

CALFED

**TECHNICAL REPORT
AFFECTED ENVIRONMENT**

URBAN RESOURCES

**Including Urban Land Use, M&I Water Supply Economics,
and Utilities and Public Services**

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LIST OF ACRONYMS

BCDC	San Francisco Bay Conservation and Development Commission
CALFED	CALFED Bay-Delta Program
CCWD	Contra Costa Water District
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D	Decision
Delta	Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
ECCID	East Contra Costa Irrigation District
EPA	U.S. Environmental Protection Agency
KCWA	Kern County Water Agency
M&I	municipal and industrial
mgd	million gallons per day
MWD	Metropolitan Water District of Southern California
NCFCWCD	Napa County Flood Control and Water Conservation District
NEPA	National Environmental Policy Act
PFMC	Pacific Fishery Management Council
ppm	parts per million
Protection Plan	Suisun Marsh Protection Plan
Reclamation	U.S. Bureau of Reclamation
RWQCB	Regional Water Quality Control Board
SBCFCWCD	Santa Barbara County Flood Control and Water Conservation District
SCFCWCD	Solano County Flood Control and Water Conservation District
SCVWD	Santa Clara Valley Water District
SWP	State Water Project
SWRCB	State Water Resources Control Board

URBAN RESOURCES

INTRODUCTION

This technical report describes the affected environment for resources associated with municipal and industrial (M&I) water supply economics, urban land use, and utilities and public services. The report focuses on characteristics of these resources that could be affected by implementation of the CALFED Bay-Delta Program (CALFED).

Several assessment variables have been identified to provide ways of measuring and comparing the potential effects of the proposed and alternative CALFED actions on M&I water costs and economics. The key assessment variables are:

- Water supply and shortage costs,
- Water treatment and other water quality costs, and
- Water conservation costs.

This technical report also discusses land use in developed, urban areas. Developed lands are those designated for various types of urban development. Principal types of developed uses include residential, commercial, light industrial, and industrial lands; and transportation facilities.

Lastly, this technical report discusses utilities and public services, including power infrastructure (e.g., electricity and gas lines) and public safety services, such as fire and police.

SOURCES OF INFORMATION

M&I Water Supply Economics

The primary sources of data used in this description were provided by the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation). DWR's Bulletin 166-4 (1994a), *Urban Water Use in California*, provides detailed information on water use for individual providers and is used as the primary source of information on historical and current M&I water use.

Bulletin 160-93, *The California Water Plan Update* (1994b), provides population data and regional-level estimates of water demand and supply. Data on M&I deliveries of the Central Valley Project (CVP) and the State Water Project (SWP) are from Reclamation's 1996 *Municipal and Industrial Full-Cost Water Rates* and from DWR's Bulletin 132-93, *Management of the California State Water Project* (1994c), respectively.

These sources have been supplemented with data supplied by individual providers concerning their water rates and water supply plans. Some providers have supplied recent water supply studies and other relevant documents. In general, little data are available for small providers and residential use outside defined water districts. For the South Coast region, additional information is obtained from Metropolitan Water District of Southern California's (MWD's) *Integrated Resources Plan* (1996), and information about water quality problems was obtained from MWD's *Salinity Management Study Phase 1 Progress Report* (Bookman Edmonston Engineering 1997).

Urban Land Use

Information for urban land use was compiled from a variety of sources, including DWR's *California Water Plan Update* (1994b); existing technical studies; county General Plans; and personal communications with offices of the state, regional councils of government, and counties.

Utilities and Public Services

Utility documents from Pacific Gas and Electric and the Western Area Power Administration were used in addition to the personal communications. Local public services providers were also consulted.

ENVIRONMENTAL SETTING

Regulatory Context

M&I WATER SUPPLY ECONOMICS

Water rights define the terms and conditions of M&I water use. Water rights are a right of use, not ownership; and are subject to changing regulations that condition the timing, quantity, place, and type of use. Water diversions from the Delta are allowed under riparian or appropriative water rights. Riparian landowners have a right to divert a portion of the natural flow for reasonable and beneficial use on the owner's land within the watershed.

In case of water shortage, users must share in the available supply according to each owner's reasonable requirements and uses (Jones & Stokes Associates 1995). Appropriative water rights are based on a history of beneficial use

rather than location adjacent to the water supply. Appropriative rights established after 1914 require a permit from the State Water Resources Control Board (SWRCB) (Thomas 1992).

Diversion and storage by the CVP are allowed under appropriative rights. Permits for CVP were first issued in 1958 (Decision [D]-893), and permits for SWP were issued in 1967 (D-1275 and D-1291). The Delta Protection Act of 1959 declared that the maintenance of an adequate water supply for urban use and for export to water-deficient areas, among other uses, was necessary. D-1485, adopted by SWRCB in 1978, required SWP and CVP to meet Delta water quality standards. D-1630 was proposed in 1992 but withdrawn, and Delta export operations have been guided recently by D-1485; the Endangered Species Act; the Bay-Delta Agreement of December 15, 1994; the Coordinated Operations Agreement between SWP and CVP; and the Central Valley Project Improvement Act (CVPIA) of 1992.

The SWP is involved in several initiatives that may affect SWP M&I water supplies. In particular, the Monterey Agreement will (1) allow water to be allocated in proportion to each contractor's share of entitlements with no initial reduction in agricultural supplies, (2) retire 45,000 acre-feet of agricultural entitlement, (3) transfer 130,000 acre-feet of entitlement from agricultural to urban contractors by willing sale, (4) transfer control of the Kern Fan Element to designated agricultural contractors, and (5) change the way in which Castaic Lake and Lake Perris may be operated.

M&I water providers are also subject to laws involving water quality. California's Porter-Cologne Water Quality Control Act requires the adoption of water quality control plans by nine Regional Water Quality Control Boards (RWQCBs). The plans are subject to approval by the SWRCB and the U.S. Environmental Protection Agency (EPA). Anyone who discharges or proposes to discharge waste must

file a report for approval of applicable permits by appropriate RWQCBs.

The 1974 Federal Safe Drinking Water Act (Act) requires EPA to set national standards for drinking water quality. The 1986 amendments set deadlines for standards for specific contaminants; increased the number of contaminants that must be monitored; and strengthened enforcement, groundwater, and technical assistance programs. The Act allows states to set and enforce their own standards, as long as the state's standards are at least as protective as the federal standards. The 1996 amendments reform the standard-setting process used by EPA, require EPA to work with states to develop source-water assessment programs, and establish a state revolving loan fund. California's Safe Drinking Water Act of 1976 requires the State Department of Health Services to administer the state law. The standards are described in the California Code of Regulations, Title 22.

URBAN LAND USE

Land use planning in California is governed principally through the following state laws (references are to the Government Code unless otherwise noted):

- establishment of planning agencies, commissions, and departments (65100 et seq.);
- general plans and specific plans (65300 et seq.);
- zoning regulations (65800 et seq.);
- Subdivision Map Act (66410 et seq.); and
- California Environmental Quality Act (Public Resources Code 21000 et seq.).

Both the State and local planning jurisdictions govern land in the study area. The California

State Legislature passed laws resulting in state policy that guides land uses, and local jurisdictions govern land use through general plans and the development review process. Several state and federal agencies also have jurisdiction for certain resources, such as water quality and biological resources.

The California State Legislature passed the Delta Protection Act of 1992, which created the Delta Protection Commission to provide regional coordination of the Delta. The Commission developed the long-term *Land Use and Resource Management Plan for the Primary Zone of the Delta* (Delta Protection Commission 1995).

The California State Legislature recognized the threat of urbanization to the Suisun Marsh and enacted the Suisun Marsh Preservation Act in 1974 which required that a protection plan be developed for the marsh. The act directed the San Francisco Bay Conservation and Development Commission (BCDC) and the California Department of Fish and Game (DFG) to prepare the Suisun Marsh Protection Plan (Protection Plan) "to preserve the integrity and assure continued wildlife use" of the Suisun Marsh.

All Regions

M&I WATER SUPPLY ECONOMICS

For the purposes of economics, the specific groups of affected persons must be described. The term "provider" includes all persons having a direct economic stake in the water supply and costs of the provider. End-users of water, shareholders in private water utilities, and any public or private interests who pay any part of the costs or receive the benefits of water services qualify.

The providers may be affected by CALFED actions in many ways. For example, any Delta M&I provider may be affected by CALFED actions that directly or indirectly affect land use. M&I water supply economics is concerned only with CALFED actions that may affect M&I provider water supplies or costs, including costs of potable water treatment.

URBAN LAND USE

Land use in the study area is discussed by region. Urban land use acreages for all CALFED regions are shown in Table 1.

Region	Approximate Acres of Urban Development in Region	Percent of Region
Delta Region	71,330	8
Bay Region	655,600	2
Sacramento River Region	862,720	4
San Joaquin River Region	471,600	2
SWP and CVP Service Areas Outside the Central Valley	2,200,000	12
Total for Study Area	4,261,250	

SOURCES:
DWR 1991, 1994b, and 1994d.

Table 1. Urban Land Use in All Regions

UTILITIES AND PUBLIC SERVICES

Most water conveyance facilities have been developed under the authority of the federal

government's Central Valley Project (CVP) and California's State Water Project (SWP). CVP facilities, operated under Reclamation Law and the authorizing legislation, were initially authorized under the Reclamation Act of 1902 as projects solely for irrigation and reclamation purposes. The law was amended in 1906 to include power as a potential purpose of authorized projects.

Today the CVP includes 20 reservoirs, 500 miles of canals, and other facilities. Its primary purpose is to provide water for irrigation throughout California's Central Valley, although it also provides flood control, urban water supply, power generation, recreation facilities, and fish and wildlife enhancement.

Existing CVP facilities provide temporary or supplemental water supplies to about 3 million acres of agricultural land in the Sacramento and San Joaquin valleys. Additionally, domestic, industrial, and municipal needs are met by these facilities. Figure 1 presents the major features of the SWP and CVP.

The SWP system, development of which began in the 1960s, consists of 22 reservoirs, 17 pumping plants, 8 hydroelectric power plants, and 550 miles of aqueducts and pipelines. Using rivers and a system of canals and pipelines, water is transported from storage facilities to the Bay area, San Joaquin Valley, and southern California for agricultural, municipal, and industrial uses. Primary storage facilities are located at Oroville on the Feather River. Additional storage exists at other southern California sites along the aqueduct and is developed from surplus flows in the Bay Delta.

Some infrastructure was developed to be used jointly by the CVP and SWP. Some of the more predominant facilities include San Luis Reservoir, O'Neill Forebay, more than 100 miles of the California Aqueduct, and related pumping facilities. This infrastructure is used to convey, store, and distribute water to state and federal service areas.

The California electric power system consists of generating plants, transmission lines, and local distribution systems. The transmission system is a network of lines providing multiple paths from electricity suppliers (generators) to load centers (distribution substations). Customers are connected to substations by distribution lines.

Numerous technologies are employed to generate power: gas/oil/coal-fired, geothermal, wind, solar, organic matter, and hydroelectric. Out of 550 investor and public-owned generating plants in the state, 250 are thermal plants and 300 are hydroelectric facilities. However, only four of the hydroelectric facilities have a generating capacity over 500 megawatts (MW); one megawatt is enough energy to power 1,000 average California homes per day. Power plants associated with the CVP are presented in Figure 1.

State-wide water storage and conveyance is directly tied to power generation and distribution. Although the SWP annually produces about 5.5 billion kilowatt-hours (kWh) in hydropower, it consumes nearly 13 billion kWh; great quantities of electricity are needed to transport and pump water over hilly terrain. Energy to meet the deficit is purchased from other utilities. Presently, annual SWP energy requirements are about 8 billion kWh by the year 2000 they are expected to reach nearly 11 billion kWh.

More than half of the natural gas used in California (about 57% in 1994) is imported into the state through interstate pipelines. In-state gas supplies (storage areas) are concentrated in the north Bay Delta/Sacramento valley and Los Angeles areas.

Because gas is used to generate power, it is also tied to state-wide water storage and conveyance. In fact, gas is the most widely used fuel (for generating electricity) and is relatively clean-burning and inexpensive compared to other fossil fuels. It is used to generate about one-third of California's electricity each year, although this value varies according to the

amount of hydroelectric generation and other variables.

Delta Region

The Delta Region is defined as the service areas of Delta M&I providers, including the cities of Pittsburg, Antioch, Tracy, Brentwood, Isleton, parts of Stockton and Sacramento, and a variety of small communities and residential users located around the Delta.

HISTORICAL PERSPECTIVE

URBAN LAND USE

The human history of the Delta is characterized by changing cultures, economy, and population patterns. At the time Europeans first arrived, most of the Delta was inhabited by Miwok Indians. The early economy was largely fur trade. In the mid-1800s, steamboats and the gold rush increased commerce between San Francisco and Sacramento. Sedimentation from hydraulic mining had largely curtailed deep draft navigation by 1890. Settlement of the Delta for agriculture and fisheries also increased during this period, and the advent of power dredges and more permanent reclamation led to permanent settlements. Flooding, siltation, and loss of commercial fisheries led to the abandonment of a number of Delta settlements over time (California State Lands Commission 1991).

Accounts of urban land development (urban acreage calculations) in California were not recorded and, therefore, are not readily available prior to 1920. In general, urban development in the Central Valley began during the same period, following construction of the railroads when the San Francisco Bay and southern California geographic regions were developing into urban centers.

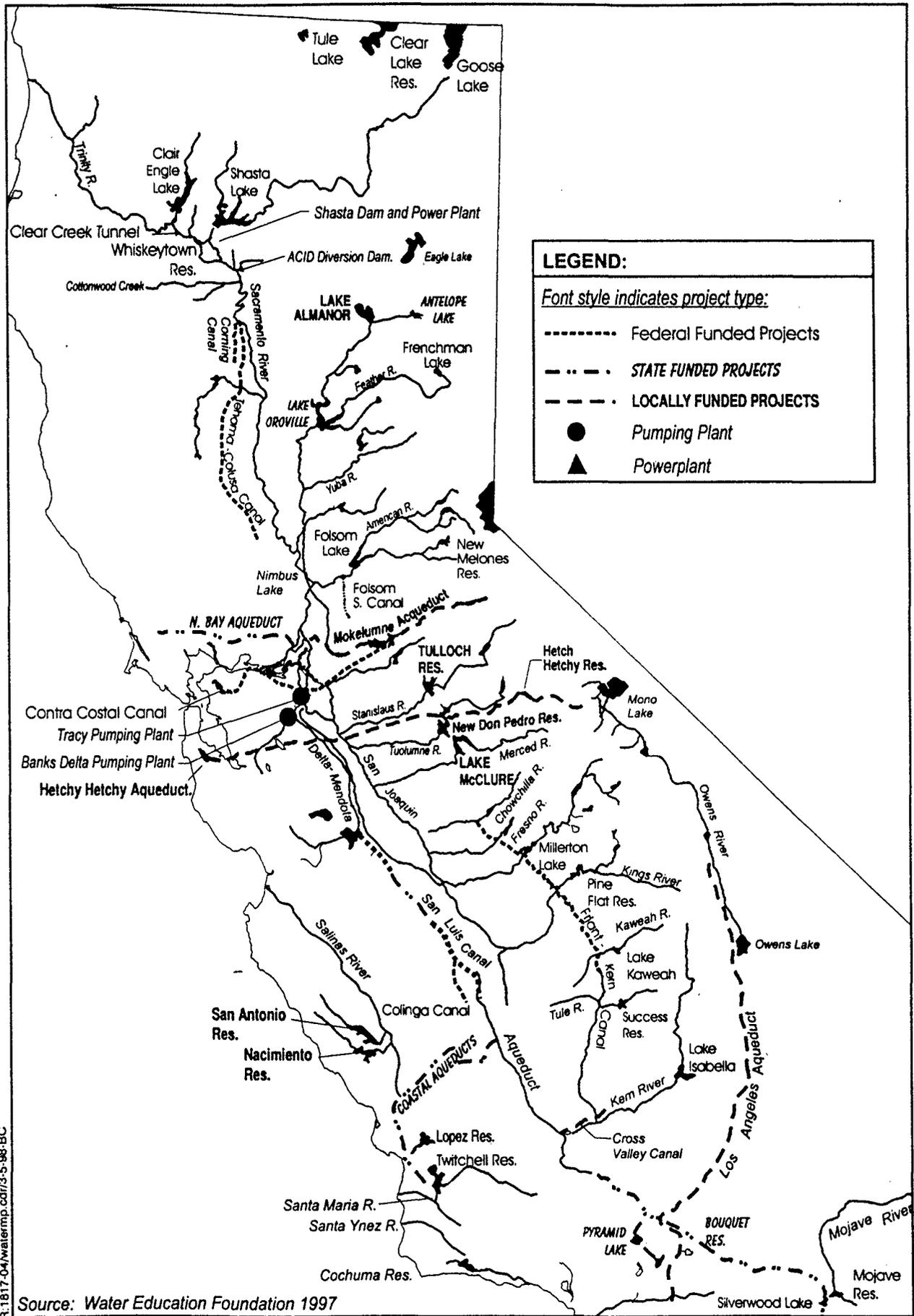


Figure 1 Major Features of the Central Valley Project and State Water Project

Between 1920 and 1950, urban land use expanded. Private water development projects by cities and utility districts assisted in the expansion of urban development throughout California.

The expansion of urban areas has continued since 1950. However, more recently, urban development has begun encroaching on agricultural land and reducing the total amount of agricultural land in the Delta.

Between 1976 and 1993, the areas where large acreages of agricultural land were reclassified to urban lands were the Brentwood and Oakley area in Contra Costa County, the Pocket area in Sacramento County adjacent to the Sacramento River, the West Sacramento area in Yolo County, and the Stockton and Tracy areas in San Joaquin County.

Between 1976 and 1993, urban land in the legal Delta increased by approximately 22,700 acres, again with the majority occurring in the Delta Secondary Zone. In 1993, there were about 44,400 acres of land classified as urban land and 83,000 acres classified as native land in the legal Delta the majority of which were located in the Delta Secondary Zone and Delta Primary Zone, respectively. Since 1976, approximately 12,000 acres of native land, mostly in the Secondary Zone, was lost in the legal Delta (DWR 1993b). Table 2 summarizes the land use acreage changes between 1976 and 1993.

Land Use	1976	1993	Net Change
Agriculture	541,820	527,309	-14,511
Urban	44,474	67,219	+22,745
Open Space	95,021	82,846	-12,175
Water Surface	57,178	61,119	+3,941

SOURCE:
DWR 1993b.

Table 2. Land Use Acreage Changes Between 1976 and 1993 in the Legal Delta

Much of the residential development in the Delta is now part of the Sacramento and Stockton metropolitan areas, and other towns and developments provide housing for Central Valley or coastal city commuters. Until recently, most urbanization in California occurred near the coastal cities. In the last decade, there has been a relative shift in new development from the coast to more inland locations such as the Delta.

M&I WATER SUPPLY ECONOMICS

The Delta Region is defined as the service areas of Delta M&I providers, including the Cities of Pittsburg, Antioch, Tracy, Brentwood, Isleton, parts of Stockton and Sacramento, and a variety of small communities and residential users located around the Delta.

In the study area, the extensive levee system, constructed waterways (Contra Costa Canal, Stockton Deep Water Channel), water development facilities, groundwater development, and railroads enabled irrigated agriculture and urban communities to extend deeper into the Delta. Between 1920 and 1950, irrigated agriculture development increased rapidly from 2.7 million acres to more than 4.7 million acres for the entire Central Valley. The expansion of irrigated agriculture and urban growth has continued since 1950. Increased water development projects, such as CVP and SWP, in addition to local water projects, secured more dependable water supplies for the Central Valley and Southern California regions.

Much of the residential development in the Delta is now part of the Sacramento and Stockton metropolitan areas, and other towns and developments provide housing for Central Valley or coastal city commuters. Until recently, most urbanization in California occurred near the coastal cities. In the last decade, there has been a relative shift in new development from the coast to more inland locations such as the Delta. Areas that were once suburbs developed their own service industries, and the jobs created there make commuting from inland locations a feasible

proposition. Total M&I water use in the Delta has increased over time with the increase in population. Figure 2 shows population trends for some Delta M&I providers.

Utilities and Public Services

The Delta's proximity to populated cities, its natural resources (mainly agricultural land, gas, and water), and its relatively flat terrain has facilitated development of major infrastructure: water conveyance facilities and electricity transmission lines, and natural gas fields, pipelines, and storage areas.

Concurrently, the region—combined with the central Sierra area—has grown into the central hub of major state and federal water development facilities that divert water from Delta channels to meet the needs of about two-thirds of the state's population and to irrigate 4.5 million acres.

Water Supply and Related Infrastructure: Plans for the CVP were developed during the early 1930s when the state completed studies regarding the transfer of northern California water to other parts of the Central Valley. Some of the first projects were developed in the Delta region. As part of CVP development, exportation of water began in 1940 with the completion of the first unit of the CVP, the Contra Costa Canal. Other major federal units were completed during the early 1950s, and included completion of the Delta Mendota Canal and construction of the Delta Cross Channel. This canal transfers water across the Delta from the Sacramento River to the Tracy pumping plant, which serves the Delta Mendota canal. Additionally, numerous SWP facilities have been developed in the Delta: Harvey O. Banks Delta Pumping Plant, the California Aqueduct, and the North Bay Aqueduct.

Electric Utility Infrastructure: Power transmission facilities have developed parallel to the population growth of various communities surrounding the Delta, much of which was made possible by the exploitation of water resources. Pacific Gas and Electric

(PG&E) and the Western Area Power Administration (WAPA) have developed power transmission lines across Delta islands and waterways.

Natural Gas Infrastructure: Natural gas was discovered in the Delta region in 1935. Since the 1940s, it has been developed into a significant source supply and depot for underground storage.

CURRENT RESOURCE CONDITIONS

URBAN LAND USE

Approximately 71,000 acres in the Delta Region are developed for urban uses, with most of the development located on the periphery of the Delta Region in Sacramento, San Joaquin, and Contra Costa Counties. The majority of urban development is located in the legal Delta, with less than 1,800 acres of developed land in the Suisun Marsh and Bay Area. Urban development includes residential, commercial, industrial, and other urban uses. Table 3 summarizes the types and amount of urban development in the Delta Region.

Urban Development Type	Approximate Acres in Region (%)
Residential (one- and two-family units including trailer courts)	4,830 (0.6%)
Commercial (retailers, hotels, apartments, institutions)	1,660 (0.2%)
Industrial (manufacturing, extractive industries, sewage treatment plants)	6,340 (0.7%)
Other (freeways, airports, cemeteries, vacant land, undefined urban development)	58,510 (6.8%)

SOURCES:
DWR 1991, 1994d.

Table 3 . Developed Lands in the Delta Region

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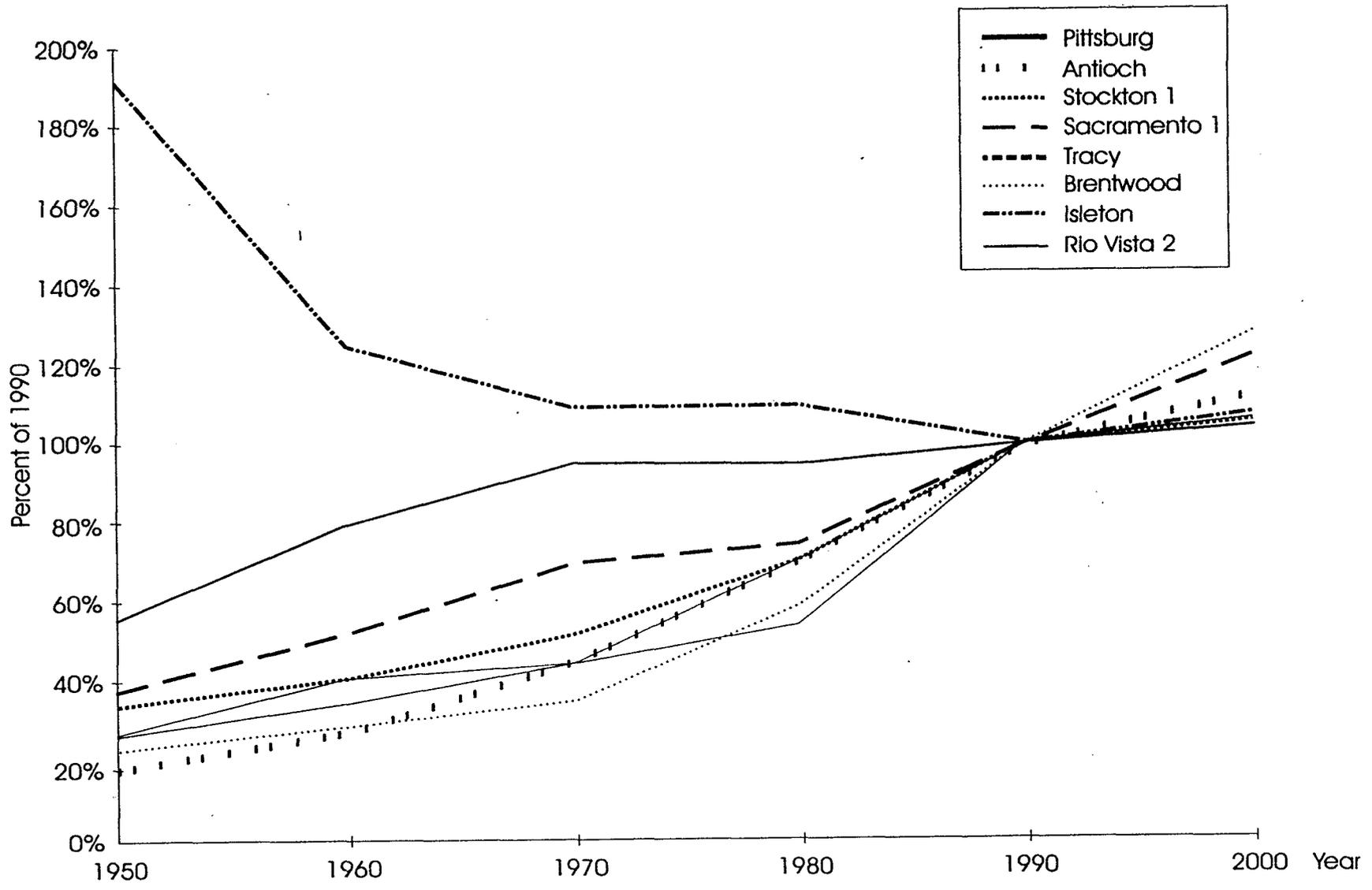


Figure 2. Population Trend for Some Delta Region M&I Providers as a Percentage of 1990 Population

Much of the urban development in the Delta Region is located in the incorporated cities, (Antioch, Brentwood, Isleton, Pittsburg, Rio Vista, and Tracy are located entirely within the Delta; Sacramento, Stockton, and West Sacramento are located partially within the legal Delta), and the 14 unincorporated communities within the legal Delta (Discovery Bay, Oakley, Bethel, Courtland, Freeport, Hood, Ryde, Walnut Grove, Byron, Terminous, Thornton, Hastings Tract, and Clarksburg) (DWR 1993a).

M&I WATER SUPPLY ECONOMICS

The Delta M&I providers include the cities of Pittsburg, Antioch, Tracy, Brentwood, Isleton, parts of Stockton and Sacramento, and a variety of small communities and residential users located around the Delta.

Table 4 shows population, water use, and cost data from DWR (1994a) for some major Delta providers. Industrial use occurs within the service areas of these providers, and a few large industrial users divert a significant share of total M&I use within the Delta. Figure 3 shows 1980 to 1990 use by the Delta providers as a percentage of 1990 use.

Costs of existing and additional water supplies for Delta providers differ substantially, depending on existing and potential sources of water. Existing raw water costs for CCWD are influenced by CVP rate-setting policies and the CVPIA. The 1996 CVP contract rate was \$32.35 per acre-foot. Water costs to wholesale buyers and at the retail level also are being affected by the Los Vaqueros Reservoir Project. In the future, new water costs probably will be affected by water reclamation and water transfer costs. Water costs near Sacramento and Stockton also are affected by CVP policies. In many locations, raw water costs will be affected by groundwater development and extraction costs.

The 1996 CVP contract rate for Tracy was \$37.02 per acre-foot (Reclamation 1996). In 1992, the City of Tracy filed a water rights

application with SWRCB to divert water from the Delta in the vicinity of the Westside Irrigation District pump station on Wicklund Road (Bayley pers. comm.). The City also may propose to convert existing agricultural rights to M&I uses as the land is developed, and may propose to have both of these supplies wheeled through the Delta-Mendota Canal to its water treatment plant.

UTILITIES AND PUBLIC SERVICES

Water Supply and Related Infrastructure:

Water conveyance infrastructure consists of a multitude of agricultural, industrial, and municipal diversions for supplying water to the Delta itself and for export by the SWP and CVP. Diversions and conveyance require canals, waterways, levees, siphons, pumps, radial gates, and other miscellaneous infrastructure. Delta agricultural water users divert directly from the channels, using more than 1,800 unscreened pumps and siphons, which vary from 4 to 30 inches in diameter, and with flow rates of 4 to about 200 cubic feet per second (cfs). Total diversions vary between 2,500 and 5,000 cfs during April through August, with maximum rates in July.

Municipal and industrial demands are met by conveying water through the Contra Costa Canal to the cities of Martinez, Antioch, and Pittsburg and to numerous industrial complexes in the vicinity.

The City of Sacramento serves water to a section of the city within the Delta. Much of this area is commonly known as "the pocket" because of its location within a bend of the Sacramento River east of Interstate 5. The Delta also includes part of South Sacramento. The city provides water from the Sacramento and American rivers and from groundwater. The city does not divert surface water from within the Delta Region.

Provider	Current Population	Population (1990)	Water into System (1990 mg)	Water into System (1990 af)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	Average Cost (\$/af)
Pittsburg	50,400	47,564	3,066	9,411	12,313	176	100	99	100	\$952
Antioch	69,500	62,195	3,823	11,734	18,801	168	64	100	100	\$702
Stockton ^a	226,300	210,943	17,130	52,578	64,179	183	52	100	52	\$311
Sacramento ^a	391,100	369,365	37,157	114,048	111,785	272	0	3	95	\$165
Tracy	40,500	33,000	3,345	10,267	9,964	270	42	100	42	\$485
Brentwood	9,675	7,563	532	1,633	2,278	193	0	100	0	N/A
Isleton	870	833	83	255	353	273	0	100	0	N/A
Rio Vista ^b	N/A	3,316	370	1,136	1,403	306	0	14	0	N/A

NOTES:

mgd = Million gallons per day.
N/A = Not Available

^a Only part of the provider is located within the statutory Delta.
^b Borders the statutory Delta.

SOURCES:
DWR 1993a, 1994a, 1994b

Table 4. Characteristics of Some Delta Region M&I Providers

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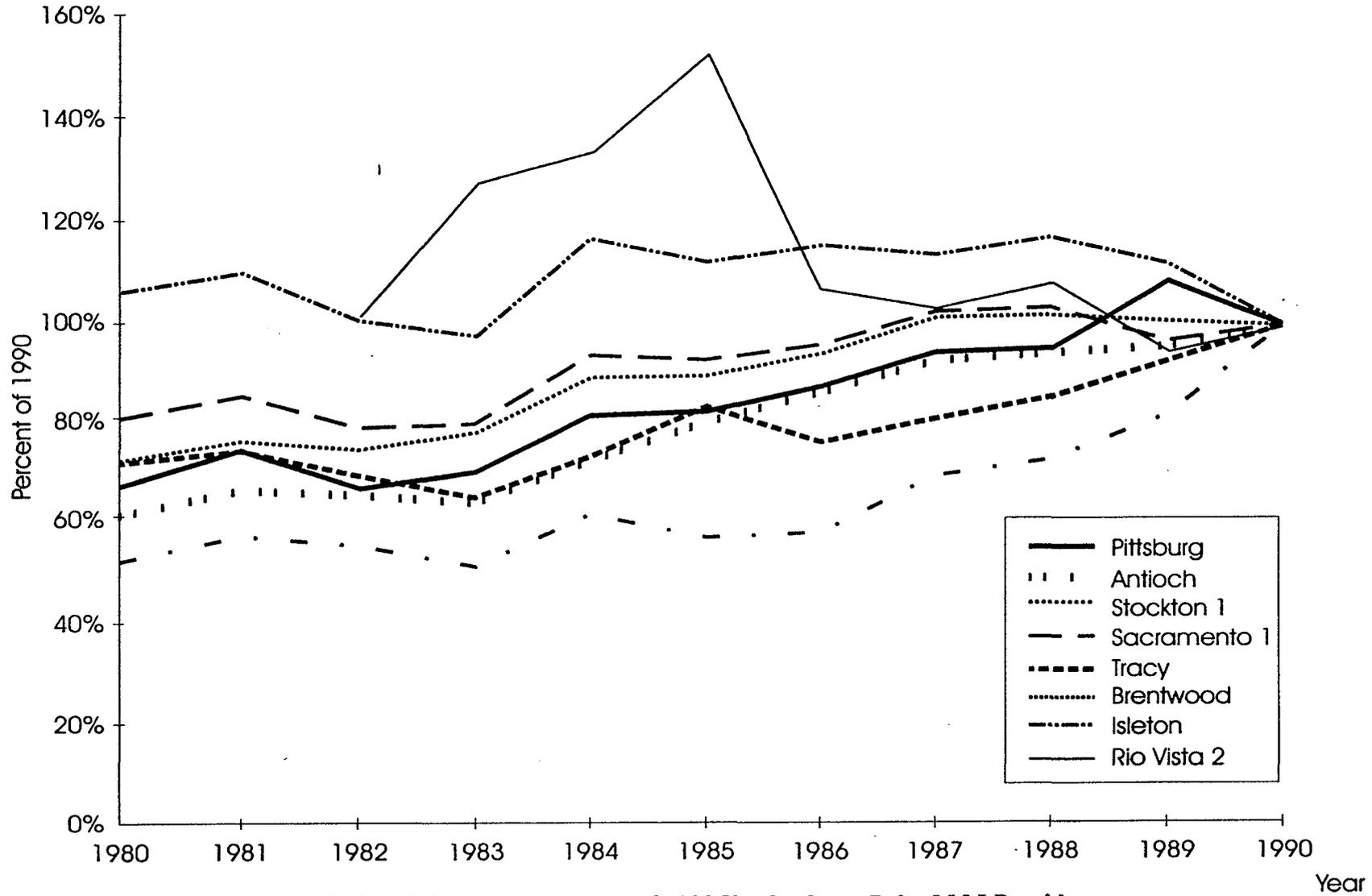


Figure 3. 1980 to 1990 M&I Use as a Percentage of 1990 Use for Some Delta M&I Providers

West Sacramento serves M&I uses west of the Sacramento River and within the Delta. Data for West Sacramento are not available. Surface water and groundwater are used. Approximately 9,700 acre-feet were diverted into the system in 1995, of which approximately 9,000 acre-feet were surface water (Houston pers. comm.). Surface water is taken from the Sacramento River under water rights and a CVP contract at a point within the Delta just north of Interstate 80.

The City of Stockton is served by three purveyors: the California Water Service Company, the City of Stockton, and San Joaquin County. Each of these agencies serves parts of the Delta. The only direct diversion of water from the Delta is for several golf courses and small landscape uses. Most M&I water is from groundwater, from the Calaveras River through Stockton East Water District, and from the Stanislaus River through CVP. The share of supplies provided by surface water and groundwater varies according to hydrologic conditions. The city supplies a small parcel within the Delta with reclaimed water.

The City of Stockton has submitted an application to SWRCB to divert up to 45,000 acre-feet annually from the San Joaquin River downstream of its existing wastewater treatment plant. The diversion would recover "an amount of water equal to that discharged into the San Joaquin River at the City's Regional Waste Water Control Plant..." (City of Stockton 1996). The additional water would be brought into the city for treatment or would be provided to agriculture in exchange for groundwater currently used for agriculture.

Contra Costa Water District (CCWD) serves lands within and outside the legal Delta in Contra Costa County. CCWD currently provides municipal water within the Delta for the Cities of Antioch and Pittsburg, and in Oakley Water District. Most of CCWD's water is obtained through a 195,00-acre-foot contract for CVP water, which is pumped from the Delta into the Contra Costa Canal from Rock Slough. CCWD can also pump up to 26,700 acre-feet annually from Mallard Slough and has agreed to

use up to 21,000 acre-feet per year of East Contra Costa Irrigation District (ECCID) water to serve M&I demands within ECCID.

CCWD operates two water treatment facilities: The Ralph D. Bollman Treatment Plant began operations in 1968 and can treat 90 to 100 million gallons per day (mgd); the Randall-Bold Water Treatment Plant began operations in 1992. The Los Vaqueros Reservoir Project will improve the quality and reliability of CCWD's M&I supplies.

The City of Antioch obtains its supply from CCWD and from a separate Delta diversion under a 7,670-acre-foot right. The diversion and treatment facility can handle up to 8.3 mgd (9,300 af/year), but water quality limits that amount. The salinity of the water at the diversion determines when water will be diverted and, consequently, the share of the city's water provided by the diversion as opposed to that supplied by CCWD. Typically, diversion ceases when salinity reaches about 200 parts per million (ppm), but diversion may continue at higher salinity if water quality (as a function of the tidal cycle) is expected to improve. As suggested by Table 4, Antioch is able to supply about 35% of its water needs with this diversion.

The City of Brentwood currently relies on groundwater for its water supplies, but the city has an agreement with CCWD to acquire up to 7,000 acre-feet annually in the future. Some of this need will be met with the 21,000 acre-feet CCWD has agreed to distribute for ECCID.

Additional towns and communities in the Delta region not included in Table 3 or in the discussion above include Bethany, Bethel Island, Byron, Collinsville, Cortland, Discovery Bay, Four Corners, Freeport, Hood, Oakley, Ryde, San Joaquin City, Terminous, and Walnut Grove. Most of these towns are served by a larger provider, a small district, or individual groundwater wells. Oakley is served by Diablo Water District, which obtains raw water from CCWD. The City of Antioch is the purveyor for the Discovery Bay Area. Bethel Island

residential users are served by several small water districts.

Other industrial users in the Delta divert water under individual water rights. CCWD (1996b) lists the following industrial water users and their annual diversion right: Gaylord Container Corporation (28,000 acre-feet), El Dupont De Nemours & Co. (1,405 acre-feet), Tosco Corporation Lion Oil Division (16,650 acre-feet), and USS Posco (12,900 acre-feet). Dupont obtains most of its water needs through Diablo Water District. All of these users, except for Dupont, also obtain water through CCWD. Shell Oil also is an important industrial customer for CCWD, diverting about 10,000 acre-feet annually from the Contra Costa Canal. Total industrial water sales by CCWD ranged from 27,000 to 48,000 acre-feet between 1984 and 1993, accounting for about one-third of CCWD's raw water demand (CCWD 1996cb).

Electric Utility Infrastructure: PG&E and WAPA have a number of transmission lines in the region. As with many of the other infrastructure systems, most corridors lie within the periphery of the upland areas and avoid the central Delta. Power generating facilities are also absent from the central Delta, although several natural gas-fired plants are located on the Delta periphery.

Natural Gas Infrastructure: Gas fields, pipelines, underground storage areas, and related infrastructure are located in the Delta. Infrastructure consists mainly of pipelines and storage facilities owned by oil and gas companies such as Chevron, public utilities such as PG&E, and various independent leaseholders.

Recreational Resources: Miles of channels and sloughs provide recreational resources to a diverse and growing number of people. The presence of waterfowl and wildlife and unique aesthetic conditions attracts visitors. Motor boating and fishing are the leading activities, although overnight camping, swimming, picnicking, waterskiing, photography, hunting, and sailing are also popular. Recreational

resources are further described in the Recreational Resources Technical Report.

Public Services: Various departments within the cities and counties of the Delta Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

Bay Region

The Bay Region, for the purposes of this report, includes areas served by any of four facilities that export water from the Delta for M&I use: the Contra Costa Canal of the CVP, the San Felipe Division of the CVP, the North Bay Aqueduct of the SWP, and the South Bay Aqueduct of the SWP. In addition, some other areas are affected because of water exchanges that occur involving the Hetch-Hetchy and South Bay aqueducts.

HISTORICAL PERSPECTIVE

URBAN LAND USE

Prior to the 1940s, land uses in the Bay Region were principally urban in the city of San Francisco and rural in other portions of the region. Over the last 50 years, however, land uses throughout the region have become progressively more urbanized. Post-World War II urbanization in the metropolitan San Francisco area was the principal catalyst for this development, along with growth in the cities of Oakland and San Jose. Since the 1970s, the southern portion of the Bay Region has become a hub for companies providing high-technology products and services. Suburban sprawl, characterized by low-density residential and light manufacturing land uses, occupies much of the Bay Region outside the San Francisco area.

M & I WATER SUPPLY ECONOMICS

Early in the state's history, population growth along the coast outstripped the ability of the coast's small and seasonally dry watersheds to provide adequate water supplies. Urban providers built projects, such as Hetch-Hetchy, to bring water from more reliable supplies. Continued growth led to projects such as the SWP and CVP, which generally move water from the north and east to the south and west.

The Bay Region includes areas served by any of four facilities that export water from the Delta for M&I use: Contra Costa Canal and the San Felipe Division of the CVP; and the North Bay Aqueduct and the South Bay Aqueduct of the SWP. In addition, some other areas are affected because of water exchanges that occur involving the Hetch-Hetchy and South Bay aqueducts.

Figure 4 shows population in the Bay Region from 1963 to 1990 and projected population to 2000. The region's population increased from about 4.537 million in 1970 to 5.484 million in 1990, for an annual growth rate of 2.25%. The growth rate slowed between 1990 and 1995.

Per capita use has been affected by several trends. Increased real incomes and new water-using technologies increased per capita use. As urbanization spread eastward within the region, the warmer climate and increased average lot size increased average per capita use. More recently, urban water conservation measures have slowed these trends. Table 5 shows per capita water use in the Bay Region in 1968, 1980, and 1990. Since 1968, per capita use has increased slightly, probably due to new residential development in the warmer, more inland portions of the region.

CURRENT RESOURCE CONDITIONS

URBAN LAND USE

Land uses in the Bay Region are diverse, and include the Napa Valley and Sonoma County wine industry; international business and tourism in San Francisco; technological development and production in the Silicon Valley; and urban, suburban, and rural living. Urban land accounts for about 23% (655,600 acres) of the land area. Major urban areas include the San Francisco, Oakland, and San Jose metropolitan areas.

Year	All Uses
1990	193
1980	180
1968	179

SOURCES:
DWR 1994a.

Table 5. Per Capita per Day Water Use, San Francisco Bay Region, 1968 to 1990 (gallons)

M&I WATER SUPPLY ECONOMICS

The Bay Area currently relies on the CVP and SWP for about 30% of its urban water demands. Without the East Bay Municipal Utilities District (EBMUD), the share rises to about 40%. Table 6 shows recent imports into the region through CVP and SWP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. Most imported water is delivered through the Contra Costa Canal and the South Bay Aqueduct, with smaller shares delivered through the CVP's San Felipe Unit and the North Bay Aqueduct. Table 7 shows characteristics of some Bay Area M&I providers.

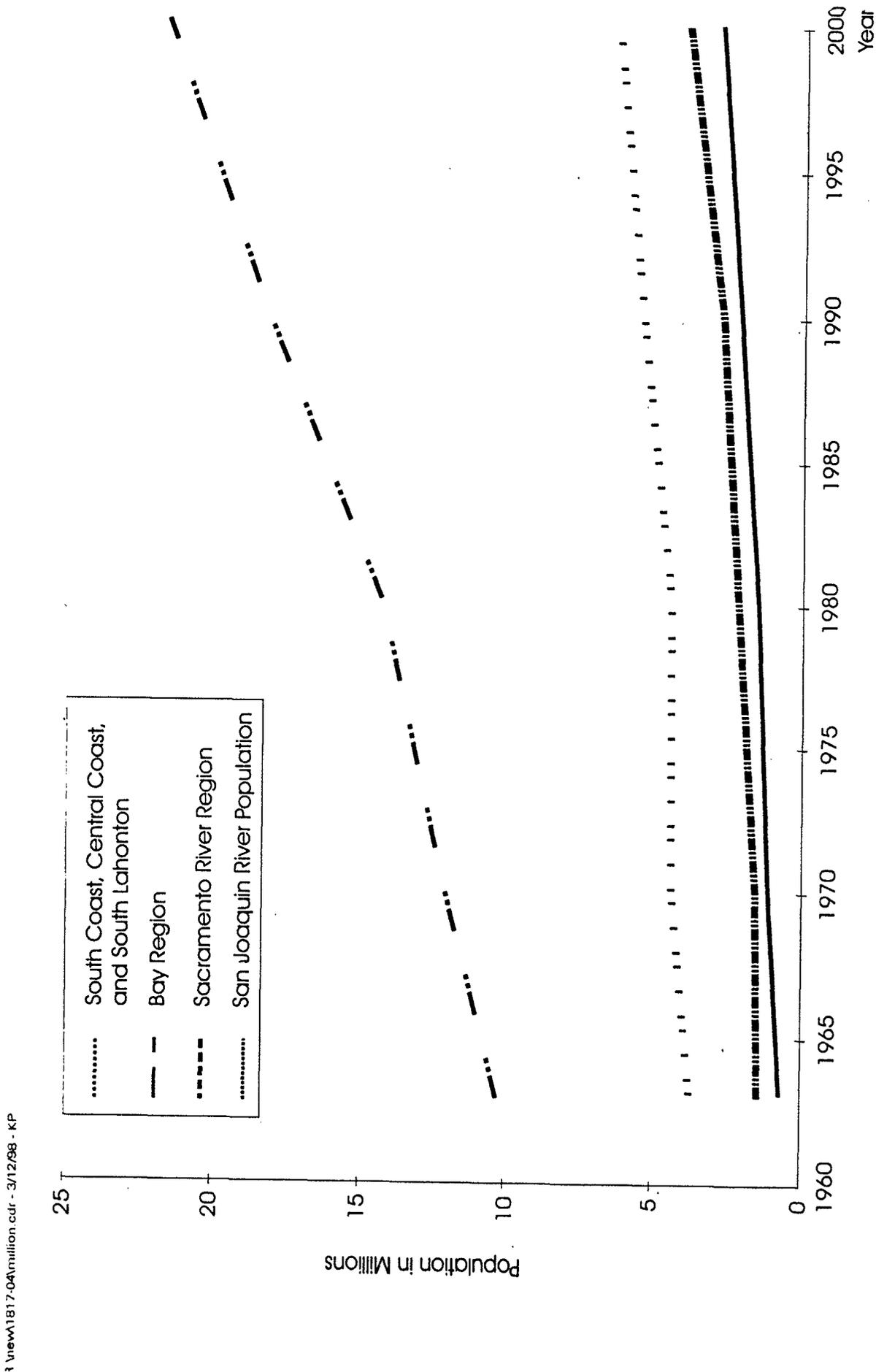


Figure 4. Regional Population Trend, 1963 to 1990, and Predicted Population, Year 2000 (includes Bay, Sacramento River, San Joaquin River regions and SWP and CVP Service Areas Outside the Central Valley)

Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Contra Costa Canal	186,679	153,363	109,576	93,267	134,903
San Felipe Unit	65,390	53,352	69,530	56,066	81,842
State Water Project					
North Bay Aqueduct	26,071	8,352	16,171	24,234	--
South Bay Aqueduct	<u>156,737</u>	<u>50,259</u>	<u>76,661</u>	<u>124,180</u>	--
Total	434,877	265,326	271,938	297,747	216,745

NOTES:
Does not include water rights deliveries or water transfers.
-- = Not available.

SOURCES:
Reclamation 1996, DWR 1996.

Table 6. M&I Water Delivered to the Bay Region from the Delta, 1990 to 1994 (in acre-feet)

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	\$/af Average Cost
Vallejo	109,199	7,087	35,000	178	79	100	100	N/A
Fairfield	77,211	5,405	19,088	192	100	100	100	N/A
Vacaville	71,479	4,720	20,412	181	53	100	53	N/A
San Francisco	723,959	31,685	164,892	120	0	100	100	\$484
Palo Alto	56,000	4,465	18,912	218	100	100	100	N/A
San Jose	873,714	41,154	201,150	129	47	100	55	\$664
Santa Clara	93,800	7,988	23,031	233	38	100	38	N/A
Sunnyvale	117,229	7,606	27,434	178	80	100	80	N/A
Pleasanton	50,570	4,818	16,195	261	68	98	68	N/A
Concord	190,000	12,107	54,538	175	100	100	100	N/A

NOTES:
N/A: Not Available.

SOURCE:
DWR 1993a, 1994a, 1994b.

Table 7. Characteristics of Some Bay Region Providers

Water quality varies among the export facilities that serve the region. The North Bay Aqueduct intake is in the North Delta, where water quality is often better than in the southern or western Delta. The CCWD intake is located in Rock Slough in the western Delta, where salinity is a major concern. Water quality influences treatment costs.

Costs of existing and future water supplies are affected by the mix of supplies and their costs. DWR (1994b) estimated that groundwater for urban use in the region costs \$85 to \$330 per acre-foot. Costs of CVP supplies, which currently range from \$32 to \$95 per acre-foot, will be affected by the CVPIA. DWR (1994a) estimated SWP unit water charges for North and South Bay contractors of \$212 and \$109 per acre-foot, respectively. Because local water supplies are generally fully utilized, future supply increases are likely to come from additional water imports or reclamation. The region generally has adequate water supplies during average conditions, but supply deficits are a problem in dry conditions. Water transfers and conservation were used during the recent drought to attain balance between supplies and demand (CUWA 1991), and this pattern could be expected to continue in the future.

UTILITIES AND PUBLIC SERVICES

Water Supply and Related Infrastructure: Three subregions within the Bay Region are internally independent in terms of water supply: the North Bay, the South Bay, and CCWD. The North Bay consists of SWP entitlement holders served by the North Bay Aqueduct of the SWP and others who have used or could use this facility in exchanges. Two water districts are served by the North Bay Aqueduct: Napa County Flood Control and Water Conservation District (NCFWCWD), and Solano County Flood Control and Water Conservation District (SCFCWCD). NCFWCWD serves SWP water in southern Napa County. SCFCWCD serves the cities of Vallejo, Vacaville, Fairfield, Benicia, and Suisun. The two districts have transferred water and obtained surplus water

through the facility. In addition to SWP entitlement water, Vallejo receives water-rights water through the North Bay Aqueduct.

The South Bay is served by the South Bay Aqueduct, an SWP facility, and through CVP contract supplies supplied through the San Felipe Unit. Three SWP entitlement holders—Alameda County Water District, Alameda County Zone 7, and the Santa Clara Valley Water District (SCVWD)—are located in the South Bay. SCVWD is also served by the San Felipe Unit of the CVP and wholesales water in a large part of the south San Francisco Bay.

For purposes here, CCWD includes that portion of the district not within the Delta. This includes the cities of Concord, Walnut Creek, Pleasant Hill, and Martinez, and other areas south and west of the statutory Delta.

Per capita use is generally largest in the southern and eastern parts of the region. Many providers are entirely reliant on water wholesalers for their supplies. Water users in the region are almost entirely metered, and groundwater is an important part of supply for some providers.

Electric Utility Infrastructure: Bay Region electric infrastructure consists of a large and complex grid of power plants, transmission lines, and substations. Generating facilities in the region are primarily fired with natural gas and oil.

Natural Gas Infrastructure: There are a number of interstate gas pipelines passing through the Bay Region.

Recreational Resources: Mild temperatures and brisk winds make San Francisco Bay favorable for boating. More than 150,000 recreational boats were registered in the Bay Area in 1987. Other water-related recreation includes sight-seeing, picnicking, fishing, nature walking, and camping. Wildlife areas host a variety of recreational activities ranging from

hiking and bird watching to mountain biking. Recreational resources are further described in the Recreational Resources Technical Report.

Public Services: Various departments within the cities and counties of the Bay Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

Sacramento River Region

This region includes the CVP service areas of M&I providers in the Sacramento Valley and a small SWP service area in the Feather River basin. Most of the region is located in the Sacramento area and near Redding.

HISTORICAL PERSPECTIVE

URBAN LAND USE

Agriculture and open space have historically comprised the majority of land in the Sacramento River Region. Since the 1970s, however, urban land uses in the greater metropolitan Sacramento area have begun to supplant some agricultural uses. Except for Sacramento County, the region generally contains large quantities of parklands, forests, and other open space, and has preserved its traditionally rural nature.

M&I WATER SUPPLY ECONOMICS

The first use of the Sacramento River Region was for grazing and trapping, but the first significant immigration into the region involved the Gold Rush period of 1849 through the late nineteenth century. Most of the population lived in mining communities in the foothills, and Sacramento grew first as a port for delivery of goods and people from San Francisco, and later as the terminus of the first transcontinental

railroad. Agriculture developed to serve the mining communities, and the designation of Sacramento as the state capitol led to additional growth. Economic patterns in the twentieth century have mirrored national trends as services, trade, and government have become larger shares of the economy; while mining and agriculture have declined in relative, if not absolute, terms.

Figure 4 shows population in the Sacramento River Region from 1963 to 1990, and projected population to 2000. Population increased from about 1.227 million in 1970 to 2.209 million in 1990 for an annual growth rate of 8.26%. The growth rate slowed between 1990 and 1995.

Table 8 shows per capita water use in the Sacramento River Region in 1968, 1980, and 1990. Since 1968, average per capita use has declined, possibly due to smaller lot sizes and conservation measures in new residential developments.

Year	All Uses
1990	301
1980	305
1968	351
SOURCES: DWR 1994a.	

Table 8. Per Capita per Day Water Use in the Sacramento River Region, 1968 to 1990 (gallons)

CURRENT RESOURCE CONDITIONS

URBAN LAND USE

Land uses in the Sacramento River Region are principally agricultural and open space, with

urban development focused in the City of Sacramento. More than half the region's population lives in the greater metropolitan Sacramento area. Other fast-growing communities include Vacaville, Dixon, Redding, Chico, and various Sierra Nevada foothill towns. Urban development has occurred along major highway corridors in Placer, El Dorado, Yolo, Solano, and Sutter counties, and has taken some irrigated agricultural land out of production. Suburban ranchette homes on relatively large parcels surround many of the urban areas, and often include irrigated pastures or small orchards.

M&I WATER SUPPLY ECONOMICS

The region generally has adequate supplies, even during drought, and some providers have excess supplies in the form of unused contracts, water rights, and excess groundwater capacity.

DWR (1994b) estimated that urban groundwater in the region costs \$50 to \$80 per acre-foot. Some providers, however, are entirely dependent on CVP water service contract supplies for their water, and these supplies can be reduced in dry conditions. CVP contract supplies currently cost anywhere from \$9 to \$46 per acre-foot (Reclamation 1996). For these providers, drought conservation and water transfers may be used in the future during a drought to obtain supply/demand balance.

Table 9 shows recent diversions for M&I use through CVP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. Most providers in the region have water service contracts that exceed their immediate needs; therefore, reductions in deliveries during the drought were not as noticeable as in some other regions.

Table 10 shows some characteristics of Sacramento area M&I providers. Per capita use rates are among the highest in the state, reflecting climate, landscaping, and pricing factors. Some providers are entirely reliant on

the CVP for their supplies. A large share of water users in the region are not metered. Groundwater is the sole source of supply for some providers; however, some rely entirely on surface water deliveries, especially CVP water-service water. Water costs per acre-foot delivered are generally low in comparison to other regions.

This region is almost entirely upstream of the Delta, and surface water quality is generally good to excellent. At times, drainage upstream of Sacramento from the Colusa Basin Drain and other return flows has resulted in loading of agricultural chemicals. Rice farmers have recently worked to manage drainage discharges to reduce this problem. Other water quality problems in the basin have involved mine drainage, wastewater, and urban runoff, but none of these problems are considered serious.

UTILITIES AND PUBLIC SERVICES

Water Supply and Related Infrastructure:

The Sacramento Valley has relatively abundant water supplies of good quality in comparison to the other regions. The region also differs from the other regions in that it does not use M&I water exported directly from the Delta. Rather, the region is affected primarily because CVP project yield is allocated among all CVP water service contracts, and CVP yield could be affected by CALFED actions.

The major M&I water use in the region occurs in the Sacramento metropolitan area. Most surface water use in the region is diverted from the American River. Direct diversions from the Sacramento River may provide a larger share of supplies in the future. The other part of the region affected by CALFED actions is in and near the City of Redding. The CVP provides municipal water service to a large number of small M&I providers in the area.

Water resources in the Sacramento basin have been developed during this century for a wide range of uses. They supply local agricultural, municipal, and industrial needs; they are

Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Clear Creek Unit	1,451	659	2,460	2,076	2,329
Cow Creek Unit	3,342	1,817	3,206	5,342	6,674
Folsom Dam and Reservoir	27,454	40,743	23,360	20,895	30,693
Folsom South (SMUD)	5,829	3,600	3,564	1,673	1,727
Sacramento River	8,900	7,753	7,945	8,314	9,321
Shasta Dam and Reservoir	1,852	1,417	1,017	2,694	1,338
Spring Creek Conduit	638	337	777	885	688
Toyon Pipeline	2,471	2,071	2,537	2,164	2,479
State Water Project					
Feather River Area	<u>1,448</u>	<u>866</u>	<u>2,128</u>	<u>3,476</u>	--
Total	53,385	59,263	46,994	47,519	55,249
NOTES:					
-- = Not available.					
Does not include water rights deliveries or water transfers.					
SOURCES:					
Reclamation 1996, DWR 1996.					

Table 9. M&I Water Delivered to the Sacramento River Region by the SWP and CVP

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	\$/af Average Cost
Redding	66,462	6,890	21,112	284	70	100	70	\$254
Sacramento, Citizens Utility	166,000	16,055	46,064	265	0	100	0	
Fair Oaks	38,005	4,949	12,641	357	95	6	95	
Roseville	44,685	4,642	17,249	285	100	10	100	
Sacramento, City of	369,365	37,157	111,785	276	0	2	95	\$165
Orangevale/Roseville	20,000	4,309	6,402	590	100	6	100	
Carmichael	38,550	4,191	10,830	298	60	5	60	
NOTES:								
Metered percentage based only on available data for all service connections.								
GPCD = Gallons per capita per day.								
SOURCES:								
DWR 1993a, 1994a, 1994b.								

Table 10. Characteristics of Some Sacramento River Region Providers

exported to the Bay Delta; and they are used to generate power at hydroelectric facilities. Reservoirs, levees, channels, and bypasses are used to store and convey water and to control flooding. About 10.6 MAF of the area's 16 MAF of developed surface storage are contained in four major reservoirs: Lake Shasta on the Sacramento River (about 4.5 MAF), Oroville Reservoir on the Feather River (about 3.5 MAF), Folsom Lake on the American River (about 1.0 MAF), and Lake Berryessa in Putah Creek (about 1.6 MAF). An additional 2.2 MAF of flood-control storage is provided by a system of basins, levees, channels, and bypasses—including the Butte, Colusa, Sutter, American, and Yolo basins. Levees and bypasses extend more than 150 miles, from Red Bluff to Suisun Bay. Flood control is achieved by developing bypass overflows that act as auxiliary channels to the Sacramento River during high water periods.

Electric Utility Infrastructure: Infrastructure consists primarily of natural gas turbine and hydroelectric generating facilities, transmission lines, substations, and distribution lines. Hydropower generation levels fluctuate significantly with reservoir releases that are in turn affected by droughts (and other climatic conditions), minimum stream flow requirements, flow fluctuation restrictions, and water quality requirements. For example, cold water has been released from Shasta Reservoir to control temperature and protect winter-run chinook salmon in the Sacramento River. Releases by-passed the power plant and generation levels were reduced, although engineering controls will soon allow such water to pass through the plant. Other causes of power reduction, such as drought, cannot be mitigated. Changes in power generation affect coordinated operations of both PG&E and CVP facilities.

Natural Gas Infrastructure: Pipelines, storage areas, and compressor stations exist throughout the Sacramento valley and other parts of northern California.

Recreational Resources: Over 2 million people participate in recreational activities along the Sacramento River annually. Fishing is listed as one of the most popular activities; pleasure boating, swimming, water skiing, camping, hiking, and other outdoor sports are also practiced. Shasta reservoir and Lake Oroville are used for camping, water-skiing, boating, hunting (primarily for waterfowl), fishing, mountain biking, and picnicking. A total annual recreation participation has been estimated at over one million hours for the area between Shasta Dam and the Red Bluff Diversion Dam. Backpacking, camping, and fishing are enjoyed in mountain areas.

Public Services: Various departments within the cities and counties of the Sacramento River Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

San Joaquin River Region

The San Joaquin River Region includes only those M&I providers in the San Joaquin Valley with some current or planned use of CVP or SWP supplies exported from the Delta. CVP water service contracts in the region are served by the Delta-Mendota or San Luis canals. SWP entitlements are served via the California Aqueduct.

HISTORICAL PERSPECTIVE

URBAN LAND USE

The European history of the San Joaquin Valley Region began with settlement by the Spanish for cattle ranching. By the mid-1800s, gold mining to the north and east created a demand for agricultural products and led to the first large irrigation developments in the region. Large areas of wetlands such as Tulare Lake were reclaimed for agriculture, and the advent of the

railroad expanded agricultural markets to the rest of the nation. Many early irrigation developments were private, but the federal government played a larger role in this century with multi-purpose projects on the eastside rivers and valley floor.

Prior to the 1960s, land uses in the San Joaquin River Region were principally agriculture and open space, with urban uses limited to small farm communities. Although agriculture and food processing are still the region's major industries, expansion from the San Francisco Bay Area and Sacramento over the past 30 years have resulted in the creation of major urban centers throughout the region. Open space uses, including national forest and park lands, state parks and recreational areas, and Bureau of Land Management and military properties, have historically comprised about one-third of the region.

M&I WATER SUPPLY ECONOMICS

The historic population trend in the San Joaquin River Region from 1963 to 1990, and projected population to 2000, are shown on Figure 4. Population increased from about 1.676 million in 1970 to 2.974 million in 1990, for an annual growth rate of 7.72%. The growth rate slowed between 1990 and 1995. Table 11 shows three measures of per capita water use in the San Joaquin River and Tulare Lake regions in 1963, 1968, 1980, and 1990. Since 1968, per capita use has declined, probably in response to smaller lot size, more use of modern conservation in new housing, and perhaps changing patterns of water use in industry and commerce.

UTILITIES AND PUBLIC SERVICES

The population has increased from 0.8 million in 1972 to 1.4 million in 1990. Because the region is generally too arid to support viable rain-fed cropping, growth and development have been tied to the development of limited groundwater supplies and storage and

conveyance infrastructure used to move large quantities of irrigation water into the region.

Year	All Uses	Agency Only	Residential Only
Tulare Lake Region			
1990	301		202
1980	320		
1968	363	325	
1963		314	
San Joaquin River Region			
1990	309		216
1980	355		
1968	436	338	
1963		317	
SOURCES: DWR 1994a			

Table 11. Gallons per Capita per Day Water Use, San Joaquin River Region, 1963 to 1990

CURRENT RESOURCE CONDITIONS

URBAN LAND USE

Land uses in the San Joaquin River Region are predominantly open space in the mountain and foothill areas, and agricultural in the San Joaquin Valley area. Urban land usage in 1990 totaled 295,300 acres. Urban areas include the cities of Stockton, Modesto, Merced, and Tracy, as well as smaller communities such as Lodi, Galt, Madera, and Manteca. In contrast to the large valley urban centers, separated by flat agricultural fields and linked by freeways, the foothills are sprinkled with small communities connected by small two-lane roads. Off from the north-south trending Highway 49 is a series of roads that lead to Sierra Nevada mountain passes. The western side of the region, south of Tracy, is sparsely populated. Many small agricultural communities dot the eastern side of the southern San Joaquin Valley, with urban

development and anticipated population growth focused in the cities of Fresno, Bakersfield, Visalia, and Tulare.

The region also contains thousands of acres of wildlife areas, preserves, and refuges managed by a variety of federal, state, county, and local government and private institutions. An example of some of the more prominent areas set aside for wildlife include the National Wildlife Refuges in Merced County, owned by the U.S. Bureau of Reclamation, Kesterson National Wildlife Refuge, and Cottonwood Creek, Los Banos, Mendota, and North Grasslands Wildlife Areas, owned by the California Department of Fish and Game.

M&I WATER SUPPLY ECONOMICS

Table 12 shows recent imports into the region through CVP and SWP facilities. These data show the influence of the recent drought and reduced allocations, especially in 1991 and 1992. Most Delta water delivered into the region is provided to KCWA. This water is delivered for several uses within Kern County in exchange for groundwater pumped by the City of Bakersfield.

Table 13 shows characteristics of some San Joaquin Valley M&I providers. Per capita use rates are generally higher than in the coastal regions, reflecting climate and landscaping factors.

Existing and future water supply costs are affected by the mix of water sources and their costs. Groundwater and surface water costs are important. DWR (1994b) estimated that groundwater for urban use costs anywhere from \$70 to \$270 per acre-foot. In 1996, contract rates for CVP water were \$18 to \$66 per acre-foot (Reclamation 1996). DWR (1994b) estimated SWP unit water charges of \$57 per acre-foot. Additional groundwater development in some areas may be limited by water-quality concerns. Water transfers and conservation are likely future sources of supply in dry years.

UTILITIES AND PUBLIC SERVICES

Water Supply and Related Infrastructure:

The largest CVP M&I water users in the San Joaquin River Region are Avenal, Coalinga, Huron, Westlands Water District, and Tracy, but small amounts of M&I water are taken by a number of other districts. Stockton East is included in this group, with a CVP contract of 38,000 AF.

M&I water use in the Friant Division of the CVP is not included. The City of Bakersfield obtains SWP M&I supplies through Kern County Water Agency (KCWA).

Local water supplies are unable to meet local demands. Supplemental water is imported from the Delta Region. SWP and CVP water is pumped from Clifton Court Forebay in the Delta and is transported into the region via the California Aqueduct and the Delta—Mendota Canal. Infrastructure in the region consists mainly of channels, aqueducts, reservoirs, and irrigation structures.

Electric Utility Infrastructure: Infrastructure consists primarily of natural gas-fired and hydroelectric-generating facilities, transmission lines, substations, and distribution lines).

Natural Gas Infrastructure: Although gas fields and storage areas are not known to exist in the region, several major pipelines traverse the entire length of the San Joaquin Valley.

Recreational Resources: Several reservoirs in the area support boating, fishing, and related activities. Picnicking, swimming, water skiing, hunting, and camping are also enjoyed. The California Aqueduct supports walk-in fish sites and 170 miles of bike paths.

Public Services: Various departments within the cities and counties of the San Joaquin River Region provide fire protection, police protection, and emergency medical services to members of their respective communities.

Water Source	1990	1991	1992	1993	1994
Central Valley Project					
Cross Valley Canal	459	407	297	0	0
Delta Mendota Canal	5,531	5,586	7,221	8,005	7,843
San Luis Canal	12,996	10,528	15,098	11,787	14,374
State Water Project					
Kern County Water Agency	<u>127,837</u>	<u>33,122</u>	<u>56,305</u>	<u>94,220</u>	--
Total	146,823	49,643	78,921	114,012	22,217

NOTES:
Does not include water rights deliveries or water transfers.
-- = Not available.

SOURCES:
Reclamation 1996, DWR 1996.

Table 12. M&I Water Delivered to the San Joaquin River Region from the Delta, 1990 to 1994

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	\$/af Average Cost
Stockton	210,943	17,130	64,179	222	52	100	52	\$311
Huron	4,766	284	621	163	100	N/A	100	
Coalinga	8,450	1,032	2,665	327	100	16	100	
Bakersfield, CA Water	172,800	20,222	51,641	321	15	24	15	\$263

SOURCE:
DWR 1993a, 1994a, 1994b

Table 13. Characteristics of Some San Joaquin River Region Providers

SWP and CVP Areas Outside the Central Valley

HISTORICAL PERSPECTIVE

URBAN LAND USE

The first European use of the Central and South Coast regions involved Spanish settlement for trade and cattle production. After statehood, the region grew quickly as agriculture, business, and industry took advantage of the region's warm Mediterranean climate. The rapidly expanding South Coast population soon required water imports from the east, and the Los Angeles Aqueduct, the Colorado River Aqueduct, the San Diego Aqueduct, and the SWP were developed to meet this need. The Los Angeles metropolitan area is now the second largest in the nation.

The development of SWP and CVP Service Areas Outside the Central Valley has steadily increased since the 1880s. Urban land uses grew quickly during and after World War II, as the combination of major industries (defense, tourism, entertainment), international trade, and an expanding interstate highway system brought thousands of new residents to the greater Los Angeles and San Diego metropolitan areas. Since the 1970s, suburban sprawl has grown to comprise the majority of coastal and inland valley land uses. Open space uses, including national forest and park lands, and state parks and recreational areas, historically have comprised about one-third of the region.

M&I WATER SUPPLY ECONOMICS

The SWP and CVP Service Areas Outside the Central Valley includes the service areas of all SWP entitlement holders south of Kern County. The single largest provider is MWD in DWR's South Coast Region. The South Coast M&I water demand exceeds the demands of all other M&I regions combined. The region includes

Ventura, Los Angeles, and Orange counties; and the western portions of San Diego, Riverside, and San Bernardino counties.

The SWP and CVP Service Areas Outside the Central Valley also includes service areas receiving SWP water in DWR's Central Coast Region, the Antelope Valley and Mojave River planning subareas of the South Lahontan Region, and the Coachella planning subarea of the Colorado River Region. Central Coast SWP contractors are Santa Barbara County Flood Control and Water Conservation District (SBCFCWCD) and San Luis Obispo Flood Control and Water Conservation District. These districts are served by deliveries through the Coastal Aqueduct of SWP.

Figure 4 shows population in DWR's Central Coast, South Coast, and South Lahontan regions from 1963 to 1990, and projected population to 2000. This population increased from about 12.1 million in 1970 to 18.2 million in 1990, for an annual growth rate of 4.4%. The population growth rate slowed between 1990 and 1995.

Table 14 shows three measures of per capita water use in DWR's Central Coast, South Coast, and South Lahontan regions in 1963, 1968, 1980, and 1990. Since 1970, per capita use in the South Coast Region has increased slightly, probably due to new residential development in the more inland, hotter portions of the region. Use per capita in the Central Coast Region has declined, probably due to high water prices and more intensive water conservation in this region.

CURRENT RESOURCE CONDITIONS

URBAN LAND USES

The SWP and CVP Service Areas Outside the Central Valley comprise portions of four hydrologic regions in California: the Central Coast Hydrologic Region (excluding Monterey

Year	All Uses	Agency Only	Residential Only
South Coast Region			
1990	211		124
1980	191		
1968	179	173	
1963		167	
Central Coast Region			
1990	189		112
1980	210		
1968	194	165	
1963		148	
South Lahontan Region			
1990	278		175
1980	280		
1968	305	264	
1963		298	

SOURCE: DWR 1994a.

Table 14. Gallons per Capita per Day Water Use, SWP and CVP Service Areas Outside the Central Valley, 1963 to 1990

County, Santa Cruz County, and Benito County); the South Coast Hydrologic Region (excluding a small portion of southeastern San Diego County); the South Lahontan Hydrologic Region (excluding Mono County, Inyo County, and eastern San Bernardino County); and the western portion of the Colorado River Hydrologic Region.

The Southern Planning Subarea of the Central Coast Hydrologic Region comprises those portions of the region south of, and including, San Luis Obispo County. Urban land uses in this subarea of the region include the cities of San Luis Obispo, Morro Bay, Santa Maria, Lompoc, and Santa Barbara. Military installations include Vandenberg Air Force Base and Camp Roberts. The Los Padres National Forest provides recreation and open space land uses.

The South Coast is the most urbanized region in California. Of the approximate 7,000,000 acres in the region, about 1,700,000 acres are urban

land. Most of the region's coastal plains and valleys are densely populated. The largest cities are Los Angeles, San Diego, Long Beach, Santa Ana, and Anaheim. Areas undergoing increased urbanization include the coastal plains of Orange and Ventura counties, the Santa Clarita Valley in northwestern Los Angeles County, the Pomona/San Bernardino/Moreno valleys, and the valleys north and east of the City of San Diego.

SWP and CVP service areas in the South Lahontan Hydrologic Region comprise the eastern portion of Kern County, the northeast portion of Los Angeles County, and western San Bernardino County. The region is a closed basin with many desert valleys and small mountain ranges. Although not densely populated, the region contains many growing urban areas, including the cities of Lancaster and Palmdale in the Antelope Valley of Los Angeles County, and the Victor and Apple valleys of San Bernardino County. Other urban areas include the cities of Bishop, Ridgecrest, and Barstow. Military installations include Edwards Air Force Base, Fort Irwin, and the China Lake Naval Weapons Center.

The entire South Lahontan Region comprises about 18,600,000 acres; about one-third of this acreage (6,200,000 acres) is estimated to lie in the region's SWP and CVP service areas. Urban and suburban uses for the entire region totaled about 170,000 acres in 1990; about three-fourths of this acreage (127,500 acres) is estimated to lie in the region's SWP and CVP service areas.

SWP and CVP Service Areas in the Colorado River Hydrologic Region comprise part of the southern portion of San Bernardino County, the middle portion of Riverside County, and the Salton Sea in Imperial County. Despite its arid climate, the area contains many productive agricultural areas and vacation resorts. Principal urban areas in the SWP and CVP service areas are located in the Coachella Valley, and include Palm Springs, Indio, Cathedral City, and Palm Desert. Vacation and resort facilities in these areas include hotels,

country clubs, golf courses, and other residential communities.

The entire Colorado River Hydrologic Region comprises about 12,630,000 acres. About one-fifth of this acreage (2,525,000 acres) is estimated to lie in the region's SWP and CVP Service Areas. About 10% of this acreage (252,500 acres) is estimated to comprise urban and suburban land uses.

M&I WATER SUPPLY ECONOMICS

Table 15 shows recent imports into the SWP and CVP Service Areas Outside the Central Valley through SWP facilities. These data show the influence of drought and reduced water allocations, especially in 1991 and 1992. SWP deliveries to MWD declined 72% from 1990 to 1991 and did not recover again until 1993. Similar delivery patterns were experienced by the other SWP M&I entitlement holders in the region.

DWR's Bulletin 160-93 (1994b) estimated that the South Coast Region will experience a 2020 supply deficit of 1.4 and 2.5 million acre-feet in average and dry years, respectively, or enough to meet the demands of about 6.7 million persons in the average year. Most of this shortage would be eliminated with new supplies; especially reclaimed water and new yield from Colorado River, local and SWP improvements, and conservation. Still, a substantial supply deficit would remain.

Table 16 shows some characteristics of M&I providers in the region. Only those providers delivering more than 10,000 million gallons, or 30,700 af, annually are included. In the South Coast Region, per capita use rates generally reflect distance from the coast. Most providers supply a mix of purchased and developed water, and almost all providers use a mix of surface water and groundwater supplies. The Central Coast Region exhibits some of the highest water prices and lowest per capita use rates in the state. For providers with data available, 100% of customers are metered.

MWD recently developed an Integrated Resources Plan as a policy guideline for future resource and capital development (MWD 1996). The Preferred Resource Mix for 2020 includes: 512,000 acre-feet annually of new conservation; 290,000 acre-feet of new water recycling; 40,000 acre-feet of groundwater recovery; dry-year yields of 220,000 and 400,000 acre-feet from existing reservoirs and the Eastside reservoir, respectively; 200,000 acre-feet of dry-year yield from conjunctive use; about 700,000 acre-feet of additional dry-year SWP supplies; and 300,000 acre-feet of water transfers from willing sellers. DWR (1994a) estimated that groundwater for urban use in the South Coast Region costs \$45 to \$190 per acre-foot. There is little potential for new yield without intentional recharge or expensive treatment. DWR (1994c) estimated an SWP unit water charge in the southern California area of \$206 per acre-foot. The Integrated Resources Plan estimates the potential costs of future water supplies. Development, treatment, and distribution costs of new Colorado River Aqueduct supplies are expected to be about \$250 per acre-foot, but the yield of these options is limited by the conveyance capacity of the Colorado River Aqueduct. Additional storage, low-cost transfers, and additional SWP supplies would cost around \$300 per acre-foot, low-cost reclamation and high-cost transfers about \$400 per acre-foot high-cost reclamation about \$600 per acre-foot groundwater recovery about \$700, and desalination would cost more than \$1,400 per acre-foot.

Water quality, especially salinity, is an important economic and planning problem for the South Coast. Salinity can adversely affect the taste of drinking water; inhibit plant growth; accelerate depreciation of plumbing, appliances, treatment facilities, and pipelines; increase use of soaps and detergents; increase industrial costs; and increase costs of wastewater treatment and reclamation. Almost all of the available water sources in the region contribute salinity, but Colorado River supplies and degraded groundwater are the primary sources. Salinity concentrations have tended to increase over time as upstream development on the

Water Source	1990	1991	1992	1993
State Water Project				
Metropolitan Water District of Southern California	1,396,423	391,447	707,311	1,408,050
Other southern California	<u>189,483</u>	<u>51,249</u>	<u>105,090</u>	<u>193,092</u>
Total	1,585,906	442,696	812,401	1,601,142
NOTE: Does not include water rights deliveries or water transfers.				
SOURCES: Reclamation 1996, DWR 1996.				

Table 15. M&I Water Delivered to the Central Coast and South of Kern County from the Delta, 1990 to 1993 (in acre-feet)

Colorado River has increased loads and reduced dilution, and water reuse has concentrated salinity in groundwater basins. Blending of supplies is often used to reduce average salinity. MWD recently initiated a two-phase comprehensive salinity management study to develop information in support of regional salinity management policies and to coordinate interagency action to solve salinity problems (Bookman Edmonston Engineering 1997). A number of possible salinity management actions have been identified for consideration in Phase II.

compressor stations also are present in northern California.

Recreational Resources: Recreational resources for the SWP and CVP Service Areas are described in the CALFED Bay-Delta Program Recreation Technical Report.

Public Services: Various departments within the cities and counties of the CVP and SWP Service Areas provide fire protection, police protection, and emergency medical services to members of their respective communities.

UTILITIES AND PUBLIC SERVICES

Water Supply and Related Infrastructure: Key SWP and CVP infrastructure includes reservoirs, aqueducts, power plants, and pumping plants.

Electric Utility Infrastructure: A complex system of generating facilities, substations, and transmission infrastructure exists in the southern California and Central Coast regions. Natural gas, nuclear, oil, hydroelectric, and other technologies are employed in producing power.

Natural Gas Infrastructure: Gas storage areas, pipelines, and compressor stations are present in southern California. Pipelines and

Provider	Population (1990)	Water into System (1990 mg)	Service Connections (1990)	GPCD (1990)	Percent Purchased	Percent Metered	Percent Surface Water	S/af Average Cost
Central Coast Region								
San Luis Obispo	41,958	1,560	12,350	102	0	100	59	\$890
Goleta	70,480	1,934	13,750	75	76	100	75	\$1,381
Santa Barbara	85,571	3,079	24,146	99	61	100	68	\$1,364
South Coast Region^a								
Carson et al.	101,000	12,667	31,611	344	73	100	73	
Long Beach	429,433	24,448	87,923	156	65	100	65	\$498
Los Angeles	3,485,398	218,809	635,698	172	73	100	89	\$462
Glendale	180,038	10,144	32,778	154	93	100	93	\$312
Pasadena	131,590	12,629	36,998	263	66	N/A	67	\$331
Anaheim	266,406	24,064	55,500	247	49	100	49	
Fullerton	114,144	10,584	27,890	254	54	100	54	
Huntington Beach	181,519	12,530	48,571	189	53	100	53	
Santa Ana	293,742	16,665	43,491	155	25	N/A	25	
Riverside	226,505	22,217	66,348	269	8	100	8	\$268
Ontario	133,179	12,101	28,019	249	46	100	46	
Rancho Cucamonga	101,409	13,810	32,567	373	46	100	59	
Fontana	75,000	10,411	28,000	380	100	100	30	
Mission Viejo	109,250	10,700	37,445	268	100	100	100	
El Cajon et al.	227,293	13,514	53,347	163	98	100	99	
San Diego	1,100,549	73,927	235,810	184	100	100	100	\$576
Chula Vista and Vicinity	135,163	15,986	60,673	324	87	100	96	
South Lahontan Region								
Palmdale	68,842	6,073	19,626	242	43	100	44	\$488
NOTE:								
^a Only those providers with 10,000 million gallons per year or more.								
SOURCES:								
DWR 1993a, 1994a, 1994b.								

Table 16. Characteristics of Some SWP and CVP Service Areas Outside the Central Valley Providers

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