento-San Joaquin Delta, along the intake channel to Banks Pumping Plant, the Skinner Fish Facility diverts fish from entering the plant's pumps. Salvaged fish are counted, identified, and recorded then transported back to the Delta for release. The facility salvages an annual average of about 15 million fish.

A viewing window at the Feather River Fish Hatchery.

Also located in the Delta, the Suisun Marsh Salinity Control Gates was built to protect the Bay-Delta estuary. The gates protect water quality in the Suisun Marsh, one of the State's largest contiguous brackish water wetlands. Its radial gates trap fresh water in the marsh while keeping out more saline waters entering from the San Francisco Bay.

Other environmental protection/mitigation measures include streamflow maintenance, spawning gravel restoration, real-time monitoring of fish migration in the Delta, restricted pumping schedules, fish screens, mitigation agreements, water delivery systems to refuges in the Suisun Marsh, wetland development, environmental monitoring of SWP lands, and interagency studies.

DWR's environmental specialists at work.

An Ecological Effort

DWR works with a number of other agencies, mainly State and federal, to collect and analyze data to understand the factors that are controlling the health of the Bay-Delta estuary and its fishery and wildlife. Their efforts, known as the Interagency Ecological Program, share their findings with other agencies and the public.

One IEP effort is fish screen research.

IEP's projects range from fish facilities and fish screen development to fishery, water quality, and hydrodynamics monitoring and studies. Their web site is located at <http:www.iep.ca.gov>.

Early Salinity Investigations

Salinity conditions were first noted by Father Crespi during a 1772 expedition to San Francisco Bay. He recorded tasting fresh water in the estuary near the present city of Martinez.

The adverse effects of salinity have been studied since 1916 by the State Water Commision. Saline water conditions were affected by dryer summer months during high tide conditions. Agricultural water diversions, as when farmers began to grow rice in the valley, added to salinity problems. These problems were also influenced by attempts to allow faster drainage of winter outflows by clearing river channels of hydraulic mining sediments and altering them for flood control projects. These attempts instead allowed saline water to further intrude upstream.

In 1920 a critically dry year combined with increased upstream agricultural diversion to produced a crisis, causing Delta landowners to meet with the commission. A committee was formed, the Riverlands Association, to begin an extensive salinity investigation, coordinated with the State, at 28 Delta stations.

The conditions precipitated a lawsuit to prevent upstream users to take any water that would reduce Sacramento River flows to less than 3,500 cfs past Sacramento. In the end, the lawsuit was overruled by the State Supreme Court and litigation continued.

In 1921, salinity investigations were assigned to the Division of Water Rights, now the State Water Resources Control Board. Presently, the Board is a regulatory agency that has authority over water quality standards in the Delta and statewide, and water rights to protect the beneficial uses of California's water.

SALINITY CONTROL

The SWP, coordinating with the federal Central Valley Project, is operated to limit salinity intrusion into the Delta and Suisun Marsh. This is accomplished by supplementing freshwater outflows to San Francisco Bay and limiting water exports from the Delta during specific times of the year. The projects are also operated to meet instream flow requirements in the Feather and Sacramento Rivers, and Delta channels.

RECREATION

Project reservoirs were designed to provide a variety of recreational opportunities such as boating, fishing, windsurfing, sailing, houseboating, skiing, swimming, picnicking, camping, cycling, horseback riding, and hiking. Bass tournaments are held at many SWP lakes and reservoirs, where trophy-sized fish have been caught.

The SWP offers 37 developed recreational areas and 17 fishing access sites, most along the California Aqueduct. Bicycling is also allowed along certain sections of the aqueduct.

Usage of facilities averages over 4 million recreation-days a year. The most popular SWP recreation sites are the four Southern California lakes: Pyramid Lake, Castaic Lake/Lagoon, Silverwood Lake, and Lake Perris.

Costs for recreational features were initially provided by the Davis-Dolwig Act, with later legislation offsetting SWP contractors' expenditures for these projects. The recreational facilities themselves are operated by the State Department of Parks and Recreation or private concessionaires.

Suisun Marsh Salinity Control Gates.

Los Banos Reservoir offers fishing opportunities.

Coastal Branch Construction:

A GROWING ENVIRONMENTAL AWARENESS

Before the 1960s, environmental factors were not considered crucial in the planning, design, or cost of constructing a dam, reservoir, canal, pipeline, pumping or power plant. But as laws were passed that regulated how the environment would be protected, their impacts had to be calculated into a proposed project.

Stephen Kashiwada, Chief of the Division of Operations and Maintenance, knows very well how these requirements can affect even the smallest repair jobs. When he joined the Department in 1978, Kashiwada dealt with permits and regulations as an engineer designing the Suisun Marsh Initial Facilities, aqueduct repairs, and sediment removal in Clifton Court Forebay.

Stephen Kashiwada

In his more than 20 years with DWR, Kashiwada has dealt with obtaining permits, conducting environmental studies, and staying within the parameters of environmental laws for projects from the planning stage to the construction phase. "With these regulations, we must make extra efforts to ensure our compliance," he says. "In many cases, it makes the process longer and in turn more expensive.

"We know however it's important to take these steps. The Department recognizes the importance and value of protecting and enhancing the environment."

Obtaining permits and complying with regulations are now an integral part of all projects, small and large, Kashiwada says. Care must be taken to preserve existing environmental conditions at the project site. He is familiar with all of the "extra efforts" that were an integral part of the Coastal Branch's construction, a project he was involved in from beginning to end.

Even before Coastal Branch construction contracts were advertised and the earthmovers broke ground, much time was devoted to completing environmental studies and reports. Reviews by the many governmental and regulatory agencies and the public generally required more time be allowed before the start of construction. This added to the cost equation, with more staff time needed for research and report reviews and revisions.

Consultants, DWR environmental specialists, and State and federal fish and wildlife experts spent hours determining which listed species (under federal or State endangered species acts) were located within the project area. When necessary, listed species were

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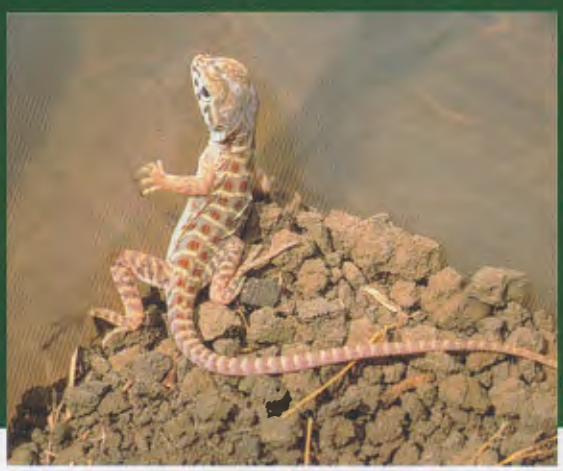


To protect the endangered blunt-nosed leopard lizard, California Conservation Corps members helped the Department build miles of exclusion fencing to keep the lizards out of the construction site. The fence also made it easy to capture those within the fenced area.

relocated and kept out of the project site. For example, for the Coastal Branch construction, 80 blunt-nosed leopard lizards were caught and relocated, and a nine-mile-long fence was built to keep others from entering the project site.

In some cases, environmental surveys were conducted over an area much larger than planned for the project. This extra area allowed for adjustment of the project's alignment, or path, if necessary.

Experts coordinated their efforts with regulatory agencies, water organizations, and interested public groups or individuals to complete EIRs and decided what mitigation measures must be taken. Environmental training of construction crews was completed before they began their work.

When construction began, environmental monitors were on site for consultation. They were responsible for making certain the mitigation measures were implemented. Such measures included timed construction to avoid impacts on listed species, vehicle speed limits on site, diversion and flow restrictions to protect fisheries, change of project alignment to avoid significant cultural (archeological) areas, capture and relocation of listed species, real-time monitoring of fish migration, and collection and propagation of native plants for replanting.

"We have witnessed a significant change in attitudes and protection of the environment from the past to the present," Kashiwada says. "And we've learned how to manage and comply with the change. We wonder what the years ahead will have in store for our projects, but are up to whatever challenges the future holds for us."

Among the protected resources along the Coastal Branch were the region's oak trees. DWR aligned the pipeline around critical areas or tunneled the pipe underground to avoid disturbing the trees. For those trees impacted, DWR collected acorns and seeds along the pipeline's route to preserve the "species integrity" and genetic diversity of the revegetated areas.

The habitats of several state and federally endangered species were found within the project's boundaries. Among the listed species was the San Joaquin kit fox.

Field division Area Control Center.

THE PROJECT OPERATIONS CENTER

Staffed 24 hours a day, the POC is the nerve center of the SWP. From its headquarters in Sacramento, the POC can, if necessary, remotely control all of the SWP's major facilities. This includes power and pumping plants, reservoirs and lakes, and more than 660 miles of pipelines and canals, including the California Aqueduct.

During each 8-hour shift, three dispatchers are responsible for:

- Coordinating the activities of the five field divisions that maintain and operate SWP facilities within their respective geographic boundaries;
- Acting as backup control for any of the field divisions when their computer systems are not working.
- Monitoring and collecting Project data for daily reports and operations.
- Buying or selling power supplies from the Power Exchange or through exchange agreements with other utilities and arrange for its transmission through the Independent Service Operator, created to oversee California's power transmission system.

POC AND ACC OPERATIONS

Day-to-day operations are normally handled by five Area Control Centers, one in each of the five field divisions–Oroville, Delta, San Luis, San Joaquin, and Southern–that are responsible for the facilities within their geographic boundaries.

Each field division can remotely operate and monitor the major facilities within their jurisdictions. These include startup or shutdown of pumping and generating units, and opening or closing of radial gates that control the flow of water through the California Aqueduct and South Bay Aqueduct or valves that do the same function in the underground pipeline systems of the North Bay Aqueduct and Coastal Branch.

A dispatcher watches monitors at the POC.

SWP DEVELOPMENT TIMELINE

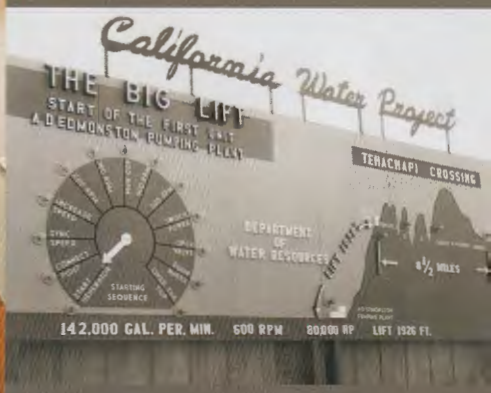
1968 **Oroville Dam** and **Lake Oroville** are dedicated by Governor Ronald Reagan. The reservoir is filled to its 3.5 million acre-feet capacity for the first time.

First water deliveries made to San Joaquin Valley contractors.

1970 **Tehachapi Afterbay** construction begins in 1970 and ends in 1971.

1971 State Water Resources Control Board issues Decision 1379, setting water quality standards for the CVP and SWP

1972 **Edmonston Pumping Plant** is dedicated. This pumping plant has the world's highest single lift of water, nearly 2,000 feet up and over the Tehachapi Mountains.



Dedication, Edmonston Pumping Plant.

First water deliveries begin to Southern California.

Unit 7 of the **Castaic Powerplant** begins operations in advance of the main facility's completion to begin water deliveries to users from Castaic Lake. *(The power plant was designed, constructed, and is operated by the Los Angeles Department of Water and Power under an agreement with the Department.)*

Last of the Burns-Porter Act general obligation bonds are sold.

SWP
DEVELOPMENT TIMELINE

1973 John R. Teerink is appointed DWR Director, serving until 1975.

John R. Teerink

1975 A 5.7 magnitude earthquake hits the Oroville area, causing minor damage to the Oroville facilities. A side consequence is that the quake halts construction on Auburn Dam.

Ronald E. Robie is appointed DWR Director. He serves until 1983.

Ronald E. Robie

1976 Start of a two-year drought. SWP delivers nearly 1.4 million acre-feet of water to contractors.

1977 Driest year of record. SWP deliveries drop to less than 600,000 acre-feet.

THE Present

THE CONTROL SYSTEM

In 1995 the POC moved to new and larger quarters and began a search for a control system that would provide more detailed data, quicker data updates, and a more fault-tolerant, reliable system. With data expected from 70,000 monitor-and control points, the system required a fast and easy-to-navigate display system. Another requirement was a software system that could be easily modified as operational needs changed.

Today, POC dispatchers monitor the SWP through a new computer system with similar localized control systems at each field division. Using four or more computer screens, they can access data from any RTU (Remote Terminal Unit) displayed in easy-to-read tables, charts, and graphs instead of lines of numbers. With the new system, data transmission is down to 4 seconds along the aqueduct and 8 seconds from major plants. The technology is easier to use and maintain than the old system, and data can be located by a name or ID, instead of remembering its specific location in the database. Alarms are prioritized, so dispatchers will know which are urgent or emergencies.

The new system also allows any DWR computer user to observe the POC in action Through the Information Storage and Retrieval System, users can have access to a near real-time, mirror image of the data that can be viewed but not changed.

CALIFORNIA AQUEDUCT OPERATIONS

The California Aqueduct transports most of the State Water Project's water. Its main line is divided into 66 pools by radial gates that control the flow of water in the open canal. When water is moved down the open canal, all of the gates can be programmed to simultaneously open at a specific time. Each gate has a computer sensor that monitors the water level on both sides of the gate. These sensors, RTUs, are continually sending real-time data about water levels and flows to both the POC and the ACCs through a fiber optics communications system. The RTUs also permit remote control of the facilities they monitor.

Partnerships

WITH FEDERAL AND LOCAL GOVERNMENTS

Joint-Use Facilities

In 1961, DWR and the U.S. Bureau of Reclamation agreed to jointly develop the San Luis Unit facilities. Joint-use facilities include O'Neill Dam and Forebay, B.F. Sisk Dam, San Luis Reservoir, William R. Gianelli Pumping-Generating Plant, Dos Amigos Pumping Plant, Los Banos Reservoir, Little Panoche Reservoir, and the San Luis Canal, a 103-mile segment of the California Aqueduct.

The Bureau designed and constructed the facilities, and DWR operates and maintains them. All costs and reservoir storage are split 45/55 with DWR having the larger share of both.

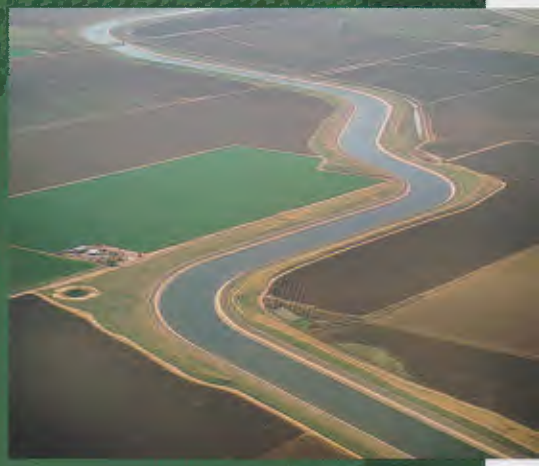
Castaic Powerplant

Located about 40 miles northwest of Los Angeles between Pyramid Lake and Castaic Lake, Castaic Powerplant was built under a cooperative agreement between DWR and the Los Angeles Department of Water and Power. Initially, DWR had planned to build a 214-MW (megawatt) plant to recover power from the lift over the Tehachapis.

With LADWP's participation, the facility's generation capacity was enlarged to 1,200 MW and pumpback capability was added for peaking capacity. In addition to the power plant, the facilities include the Angeles Tunnel and Elderberry Forebay.

DWR and LADWP share costs on a 45/55 split with the Department having the larger share.

William R. Gianelli Pumping-Generating Plant



San Luis Canal

Coordinated Operation Agreement

In 1986, the Bureau and DWR signed a Coordinated Operation Agreement defining the rights and responsibilities of both agencies in operating the CVP and the SWP to maximize benefits to the people of California. This agreement expanded a series of interim agreements which had been in effect since the beginning of SWP operations. The COA provides for increased operational flexibility and efficiency of both projects, equitable sharing of available surplus water, and sharing of responsibilities in meeting Delta water quality standards. Under the agreement, the SWP and the CVP coordinate operations, including releases from upstream reservoirs and pumping from the Delta.

Castaic Powerplant

Dealing with an Aging System

Many SWP facilities are 30 years or older. Aging from the wear and tear of stopping and starting pumps and changing water elevations in canals and pipelines has begun to present certain challenges for DWR's maintenance staff.

All structures that fall under the Division of Operation and Maintenance's Civil Maintenance Section – roads, bridges, roofs, dams, canals, pipelines, buildings – are inspected every other year by Headquarters and field division staff. Minor repairs are made quickly by the field division, while larger (non-emergency) ones must sometimes wait several years as repair contracts are prepared.

Field division personnel, on an almost daily basis, inspect the Project for leaks, settlement, cracking, and other obvious signs that something may be wrong. An obvious sign in the late spring, when the grass begins to dry and turn brown, is a green patch of vegetation, indicating a possible leak.

Other O&M staff in water operations, sometimes called "water dogs," traverse the Project daily. They do water measurements and collect water samples for analysis. They also keep a close eye, looking for new seeps and monitor existing seepage locations.

In recent years, several canal failures have occurred – some that were monitored for several months and some that were unexpected. Such failures can often be attributed to the unexpected settling of high earth embankments on weak foundations. These differential settlements cause cracking in the embankment and the concrete lining. This situation has been the cause of many of our canal leaks and continues to be a place where more problems are expected in the future.

Another problem is the potential hydrostatic water pressures behind the lining when a canal section is dewatered for repair or inspection. Only a few feet of hydrostatic pressure can cause lining or slope failure if the rate of dewatering is too rapid.

When repairs are needed, outages are scheduled or needed repairs are performed during previously scheduled outages. To complete the repair, Division of Engineering staff work with O&M to design the project and bid the job out to potential contractors. The actual work is overseen by DOE.

One repair project under way by O&M, and which will continue for at least the next two years, is refurbishing the radial gates that control the flow along the California Aqueduct. The gates are removed, taken to a facility where they can be

Radial gates on the California Aqueduct's 66 check structures are being cleaned and repaired after 25 years of service.

A Division of Safety employee checks a radial gate on Thermalito Diversion Dam.

cleaned, sandblasted, and repaired and repainted, and then replaced. Gates in the San Joaquin and San Luis field divisions still need attention, but the work can only be done during the non-flood season, a six-month period.

SWP power and pumping plants also are inspected regularly by Headquarters staff, while routine maintenance and repairs are done by the field division's electricians and mechanics (many trained by DWR's own apprenticeship program). When major repairs are required, HQ staff administers service repair contracts with outside vendors.

Since the 1970s, technology has changed for pumps and generators, and the Department has installed new equipment and replaced older technology such as the computer systems and circuit breakers. Each year, millions of dollars are budgeted to keep the system in service with as few unexpected outages as possible.

SWP's operational flexibility (pumping water at night when power rates are cheapest and generating power during the day when it can be sold or exchange at a higher rate) has its trade-off when it comes to some electrical equipment. Thermal cycling, like turning lights off and on, takes a physical toll on the huge circuit breakers in SWP plants.

The Project's earthfill dams are other facilities that must be routinely watched. O&M staff monitors the settlement in the dams through precise surveys to insure that it is within anticipated limits.

Radial gates on SWP dams, mainly in the Oroville complex, were also inspected after the 1995 radial gate failure at Folsom Dam.

Since the 1970s, technology has changed for pumps and generators, and the Department has installed new equipment and replaced older technology such as the computer systems and circuit breakers.

The Repair Side

The task of designing repairs to SWP's aging facilities falls to DWR's Division of Engineering. DOE's staff must determine what kinds of methods and materials to use that will best do the job. "Engineering staff design the repairs, prepare the plans and the specifications, and package them with contract documents for public works contracts," says Les Harder, Chief of DOE.

When the repair begins, Engineering staff oversee the construction and inspect the work and can reject it if they feel it doesn't meet the contract's requirements. DOE's inspectors work out of two offices, one in Sacramento and another in Lancaster. A temporary office in Yucaipa is associated with the construction of the East Branch Extension Project.

The repairs include just about every part of the Project – buildings, pumps and generators, roads, tunnels, pipelines and more. However the most visible ones, those often covered by the media, have been along the California Aqueduct. Harder says that considering its large size, length, and the many difficult geologic conditions it traverses, the aqueduct has performed well over the years.

The canal is now more than 30 years old, and it is experiencing more distress from settlement, seepage, hydrocompaction, and foundation solutions, all of which can result in canal slippage or failure. In the past decade, there have been 16 major repairs, which added up to more than $40 million.

The aqueduct was originally constructed with unreinforced concrete lining about 3–4 inches thick. The lining reduces seepage, provides a smooth surface to reduce friction and thus conserves pumping energy, and prevents erosion of its slopes. Since then, technology has changed and created new methods and materials that strengthen the canal slopes by keeping water from leaking into the soil. Now plastics and rubberized asphalt materials are used to reduce seepage distress.

What method is selected is sometimes determined by how much of the embankment needs to be removed and what is the cheapest but most effective repair. DOE has recently used both a spray-on geomembrane (trade name Liquid Boot) in conjunction with a plastic geotextile material, then covered with a two-inch layer of shotcrete and an asphatic elastometic geomembrane (tradename Teranap), which can be rolled over the canal prism. The Teranap rows are overlapped and sealed by applying heat to the edges of the rolls, and also covered with a 2-inch layer of shotcrete.

Before and during repairs, environmental concerns are always a priority, especially when borrow sites or spoil areas are required that might disturb habitat. When dewatering a canal repair section, fish are often stranded within that canal section, and DOE must work with Department of Fish and Game staff to remove the fish safely.

Canal lining failure along the East Branch Aqueduct.

Repair work along the aqueduct also involves working with O&M to schedule outages for dewatering the canal and stopping water deliveries beyond that section. As demands by the SWP contractors for water increase, timing is everything in terms of when and how long the repair takes. For DOE, that means working around the clock at an accelerated pace.

A 23-year DOE veteran, Harder says more surveillance and preventive work are needed if emergencies are to be prevented. In recent years DOE and O&M staff have carried out several preventative repairs to deter problems escalating into true emergencies. But as contractors' water requirements rise, there will be fewer opportunities for outages to do repairs. "We'll just have to find more inventive ways to do the job."

Repair at mile 56 was a planned outage in 1990. Canal lining is underway (above).

What method is selected is sometimes determined by how much of the embankment needs to be removed and what is the cheapest but most effective repair.

SWP

DEVELOPMENT TIMELINE

1978 The State Water Resources Control Board issues Decision 1485, extending the water quality standards to San Francisco Bay and holding the SWP and federal CVP mainly responsible for meeting the standards.

1981 Construction begins on **Bottlerock Powerplant** to provide energy from geothermal sources. It begins operations in 1985. The plant is mothballed in 1990 and remains in that condition today.

1980 Governor Edmund G. Brown, Jr., signs SB 200 authorizing the Peripheral Canal. Voters repeal it in a 1982 referendum.

1982 Work starts on **Alamo Powerplant**, completed in 1985.

Alamo Powerplant

Construction contract for **South Geysers** is awarded. It is suspended in 1984 after completion of the building but before installation of the equipment which is subsequently sold. The project is subsequently decommissioned, and the building and land are currently for sale.

THE Present

STATE WATER CONTRACTORS

In the early 1960s, long-term contracts were signed with water agencies, known as the State Water Project contractors, to ultimately receive 4.2 million acre-feet of water from the State Water Project. Through these contracts, the contractors are repaying principal and interest on both the general obligation bonds that initially funded the Project's construction and the revenue bonds that paid for additional facilities. The contractors also pay the costs to maintain, operate, and replace the Project's facilities.

Today, there are 29 SWP contractors. They are entitled to receive the annual amounts of water specified in their contracts with DWR. The contracts run until the year 2035. Each contract contains a schedule of the amount of water the agency is entitled to receive each year. For most contracts, the amounts increase yearly up to the maximum annual entitlement. Water contractors may not receive their full entitlement in any one year due to hydrological conditions such as during times of low precipitation. Contractors can also request to receive less than their normal entitlement.

The service areas of the 29 contracting agencies extend from Plumas County in the north to the Mexican border. These agencies' service areas comprise almost one quarter of California's land area and more than two-thirds of its population.

SWP water is used mostly for irrigated agriculture in the southern San Joaquin Valley, where the largest agricultural contractor is Kern County Water Agency with an annual maximum entitlement of more than 1 million acre-feet. In other service areas, it satisfies mainly urban needs, such as for the agencies under the Metropolitan Water District of Southern California with an annual maximum entitlement of more than 2 million acre-feet.

The SWP serves mainly urban water users to meet the needs of developing industries and residential areas.

WHO ARE THE SWP CONTRACTORS?

Since 1962, the SWP has delivered more than 57 million acre-feet of water to its 29 contractors, water that has fueled the development of communities and their economies statewide, as well as contributed to the multibillion-dollar agricultural industry. Here are brief profiles of these agencies:

Plumas County Flood Control and Water Conservation District water first received in 1970, 100 percent residential use Cumulative payments*: about $1.04 million

County of Butte water first received in 1968, residential use. Cumulative payments: $522,359

City of Yuba City water first received in 1984, 70 percent for residential uses with rest for industrial uses including food processing (prunes), electrical cogeneration, and general commercial. Cumulative payments: $2.1 million

Napa County Flood Control and Water Conservation District water first received in 1968, 100 percent municipal and industrial (M&I). This saves local groundwater for rural residential and agricultural use. Cumulative payments: about $41.1 million

Solano County Water Agency water first received in 1986, 100 percent M&I with 80% for residential. The area's top industries are Exxon Refinery, Genontech, and Travis Air Force Base. Also used in a groundwater storage program with the Mojave Water Agency. Cumulative payments: $52 million

Alameda County Water District water first received in 1962, 100 percent M&I use with 69 percent for residential. Top industrial users include auto manufacturing and high tech industries. Other noteworthy use is recharge of the Niles Cone Groundwater Basin. Cumulative payments: about $60.2 million

Alameda County Flood Control and Water Conservation District, Zone 7 water first received in 1962, 12 percent agriculture, 76 percent M&I (90 percent of that for residential), and 12 percent for other uses. Wholesales water to other major retailers and sells directly to agricultural contractors. Cumulative payments: about $56.2 million

Santa Clara Valley Water District water first received in 1965, 100 percent M&I. Top commercial/industrial users are high tech manufacturing, business services, and retail trade. Other uses are groundwater recharge and treated drinking water. Cumulative payments: about $191 million

Oak Flat Water District water first received in 1968, 100 percent agriculture. Top crops include almonds, walnuts, tomatoes, and sod. Cumulative payments: about $3.6 million

County of Kings water first received in 1968, 100 percent agriculture.**Cumulative payments: about 2.7 million

**The county, designated as an M&I user, contracted for SWP water for recreational purposes. The county's water is delivered for use within the Tulare Lake Basin Water Storage District. By exchange, Tulare releases a like amount of its Kings River water for delivery within the county from the Kings River channel.

Empire West Side Irrigation District water first received in 1968, 100 percent agriculture. Top crops include cotton, wheat, alfalfa, and sugar beets.Cumulative payments: about $2.3 million

Dudley Ridge Water District water first received 1968, 100 percent agriculture. Top crops include pistachios, cotton, alfalfa, almonds, and barley. Water is banked in groundwater basins outside of the district's service area; participates in the Kern Water Bank Authority. Cumulative payments: $45 million

Tulare Lake Basin Water Storage District water first received in 1968, 100 percent agriculture (cotton, wheat, seed alfalfa); also for indirect recharge of groundwater basins. Cumulative payments: $90 million

San Luis Obispo County Flood Control and Water Conservation District water first received in 1997, 100 percent M&I use for residential, tourism, small businesses, incarcerated, and education. Cumulative payments: about $28.5 million

Kern County Water Agency water first received in 1968, 88 percent agricultural (grapes, almonds, cotton, milk, carrots); 11 percent M&I (food processing, light industrial, commercial businesses). 120,000 acre-feet is treated and used for residential purposes, with the rest recharged into local groundwater basins. Cumulative payments: $1,037,856,000

Antelope Valley-East Kern Water Agency water first received in 1972, 30 percent agricultural and 70 percent M&I use, of which 95 percent is residential. Borax processing is the top industrial use of water. The use of SWP water is in lieu of groundwater pumping. Cumulative payments: $235 million

Mojave Water Agency water first received in 1972, for groundwater recharge. Cumulative payments: about $105 million

Central Coast Water Authority* water first received in 1997, 100 percent M&I use, with 85 percent residential. CCWA's SWP entitlement must first be used to offset each of its retailers' proportionate share of groundwater overdraft before any of it can be used for new growth. Under a joint exercise of powers agreement with DWR, CCWA is operating a portion of the Coastal Branch and delivering treated SWP water to San Luis Obispo and Santa Barbara counties. Cumulative payments: about $136.6 million

Ventura County Flood Control District is the legal entity of a maximum annual entitlement of 20,000 acre-feet, assigned to Casitas Water District, which in turn maintains an entitlement of 5,000 acre-feet and assigns 5,000 acre-feet to United Water Conservation District and 10,000 acre-feet to the City of San Buenaventura. Cumulative payments: about $30.3 million

Castaic Lake Water Agency water first received in 1968, 100 percent M&I use, primarily for residential and small businesses. Wholesales water to retail water agencies.Cumulative payments: about $110.7 million

Palmdale Water District water first received 1985, 100 percent M&I use, of which 82% is residential. Top M&I water users in its service area are Lockheed Martin, R & R Investments, and Ray K. Farris, II. Cumulative payments: $32 million

Littlerock Creek Irrigation District water first received in 1972, 70 percent residential, 30 percent agriculture (peaches, pears, apples). Cumulative payments: $4 million

Metropolitan Water District of Southern California water first received in 1972, 93 percent M&I (62 percent of that for residential, 31 percent for commercial/industrial/institutional), 7 percent for agriculture. Schools, hospitals and hotels combined with industries such as electronics, aerospace, and petroleum refining, and tourism include many of the M&I uses. SWP water is also used for groundwater recharge and blending with Colorado River water with its high salinity content. Cumulative payments: $5.6 billion (through 2000)

San Gabriel Valley Municipal Water District water first received in 1974, 100 percent for groundwater recharge. Cumulative payments: $79 million

Crestline-Lake Arrowhead Water Agency water first received in 1972, 100 percent M&I use. Also provides supplemental supply to San Bernardino Mountain Area and Silverwood Recreation Area, and water for wildlife forest fire protection. Cumulative payments: about $14.4 million

San Bernardino Valley Municipal Water District water first received in 1972, 100 percent M&I, residential use (no retail connections). Minor amount for citrus crop. Cumulative payments: about $252 million

San Gorgonio Pass Water Agency last SWP contractor to receive water, 95 percent M&I and 5 percent agriculture. The agency will use SWP water to recharge its groundwater basin. Cumulative payments: $36 million

Desert Water Agency water first received in 1973, used for groundwater recharge. A SWP water exchange with Metropolitan Water District of Southern California, for water from its Colorado River Aqueduct, enabled DWA to avoid the cost of building SWP facilities to reach its area. Cumulative payments: $139 million

Coachella Valley Water District water first received in 1973, 100% for groundwater recharge. Top industrial/commercial users are hotels and resorts. Top crops: dates, peppers, grapes, tomatoes, and celery. Cumulative payments: about $108 million.

*Cumulative payments to end of 1999

Water Contractors

Twenty-nine water agencies have long-term contracts for water entitlements and repayment of facilities through the year 2035. Whether they receive their annual entitlements depends on available water supply and local water demands.

CONTRACTING AGENCY	MAXIMUM ANNUAL ENTITLEMENT (ACRE-FEET)
UPPER FEATHER RIVER	
1. City of Yuba	9,600
2. County of Butte	27,500
3. Plumas County Flood Control & Water Conservation District	2,700
Subtotal	**39,800**
NORTH BAY AREA	
4. Napa County Flood Control & Water Conservation District	25,000
5. Solano County Water Agency	42,000
Subtotal	**67,000**
SOUTH BAY AREA	
6. Alameda County Flood Control & Water Conservation District, Zone 7	46,000
7. Alameda County Water District	42,000
8. Santa Clara Valley Water District	100,000
Subtotal	**188,000**
SAN JOAQUIN VALLEY	
9. County of Kings	4,000
10. Dudley Ridge Water District	53,370
11. Empire West Side Irrigation District	3,000
12. Kern County Water Agency	1,112,730
13. Oak Flat Water District	5,700
14. Tulare Lake Basin Water Storage District	118,500
Subtotal	**1,297,300**
CENTRAL COAST	
15. San Luis Obispo County Flood Control & Water Conservation District	25,000
16. Santa Barbara County Flood Control & Water Conservation District	45,486
Subtotal	**70,486**
SOUTHERN CALIFORNIA	
17. Antelope Valley-East Kern Water Agency	138,400
18. Castaic Lake Water Agency	54,200
19. Coachella Valley Water District	23,100
20. Crestline-Lake Arrowhead Water Agency	5,800
21. Desert Water Agency	38,100
22. Littlerock Creek Irrigation District	2,300
23. Mojave Water Agency	50,800
24. Palmdale Water District	17,300
25. San Bernadino Valley Municipal Water District	102,600
26. San Gabriel Valley Municipal Water District	28,800
27. San Gorgonio Pass Water Agency	17,300
28. The Metropolitan Water District of Southern California	2,011,500
29. Ventura Country Flood Control District	20,000
Subtotal	**2,510,200**
Total State Water Project	**4,172,786**

**Castaic Lake Water Agency acquired Devil's Den W.D. entitlement in 1992.*

Financing by Bonds

The State Water Project is financed by two major types of bonds: initially by general obligation bonds until 1972 and subsequently revenue bonds. General obligation bonds are backed by the "full faith and credit" of the State and are normally paid back from general fund revenues. The $1.75 billion in general obligation bonds sold by the Department for the SWP under the Burns-Porter Act in 1960 is being repaid, with interest, by the Department from revenues received from the SWP contractors.

To supplement general obligation bonds, DWR has sold revenue bonds under the authority of the 1933 Central Valley Project Act. These revenue bonds help finance projects including power plants that generate revenue. The revenue is then used, in part, to repay the principal and interest of the revenue bonds.

FINANCING OF THE SWP

By the end of 1998, about $5.1 billion had been spent to construct SWP facilities. Total projected capital expenditures for 1998 through 2010 is $448 million, of which $175 million is for the East Branch Extension underway and the planned South Delta facilities (now integrated into the CALFED plan). The remainder is reserved for a variety of projects and activities including modifications to the West and East Branches.

SWP financing comes from various sources, the major source now being the sale of revenue bonds (about 78 percent, see sidebar on the left). The last of general obligation under the Burns-Porter Act was sold in 1972. Other capital funding sources have included tideland oil revenues, investment earnings, funds advanced by the SWP contractors, recreation appropriations, and federal flood control payments.

While each contract contains basically the same provisions, each has some differently agreed to provisions based on the individual needs of the contracting agency.

The Delta Water Charge is common to all agencies. Each pays the same amount per acre-foot of entitlement for constructing and operating the SWP conservation facilities, which are used to develop the Project's water supply. These facilities include Lake Oroville, San Luis Reservoir, and a portion of the California Aqueduct from the Delta to San Luis Reservoir. The Delta Water Charge also provides funds to maintain water quality in the Sacramento-San Joaquin Delta, where the water is exported to various regions of the State. Each contractor also pays transportation charges for the construction, operation, and maintenance of necessary facilities to convey the water to its respective location. The greater the distance the water is transported, the higher the cost.

Repayment of bond principal and interest make up about 37 percent of contractors' costs, while about 32 percent is for power purchases, 25 percent for labor and equipment, and 6 percent for replacement and other miscellaneous expenses.

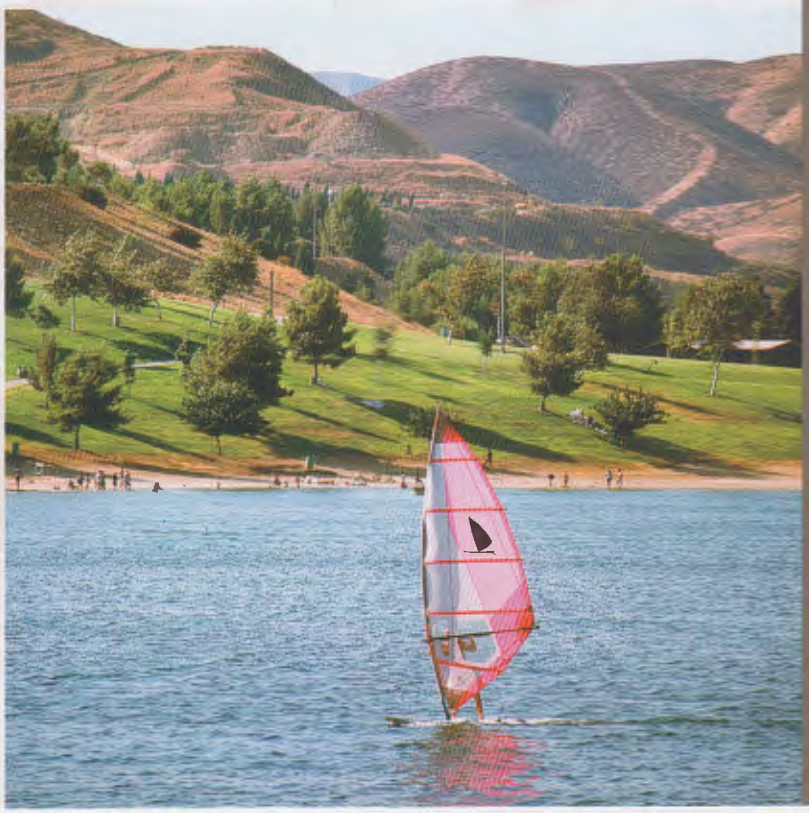
All SWP contractors pay for construction of certain conservation facilities such as Oroville (bucketwheel in background) and San Luis Reservoir.

CONTRACT AMENDMENTS

Nearly all of the contracts have been amended since the agencies first signed them. The most recent and significant set of amendments is known as the Monterey Amendment. In December 1994, representatives of the Department of Water Resources and the participating State Water Project contractors signed the agreement, containing provisions that redefine the way DWR administers its long-term water contracts. Major issues covered by the agreement include:

- changes in the formula for allocating water among contractors in years of short supply;
- transfers of entitlements from agricultural contractors to urban users (45,000 acre-feet of agricultural entitlement was permanently transferred to DWR and retired, and 130,000 acre-feet is available for permanent sale (willing buyer-willing seller basis) to urban contractors);
- transfer of Kern Fan Element to agricultural contractors for use in regional banking programs;
- financial restructuring to establish a SWP operating reserve and a water rate management program for agricultural contractors; and
- added operational flexibility, including storage of SWP water in non-SWP surface storage facilities outside a contractor's service area for later use, expanded rules for carryover in SWP conservation reservoirs; and no limits for groundwater storage of SWP water outside a contractor's service area for later use within the service area.

* Because not all SWP contractors signed the Monterey Amendment, DWR has to carefully administer the provisions of each contract.



The amendments allowed the contractors a larger role in operations of certain SWP storage facilities such as Castaic Lake (right).

SWP DEVELOPMENT TIMELINE

1983 DWR becomes a bulk power entity. The Department is the State's largest consumer of power.

David N. Kennedy is appointed DWR Director. He retires in 1998.

David N. Kennedy

Record rainfall makes it California's wettest year on record.

DWR contracts for power from one unit in Reid Gardner, a coal-fired plant in Nevada for SWP's use.

1985 **Phase II of the North Bay Aqueduct** begins construction and is completed in 1988, with work on **Barker Slough** and **Cordelia pumping plants** beginning in 1986 and ending in 1987 and 1988; respectively.

Work starts on **Thermalito Diversion Dam Powerplant**, ending in 1987.

1986 The Coordinated Operation Agreement is signed by State and federal governments for sharing responsibilities to meet Delta water quality standards and water rights of other Central Valley diverters.

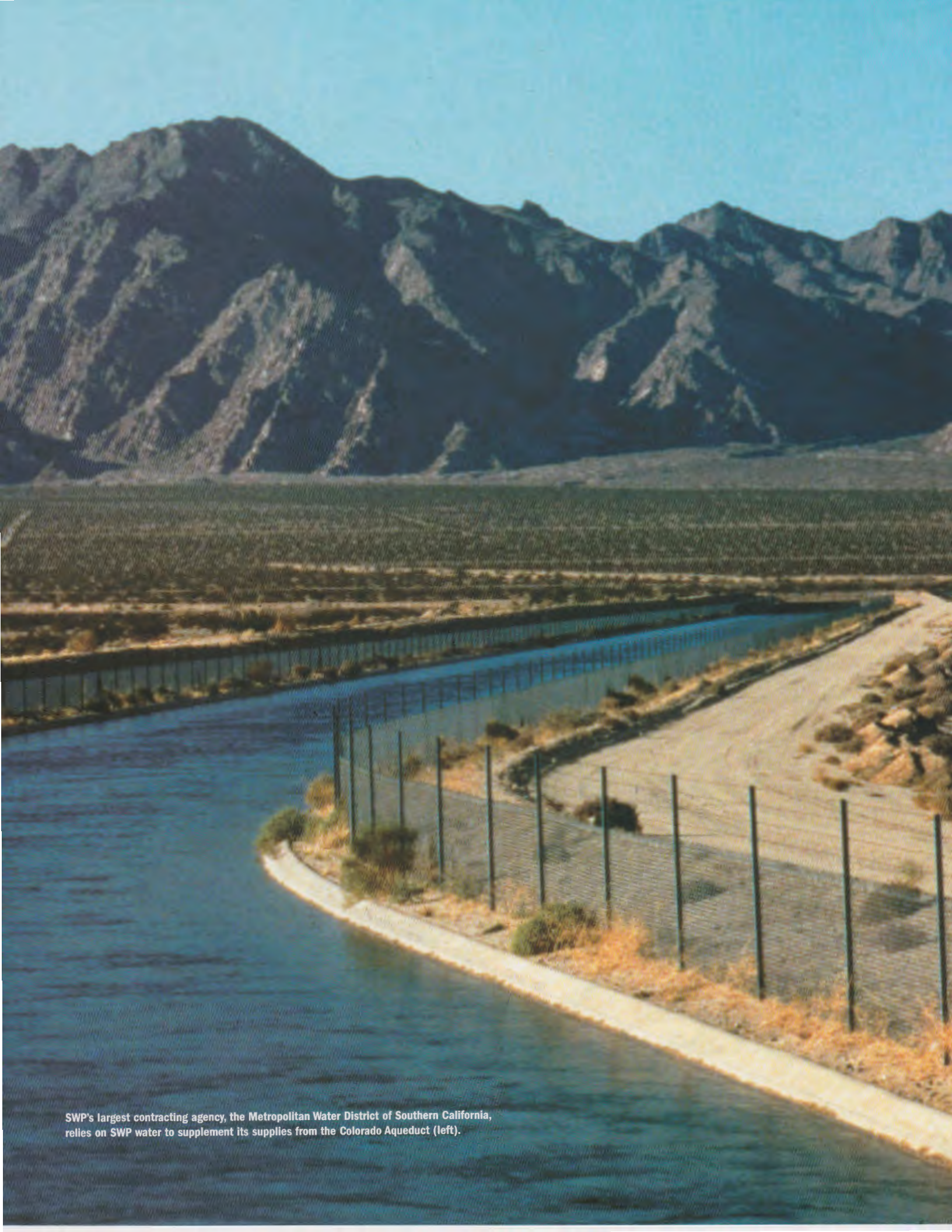
The Suisun Marsh Salinity Control Gates' construction starts. Its operations help maintain proper salinity levels in the marsh by controlling tidal flows through Montezuma Slough. Operations start 1989.

THE FUTURE

Water supply reliability and water quality are major issues for the future. Demand for additional water supplies will be greatest in growing urban areas. Agricultural users face challenges too, including rising water costs and depleting groundwater basins. Meeting future water needs will require major new investments and a greater commitment to integrated regional water management, water efficiency, improved statewide water systems, and environmental stewardship.

THE future

The restoration of the Bay-Delta estuary will largely determine the future of many regions' water supply reliability.



SWP's largest contracting agency, the Metropolitan Water District of Southern California, relies on SWP water to supplement its supplies from the Colorado Aqueduct (left).

The California Water Plan Update 2005 (Bulletin 160) describes in detail the water management strategies and the investments needed to ensure California's water future. The plan represents a fundamental transition in water resource management. It also represents a fundamental transition in the way state government needs to be involved with local entities and interest groups to deal with water issues in the state. Instead of looking for single solutions with water projects, Californians will find success with integrated projects such as conservation, groundwater storage, and water recycling.

Whether drawn from the SWP or a local source, water will always play a vital role in the future growth of the Golden State's population, economy, and quality of life.

Public agencies that have water deliveries from the State Water Project will need to look to local answers to meet the needs of their growing communities.

SWP DEVELOPMENT TIMELINE

1986 Design is completed and construction begins on the **East Branch Enlargement,** Phase I. It is completed in 1996 to carry increased water deliveries requested by Metropolitan Water District of Southern California. It includes raising the canal lining 4 feet from **Alamo Powerplant** to **Mojave Siphon;** enlarging **Devil Canyon Powerplant,** adding two turbines and a second afterbay; enlarging **Pearblossom Pumping Plant,** adding three units and new discharge lines; and completing **Mojave Siphon Powerplant** (conditionally operational 1996).

1987 Six-year drought begins, ending in 1992.

Drought at Oroville Lake.

DWR begins a joint venture with MCI to install a fiber optics cable communications system for a new control system for the SWP.

THE future

(Top) Drip irrigation is often used in vineyards. To conserve water in the garden, Californians have turned to a variety of colorful drought-resistant plants and recirculating ponds.

WATER MANAGEMENT STRATEGIES

In the 1990s, voters passed two important bond issues that provided nearly $3 billion for a myriad of water programs statewide. Each measure contained funds for local communities, including some SWP contracting agencies, to invest in their water systems and water resources with alternative strategies to manage or augment their current supplies.

Such strategies include water recycling, water conservation, groundwater recharge and banking, conjunctive use of surface and groundwater resources, treatment of contaminated groundwater basins, and water transfers and water marketing. These technologies will play an increasing role statewide in meeting the needs of Californians in the years ahead.

Water conservation is already a way of life in California. Agricultural and urban SWP water users use conservation to stretch their local water supplies. Both groups have signed "best management practices" mandated by legislation to develop efficient water management strategies for both urban and agricultural uses of water. Urban water management planning includes long-range planning to ensure an appropriate level of reliability in water service to meet the needs of water suppliers' customers during normal, dry, and multiple dry water years. Urban measures that could be important elements in the plan include water audits, review of commercial and industrial water use, public information, ultra-low-flush toilet replacement and plumbing retrofit programs, and conservation pricing for water and sewer services. Each plan must also establish a contingency plan for shortages during multiple dry years.

Agricultural management plans must develop water conservation and drainage reduction programs, and efficient irrigation practices.

Water conservation includes the use of recycled water for irrigating parks and golf

Recycled water is used to water large turf areas such as parks and golf courses.

courses and flushing toilets in commercial buildings. Some communities have successful programs which inject treated **recycled water** into groundwater basins for later use as drinking water. The recycled water is treated to potable water standards before it is recharged into the basins.

Recycled water also includes desalination, which involves removing salts and dissolved solids from saline water (brackish or saltwater) through heat or membranes then reusing it as recycled water. Some communities are investing funds to build desalination plants to reuse water from the ocean. This method of recycling can be prohibitive because of high costs. However, recent research efforts are seeking ways to lower such expenses.

Groundwater recharge, groundwater development, and **conjunctive use** of groundwater and surface water are other promising water management strategies to augment existing supplies statewide.

In groundwater recharge, water is percolated into aquifers for storage. During wet years, some communities use their allocated water to recharge aquifers. This water is then pumped out for use during dry years. In certain contractor service areas, groundwater basins have been contaminated by toxins, closing down wells that provide drinking water. As technology and financial assistance advance cleanup methods, lost groundwater storage may become accessible once more to "bank" water to meet shortages or augment supplies for the future.

Water transfers and **water marketing** can reallocate supplies in a willing buyer-seller market, but such transactions are a small percentage of total supplies and involve water rights and other legal and economic factors.

SWP DEVELOPMENT TIMELINE

1988 DWR purchases Kern Water Bank property, 19,900 acres adjacent to the Kern River for a planned groundwater recharge project.

1991 DWR operates the State Water Drought Bank, also in 1992 and 1994.

1993 Construction begins on **Coastal Branch, Phase II,** which includes more than 100 miles of underground pipelines, tunnels, and siphons, 3 pumping plants (**Devil's Den, Bluestone,** and **Polonio Pass,** all built from 1994-96), and 3 storage tank sites. Operations begin in 1997.

1994 DWR, along with other State and federal agencies, signs the Framework Agreement and later the Bay-Delta Accord. It establishes the State-federal CALFED program to investigate and propose a long-term solution to problems in the Bay-Delta estuary. Such a fix would ensure water quality in the Delta and water supply reliability for SWP contracting agencies.

THE future

FERC RELICENSING OF OROVILLE FACILITIES

DWR's existing 50-year federal license to operate the Oroville Facilities - Oroville Dam, Hyatt Powerplant, Thermalito Diversion Powerplant, and Thermalito Pumping-Generating Plant, and ancillary facilities -expires in January 2007. DWR has applied for a new 50-year license to allow these multi-purpose SWP facilities to continue providing reliable power, water supply, recreation, flood control, and environmental enhancement benefits to millions of Californians.

As the heart of the State Water Project, the Oroville Facilities (known as Project 2100) generate power and capture water to make deliveries to areas of need and keep fresh water affordable. The SWP is the single largest consumer of energy in the State and, while also a major power producer, consumes more energy than it produces.

Houseboating is popular at Lake Oroville.

Approval of a new license is under the purview of the Federal Energy Regulatory Commission (FERC). FERC regulates the country's hydroelectric projects, as well as natural gas industry, wholesale gas and electricity rates, and nonfederal oil pipelines.

Before issuing a new license, FERC must consider how to balance competing uses and address the direct and indirect impacts of operating the Oroville Facilities. DWR convened a collaborative process with dozens of stakeholder groups to guide the studies and environmental documentation required to prepare the new license application.

Aerial view of Oroville Dam's spillway used to release high waters.

DWR's consultants, engineers, biologists, and others worked on the different technical issues that were involved. These included project impacts on instream flows, downstream uses, water temperature, recreational facilities, cultural resources, project operations on Indian tribes, fish hatchery operations, water quality, watershed management, listed species, and more.

DWR coordinated these efforts with the Department of Fish and Game, State Water Resources Control Board, U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Forest Service, and other agencies. The Department also met with representatives from the Oroville-area Indian tribes, the City of Oroville, Butte County, and other local governmental agencies.

All together, nearly 1,200 stakeholders participated in the five-year collaborative process in accord with FERC's criteria. DWR was guided by its desire to retain the license to provide for continued cost-effective operation of the Oroville Facilities, while addressing FERC and stakeholders' concerns.

The new license application was delivered to FERC on January 26, 2005, as mandated by federal law to provide a minimum of 24 months to process the application before expiration of the existing license. An accompanying Settlement Agreement among the stakeholders will enhance the benefits identified in the application and document the diverse level of support for the new license.

SWP DEVELOPMENT TIMELINE

1995 **New Joint Operations Center** is officially opened. It houses both the SWP and CVP operations centers.

1997 A new seismically acceptable intake tower is completed at **Silverwood Lake.** A high water event leads to **Lake Oroville** releasing 160,000 cfs of water through the spillway. Power utility industry is deregulated in California.

1998 The Department creates the California Energy Resources Scheduling office to deal with power deregulation and its changes in markets, prices, and purchasing. The Suisun Marsh Salinity Control Gates begin operations.

1999 Construction begins on the **East Branch Extension** to expand service to the San Bernardino and San Gorgonio Pass areas. It is completed in 2003. Thomas M. Hannigan is appointed DWR Director. He retires in 2003.

Thomas M. Hannigan

THE future

South Delta fish barriers

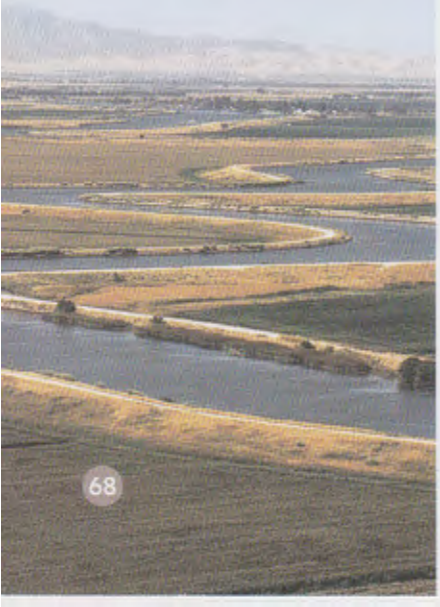
SOUTH DELTA PROGRAM

In the 1960s, DWR began installing a barrier at the head of Old River each fall to assist salmon migrating up the San Joaquin River to spawn. In the late 1980s, barriers were installed in other south Delta channels to raise water levels and improve circulation for local irrigators. Installation of a spring fish barrier began in 1992 at the same location as the fall barrier to protect young salmon migrating down the San Joaquin River from swimming toward the CVP and SWP water export facilities where they are subject to entrainment. Today, all of these barriers are installed as part of the South Delta Temporary Barriers Program. The barriers are rock structures that contain operable culverts to pass flow upstream or downstream of the barriers as needed.

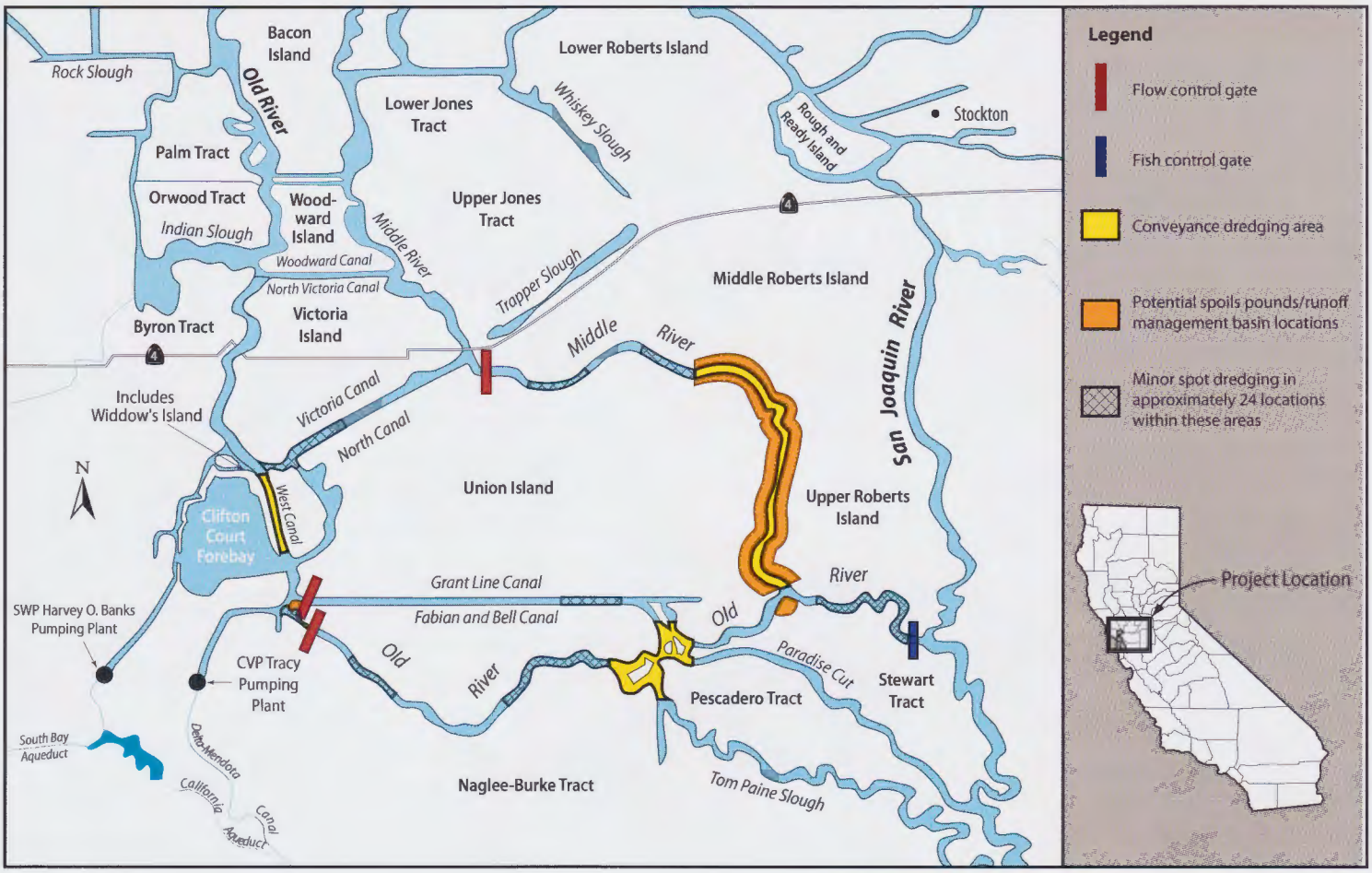
In the 1980s, DWR and the Bureau of Reclamation began formulating a program that included four permanent, fully operable barriers to replace the temporary structures of south Delta improvements.

DWR and Reclamation originally planned for this program to be implemented in advance of the long-term solutions to be developed by the CALFED Bay-Delta Program. However, to avoid any incompatibility between the permanent south Delta program and the long-term CALFED process and to advance other actions proposed by CALFED for early implementation, the permanent south Delta program has been adopted as a part of the CALFED (now known as California Bay-Delta Authority) process.

The reformulated program is known as the South Delta Improvements Program (SDIP). SDIP goals include providing for more reliable long-term export capability by the State and federal water projects, protecting local diversions, and reducing impacts



South Delta channels



Map showing the location of South Delta in California, as well as the locations of the preferred physical/structural components of the South Delta Improvements Program

on San Joaquin River salmon. Specifically, the Authority-approved actions in the South Delta Improvements Program include the possible placement of a fish barrier at the head of Old River, up to three hydraulic barriers in south Delta channels, dredging and extension of some agricultural diversions, and increasing diversion at Clifton Court Forebay when environmental conditions permit.

The Draft EIR/EIS was released to the public in November 2005. The decision process for the project has two stages. The first stage will decide on the physical component. The second stage will address changes in the diversion limit and will incorporate the new information regarding Delta fish.

What I See in Store for the Future of the SWP

BY WILLIAM R. GIANELLI
DWR DIRECTOR, 1967-73

William R. Gianelli served more than 30 years in a distinguished engineer career in public service, both in State and federal governments. He was appointed in 1967 to head DWR and oversee the building of the California State Water Project. Then, from 1981–84, Mr. Gianelli was appointed Assistant Secretary of the Army for Civil Works. Since 1984, he has been a private consultant in water resources. This article reflects Mr. Gianelli's views of key developments and future options of the SWP.

William R. Gianelli

When I left the DWR Director position in 1973, following the completion of the first phases of the SWP construction, we recognized that project features would have to be added from time to time if the Department was to deliver the amounts of water called for in its contracts with its 31 (now 29) contracting entities. As I recall, our studies indicated the Department would be approximately 800,000 acre-feet short of meeting its 4.2 million acre-feet contract amount obligations.

In order to meet that shortfall the Department was looking at the possibility of constructing additional storage on California's North Coast or additional offstream storage north or south of the Delta. It was also clear that some sort of a Delta transfer facility would be needed to reach the SWP Delta Pumping Plant.

What has happened in the intervening 27 years?

First of all, the Department estimated shortfall is probably at least twice the 800,000 acre-feet originally envisioned due to additional environmental constraints, fishery demands, and the provisions of the Endangered Species acts, none of which were in existence when the SWP was formulated.

The rivers of the North Coast have been declared to be Wild and Scenic Rivers, thereby essentially placing them out-of-bounds for SWP augmentations. After years of study DWR Director Bill Warne in 1966, under the authority granted to the Director under the Burns-Porter Act, designated and authorized the Peripheral Canal as the Delta Water Facility described under the Act. Both the subsequent Ronald Reagan and Jerry Brown administrations, and their DWR directors, endorsed this authorization.

Gianelli (left) shakes hands with Governor Ronald Reagan at the Lake Perris dedication, signifying the completion of the SWP's southernmost facility.

In 1982, funding for the canal was included in a multi-billion package of water projects. This legislation was rejected by the State electorate. An argument still exists as to whether the vote signalled nonsupport for the canal or whether the multi-billion package was too expensive for the electorate to approve. In the meantime, borrow (earth) from the Peripheral Canal's right-of-way was utilized to construct Interstate Highway 5 between Stockton and Sacramento under an agreement I entered into with the Director of Caltrans. Thus, part of the canal has been excavated.

While the Peripheral Canal has become extremely controversial and may not be constructed as originally envisioned, it is clear to me that either it or some other Delta transfer facility will need to be constructed if the State is going to meet its contractual obligations for supplying water to meet California's water needs.

In the mid-1990s several State and federal agencies joined together in the CALFED Bay-Delta Program aimed at developing a long-term solution to the problems of the Delta, many of which are unrelated to the problems of water transfer by the State and federal water projects. Thus far, the CALFED process seems to have spent more time addressing the ecosystem problems of the Delta than it has on the need for solutions to protect the water supply integrity of the SWP and the CVP.

In the meantime, with population projections of the State now estimated to reach 40 million people by 2010, and the majority of the growth occurring in the semi-arid central and southern portions of the State, it becomes imperative that a reliable source of water be secured for these areas in the near future.

The State Water Project can provide for much of this growth if the Department, aggressively supported by the State administration, is allowed to do those things which are necessary to protect the water supply and financial integrity of the Project, as envisioned when the Burns-Porter Act was passed 40 years ago.

It is clear to me that either [the Peripheral Canal] or some other Delta transfer facility will need to be constructed if the State is going to meet its contractual obligations for supplying water to meet California's water needs.

DELTA LEVEES

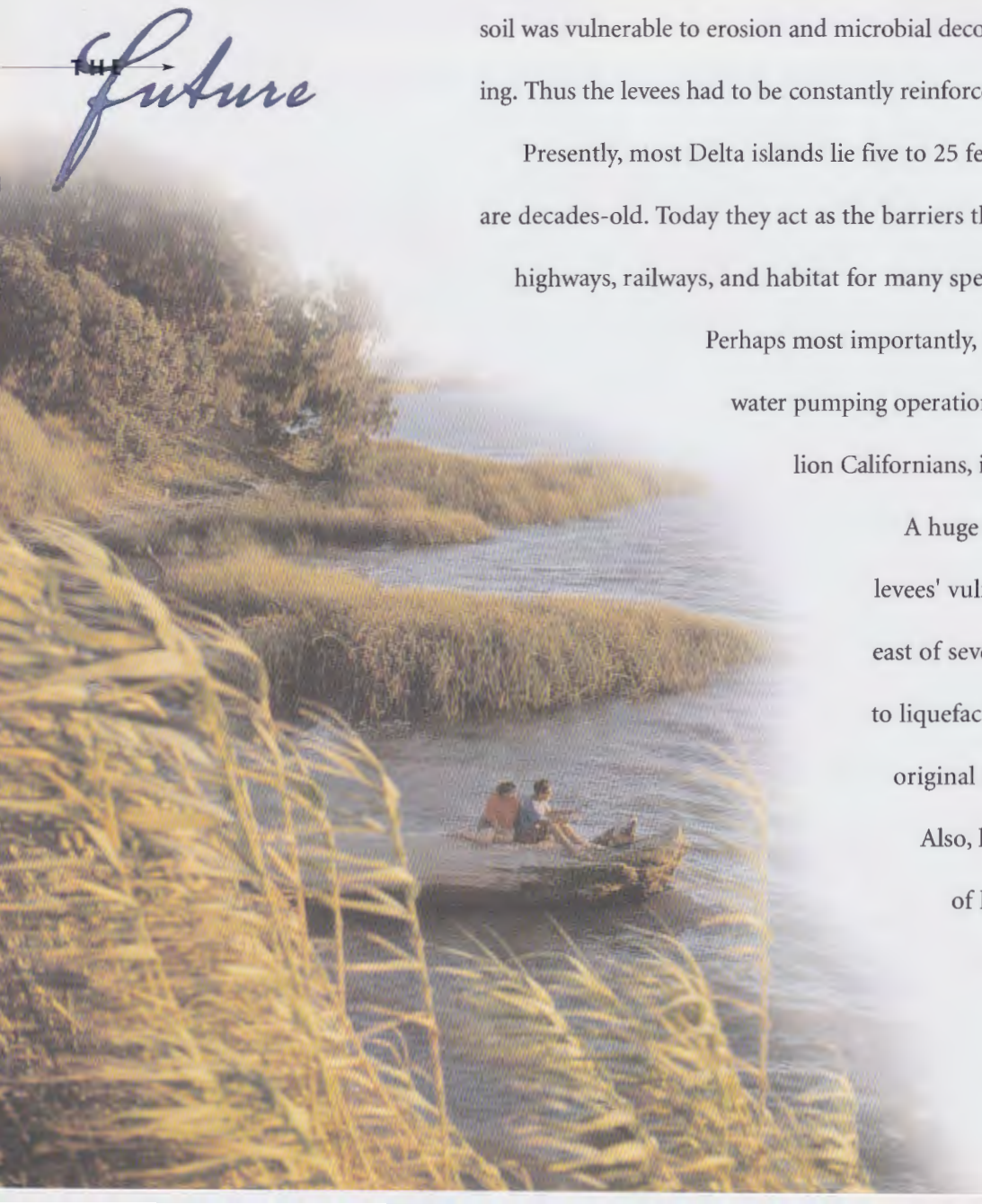
As the 49ers saw the promise of gold fade, some turned to farming for their livelihood. They found fertile lands in the region called the Sacramento-San Joaquin Delta, where fresh water from California's two largest rivers meets salt water from the Pacific Ocean.

Much of the Delta in the 1800s was marshy lands that lay below sea level. To reclaim the land, the farmers built levees made from the same soil they farmed. However the fertile peat soil was vulnerable to erosion and microbial decomposition, which was accelerated by farming. Thus the levees had to be constantly reinforced and the land itself began to subside.

Presently, most Delta islands lie five to 25 feet below sea level; many existing levees are decades-old. Today they act as the barriers that protect valuable farmland, utilities, highways, railways, and habitat for many species of wildlife and fish.

Perhaps most importantly, the Delta is the hub of State and federal water pumping operations that deliver water to more than 25 million Californians, industry, and agriculture.

A huge threat to this vital resource is the Delta levees' vulnerability to earthquakes. The Delta lies east of several active faults. Delta levees are subject to liquefaction, a state in which soil loses most of its original strength and liquefies during earthquakes. Also, levee maintenance, under the jurisdiction of local reclamation districts, remains a concern due to lack of funds.



A 300-foot wide levee break at the Jones Tract required around 200,000 to 215,000 tons of rock to fill. The breach allowed about 160,000 acre-feet of water to cover the 12,000-acre island to an average depth of about 12 feet.

After the 2005 Katrina Hurricane disaster in New Orleans, where levees failed after their foundations were undermined by seepage and liquefaction, California water agencies and legislators began to seriously focus on the Delta. The vulnerability of Delta levees had recently been demonstrated in June 2004, when an unexpected levee break flooded Jones Tract, destroying crops, houses, and equipment. The cost to repair the breach and pump out the island neared $100 million.

To emphasize the critical need for funding Delta levee repairs, DWR Director Lester Snow in late 2005 presented a scenario in which a 6.5 magnitude earthquake hits near the Delta's western edge. Thirty levee breaches occur; 16 islands are flooded; and 200 miles of levees are weakened with damage that could lead to more failures. In the first few days, 300 billion gallons of salt water flow into the Delta, and water exports cease. People, farmland, transportation, shipping, and utilities are interrupted.

The scenario predicts emergency response will be difficult. Levees will require at least 15 months of repair under the best conditions, leaving Southern California water agencies drawing down reserves, depleting groundwater basins, and calling for extreme conservation measures. A year later, more levees fail, efforts to close breaches are incomplete. Only a handful of islands are saved; the rest are abandoned.

SWP DEVELOPMENT TIMELINE

2000 Governor Gray Davis and U.S. Secretary of Interior Bruce Babbitt announces a framework agreement that outlines proposed plans by CALFED for a long-term fix for the Sacramento-San Joaquin Delta. It includes projects for ecosystem restoration, water quality, levee rehabilitation, and water supply reliability. The final Programmatic EIS/EIR is released in July, with the Record of Decision signed in August.

2001 Governor orders DWR to negotiate contracts and arrange for selling and buying of electricity to help the State mitigate for effects of power shortage. SWP is recognized by the American Society of Civil Engineers as one of the 20th century's greatest engineering achievements.

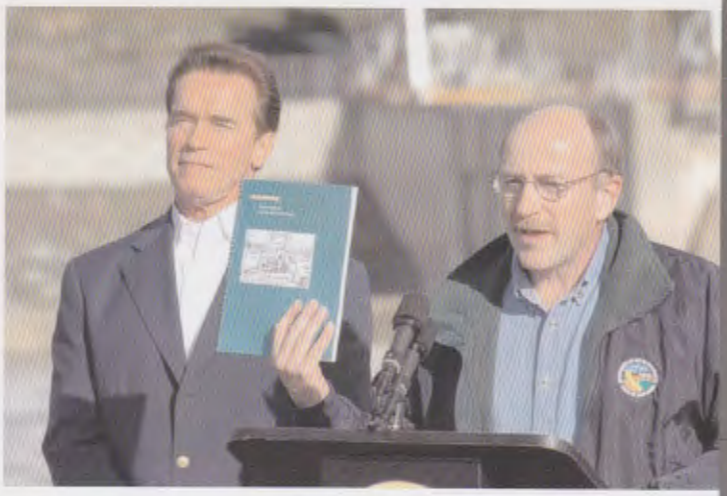
2004 Lester Snow is appointed DWR Director. Lake Oroville reaches full capacity for summer recreation.

Lester A. Snow

THE future

Long-term costs would include economic losses of up to $40 billion in the first five years, with job losses exceeding 30,000. Water delivery would be lessened and water treatment costs higher due to increased salinity and carbon content. Delta and state agriculture would be greatly impacted, as would businesses around the periphery of the Delta.

Responding to this potential threat and the need for a sustained investment approach to water management, Governor Schwarzenegger in his 2006 State of State proposed a Strategic Growth Plan that will invest $35 billion over the next 10 years to strengthen the flood management system, and provide safe, reliable water supplies for Californians. The Governor also declared a state of emergency for California levees to provide additional State resources to fast-track the repair of critical erosion sites that represent the gravest danger of catastrophic levee failure in the Central Valley flood system.



(left) Comprised of winding channels and island tracts, the Delta's existence depends on its levees. (right) At a 2006 press conference, Governor Arnold Schwarzenegger (l) and DWR Director Lester Snow discussed the necessity of increasing funds to improve the condition of existing levees in the Delta and the Central Valley.

SWP DEVELOPMENT TIMELINE

2004 DWR and U.S. Bureau of Reclamation (USBR) coordinate their efforts on levee break at Upper and Lower Jones Tracts. By end of year, levee repair and pump-out of tracts are completed at a cost of nearly $100 million.

2005 DWR submits an application for a new federal license to operate the SWP's Project 2100, the Oroville Facilities. DWR, with USBR, releases CALFED Bay-Delta Program Surface Storage Investigations progress report, which presents overview of findings and status of five storage investigations. Lake Perris is drawn down to repair its dam which could be damaged during an earthquake. Draft EIR/EIS reports released on South Delta Improvement Projects.

2006 Bulletin 160-2005 is released. Department works on bonds to provide funding for levee improvements in the Delta and Central Valley. DWR celebrates its 50th anniversary of State service.

THE future

Enlarging Los Vaqueros Reservoir in Contra Costa County is only one of the options being investigated to provide more surface storage to meet California's increasing water demands.

SURFACE STORAGE INVESTIGATIONS

Additional surface storage is needed to meet the needs of California's growing population and economy. If strategically located, it will provide much needed flexibility in the system to improve water quality and support fish restoration. The Department - in cooperation with local, regional, State and federal agencies, and stakeholders - is investigating the following surface storage options:

- **Shasta Enlargement**
  Assess the engineering and economic feasibility and the environmental impacts of enlarging Shasta Dam.
- **North-of-the-Delta Offstream Storage Investigation**
  Prepare engineering, economic, and environmental impact analyses to determine the feasibility of Sites Reservoir and various alternatives in accordance with the California Environmental Quality Act, the National Environmental Policy Act, and Section 404 of the Clean Water Act.
- **In-Delta Storage Program**
  Evaluate the Delta Wetlands project and other in-Delta Storage alternatives to improve water supply reliability, ecosystem benefits, and operational flexibility.
- **Los Vaqueros Enlargement**
  Investigate the feasibility of enlarging Los Vaqueros Reservoir and project alternatives to improve water supply reliability. Coordinate with the Bay Area Blending/Exchange Project to address several potential programs, in addition to the Los Vaqueros Enlargement, to enable Bay Area water agencies to work cooperatively to address regional water quality and supply reliability concerns on a mutually beneficial basis.
- **Upper San Joaquin Storage**
  Evaluate additional storage options in the upper San Joaquin River watershed for water supply reliability and ecosystem benefits.

For more information,
visit http://www.storage.water.ca.gov/index.cfm


"The beauty of water is often
transcended by its necessity."

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