California **Water Plan**
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San Francisco Bay

INTEGRATED WATER MANAGEMENT

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Volume 3

Regional Reports

North Central Region Office

The Division of Integrated Regional Water Management assists public and private agencies and the general public with water issues throughout the state. Four regional offices are located throughout California to maintain close contact with local interests to facilitate communication and to work on water-related matters. The offices are:

- Northern Region in Red Bluff,
- North Central Region in West Sacramento,
- South Central Region in Fresno, and
- Southern Region in Glendale.

Each of the regional offices offers technical guidance and assistance in water resource engineering, project management, hydrology, groundwater, water quality, environmental analysis and restoration, surveying, mapping, water conservation, and other related areas within the boundaries of their offices. Because of the regional offices' close ties with local interests, DWR regional coordinators in each office facilitate overall communication between DWR divisions and local partners to ensure coordinated efforts throughout all DWR programs and projects.

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Cover Photos:

1. Aerial view of Golden Gate Bridge. Photo courtesy of DWR photo lab

2. 3. San Francisco skyline. Photo courtesy of DWR photo lab

4. Russian River Watershed. Photo courtesy of the Russian River Watershed Council and RMC Water and Environment

5. Portion of Marin Municipal Water District's service area; Mount Tamalpais, background; SF Bay, foreground. Photo courtesy of Marin Municipal Water District

6. Aerial view of Hetch Hetchy Reservoir. Photo courtesy of San Francisco Public Utilities Commission and RMC Water and Environment

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San Francisco Bay Hydrologic Region

Setting

The San Francisco Bay Hydrologic Region (Bay Region) occupies parts of 10 counties extending from southern Santa Clara County north to Tomales Bay in Marin County and inland to the confluence of the Sacramento and San Joaquin rivers near Collinsville (Figure SF-1). The eastern boundary follows the crest of the Coast Range, the highest peaks of which are more than 4,000 feet above sea level. Streams in the region flow into the bay estuary or the Pacific Ocean. Water agencies in the Bay Region have relied for nearly a century on imported water supplies from the Sierra Nevada to supply their customers with reliable water. Groundwater accounts for approximately 15 percent of the region's average annual total water supply. Water from the Mokelumne and Tuolumne rivers accounts for an estimated 38 percent of the region's average annual total water supply. Population growth and concerns over diminishing water quality have led to the development and re-development of local surface water supplies, recharge of existing groundwater basins, and incorporation of conservation guidelines in a continuing effort to sustain reliable, quality water for future generations.

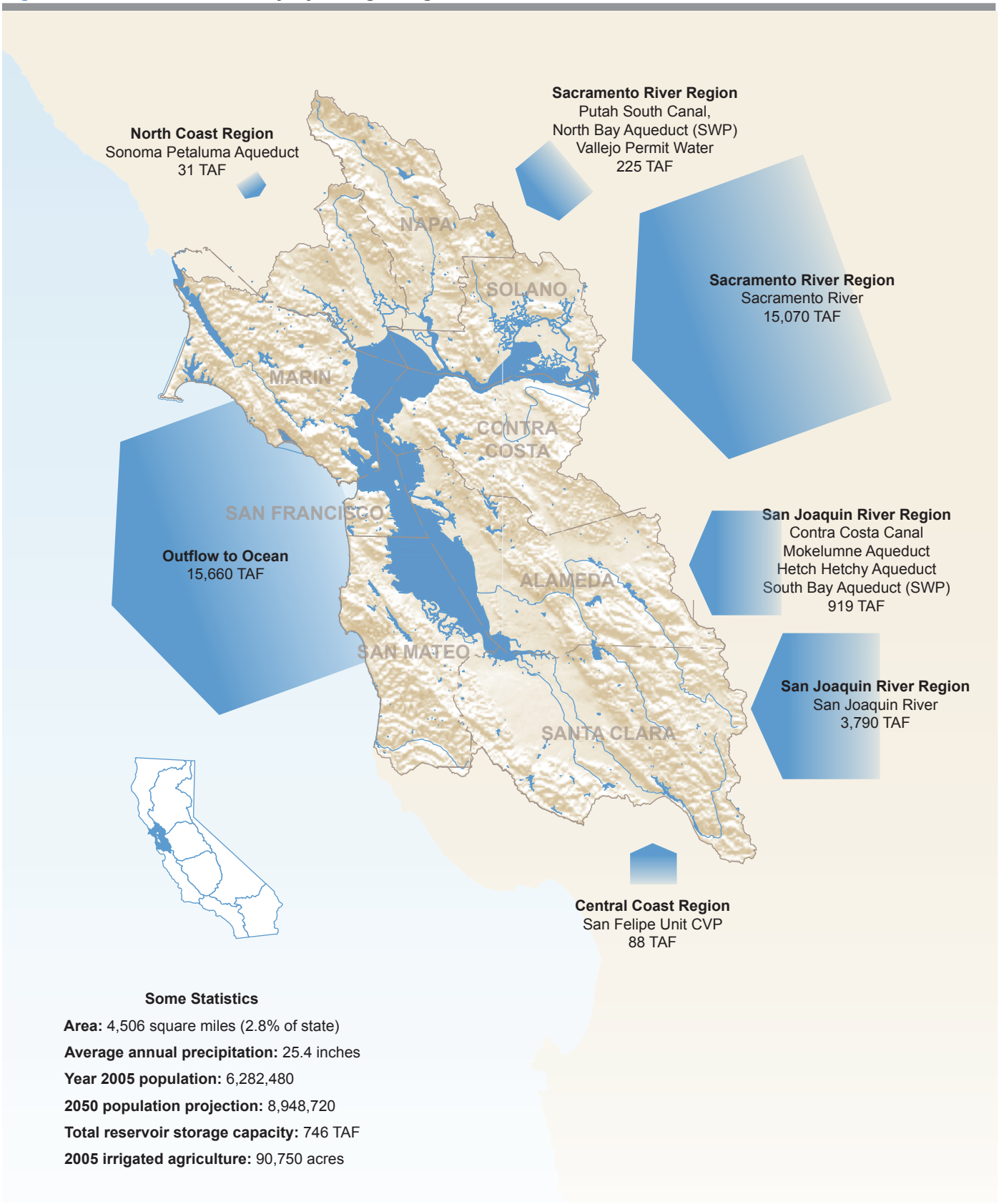
The Sacramento and San Joaquin rivers flow through the Sacramento-San Joaquin River Delta (the Delta) into the San Francisco Bay. The interaction between Delta outflow and tides determine how far salt water intrudes into the estuary. The resulting salinity gradient influences the distribution of many estuarine fishes and invertebrates as well as plants, birds, and animals in wetlands areas. Delta outflow varies with precipitation, reservoir releases, and diversions upstream. Delta outflows contribute an average of 18.4 million acre-feet per year of fresh water to the bay (California Data Exchange Center [CDEC], 2000–2008). Daily tidal flux through the Carquinez Strait is much higher than the freshwater flows.

The Bay Region boasts significant Pacific Coast marshes such as Pescadero Marsh and Tomales Bay Marsh as well as San Francisco Bay itself. San Francisco Bay is an estuary with a deep central channel, broad mudflats, and fringing marsh. The northerly lobe of the bay is known as San Pablo Bay. It is surrounded by Marin, Sonoma, Napa, and Solano counties and is more brackish, while the South and Central bays are more marine dominated. Suisun Marsh, between San Pablo Bay and the Delta, is the largest contiguous brackish water marsh remaining on the West Coast of North America, providing more than 10 percent of California's remaining natural wetlands.

Watersheds

The Bay Region includes numerous watersheds that drain directly into the San Francisco Bay downstream of the Delta and coastal creek watersheds in Marin and San Mateo counties that drain directly to the Pacific Ocean. The Bay Region covers approximately

Figure SF-1 San Francisco Bay Hydrologic Region: inflows and outflows in 2005



Some Statistics

Area: 4,506 square miles (2.8% of state)

Average annual precipitation: 25.4 inches

Year 2005 population: 6,282,480

2050 population projection: 8,948,720

Total reservoir storage capacity: 746 TAF

2005 irrigated agriculture: 90,750 acres

4,500 square miles and includes all of San Francisco and portions of Marin, Sonoma, Napa, Solano, San Mateo, Santa Clara, Contra Costa, Santa Cruz and Alameda counties.

The Guadalupe River and Coyote and Alameda creeks drain the Coast Range and generally flow northwest until terminating in San Francisco Bay. Significant tributaries of Alameda Creek are Arroyo de la Laguna, the Arroyo Mocho, and the South San Ramon Creek. The Arroyo Valle is regulated at Del Valle Dam and is a tributary to Arroyo de la Laguna. The Napa River originates in the Mayacamas Mountains at the northern end of Napa Valley and flows southward into San Pablo Bay. Sonoma Creek begins in mountains within Sugarloaf State Park, then south through Sonoma Valley and enters northern San Pablo Bay.

The Bay Region corresponds to the boundaries of the Regional Water Quality Control Board (Regional Water Board) Region 2 and the San Francisco Bay Area Integrated Regional Water Management (Bay Area IRWM) Plan. The Bay Area IRWM Plan identifies the 15 largest watersheds in the San Francisco Bay watershed (Figure SF-2).

Ecosystems

There are about 500 species of fish and wildlife in the Bay Region; 105 wildlife species are designated by State and federal agencies as threatened or endangered. Tidal flats occur from the elevation of the lowest tides to approximately mean sea level and support an extensive community of invertebrate aquatic organisms, fish, plants and shorebirds. Historically, around 50,000 acres of tidal flats occurred around the bay margins, approximately 29,000 acres remain—a reduction of more than 40 percent.

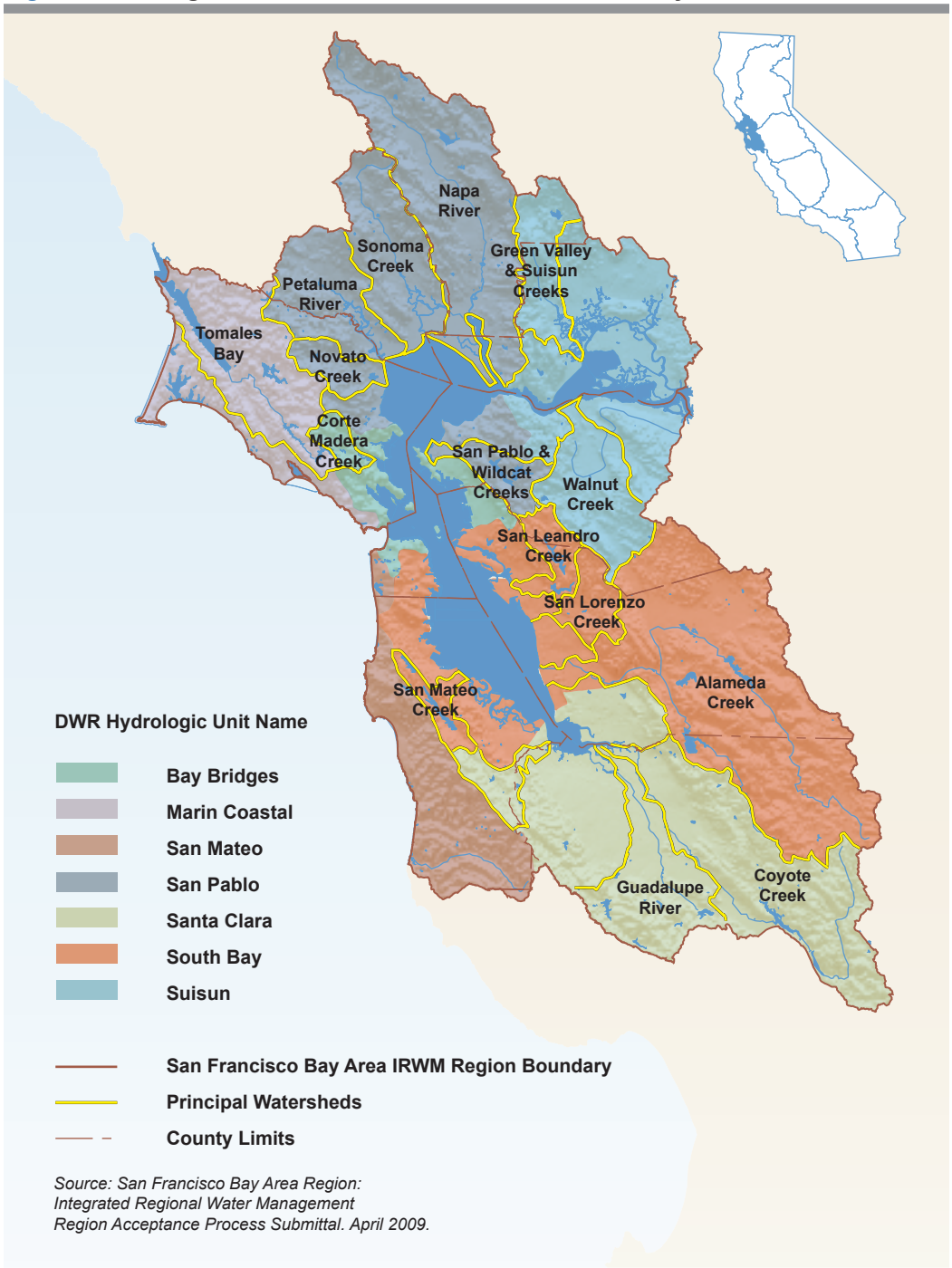
The San Francisco Bay is one of the most modified estuaries in the United States. The topography, ebb and flow of the tides, patterns of freshwater inflows locally and from the Delta, and the availability and types of sediment have all been altered. Many new species of plants and animals have been introduced. These exotic and invasive species, such as the Chinese mitten crab and Asian clam, threaten to undermine the estuary's food web and alter its ecosystem.

Water quality has also changed over time, and the character of the wetlands around the bay has changed dramatically. More than 75 percent of the bay's historical wetlands have been lost or altered through a variety of land use changes around the bay, including filling for urban and industrial uses and the construction of dikes for agricultural uses. Prior to 1800, the total area covered by the bay at high tide was about 516,000 acres, and tidal marshes covered approximately 190,000 acres on the fringes of the bay. Today, the bay covers about 327,000 acres at high tide and 40,000 acres of tidal marsh border the bay. In recent decades, filling of the bay has slowed significantly due to regulatory changes and the creation of the Bay Conservation and Development Commission (BCDC), a State agency charged with permitting activities along the shore of the bay since 1965.

Box SF-1 Acronyms and Abbreviations Used in San Francisco Bay Hydrologic Region Report

ABAG	Association of Bay Area Governments
ACWD	Alameda County Water District
af	acre-foot
AHPS	Advanced Hydrologic Prediction Service
BACWA	Bay Area Clean Water Agencies
BAFPAA	Bay Area Flood Protection Agencies Association
BAIRWMP	Bay Area Integrated Regional Water Management Plan
BARWRP	Bay Area Regional Water Recycling
BAWSCA	Bay Area Water Supply and Conservation Agency
Bay Region	San Francisco Bay Hydrologic Region
BCDC	Bay Conservation and Development Commission
Cal EMA	California Emergency Management Agency
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
CEQA	California Environmental Quality Act
CRS	Community Rating System
CVP	Central Valley Project
Delta	Sacramento-San Joaquin River Delta
DFG	California Department of Fish and Game
DOD	US Department of Defense
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
ERP	Ecosystem Restoration Program
FCWCD	Flood Control and Water Conservation District
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRMS	Flood Insurance Rates maps
GIS	Geographic Information Systems
IRWM(P)	Integrated Regional Water Management Plan
NBA	North Bay Aqueduct
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NGO	nongovernmental organization
NPDES	National Pollution Discharge Elimination System
NRCS	US Natural Resources Conservation Service
NWS	National Weather Service
PCB	polychlorinated biphenyls
RAP	Region Acceptance Process
Regional Water Board	San Francisco Regional Water Quality Control Board
SCVWD	Santa Clara Valley Water District
SCWA	Sonoma County Water Agency
SFBA	San Francisco Bay Area IRWMP
SFBJV	San Francisco Bay Joint Venture
SFPUC	San Francisco Public Utilities Commission
State Water Board	California State Water Resources Control Board
SWP	State Water Project
taf	thousand acre-feet
TMDL	Total Maximum Daily Load
USACE	US Army Corps of Engineers
USBR	US Bureau of Reclamation
USGS	US Geological Survey
VOCs	volatile organic compounds
Zone 7	Zone 7 Water Agency

Figure SF-2 Largest local watersheds in San Francisco Bay Area



Source: San Francisco Bay Area Region: Integrated Regional Water Management Region Acceptance Process Submittal. April 2009.

Climate

The climate is generally cool and often foggy along the coast, with warmer Mediterranean-like weather in the inland valleys. The average summer high temperature is 80 degrees, nearly 10 degrees higher inland than at San Francisco; resulting in higher outdoor water use in the inland areas. The gap in the hills at Carquinez Strait allows cool

air to flow from the Pacific Ocean into the Sacramento Valley. Most of the interior North Bay and the northern parts of the South Bay are influenced by this marine effect. By contrast, the southern interior portions of the South Bay experience very little marine air movement.

Rainfall amounts vary among sub-regions as well as seasonally and from year to year. Varied topography of the region creates several microclimates dependent upon elevation, creating large climatic differences over a few miles.

Like most of Northern California, the climate in the Bay Region is largely governed by weather patterns originating in the Pacific Ocean, primarily by the southern descent of the Polar Jet Stream, bringing with it mid-latitude cyclonic storms in winter. About 90 percent of the Bay Region precipitation falls between November and April. The North Bay receives about 20 to 25 inches of rain. In the South Bay, east of the Santa Cruz Mountains, annual precipitation is about 15 to 20 inches because of the rain shadow effect. Some higher elevations in the region, particularly along the west-facing slopes, average more than 40 inches of rain per year. Historical variation since 1914 for San Francisco ranges from 9 to 44 inches per year with an average of 21 inches per year.

Population

In 2005, the San Francisco Bay Hydrologic Region had a population of 6.3 million people making it the second largest population of the 10 hydrologic regions. About 17 percent of the state's total population lives in this region; 92 percent of the region's population lives in incorporated cities. Between 2000 and 2005, the region grew by 176,830 people, a growth of 3 percent over the 5-year period. For historical population data, 1960–2005, see Volume 5, The Technical Guide.

In Water Plan Update 2009, projections of population growth are based on the assumptions of future scenarios. Discussion of the three scenarios used in this Water Plan and how the region's population may change through 2050 can be found later in this report under Looking to the Future.

Historically, the San Francisco Bay Region was home to six Tribal groups – the Coast Miwok, Sierra Miwok, Ohlone/Coastanoan, Northern Valley Yokuts, Patwin (Southern Wintu), and Wappo. Forced out by the Spanish, and then the Gold Rush settlers and miners, the displaced descendents of these Tribes still have historical or cultural ties to the Bay Region. The Muwekma Ohlone Indian Tribe of the San Francisco Bay continues to seek federal recognition.

Although there are no lands of federally recognized Indian tribes in the San Francisco Bay Hydrologic Region, California government code §65352.3 requires cities and counties to consult with Native American Indian Tribes during the adoption or amendment of local general plans or specific plans. A contact list of appropriate Tribes and representatives within a region is maintained by the Native American Heritage Commission. A Tribal Consultation Guideline, prepared by the Governor's Office

of Planning and Research, is available online at http://www.opr.ca.gov/programs/docs/09_14_05%20Updated%20Guidelines%20(922).pdf.

Land Use Patterns

Land use in the region is truly diverse. The Bay Region is home to the world-famous Napa Valley and Sonoma County wine industry; international business and tourism in San Francisco; technological development and production in the "Silicon Valley"; as well as urban, suburban, and rural living. In some areas, development occurred on natural floodplains, which may have been used for agriculture prior to floodplain maps being developed by the Federal Emergency Management Agency (FEMA). In the densely populated urban areas, strategies designed to address the demands of population growth with particular focus on infill development are impacted by significant barriers including zoning restrictions, building regulations, and tax incentives encouraging urban sprawl.

Irrigated agriculture uses 21 percent of the region's land area. Agricultural acreage occurs mostly in the north and northeast in Napa, Marin, Sonoma, and Solano counties. Santa Clara and Alameda counties also have significant agricultural acreage at the edge of the urban development. The predominant crops are wine grapes (72 percent) along with fruit and nut trees, hay production, and dairy and livestock operations. In the area along the ocean coastline south of the Golden Gate, half of the irrigated acres include specialty crops, such as artichokes, strawberries, or flowers. The many federal land areas within the Bay Region include Point Reyes Seashore, John Muir Wood Monument and John Muir Historic site, Golden Gate Recreation Area, Alcatraz Island, Fort Point Historic Site, Presidio of San Francisco, San Francisco Maritime Historic Park, Eugene O'Neill Historic Site, Rosie the Riveter WWII Home Front Park, and Port Chicago Naval Magazine Memorial.

Regional Water Conditions

High-quality, reliable water supplies are critical to the Bay Region's prosperity and continued leadership in economic development and environmental protection. Bay Region water agencies seek to protect the quality and reliability of existing supplies through innovative water management strategies and regional cooperation. These agencies manage a diverse portfolio of water supplies including: groundwater, local surface water, Sierra Nevada supplies from the Tuolumne and Mokulmne rivers, Delta supplies via the State Water Project (SWP) and Central Valley Project (CVP) and other sources (recycled water, desalination, transfers).

In 1994, six SWP contractors and the California Department of Water Resources (DWR) created the Monterey Agreement. The purpose of the Monterey Agreement was to increase the reliability of SWP water and increase water management flexibility during periods of water shortage. Further details about the Monterey Agreement can be found in DWR's Bulletin 132-95 online at http://www.dwr.water.ca.gov/swpao/bulletin.cfm.

Environmental Water

Dedicated environmental water use in the area includes instream flows required below most major dams and diversions by the State Water Resources Control Board (State Water Board) licenses and Federal Energy Regulatory Commission (FERC) licenses, and agreements with other agencies. In the Bay Region, many streams flow to the ocean and bay. Coho salmon and steelhead trout, both endangered species, are found in these streams. There are no Wild and Scenic rivers in this region.

Several local governments and conservation groups have initiatives to improve fish passage and re-establish wetlands and habitat for fish and waterfowl and other species.

The Ecosystem Restoration Program (ERP) Conservation Strategy for the Delta and Suisun Marsh Planning Area provides leadership for conservation and restoration. It was developed by the California Department of Fish and Game (DFG) in collaboration with US Fish and Wildlife Service and National Marine Fisheries Service. The strategy reflects changing knowledge, conditions, and understanding of the system, and is intended to facilitate coordination and integration of actions among all resource planning, conservation, and management decisions affecting the Delta and Suisun Marsh. It is integrally linked to the Delta Vision and the conceptual models developed under the Adaptive Management Planning Team and takes into account sea level rise projections and the effects of potential seismic events.

The most important habitats of concern around the shore of San Francisco Bay are deep and shallow bay and channel environments, tidal baylands, and diked baylands. Tidal bayland habitats include tidal flats, marshes (both salt and brackish), and lagoons. Diked bayland habitats include diked wetland, agricultural lowlands, salt ponds, and storage ponds. The San Francisco Bay Joint Venture (SFBJV), established under The Migratory Bird Treaty Act and funded by the Interior Appropriations Act, was created to protect, restore, increase, and enhance all types of wetlands, riparian habitat, and associated uplands throughout the Bay Region to benefit birds, fish, and other wildlife. In 2001 the SFBJV published a 20-year collaborative plan for the restoration of wetlands and wildlife in the Bay Region called "Restoring the Estuary: an Implementation Strategy." This strategy established specific acreage goals for wetlands of three distinct types—bay habitats, seasonal wetlands, and creeks and lakes—and laid out programmatic and cooperative strategies for accomplishing them. The SFBJV partners have agreed to acquire, and/or restore or enhance 260,000 acres of these three types of wetlands over the next two decades throughout the estuary (see San Francisco Bay Joint Venture Web site, http://www.sfbayjv.org/).

The coho salmon (*Oncorhynchus kisutch*) range for California includes coastal draining watersheds from the Oregon border down to northern Monterey Bay. DFG, with the assistance of recovery teams representing diverse interests and perspectives, created the "Recovery Strategy for California Coho Salmon (*Oncorhynchus kisutch*)" (2004), a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for

Table SF-1 Sources of imported surface water, San Francisco Bay Hydrologic Region

Water conveyance facility	Water source	Operator	Counties served	Water supplied to the Bay Region via facility in 2005
San Felipe Unit of CVP	Delta via San Luis Reservoir	USBR (CVP)	Santa Clara and San Benito Counties	35.6 TAF (4%)
Sonoma and Petaluma Aqueducts	Russian River	SCWA	Sonoma and Marin Counties	30.8 TAF (4%)
North Bay Aqueduct - SWP	Northern Delta	DWR (SWP)	Solano and Napa counties	40.2 TAF (5%)
Putah South Canal	Lake Berryessa	USBR	Solano County	44.1 TAF (5%)
Contra Costa Canal	Western Delta	CCWD (CVP)	Contra Costa County	59.0 TAF (7%)
South Bay Aqueduct - SWP	Delta	DWR (SWP)	Alameda and Santa Clara Counties	131.8 TAF (16%)
Mokelumne Aqueduct	Mokelumne River	EBMUD	Alameda and Contra Costa Counties	200.6 TAF (25%)
Hetch Hetchy Aqueduct	Tuolumne River	SFPUC	San Francisco, San Mateo, Alameda, and Santa Clara Counties	267.3 TAF (33%)

restorative actions, and maintaining a balance between regulatory and voluntary efforts. Landowner incentives and grant programs are some of the many tools available to recover coho salmon. The success of this Recovery Strategy will depend on the long-term commitment and efforts of all who live in, or are involved with, coho salmon watersheds.

Water Supplies

Water supply sources include local surface streams, imported surface water, desalination, groundwater, and a small amount of recycled wastewater. About 70 percent of the urban supplies are imported to the region.

Surface Water

In the early 1900s, local water agencies developed significant imported water supplies from the Mokelumne and Tuolumne rivers to meet anticipated demands. Local reservoirs and watersheds were developed to capture surface supplies, recharge the groundwater basins, and act as terminal reservoirs for the larger projects. In the late 1960s, the SWP's South Bay Aqueduct and the North Bay Aqueduct (NBA) brought water into the region. Federal water projects began with the Contra Costa Canal in 1937, the Solano Project in 1958, and the San Felipe Project in 1979.

Table SF-1 shows the sources, conveyance facilities, and quantities of imported surface water that flow through each facility.

Local streams are used by a large part of the Bay Region population. In the South Bay, local streams make up a significant portion of the supply for the San Francisco Water

Department, City of San Jose, cities in Alameda County, and small developments in the surrounding mountainous areas.

In Santa Clara, several large dams capture more than 100 thousand acre-feet per year of local surface water, which is slowly released for groundwater recharge. The groundwater basin is used as the conveyance system to deliver the supplies to the local purveyors, who work with Santa Clara Valley Water District (SCVWD) to maintain the groundwater basin.

The Alameda County Water District (ACWD) and Zone 7 Water Agency (Zone 7) recharge their groundwater basins with local surface water and the SWP and use the basin as part of their conveyance system. Also, ACWD is also currently desalinating brackish groundwater using its aquifer rehabilitation project.

In the North Bay, local streams play a larger role, providing a majority of the supplies for Marin and Napa counties. Local surface water and groundwater provides 47 percent of the water supply for urban, agriculture, and managed wetlands. This does not include instream flow requirements.

Groundwater

Local groundwater accounts for about 15 percent of the region's average water year supply. The more heavily used basins include the Santa Clara Valley, Livermore Valley, Westside, Niles Cone, Napa-Sonoma Valley, and Petaluma Valley groundwater basins. For agencies like SCVWD, ACWD, and Zone 7, groundwater is a critically important component that reduces the demand on imported water. Conjunctive use programs have been implemented by these agencies to optimize the use of groundwater and surface water resources; currently, water quality programs are in place to monitor and protect groundwater quality. Throughout the region, additional groundwater resources continue to be investigated and developed to expand the role of conjunctive use programs.

The Bay Region has 28 identified groundwater basins. Two of these, the Napa-Sonoma Valley and Santa Clara Valley groundwater basins, are further divided into three and four subbasins, respectively. The groundwater basins underlie approximately 896,000 acres (1,400 square miles) or about 30 percent of the entire San Francisco Bay Hydrologic Region.

In general, the freshwater-bearing aquifers are relatively thin in the smaller basins and moderately thick in the more heavily used basins. In the more heavily used basins (i.e., Santa Clara Valley, Napa-Sonoma Valley, and Petaluma Valley groundwater basins), the municipal and irrigation wells have average depths ranging from about 200 to 500 feet. Well yields in these basins range from less than 50 gallons per minute to approximately 3,000 gallons per minute. In the smaller basins, most municipal and irrigation wells have average well depths in the 100-foot to 200-foot range. Well yields in the smaller and less used basins are typically less than 500 gallons per minute.

Land subsidence has been a significant problem in the Santa Clara Valley Groundwater Basin in the past with subsidence nearing 13 feet in some areas. SCVWD surveys hundreds of benchmarks each year and uses numerical modeling to monitor subsidence; SCVWD has set subsidence thresholds according to the SCVWD 2001 Groundwater Management Plan.

Recycled Water

Recycled water in the Bay Region is used in a full spectrum of applications, including landscape irrigation, agricultural needs, commercial and industrial purposes, and as a supply to the area's many wetlands. The area has a large potential market for recycled water, up to 240,000 acre-feet per year by 2025, as reported in the 1999 Bay Area Recycled Water Master Plan. The 2006 Bay Area IRWMP identified 27 recycled water projects.

The San Francisco Bay Region has a long history of regional recycled water planning. In the early 1990's, following years of drought and facing uncertain future water supplies, the Bay Area Clean Water Agencies (BACWA), consisting of wastewater and public water utilities, formed a partnership with the US Bureau of Reclamation (USBR) and DWR to study the feasibility of a regional approach to water recycling in the Bay Region. This study, the Bay Area Regional Water Recycling Program (BARWRP), remains at the foundation of regional recycled water planning throughout the Bay Area today. The integrated planning process that has been implemented has further intensified partnerships among Bay Area agencies in the development of recycled water projects, and created opportunities for collaboration between the Bay Area IRWM region and the East Contra Costa County IRWM region to develop joint recycled water projects. Integrated regional planning in the Bay Area has also led to the development of the Bay Area Regional Water Recycling Program Authorization Act in 2008, which enabled eight recycled water projects to be funded by the USBR under Title 16, and more recently, the Bay Area Regional Water Recycling Program Expansion Act of 2009, which will add six more recycled water projects to the federal stimulus funding list.

In July 2009, SCVWD was awarded federal stimulus money for two recycled water programs. The moneys will go towards the improvement of the South Bay Advanced Recycled Water Treatment Facility, a joint effort between the water district and City of San Jose to treat wastewater byproducts; it will also be used to continue to develop short-term and long-term aspects of SCVWD's South County Recycled Water Master Plan.

Water Uses

Water use in the Bay Region is predominantly urban; 50 percent of the use is residential. There are also numerous industrial users around the bay. Agricultural water use is a much smaller percentage of total water use in this region compared to inland regions, such as the Sacramento River region, San Joaquin River region, and the Tulare Lake region. For example, in the San Francisco Bay region part of the SCVWD service area,

agricultural use is less than one percent of total water use of 383,000 acre-feet per year (2005).

About 70 percent of the water supply in the San Francisco Bay Hydrologic Region is imported and is relatively expensive due to the capital, operations and maintenance costs of the projects. Water rates, small lot sizes, cooler climate, and higher density development all contribute to relatively low per capita urban water usage. The City of San Francisco has a per capita use of around 100 gallons per day; ACWD, 160 gallons per day; and Marin Municipal Water District, 145 gallons per day. In contrast, water usage rates for communities in the warmer Central Valley regions can range from 200 gallons per day to 300 gallons per day.

Droughts, climate change, and growth all could negatively impact the reliability of available water supplies. Local governments have begun requiring water efficient devices in new construction and both local governments and water agencies have rebate programs for replacing older less efficient devices such as washing machines and toilets. Some agencies are offering incentive programs to remove or reduce lawn size ranging from $0.25 to $1.00 per square-foot. Most water agencies have conservation tips and rebates and information on their websites. In addition there are state and multi-agency websites such as www.saveourh2o.org, www.h2ouse.org, and watersavinghero.com promoting conservation.

Monitoring and metering allow greater flexibility to the purveyors, enabling tier rates, incentives, public outreach programs, and other efforts to maintain low water usage. Much of the area is well-developed and is undergoing urban renewal. The older areas of Oakland and San Francisco have new construction replacing older buildings, which brings greater efficiencies to service areas.

Water Balance Summary

Figure SF-3 summarizes the total developed water supplies and distribution of the dedicated water uses within this hydrologic region for the eight years from 1998 through 2005. As indicated by the variation in the horizontal bars for wet (1998) and dry (2001) years, the distribution of the dedicated supply to various uses can change significantly based on the wetness or dryness of the water year. More detailed numerical information about the developed water supplies and uses is presented in Volume 5 The Technical Guide, which provides a breakdown of the components of developed supplies used for agricultural, urban, and environmental purposes and Water Portfolio data.

For the Bay Region, urban water uses dominate the developed water use categories, while environmental needs for instream flows are also a significant dedicated water use. As shown, agricultural water use in this region is a very small portion of the total. The water supply portion of Figure SF-3 also indicates that a large part of the water supply in this region is from surface water imports from other regions, while groundwater pumping is a smaller component of the developed water supplies.

Figure SF-3 San Francisco Bay Hydrologic Region water balance summary, 1998–2005

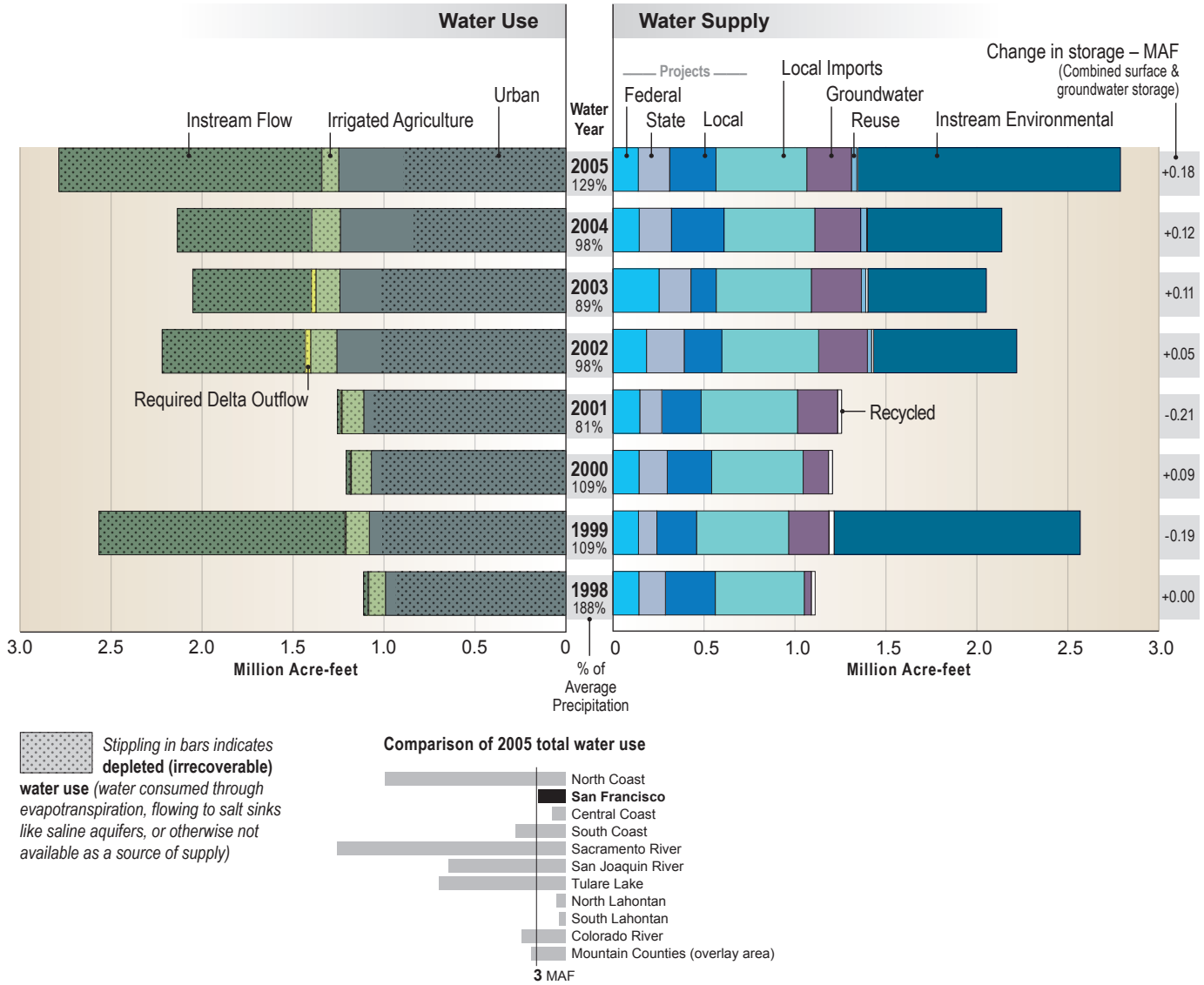


Table SF-2 presents information about the total water supply available to this region for the eight years from 1998 through 2005 and the estimated distribution of these water supplies to all uses. The annual change in the region's surface and groundwater storage is also estimated, as part of the balance between supplies and uses. In wetter water years, water will usually be added to storage, while during drier water years storage volumes may be reduced. Of the total water supply to the region, more than half is used by native vegetation; evaporates to the atmosphere; provides some of the water for agricultural crops and managed wetlands (effective precipitation); or flows to other states, the Pacific Ocean, and salt sinks like saline groundwater aquifers. The remaining portion, identified as consumptive use of applied water, is distributed among urban and agricultural uses and for diversions to managed wetlands. For some of the data values presented

Table SF-2 San Francisco Bay Hydrologic Region water balance for 1998-2005 (thousand acre-feet)

San Francisco Bay	Water Year (Percent of Normal Precipitation)							
	1998 (188%)	1999 (109%)	2000 (109%)	2001 (81%)	2002 (98%)	2003 (89%)	2004 (98%)	2005 (129%)
Water Entering the Region								
Precipitation*	11,438	6,784	6,644	4,908	6,061	5,539	6,072	8,047
Inflow from Oregon/Mexico	0	0	0	0	0	0	0	0
Inflow from Colorado River	0	0	0	0	0	0	0	0
Imports from Other Regions	764	926	823	872	950	1,157	1,163	1,175
Total	**12,202**	**7,710**	**7,467**	**5,780**	**7,011**	**6,696**	**7,235**	**9,222**
Water Leaving the Region								
Consumptive Use of Applied Water ** (Ag, M&I, Wetlands)	363	545	394	415	472	431	452	395
Outflow to Oregon/Nevada/Mexico	0	0	0	0	0	0	0	0
Exports to Other Regions	0	0	0	0	0	0	0	0
Statutory Required Outflow to Salt Sink	23	1,353	22	20	787	651	739	1,444
Additional Outflow to Salt Sink	664	589	727	759	674	701	518	569
Evaporation, Evapotranspiration of Native Vegetation, Groundwater Subsurface Outflows, Natural and Incidental Runoff, Ag Effective Precipitation & Other Outflows	11,146	5,408	6,234	4,795	5,028	4,804	5,405	6,636
Total	**12,196**	**7,895**	**7,377**	**5,989**	**6,961**	**6,587**	**7,114**	**9,044**
Storage Changes in the Region [+] Water added to storage [-] Water removed from storage Change in Surface Reservoir Storage	76	-37	-25	-56	-37	40	-39	52
Change in Groundwater Storage ***	-70	-148	115	-153	87	70	160	127
Total	**6**	**-185**	**90**	**-209**	**50**	**110**	**121**	**179**
Applied Water ** (compare with Consumptive Use)	1,060	1,192	1,158	1,214	1,285	1,254	1,237	1,180

* The percent precipitation is based upon a running 30 year average of precipitation for the region and discrepancies can occur between information calculated for Update 2009 and earlier published data.

** Consumptive use is the amount of applied water used and no longer available as a source of supply. Applied water is greater than consumptive use because it includes consumptive use, reuse, and outflows.

*** Change in Groundwater Storage is based upon best available information. Basins in the north part of the state (North Coast, San Francisco, Sacramento River and North Lahontan regions and parts of Central Coast and San Joaquin River Regions) were modeled - spring 1997 to spring 1998 for the 1998 water year and spring 1999 to spring 2000 for the 2000 water year. All other regions and years were calculated using the following equation:

GW change in storage = intentional recharge + deep percolation of applied water + conveyance deep percolation and seepage - withdrawals

This equation does not include the unknown factors such as natural recharge and subsurface inflow and outflow.

in Table SF-2, the numerical values were developed by estimation techniques because actual measured data are not available for all categories of water supply and use.

Water Quality

The Bay Region's immediate watershed is highly urbanized, resulting in contaminant loads from both point and nonpoint sources, as well as pollutants from the Delta and the Central Valley. The Regional Water Board is the lead agency charged with protecting and enhancing surface and ground water quality in the region.

Overarching Water Quality Issues. Great progress has been made over the last 50 years in dealing with water quality problems, both surface and groundwater, in the Bay Region. However, despite successful pollutant reduction efforts in the regulation of municipal and industrial wastewater discharges through the National Pollutant Discharge Elimination System (NPDES), many significant issues remain to be resolved. Among these is the decline in the quantity and quality of the biological resources of the bay. There are fewer fish and other aquatic and riparian species, native species are on the decline, and some species have significant levels of contamination, which has led to health advisories for human consumption and adverse effects on species health and reproduction. The water quality of many water bodies continues to be degraded from pollutants discharged from diffuse sources, referred to as nonpoint sources, and from the cumulative impacts of multiple point sources such as urban runoff. Many of the region's creeks are channelized, culverted, or otherwise geomorphically altered, which has had adverse impacts on aquatic and riparian habitats, sediment transfer, and hydrology.

Drinking water sources range from high quality Hetch Hetchy and Mokelumne River supplies and local surface and groundwater to variable-quality Delta water. Utilities that depend on the Delta for all or part of their domestic water supplies meet the current drinking water standards, though they remain concerned about issues such as microbial contamination, salinity, and organic carbon. Delta water constitutes about one-third of the domestic water in the Bay Region. Groundwater supplies still face threats due to contamination from spills, leaks, and discharges (e.g., solvents, fuels) affecting the beneficial uses, including potable use.

There are also water quality impacts in the more rural areas of the region from grazing and agriculture, confined animal facilities, onsite sewage systems, and land conversions. Coastal watersheds are impaired due to impacts from sedimentation and habitat degradation (e.g., excess fine sediments, lack of large woody debris, and lack of spawning gravels).

Surface Water Pollution Issues and Priorities

The main pollution challenges are associated with legacy and emerging toxic pollutants and urban and rural runoff.

Toxic Pollutants. Legacy pollutants result from past human activities such as mining; manufacture, distribution, and use of agricultural pesticides; and industrial products. These include mercury, PCBs, and chlorinated pesticides. Other pollutants of concern include selenium and PCBs, from past and ongoing discharges, and emerging pollutants such as flame retardants, pesticides, and pharmaceuticals. The Regional Water Board continues to monitor these pollutants and take steps to reduce them and continues to work with local agencies on sanitary sewer overflows and spills, which are largely due to aging infrastructure of treatment plants and collection systems.

Invasive Species. San Francisco Bay is considered one of the most highly invaded estuaries in the world. Invasive species have reduced or eliminated native populations, disrupted food webs, eroded marshes, and interfered with boating and water contact recreation. The Regional Water Board and other agencies are working to implement the *California Aquatic Invasive Species Management Plan* signed by the Governor in January 2008. The plan focuses on the early detection and rapid response actions, risk assessment of the primary introduction vectors, and improved coordination among agency partners.

San Francisco Bay Estuary, Water Diversions and Delta Issues. In addition to pollution control measures, achieving water quality objectives and protecting the beneficial uses of the San Francisco Bay Estuary system (particularly fish migration and estuarine habitat) depend on freshwater outflow from the Delta. Adequate freshwater inflow to the bay system is necessary to control salinity, to provide mixing (particularly in the entrapment zone), to maintain proper temperature, and to flush out residual pollutants that cannot be eliminated by treatment or source management. The Sacramento and San Joaquin rivers, which enter the bay system through the Delta at the eastern end of Suisun Bay, contribute almost all of the freshwater inflow to the bay. Many small rivers and streams also convey fresh water to the bay system. Flows in the creeks in the Bay Area are highly seasonal, with more than 90 percent of the annual runoff occurring during the winter rainy season between November and April.

Staff from the State Water Board and the San Francisco Bay and Central Valley water boards have formed the "Bay-Delta Team" to improve coordination of the Water Boards' activities in the San Francisco Bay and the Delta. Habitat in the Suisun Marsh is threatened by a variety of pollutants and land practices. Exotic and invasive species, such as the Chinese mitten crab, New Zealand mud snail, Asian clam, and introduced Spartina (cordgrass) threaten to undermine the estuary's food web and alter its ecosystem.

Runoff Pollution and Hydromodification. Bay Area streams have been channelized and rerouted; and riparian areas have been degraded or denuded in many cases, with significant impacts to floodplains, flood storage, and groundwater recharge areas. Both urban and rural runoff sources of pollutants include toxic residues, pathogens, nutrients, and sediment.

Wetland Restoration. The Baylands Ecosystem Habitat Goals Project, a major multi-partner, multi-disciplinary effort completed in the late 1990s, developed recommendations for the kinds, amounts, and distribution of wetlands and related habitats for the Bay Area and was a catalyst for undertaking large-scale and significant wetland restoration in the region. In the past 10 years, the Regional Water Board has been increasingly involved with providing technical input and permitting for thousands of acres of wetland and riparian restoration projects currently underway around the bay. One of the most significant long-term projects is the South Bay Salt Pond Restoration Project, a multi-year restoration of 15,100 acres of former salt ponds in Alameda and Santa Clara counties, and the largest wetland restoration project on the West Coast.

Groundwater Pollution Issues and Priorities

Groundwater basins provide excellent natural storage, distribution, and treatment systems, as well as supplying high quality water for drinking, irrigation, and industrial processes. As an important source of freshwater replenishment, groundwater also discharges to surface streams, wetlands, and San Francisco Bay. Per State Water Board Resolution No. 88-63, almost all the region's groundwater is considered to be an existing or a potential source of drinking water. DWR has identified 28 individual groundwater basins and seven subbasins in the region that serve, or could serve, as sources of high quality drinking water. Years of drought and decades of groundwater pollution have resulted in impacts or impairment to portions of these basins, mainly in shallow groundwater zones. Some municipal, domestic, industrial, and agricultural supply wells have been taken out of service due to the presence of pollution. Some of the basins were affected by over-pumping, resulting in land subsidence and saltwater intrusion, although active groundwater management has stopped or reversed the saltwater intrusion.

Future Water Quality Priorities and Actions

Total Maximum Daily Load (TMDL). One of the major shifts for the Regional Water Board in priorities over the past ten years has been toward developing and implementing TMDLs for pollutants causing water quality impairments (primarily sediments, pathogens, nutrients, mercury, polychlorinated biphenyls, and urban pesticides). TMDLs are watershed-based and should contribute to meeting goals of the California Water Plan through improved watershed and habitat management actions.

Low Impact Development. The Regional Water Board along with municipal storm water agencies, the San Francisco Estuary Project, and other partners have come together in the region to promote Low Impact Development. To support this effort, it has been proposed that the IRWM plan process be used to encourage cities and counties to link land use planning with water system and water quality planning. This includes encouraging adoption of the *Ahwahnee Water Principles for Resource Efficient Land Use* into local zoning codes, planning codes, specific plans, or general plan elements; use of imperviousness as a planning tool; and development of watershed plans.

Integrated Regional Water Management Planning. Regional Water Board staff has been involved with the San Francisco Bay Region IRWM plan process and expects to continue working closely with the coordinating committee and subregional stakeholders.

Expanded Groundwater Storage. Regional Water Board staff expect to see greater reliance on groundwater basins for offline storage of potable water in response to drought cycles and the anticipated effects of climate change (e.g., smaller Sierra snowpack). This trend will increase the need for aquifer protection and groundwater management.

Further discussion of the Water Quality issues is contained in Appendix B on:

- Surface Water Pollution Issues and Priorities: Toxic Pollutants, Water Diversions, Hydromodification and Wetland Restoration, Critical Coastal Areas
- Groundwater Protection Issues and Priorities
- Future Water Quality Issues and Priorities: TMDLs, Low Impact Development, Riparian Habitat Protection

Flooding. Floodwater in urban areas can pick up contaminants from streets, industrial areas, service stations, wastewater transmission lines, and many other sources. This toxic, urban "soup" can spread highly contaminated, toxic waters over large area, destroying homes, furniture, retail spaces, landscaping, and possibly sickening people and pets that come into contact with it. Cleaning up the soupy mess after a flood disaster presents a host of problems. The most effective approach is to work diligently to prevent flooding in urban areas.

Project Operations

More than 800 thousand acre-feet of imported water was delivered to the Bay Region through various water projects in 2005. In the North Bay, water project facilities include the Sonoma and Petaluma aqueducts, Putah South Canal, and SWP's NBA (which includes Vallejo Permit Water). Imported water in the North Bay accounts for half the total water use in 2005. In the South Bay, project water facilities include the Contra Costa Canal (CVP), Mokelumne Aqueduct, Hetch Hetchy Aqueduct, South Bay Aqueduct (SWP), and the San Felipe Unit (CVP). Annual imported water use varies in the South Bay between 60 percent and 70 percent of the total water use. Region-wide imported water accounts for about 70 percent of the total water use. The South Bay receives the largest imported water supply with more than 650 thousand acre-feet from the San Joaquin River region. In 2005, the Tuolumne River supplied more than 260 thousand acre-feet through the Hetch Hetchy Aqueduct, and more than 201 thousand acre-feet was delivered through the Mokelumne Aqueduct from the Mokelumne River. Hydrologic regions importing water to the Bay Region in 2005 were San Joaquin River, 81.4 percent; Sacramento River, 14.8 percent; and North Coast, 3.8 percent.

Urban Water Use for the 2005 water year was just over 1,300 thousand acre-feet (90 percent of total water use) in the Bay Area. Developed water progresses through

Table SF-3 Water governance and planning, San Francisco Bay Hydrologic Region

Organization	Legal Status	Purpose
Local water and wastewater agencies and districts	Local government	Water storage and delivery, wastewater treatment
Importing water agencies (EBMUD, HHW&P, SWP, CVP, numerous others)	Local government, state and federal projects	Water storage and delivery, wastewater treatment, flood management
City and county governments	Local government	Water delivery, wastewater treatment, flood management, land use zoning
Regulating agencies (SWRCB, RWQCB, DPH, DSOD, FERC)	State and federal government	Regulation of water diversions, water quality, hydroelectric projects, dam safety
IRWM planning members (numerous)	Varies	Regional water plan development and implementation

a series of State, federal and local water projects conveyed from outside the region to 30+ reservoirs and dams within the San Francisco Bay Hydrologic Region, mainly for storage purposes. The exception to this is the multi-purpose Lake Del Valle and Dam in Alameda County on the Arroyo Valle River. Over 170 thousand acre-feet were supplied to the region through SWP facilities; more than 75 percent of those deliveries were through the South Bay Aqueduct.

Water Governance

Numerous local government agencies and districts deliver water and recycled water and provide wastewater treatment in the San Francisco Bay Hydrological Region (Table SF-3). Many planning organizations in the region identify present and future challenges in the region including land use, housing, environmental quality, economic development, wetlands, water quality and reliability, storm water management and flood protection, watershed and groundwater management, fisheries and ecosystem restoration (Box SF-2 Planning Organizations). More complete information on water governance will be developed for California Water Plan Update 2013. This will include identification of local, State, Tribal, and federal government agencies and institutions that are responsible for managing the region's water resources, flood protection, and wastewater. A list of regional flood management participants is included in Appendix A Flood Management, and IRWM Plans provide information about water planning organizations in this region.

Flood Management

Because the region generally receives very little snow, floodwaters originate primarily from intense rainstorms. The northern portion of the region receives greater precipitation and floods more often than the southern portion. Flooding occurs most frequently in winter and spring, and the steep terrain results in floods that are intense and of short duration. Valley flooding tends to occur when large, widespread storms fall on previously saturated watersheds. The greatest flood damages occur in low-gradient lower

Box SF-2 Planning Organizations, San Francisco Bay Hydrologic Region

Bay Area/North Coast/Central Coast Water Quality and Sustainability Work Group. This workgroup was formed to identify and describe the connections between water quality and climate change on the coast from central California to the Oregon border as well as actions in the water quality arena that can help reduce greenhouse gases and solve the problems created by climate change.

Bay Area Water Supply and Conservation Agency (BAWSCA). The Bay Area Water Supply and Conservation Agency represents the interests of 26 cities and water districts, and two private utilities that purchase water on a wholesale basis from the San Francisco Public Utilities Commission (SFPUC) regional water system. BAWSCA's goals are to ensure high quality, reliable water supply for the 1.7 million people residing in Alameda, Santa Clara, and San Mateo Counties that depend on the SFPUC regional water system. (Website: www.bawsca.org)

Bay Area Water Forum. First convened in 2000 to provide a venue for all stakeholders in the Bay region, including water, wastewater, flood control and storm water agencies, local governments, environmental and business groups, community and civic organizations and the general public, to identify, educate one another, and work cooperatively on key water resources issues for the Bay region. (Website: www.baywaterforum.org)

ABAG. Formed in 1961, ABAG is the official comprehensive planning agency for the San Francisco Bay region. ABAG's mission is to strengthen cooperation and coordination among local governments. In doing so, ABAG addresses social, environmental, and economic issues that transcend local borders. (Website: www.ABAG.ca.gov)

Bay Area Water Agencies Coalition. Established in 2002 to provide a forum and a framework for water agency general managers to discuss water management planning issues and coordinate projects and programs to improve water supply reliability and water quality.

Northern California Salinity Coalition. Created in 2003 to advance the interests of the eight member water agencies in the development of local and regional efforts that will use desalination or salinity management technologies, practices, and approaches to improve water supply reliability for coalition members and to reduce salinity-related problems affecting the water supplies of the member agencies.

Bay Area Clean Water Agencies. Founded in 1984, BACWA is an association comprised of local governmental agencies that own and operate publicly owned treatment works that discharge to the waters of San Francisco Bay Estuary. BACWA's members serve more than 6 million people in the Bay Area, treating all domestic and commercial wastewater and a significant amount of industrial wastewater. (Website: www.bacwa.org)

Bay Planning Coalition. Established in 1983, the BPC is a nonprofit, membership-based organization representing the maritime industry and related shoreline business, ports and local governments, landowners, recreational users, environmental and business organizations, and professional service firms in engineering, construction, law, planning, and environmental sciences. (Website: www.bayplanningcoalition.org)

Bay Area Flood Protection Agencies Association. Established in 2006 as an outgrowth of the Bay Area Integrated Regional Water Management process. Membership in BAFPAA includes Bay Area counties and special districts with responsibility for flood protection and stormwater management.

Bay Area Integrated Regional Water Management Coordinating Committee (BAIRWMP). Represents a significant accomplishment in regional water resources planning. It outlines the region's water resources management needs and objectives, and presents innovative strategies and a detailed implantation Plan to achieve these objectives, contributing to sustainable water resources management in the Bay Area. (Website: www.bairwmp.org)

Bay Area Watershed Network. Organized in 2006 to provide a forum for watershed stakeholders to bring together a wide variety of agencies, technical experts, and nongovernmental organizations (NGOs) with diverse expertise and points of view to work and coordinate ideas, proposals and activities related to watershed management, planning and restoration. Working groups have been formed to work on policy, coordination with the Integrated Regional Water Management process, assessment and monitoring tools, and education and outreach activities. (Meeting information at www.sfbayjv.org)

reaches as channels overflow and floodwaters spread through urban neighborhoods. Hillsides denuded by wildfires can exacerbate flood-induced damages by increasing runoff and contributing increased sediment. Flooding at river mouths often occurs, and storm surges coincident with high tides can create severe flooding in low-lying areas.

Flood hazards in the region include these representative situations (for specific instances, see Challenges):

- Protection from flooding is not provided for a flood equal to the event with 1 percent probability (1 percent event) for some residential and commercial facilities.
- Some existing culverts and channels do not have sufficient capacity to carry flow resulting from the 1 percent event.
- Some existing levees are not able to retain the 1 percent event.
- Development occurs in the floodplain of the 1 percent event without sufficient mitigation, causing increased flood damage consequences.
- Population growth and the ensuing development increase the area of impervious surface without sufficient mitigation, increasing peak and total runoff.
- Reservoir siltation has reduced flood storage capacity.
- Unregulated streams threaten to damage aging transportation facilities at flood stages.
- Wildfires may denude steep slopes, which are then vulnerable to increased runoff and debris flow during ensuing storms.
- Unmanaged vegetation has reduced flood flow capacity at some locations.
- Invasive fauna threatens the integrity of flood infrastructure.
- Development at streamside or shoreline has made management of areas prone to tidal flooding difficult.
- Public education about flood hazards is insufficient at some locations.

Historic Floods

Notable flood events include:

- The Great Flood of 1861-1862
- The St. Valentine's Day flood of 1986 in many locations
- Alameda Creek floods in 1955 and 1958
- Corte Madera Creek floods in 1982, 1983, and 2006
- Coyote Creek floods in 1982, 1997, and 1998
- Guadalupe River floods in January and March 1995
- Napa River Floods in 1963, 1970, 1986, 1995 and 2002
- A Novato Creek flood in 1982

See Appendix A Table SFA-1 Record floods for selected streams, San Francisco Bay Hydrologic Region

Flood Governance

Flood management is a cooperative effort in which federal, tribal, State, and local governments all play significant parts. The principal participants are listed in Box SF-3, Flood Management Agencies. For more information on the agencies' roles, see Table SFA-2, Flood management participants, in Appendix A.

Box SF-3 Flood Management Agencies, San Francisco Bay Hydrologic Region

Federal

- Federal Emergency Management Agency
- National Weather Service
- Natural Resources Conservation Service
- United States Geological Survey
- United States Army Corps of Engineers

Tribal

- Tribal governments of the region

State

- California Conservation Corps
- California Emergency Management Agency
- Department of Corrections
- Department of Forestry and Fire Protection
- Department of Water Resources

Local

- Alameda County Flood Control and Water Conservation District
- Contra Costa County FCWCD
- Marin County FCWCD
- Napa County FCWCD
- San Francisco Department of Public Works
- San Francisquito Creek Joint Powers Authority
- San Mateo County Flood Control District
- Santa Clara Valley Water District
- Sonoma County Water Agency
- Zone 7 Water Agency
- County and city emergency services units
- County and city planning departments
- County and city building departments
- Local flood maintenance organizations
- Local resource conservation districts
- Local conservation corps
- Local emergency response agencies
- Local initial responders to emergencies

Flood Risk Management

Flood risk management includes a wide variety of projects and programs, which may be grouped as Structural Approaches (constructed facilities, coordination and reservoir operations, maintenance); Land Use Management (regulation, flood insurance); and Disaster Preparedness, Response, and Recovery (information and education, event management).

Structural Approaches

Constructed Facilities. Flood control facilities in the San Francisco Bay region are generally local in scope rather than parts of a flood protection system serving a large area. Completed projects include reservoirs, levees, and channel improvements. Other reservoirs may also provide incidental flood control benefits.

The region has three reservoirs with specific flood protection functions. Lake Chesbro, built by SCVWD, protects San Jose; and Lake Del Valle, a SWP facility, protects Pleasanton, Fremont, Niles, and Union City. Cull Creek Reservoir, a project of Alameda County Flood Control and Water Conservation District (FCWCD), protects Castro Valley.

Many channel improvement projects were built to reduce flooding on individual streams. These projects include channel construction, enlargement, realignment, lining, stabilization and bank protection. The US Army Corps of Engineers (USACE) projects are in place on Alameda Creek near Pleasanton (working together with Lake Del Valle), several streams near Fairfield, San Lorenzo Creek near Hayward, Walnut Creek near Concord, Corte Madera Creek at Corte Madera, Coyote Creek, Berryessa Creek, and the Guadalupe River at San Jose, the Napa River at St. Helena and Napa, Wildcat and San Pablo Creeks at Richmond, another Coyote Creek in Tamalpais Valley, Green Valley Creek north of Suisun Bay, Pinole Creek at Pinole, Rheem Creek at San Pablo, Rodeo Creek at Rodeo, and San Leandro Creek near Oakland. Another USACE project featuring bank protection on San Francisco Bay protects Emeryville from flooding. The US Natural Resources Conservation Service (NRCS) has contributed construction funds to Contra Costa County FCWCD's detention basin on Pine Creek above Concord and flood control reservoir and channel work on several tributaries of Walnut Creek in Diablo Valley, SCVWD's channel improvements on lower Silver Creek at San Jose, Alameda County FCWCD's channel stabilization on Cull Creek east of Castro Valley, and channel improvements on Conn and Tulcay creeks as part of the Napa County FCWCD's Napa River Project. There are also levees that have been constructed and are maintained by local government or individuals. Notable among these are levees in the Suisun Marsh.

Local sponsors and descriptions for reservoirs and non-storage flood control facilities in the region are listed in Appendix A in Table SFA-3, Flood control facilities.

Coordination and Reservoir Operations. There are no formal agreements for operation of flood protection facilities in the region. The reserved space in multipurpose reservoirs is most often defined by a trapezoidal diagram of volume required versus date, modified by conditions in the latter part of flood season. Generally, the diagrams require a flood space reservation increasing from zero from the beginning of the flood season, invariant with date during mid-season, and decreasing to zero again at season's end. Superimposed on these diagrams are modifications based on either an antecedent precipitation index or a runoff forecast. The index-controlled diagrams are usually decreased from the trapezoid and shortened in time during drier years, beginning in mid-season. The runoff-controlled diagrams increase the trapezoid and extend it in time for the greater runoff forecasts. Single-purpose flood control reservoirs are kept as low as possible. For any reservoir, there are usually downstream controls of various kinds on evacuation rates. For more information on flood control reservoirs, see Table SFA-3, Flood control facilities, in Appendix A.

Maintenance. Maintenance of flood control works is a critical activity that preserves the integrity of the facilities, ensuring continued protection for the public. This effort is made more difficult by two factors. Lack of adequate financing for many installations is the result of tax-management efforts of the late twentieth century which have placed controls on former sources of revenue, and heightened public awareness of the environment has resulted in new regulations making the permitting process lengthy and

expensive. Compounding the problem, deferred maintenance can cause establishment of new habitat which then must be protected.

Maintenance of flood control facilities is usually the responsibility of the local maintaining agency, which is usually the local sponsor, or if there is none, the constructing agency. USACE projects in the region are maintained by the sponsoring local maintenance agency, except that DWR maintains Lake Del Valle. NRCS projects follow a pattern of close cooperation with a local sponsor, with NRCS providing maintenance standards and the local sponsor performing the maintenance. The local constructing agency maintains non-federal projects in this region.

Land Use Management

Regulation. Counties are the main agencies responsible for regulating floodways. All counties within the San Francisco Bay Hydrologic Region have ordinances regulating floodplain development and floodplain management is usually part of the counties' general plans. A number of cities have additional ordinances that further restrict development in areas particularly susceptible to flooding. All local land use jurisdictions must adopt a floodplain management ordinance identifying 1 percent floodplains and floodways, in order to qualify for FEMA flood insurance.

Adopting designated floodways facilitates enforcement of floodplain building ordinances.

Officially designated floodways in the region include Cull, Crow Canyon, Alameda, and Arroyo de la Laguna creeks in Alameda County; the Napa River in Napa County; Sonoma and San Antonio Creeks in Sonoma County; and Novato Creek in Marin County.

Flood Insurance. The National Flood Insurance Program (NFIP) is administered by FEMA. It enables property owners in participating communities to purchase insurance as protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. About 97 percent of California communities participate in the NFIP. Of those, approximately 12 percent participate in the Community Rating System (CRS) Program, which encourages communities to go beyond minimum NFIP requirements in return for reduced insurance rates. Quality mapping is critical to administering an effective flood insurance program, developing hydrologic and hydraulic information for determining floodplain boundaries, and allocating flood protection project funds.

FEMA has provided Flood Insurance Rate Maps (FIRMs) for all counties in the region. As of June 2009, FIRMs in seven of the region's eight counties are new since 2008, and one more is scheduled to be updated by 2010. San Francisco City and County is not scheduled for update.

CRS rates communities from 1 to 10 on the effectiveness of flood protection activities. The lower ratings bring larger discounts on flood insurance. Of the 8 counties, one city and county, and 85 cities within the hydrologic region, 4 counties and 20 cities participate in CRS. As of May 2009, Contra Costa County, Milpitas, and Petaluma are in CRS Class 6; Alameda County, Solano County Fremont, Palo Alto, San Jose, Sunnyvale, and Walnut Creek, Class 7; Concord, Corte Madera, Cupertino, Los Altos, Mountain View, Napa, Novato, Pleasant Hill, Pleasanton, San Leandro, San Ramon, and Santa Clara, Class 8; Richmond, Class 9, and Santa Clara County, Class 10. See http://www.fema.gov/business/nfip/crs.shtm for more information on the CRS system.

Disaster Preparedness, Response, and Recovery

Information and Education. California Data Exchange Center (CDEC) provides real-time and historical hydrometeorological data for hundreds of stations statewide, as well as real-time data on releases, spill rates, and elevations of many reservoirs. For this region, CDEC provides gage data from California Department of Forestry and Fire Protection (31 gages), DWR (18), and several other federal, State, and local agencies, a total of 133 gages, and real-time flow and stage data for the Petaluma, Napa, and Guadalupe rivers and Alameda and Coyote creeks. For access to CDEC data, see http://cdec.water.ca.gov.

The US Geological Survey (USGS) maintains and publishes statistics for stream gages nationwide. USGS gages are the source of data for the nine stations listed in Appendix A, Table SFA-1, Flood parameters for principal streams. For access to USGS gage data, see http://waterdata.usgs.gov/nwis.

DWR's Awareness Floodplain Mapping program provides an easy-to-use computer interface for viewing areas vulnerable to flooding by the flood event having a 1 percent probability of occurrence. The program applies to areas not already covered by FEMA FIRMs. For this region, maps have been drawn for all counties except San Francisco City/County, but coverage of some areas may have been deferred. By 2015, all areas expected to develop over the next 25 years will have mapped floodplains.

Accurate hydrologic and hydraulic models inform the design of effective flood control structures and emergency actions before, during, and after floods. The National Weather Service's (NWS) Advanced Hydrologic Prediction Service (AHPS) uses historical hydrologic data, current river and watershed conditions, and near-term meteorological outlooks to forecast river flows. The service is publicly available for certain streams of the San Francisco Bay region. Locations are given in Appendix A, Table SFA-5, AHPS stream forecast points.

Event Management. Under the Standardized Emergency Management System and the National Incident Management System, initial flood emergency response is made by the responsible party at the site. When its resources are exhausted, the county emergency management organization (Operational Area) provides support. If necessary, additional

support is coordinated by the Coastal Region of the California Emergency Management Agency (Cal EMA). Through the Cal EMA region and Cal EMA headquarters, help can be obtained from any State agency. Cal EMA coordinates with federal agencies and private organizations as well. The State-federal Flood Operations Center (a joint facility of DWR and the Sacramento Weather Office and California-Nevada River Forecast Center, both units of NWS) is normally called early in the event to provide weather and river forecasts, facilitate information flow, provide field situation analysis, and give flood fight expertise. Severe situations that require Cal EMA involvement may also require emergency response by USACE, which is obtained by request of DWR. Table SFA-4, Flood emergency response organizations, in Appendix A is a listing of specific response organizations.

Recovery after a flood event may involve the funding and construction services of USACE if the facilities are parts of federal projects. Availability of resources to repair local and private facilities, remove floodwaters, and restore housing, businesses, and infrastructure often depends on the severity of the event and the allocation of event-specific federal or State funds.

Flood preparedness and mitigation efforts are promoted and funded by many organizations, including city and county governments, Cal EMA, DWR, NWS, and USACE.

Relationship with Other Regions

The San Francisco Bay region is a major importer of water supplies from other regions within the state.

In the North Bay, water is imported from several sources: Russian/Eel rivers, Putah Creek, NBA (Delta/SWP) and Vallejo Permit Water (Delta City of Vallejo Supply). From the Russian and Eel Rivers (North Coast region), water is delivered by the Sonoma County Water Agency to Sonoma and Marin Counties.

Sonoma County Water Agency delivers water from the Russian River including water diverted from the Eel River via the Potter Valley Project, which was significantly reduced through FERC relicensing. Water is conveyed from the Russian River into the North Bay through the Petaluma Aqueduct and the Sonoma Aqueduct.

SWP delivers water through the NBA to the Solano County Water Agency and Napa County FCWCD. The aqueduct extends more than 27 miles from Barker Slough to the Napa Turnout reservoir in southern Napa County. Maximum SWP entitlements are for 67 thousand acre-feet annually. The aqueduct also conveys water for the City of Vallejo, which purchases capacity in the NBA.

Solano County Water Agency contracts for water from Lake Berryessa via the Solano Project. The project was built by the USBR and began operation in 1959. The project has an annual dependable supply of 207 thousand acre-feet. The majority of the Solano Project entitlement water goes to agricultural users in the Sacramento River region.

The City of Vallejo obtained a water right to divert Sacramento River water during World War II to supply the city and National Defense needs. The diversion was from Cache Slough. The aging facilities were increasingly costly to maintain when the SWP's NBA was being planned. The City opted to purchase capacity in the new facilities. The old facilities were not abandoned and may play a role in future diversions. Vallejo Permit Water is now diverted from Barker Slough along with NBA water. The average water supply is 22.5 thousand acre-feet per year.

In the South Bay, water is imported from the following sources: Tuolumne River (Hetch Hetchy System), San Luis Reservoir (CVP-San Felipe Project), Delta (SWP-South Bay Aqueduct), and the Mokelumne River (East Bay).

San Francisco Water District imports Tuolumne River water via the 150-mile-long Hetch Hetchy System. In addition to supplying water to the City and County of San Francisco, San Francisco Public Utilities Commission (SFPUC) sells water wholesale to 28 water districts, cities and local agencies in Alameda, Santa Clara, and San Mateo counties. The water supply from Hetch Hetchy is approximately 250 thousand acre-feet per year.

The East Bay Municipal Utilities District (EBMUD) imports water from the Mokelumne River through the Mokelumne Aqueduct and delivers water to much of Alameda and Contra Costa counties. The district supplies water to approximately 1.4 million people with a supply of about 201 thousand acre-feet per year.

The Contra Costa Water District (CCWD) serves 550,000 people and receives CVP water through the Contra Costa Canal. CCWD recently signed a 40-year CVP contract for 195 thousand acre-feet year. CCWD delivers water throughout eastern Contra Costa County including a portion of the district in the San Joaquin River region. CCWD also diverts water from the Delta under its own water rights.

SCVWD serves 1.7 million people and receives CVP water through the San Felipe Project. SCVWD has a CVP contract for 152.5 thousand acre-feet year.

The SWP water is conveyed via the South Bay Aqueduct to SCVWD, Zone 7, and ACWD. The aqueduct is over 42 miles long beginning at SWP's South Bay pumping plant on Bethany Reservoir and ending at the Santa Clara Terminal Facilities. SWP water is used in the South Bay for municipal and industrial supply, agricultural deliveries, and groundwater recharge.

Regional Water and Flood Planning and Management

Some of the major water-related challenges facing the Bay Region include improving water supply reliability to sustain water supplies in drought periods and other emergency outages, maintaining and improving drinking water quality across the region by continuing to meet and exceed current and anticipated drinking water quality standards and protecting drinking water sources, and improving the ecosystem health of San Francisco Bay. Other challenges include linking local land use planning with water system planning and improving water management planning on a regional level.

Many projects and programs are already under way to address these needs. However, the various parties concerned with water-related issues in the Bay Region are increasingly recognizing that there is also a need to develop solutions on a more collaborative regional or subregional basis. Some of the longstanding regional planning efforts within the Bay Region are described in this section, including projects under way to improve water supply reliability, water quality, and ecosystem restoration through regional partnerships. In addition, some of the newer water management and drinking water quality regional planning initiatives are described in the section, Looking to the Future.

Integrated Regional Water Management

Two IRWM regions have been approved through the Region acceptance process (RAP) within the San Francisco Bay Hydrologic Region (Figure SF-4). The San Francisco Bay Area (SFBA) IRWM planning region is the largest IRWM effort within the San Francisco Bay Hydrologic Region with its boundaries largely paralleling those of the Bay Region. The East Contra Costa County IRWM region occupies only a small portion of the Bay Region and is within Contra Costa County.

IRWM plans are living documents and may change as planning efforts mature, opportunities for collaboration and partnership are discovered, and State guidance is further refined.

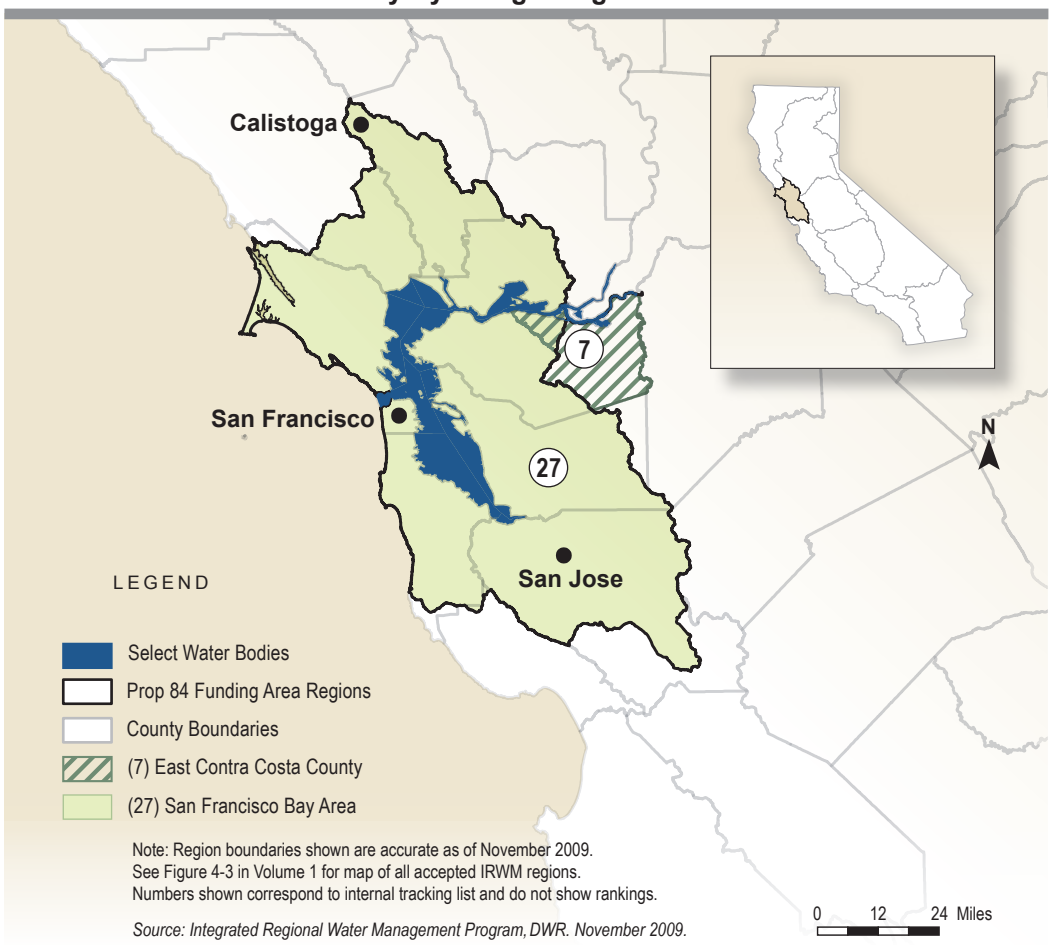
The main water issues identified by the SFBA IRWM region are providing adequate supplies to meet the needs of their customers in the future, managing floodplains amid urban development and high land costs, environmental water demands, and water quality in receiving waters. Strategies of earlier IRWM efforts are listed in Table SF-4.

Some regional projects in the San Francisco region are highlighted here.[1]

- **Mocho Groundwater Demineralization Plant.** Zone 7 Water Agency's groundwater demineralization plant slows down the buildup of salts and minerals in the Livermore-Amador Valley's groundwater basin to (1) protect the groundwater basin's long-term use as a water supply; (2) allow regional water

1 Information about these projects in the San Francisco River Hydrologic Region came to the Water Plan from the Roundtable of Regions, which provides links to and works with IRWM planning groups.

Figure SF-4 Regional acceptance process IRWM regions, San Francisco Bay Hydrologic Region



recycling for irrigation purposes, thereby enhancing the valley's overall water-supply reliability; and (3) help to soften the groundwater delivered primarily to the western side of Zone 7's water-delivery system. Using reverse osmosis technology, the demineralization plant reduces hardness of groundwater pumped from four nearby wells.

- **Water Saving Hero Campaign.** The Water Saving Hero Campaign is a regional media campaign aimed at reminding Bay Area residents and businesses that water is a precious resource that should be used efficiently. The campaign highlights simple and effective steps Bay Area residents can take to conserve water now and for the future.
- **South Bay Advanced Recycled Water Treatment Facility.** This project plans, designs, and constructs a 5- to 7-million-gallon-per-day recycled water treatment facility within the footprint of the South Bay Water Recycling's Water Pollution Control Plant in San Jose to accomplish multiple objectives, including improving recycled water quality to enhance marketability, increasing the operational reliability and flexibility of recycled water, retaining existing customers who may have water quality (especially salinity) issues, improving public acceptance of

Table SF-4 Strategies of Integrated Regional Water Management Planning efforts, San Francisco Bay Hydrologic Region

Strategy	San Francisco Bay Area IRWMP November 2006	Solano IRWMP and Strategic Plan February 2005	Napa-Berryessa IRWMP[1] July 2005	Tomales Bay ICWMP July 2007	East Contra Costa IRWMP[1] June 2006
Conjunctive use	✓	✓			✓
Desalination	✓			✓	✓
Ecosystem restoration	✓	✓	✓	✓	✓
Education and outreach	✓	✓			
Environmental and habitat protection and improvement	✓	✓		✓	✓
Flood management	✓	✓		✓	✓
Groundwater banking	✓	✓			
Groundwater management	✓		✓	✓	✓
Imported water	✓	✓			✓
Increase conveyance capacity and utilization		✓			
Infrastructure reliability	✓				
Interties	✓				
Land use planning	✓			✓	✓
Monitoring and modeling	✓	✓			
Nonpoint source pollution control	✓	✓		✓	✓
Optimize delivery of water to end users		✓			
Recreation and public access	✓			✓	✓
Regional cooperation	✓	✓			
Storm water capture and management	✓	✓		✓	✓
Surface storage	✓	✓		✓	✓
Water and wastewater treatment	✓	✓		✓	✓
Water conservation	✓	✓		✓	✓
Water quality protection and improvement	✓	✓	✓	✓	✓
Water recycling	✓			✓	✓
Water supply reliability	✓	✓	✓	✓	✓
Water transfers	✓	✓			✓
Watershed planning	✓			✓	✓
Wetlands enhancement and creation	✓			✓	✓

Note: The summary information contained in these tables was obtained from various IRWM plans. For additional details or information related to a specific plan, please consult the current version of the plan or its authors.

recycled water, maximizing water recycling alternatives, and reducing freshwater effluent discharges into San Francisco Bay to protect endangered species.

Examples of integrated, multi-benefit projects include: EBMUD-CCWD Raw Water Intertie, Regional Conservation Outreach Campaign, and the Alameda Creek fish Passage projects. The intertie connects CCWD and EBMUD to bolster water supply reliability for customers of both agencies. The outreach campaign coordinates conservation messages throughout the San Francisco Bay to increase water conservation awareness at a regional level. The fish passage maintains the existing local groundwater recharge operations while providing for steelhead fish passage and protection at the diversion.

The makeup of each IRWM planning region in this hydrologic region is unique and reflects the water management priorities and stakeholder relationships specific to that region. Regardless of the stage of development, each IRWM region represents an extensive endeavor to meet regional water needs and the new paradigm of water resource planning.

Accomplishments

Bay Region water agencies have made significant investments in programs and projects to actively protect municipal water quality including facility upgrades, advanced treatment methods, watershed monitoring, groundwater monitoring and protection, demineralization projects, and nonpoint water source evaluations.

- **Contra Costa Water District.** Completed Veale Tract drainage relocation project, 2006.
- **Contra Costa Water District.** Completed Byron Tract drainage relocation project, 2006.
- **Contra Costa Water District.** Completed California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) environmental impact documentation for the Alternative Intake Project. This project is currently in construction and is expected to begin operating in 2010.
- **Contra Costa Water District.** Completed CEQA and NEPA environmental impact documentation for Contra Costa Canal Replacement Project. Phased construction of this project began in May 2009.
- **Contra Costa Water District.** CEQA and NEPA environmental impact documentation for the Los Vaqueros Reservoir Expansion Project completed for public review in February 2009.
- **East Bay Municipal Utility District.** Freeport Regional Water Project is expected to be completed in spring 2010. The project provides additional water supplies for EBMUD, 112 thousand acre-feet in dry years – 165 thousand acre-feet over 3 years to EBMUD.
- **East Bay Municipal Utility District.** Water Supply Management Program 2040 Program-Level environmental impact report certified on October 13, 2009.

- **Marin Municipal Water District.** Operational improvements at Alpine Lake, expansions at Kent Lake, and Corte Madera pumping station upgrades help to expand water supplies, improve water quality, and increase reliability in the system.
- **North Marin Water District.** Completed the New Stafford Lake Water Treatment Plant project to meet existing and future water quality requirements and improve operating efficiency.
- **San Francisco Public Utility Commission.** Water System Improvement Program.
- **San Francisco Public Utility Commission.** Unanimously approved (2008) the construction of the New Crystal Springs Bypass Tunnel, a critical link in delivering Sierra source water to the San Francisco Peninsula. Project will take two years to complete.
- **San Francisco Public Utility Commission.** Hetchy Hetchy Water System, San Joaquin Pipeline System and Rehab Projects. New pipeline, upgrades, and assorted repairs to the 50- to 80-year-old system.
- **San Francisco Public Utility Commission.** Sunol and Niles dams were removed from Niles Canyon along Alameda Creek in 2006 to allow safe passage of the central California Steelhead trout.

In March 2009, the Bay Area Council Economic Institute formulated a Bay Area Economic Recovery Workplan. This workplan identifies projects and activities that maximize the impact and benefit of the federal stimulus funds coming to the region from the American Recovery and Reinvestment Act of 2009. The institute is actively coordinating efforts with the San Francisco Bay Area IRWM Plan group.

The Bay Region was able to secure stimulus funding for the following projects:

- **Contra Costa Water District.** $20 million awarded for construction of a state-of-the-art positive barrier fish screen at the Rock Slough intake.
- **Napa River Flood Control Project.** More than $99 million has been awarded to be used for river widening; construction of earthen levees, concrete flood walls, sheet pile flood walls; and the creation of an Oxbow Bypass channel.
- **Santa Clara Valley Water District.** $44.1 million awarded for water-treatment and flood-protection projects.

Hazard Mitigation Plans

The federal Disaster Mitigation Act of 2000 amended existing law with regards to hazard mitigation planning. The Act emphasizes pre-disaster mitigation and mitigation planning. In order to receive federal hazard mitigation funds in the future, all local jurisdictions must now adopt a hazard mitigation plan identifying hazards, risks, mitigation actions and priority and providing technical support for those efforts. Between 2004 and 2007, Alameda, Contra Costa, San Mateo, Santa Clara and Solano counties annexed to the Association of Bay Area Governments (ABAG) multi-jurisdictional hazard mitigation plan and Marin, Napa and Sonoma Counties adopted hazard mitigation plans. All subsequently received Cal EMA approval.

Flood Control

Flood control facilities have been constructed in the region to protect life and property from the consequences of high water and debris flow. Notable among the constructed works are three flood control reservoirs. For information on these facilities and others in the region, see Structural Approaches in this report and Appendix A, Table SFA-3, Flood control facilities.

Challenges

Recurrent flooding is a problem in many places in the San Francisco Bay Hydrologic Region. At many locations, lives, homes, businesses, farm lands, and infrastructure are frequently at risk. Providing better protection for lives and property remains the definitive flood management challenge. Solutions may range from governmental regulation of occupancy and building in flood-prone areas through local or watershed-based non-structural measures to infrastructure such as levees and reservoirs, constructed with consideration of environmental needs. Development of a discharge-based standard, such as protection from the flood having a 0.5 percent, 1 percent, or 2 percent probability of occurrence (or such a standard in conjunction with land use type or other pertinent factor) would facilitate equitable distribution of State and federal support funding. Some particularly vulnerable locations in the region are on the Guadalupe, Napa, and Petaluma rivers, Coyote and Corte Madera creeks, the Line A Channel, and other channels between the Union Pacific Railroad and Interstate 880. San Anselmo, Napa, and some communities in Santa Clara County are subject to frequent flooding. Existing levees are inadequate on tributaries to Alameda Creek, and railroad bridge openings are too small on major urban streams around the bay.

Throughout the state, including this region, urbanization continues. It brings greater runoff due to increases of impervious area making retention of flood protection levels a challenging issue. Urbanization often causes increases in erosion and sedimentation. Construction of flood infrastructure or changes in land use may cause subsequent undesirable vegetation growth, whether of native or invasive species. Regulation of occupancy and land use is critical for reducing the number and severity of flood damage occurrences in an era of population growth. In this region, one problem site is the Napa River floodplain, where construction of homes adjacent to unregulated tributaries continues. Developed areas subject to sea level rise, tidal floods, and storm surges are a special concern. Other challenges include dealing with sedimentation in the Petaluma River and in Cull Canyon and Don Castro Reservoirs, and controlling vegetation and beaver colonies in urban floodways.

Effective preparedness for flood events depends on accurate evaluation of the risk; adequate measures for mitigation of flood damage; sufficient preparation for response and recovery activities; and coordination among local, State, and federal agencies. Completion of floodplain mapping, both the FEMA FIRMs and the State's complementary Awareness Floodplain Mapping, will provide much needed information for evaluating flood risk. Mitigation may take many forms, including restriction of use,

flood proofing, or structural protection of vulnerable sites. Some actions that help meet the challenge of response and recovery preparedness are organization for emergency management, formal agreement on responsibilities for emergency actions and funding, and use of warning systems. In the Bay Region, some current needs are improving coordination among local jurisdictions sharing watershed resources, clarifying jurisdiction for stream maintenance, enhancing community awareness of local flood risks, and avoiding degradation of Delta water supply and damages to infrastructure due to levee failure.

Local funding for flood maintenance and construction projects and flood management administration has become less effective in recent years because of several factors:

- Heightened public awareness of the need to protect the environment has increased the cost of upkeep and improvement.
- Concern for endangered species has made scheduling more complex.
- Both environmental and endangered species considerations have made permits more difficult to obtain.
- Measures to reduce taxation, especially on property, have rendered revenue increases difficult to achieve.
- Inflation has increased costs.

Meeting the requirements of these new restraints has become a high-profile local challenge. Particular funding issues in the region are the cost of certifying levees to meet FEMA or USACE standards, and the cost of assessing the condition of flood facilities.

Wildfires may denude steep erodible slopes in canyons and upland areas above urban development below. Ensuing winter rains may threaten these areas not only with high water, but also with debris flows. In these situations, flooding may cause greatly increased damages to structures and other installations and may leave large amounts of sediment and other detritus.

Drought and Flood Planning

Most agencies in the region presently have some level of flood planning. Vallejo Sanitation and Flood Control District has an emergency preparedness program in place and emergency funds available in the event of flooding damage. The City of Napa has a system of road closures based on the stage of the Napa River that reduces risk to individuals and property in the event of a flood. Solano County Water Agency provides a Flood Awareness Manual that gives guidelines to citizens for appropriate planning and response behaviors for floods, as well as small grants for construction of flood control infrastructure. The Contra Costa Resource Conservation District has a watershed management plan for Alhambra Creek, which discusses a myriad of options for reducing the risk of flooding in Martinez and surrounding areas. The newly created Bay Area Flood Protection Agencies Association (BAFPAA) is a consortium of flood control and water agencies within the hydrologic region that provides a forum for discussing flooding issues, collaborating on multi-agency projects, and sharing resources.

Three of the nine counties in this region have adopted hazard mitigation plans, and six have annexed to the ABAG Multi-Jurisdictional Local Hazard Mitigation Plan.

FloodSAFE is a strategic initiative of DWR that seeks a sustainable integrated flood management and emergency response system throughout California that improves public safety; protects and enhances environmental and cultural resources; and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding. FloodSAFE is guiding development of regional flood management plans. These plans will encourage regional cooperation in identifying and addressing flood hazards, and will include flood-hazard identification, risk analyses, review of existing measures, and identification of potential projects and funding strategies. The plans will emphasize multiple objectives, system resiliency, and compatibility with State goals and IRWM plans.

Looking to the Future

Climate Change

Climate change is projected to present water resource management challenges to the Bay Region. Many climate models predict warming and increased precipitation variability over the entire Sierra Nevada, which would result in reduced snow accumulation, earlier and quicker snowmelt, and potentially affect water supplies for the San Francisco region.

Another effect of the projected climate warming is mean sea level rise. California's coastal observations and global model projections indicate that California's open coast and estuaries will experience increasing sea levels during the next century. Historical records show that sea level in San Francisco Bay has risen about 7 inches over the past 100 years. The 2006 California Climate Action Team Report projects that global sea level will rise between 4 and 33 inches by the year 2100. As the mean sea level increases, historical coastal structure design criteria may be exceeded causing the need for newer or higher levees and jeopardizing structures. Additionally, ecosystems, salinity levels and water resources could be adversely affected. The BCDC has become increasingly concerned that continued sea level rise from global warming will have extreme impacts in the Bay Region. Using Geographic Information System data the BCDC has prepared illustrative maps showing that a one-meter rise in the level of the San Francisco Bay could flood more than 200 square miles of land and development around its perimeter.

Future Scenarios

For Update 2009, DWR evaluated different ways of managing water in California depending on alternative future conditions and different regions of the state. The ultimate goal is to evaluate how different regional response packages, or combinations of resource management strategies from Volume 2, perform under alternative possible future conditions. The alternative future conditions are described as future scenarios.

Box SF-4 Scenario Descriptions

Update 2009 has three future scenarios through the year 2050 to which the water community would need to respond regionally by implementing a mix of resource management strategies. The scenarios are referred to as baseline because they represent changes that are plausible and could occur without additional management intervention beyond those currently planned. Each scenario affects water demands and supplies differently.

- **Scenario 1 – Current Trends.** For this scenario, recent trends are assumed to continue into the future. In 2050, nearly 60 million people live in California. Affordable housing has drawn families to the interior valleys. Commuters take longer trips in distance and time. In some areas where urban development and natural resources restoration has increased, irrigated crop land has decreased. The state continues to face lawsuits: from flood damages to water quality and endangered species protections. Regulations are not comprehensive or coordinated, creating uncertainty for local planners and water managers.
- **Scenario 2 – Slow & Strategic Growth.** Private, public, and governmental institutions form alliances to provide for more efficient planning and development that is less resources intensive than current conditions. Population growth is slower than currently projected—about 45 million people live here. Compact urban development has eased commuter travel. Californians embrace water and energy conservation. Conversion of agricultural land to urban development has slowed and occurs mostly for environmental restoration and flood protection. State government implements comprehensive and coordinated regulatory programs to improve water quality, protect fish and wildlife, and protect communities from flooding.
- **Scenario 3 – Expansive Growth.** Future conditions are more resource intensive than existing conditions. Population growth is faster than currently projected with 70 million people living in California in 2050. Families prefer low-density housing, and many seek rural residential properties, expanding urban areas. Some water and energy conservation programs are offered but at a slower rate than trends in the early century. Irrigated crop land has decreased significantly where urban development and natural restoration have increased. Protection of water quality and endangered species is driven mostly by lawsuits, creating uncertainty.

Together the response packages and future scenarios show what management options could provide for sustainability of resources and ways to manage uncertainty and risk at a regional level. See Box SF-4 for scenario descriptions.

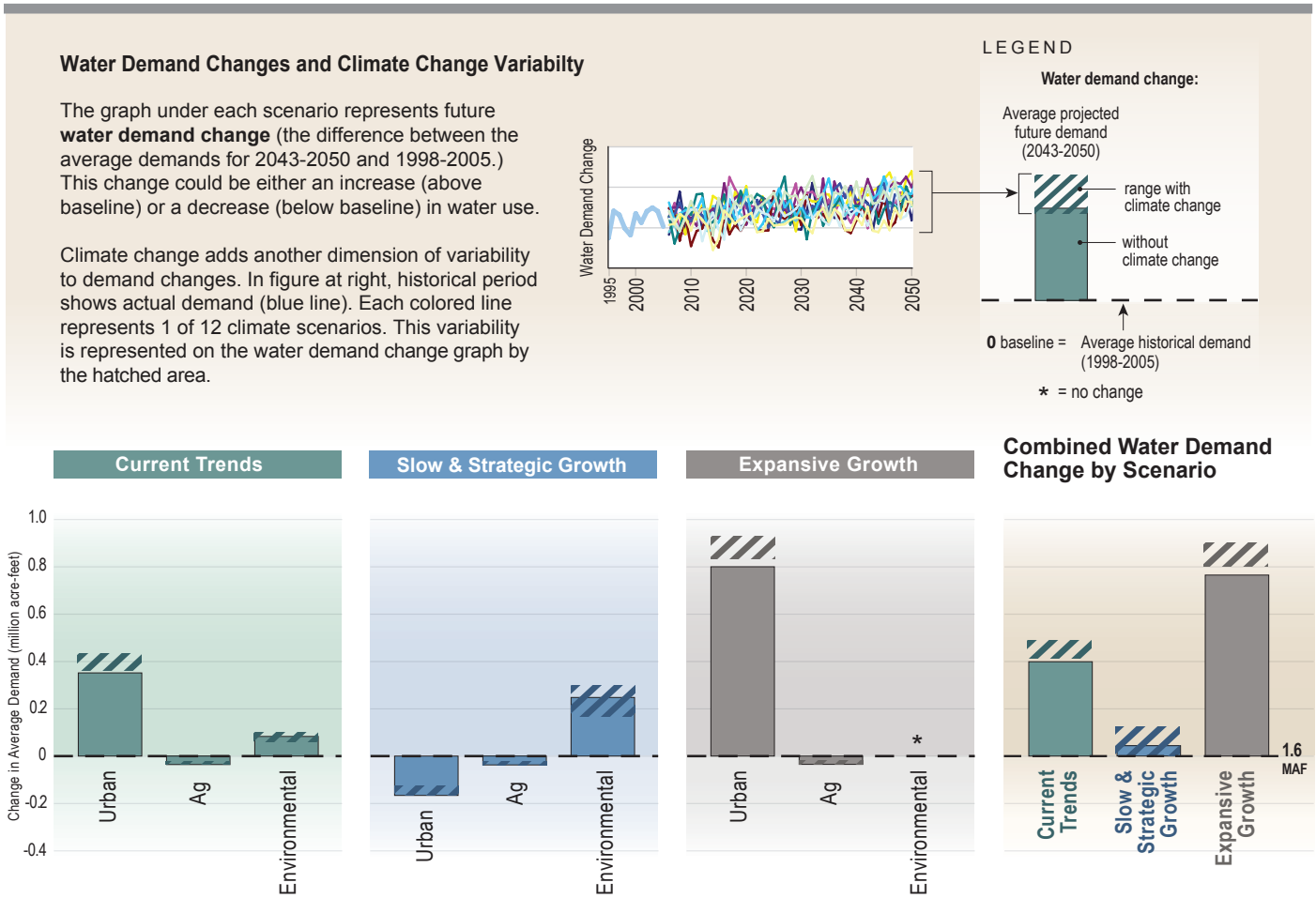
Total Demand Change

Change in total water demand in the Bay Region for each scenario is shown in Figure SF-5. The change in water demand is based on the difference between the historical average (1998–2005) and future average (2043–2050) water demands. Future water demand is shown with and without climate change. The change in water demand without climate change is shown with solid bars and with climate change is shown with hatched bars. As shown in the figure, Expansive Growth shows the most increase in water demand without climate change (solid bar), by about 765 thousand acre-feet, and Slow & Strategic Growth shows the least amount of increase (40 thousand acre-feet). The Current Trends scenario falls in between with an increase of about 400 thousand acre-feet. Considering the 12 alternative climate change sequences (hatched bar) on water demands, Expansive Growth still shows the largest variation in water demand, between 800 thousand acre-feet and 900 thousand acre-feet.

Urban Demand Change

Figure SF-5 shows urban water demand change in the Bay Region with and without climate change under the Current Trends, Slow & Strategic Growth, and Expansive

Figure SF-5 2050 Water demand changes, San Francisco Bay Hydrologic Region



Growth scenarios. Without climate change, Current Trends and Expansive Growth both show an increase in water demand of 350 thousand acre-feet and 800 thousand acre-feet, respectively. But, Slow & Strategic Growth shows a reduction in water demand of about 165 thousand acre-feet when compared with historical average. When climate change is considered, the change in water demand is even more pronounced under Expansive Growth. The range varies from a minimum of 830 thousand acre-feet to a maximum of 925 thousand acre-feet for the 12 climate sequences studied. Under the Slow & Strategic Growth scenario, a smaller reduction in water demand is observed when climate change was factored in, which ranged in a reduction between 130 thousand acre-feet and 165 thousand acre-feet.

Agricultural Demand Change

Change in agricultural water demand in the Bay Region is shown in Figure SF-5. Agricultural water demand is generally reduced due to reduction in irrigated acreage and increases in background water conservation. Without climate change (solid bar), all three scenarios show almost the same reduction in water demand of about

35 thousand acre-feet. The expected water demand change with climate change (hatched bar) are less than without climate change for all three scenarios.

Environment Demand Change

Figure SF-5 shows environmental water demand change for the Bay Region. Future environmental water demand is based on historical unmet demand and indexed to climate. With no climate change, Current Trends and Slow & Strategic Growth show an increase in water demand of about 83 thousand acre-feet and 250 thousand acre-feet, respectively. Expansive Growth shows no increase in water demand due to the assumption that environmental water would be limited under this scenario. When climate change is factored in, Current Trends and Slow & Strategic Growth both show an increase in environmental water demand under warmer and drier climate. No additional water beyond current commitments is provided for environmental water demands under the Expansive Growth scenario.

Implementation Next Steps

Key resource management strategies identified in San Francisco Bay regional workshops include the following:

- address infrastructure needs for replacing aging systems and for new development
- diversify regional water portfolios: desalination, recycled water
- conserve water, reuse storm water and gray water
- develop future conservation best management practices
- integrate land use and water planning, develop land use strategies to cluster development to economically serve water/wastewater needs instead of wells and septic systems
- protect watersheds and natural resources and habitat
- address environmental justice groups and disadvantaged communities;
- reduce water transfers
- protect groundwater quality
- link habitat/riparian water issues with water quality and supply
- expand reuse and storage

These strategies need support and funding that will be dedicated specifically to local development and implementation of IRWM projects in the San Francisco Bay Hydrologic Region. Potential steps include designation as a funding area, specific wastewater repair bond funding, prioritization of water bond funding to improve areas that have been neglected in the past, and focusing IRWM funding on implementation measures to improve quantity and quality of water supplies and lasting environmental health.

Additionally, federal stimulus funds signed by President Barack Obama in February 2009 and awarded by the USBR will be made available through the American

Recovery and Reinvestment Act economic stimulus package. The Bay Region has a chance to maximize its share of the approximately $20 billion potentially available to California. These funds and projects will need to be further coordinated with other planning efforts including IRWM planning groups.

Key project implementation steps identified in San Francisco Bay regional workshops include the following:

- outreach to local agencies on key challenges and strategies in California Water Plan; include functional, transferable data that local agencies can use; provide education programs
- improve linkage between water and land use planning (general plan elements, emergency plans beyond two days, regional planning, growth, flood management, drought plans);
- improve hydrologic data collection, compilation, sharing programs
- quantify success with indicators to track regional goals and how they interrelate;
- prioritize regional, multi-objective projects
- integrate with comprehensive regional plans and General Plan updates
- identify costs and benefits for actions; include cost of failure (risk analysis); establish quantifiable indicators/measures of success to track process on reaching goals; provide flexibility on how to achieve targets
- improve consistency in methodology and reporting in urban water management plans
- discuss water-smart growth (toolkit); assist with increasing the acceptance and use of recycled water
- prioritize implementation and economic efficiency - reduce permitting roadblocks, frame as 'action plan,' report cost effectiveness of recommendations, include performance metrics and accountability, enhance public communication; prioritize regional multi-objective projects; fund demonstration projects.

Appendix A. Flood Management

Historic Floods

Flood Parameters

Table SFA-1, Record floods for selected streams, is based on US Geological Survey records. The stations were selected from all USGS gaging stations in the hydrologic region, according to the criteria in Box SFA-1.

Box SFA-1 Selection Criteria

- The watercourse must be a natural stream with a watershed of at least 100 square miles.
- The station must have a reasonably continuous record of discharge from 1996 to the present.
- The station must be far enough from other stations on the same river to reasonably represent a separate condition.
- Stations in well defined watercourse locations such as deep canyons are omitted, unless particularly important to the overall flood situation.

Flood Descriptions

Early Floods. Records of flooding in California have been kept for over 150 years. A devastating flood in 1861-1862 (the "Great Flood") inundated large areas of the West Coast, including the San Francisco Bay area. The Napa River has flooded Napa Valley numerous times, often causing widespread losses of structures and damage to agricultural lands.

Repeated Flooding. Several San Francisco Bay region streams have a history of repeated flooding. Corte Madera Creek has damaged San Anselmo, Ross, Kentfield, Larkspur, Fairfax, and vicinity numerous times, notably in 1914, 1951, 1955, 1958, 1960, 1962, 1963, 1967, 1969, 1982-1983, 1986, and 2006. Berryessa Creek in San Jose floods about every four years. The Guadalupe River flooded downtown San Jose and Alviso in 1862, 1895, 1911, 1955, 1958, 1963, 1969, 1982, 1986, and 1995. The Napa

Table SFA-1 Record floods for selected streams, San Francisco Bay Hydrologic Region

Stream	Location	Mean annual runoff (taf)	Peak stage of record (ft)	Peak discharge of record (cfs)
Guadalupe River	above Highway 101, at San Jose	57	14.6	6,070
Coyote Creek	above Highway 237, at Milpitas	34	13.9[1]	2,550
Coyote Creek	near Gilroy	35	13.8[1]	10,100
Alameda Creek	near Niles	101[2]	14.8	29,000
Arroyo de La Laguna	at Verona	55[2]	22.6	11,400
Arroyo Valle	near Livermore	17[2]	9.2	2,980
Napa River	near Napa	155[2]	30.5[1]	37,100
Napa River	near St. Helena	68	23.6	18,300
Sonoma Creek	at Agua Caliente	53	32.5	20,300

Note: taf=thousand acre-feet; ft=feet; cfs=cubic feet per second

[1] Different date than peak discharge

[2] Most recent but less than period of record

River flooded Napa 27 times between 1862 and 1997, and has also flooded St. Helena. Novato Creek in Novato has a long history of flooding. The Petaluma River flooded some or all of the Denman Flat, Lynch Creek, and Payran Floodplain areas with sheet flow in 1982, 1983, 1986, 1992, 1995, 1997, 1998, and 2006. San Francisquito Creek overflowed seven times since 1910, damaging Palo Alto, and Sonoma Creek flooding in the vicinity of Sonoma has been recorded several times. Larger events on these streams are described below in more detail.

1955 and 1958. Precipitation from a warm, moist air mass caused widespread flooding within the region and throughout the rest of California in December 1955. In that event, a levee failed on Alameda Creek, allowing floodwaters to inundate portions of Niles, Centerville, Mission San Jose, Irvington, and Warm Springs. The event was repeated in 1958, destroying crops and damaging industries and more than 225 homes in Niles, Alvarado, and Alviso. The same years, San Francisquito Creek overflowed, causing extensive damage to Palo Alto.

January 1963. A flood on the Napa River caused an estimated $5.5 million in damages.

January 1970. Heavy precipitation falling upon water-logged soils caused the Napa River to overtop its banks and inundate lands and roads around St. Helena.

1982. Record flooding on Corte Madera Creek damaged San Anselmo, Ross, Kentfield, and Larkspur in 1982. Severe flood occurred on Coyote Creek in the Alviso area of San Jose, causing more than $6 million in damages to about 360 homes and 40 businesses. There was a major flood on Novato Creek. The largest of the Petaluma Creek sheet flow floods occurred, causing about $28 million in damages plus damaging Petaluma's wastewater treatment plant.

1983. The third-largest recorded Corte Madera Creek flood occurred, damaging the same areas as in 1982.

February 1986. Strong gusts coupled with high tides and heavy precipitation from the St. Valentine's Day storm caused streams to pool at their confluences with San Pablo Bay in 1986, flooding shoreline buildings and arterial roads. The Guadalupe River overflowed its east bank in San Jose, flooding residences and businesses. The flood caused three deaths in the Napa area, destroyed 250 houses, damaged 2,500 more, forced more than 5,000 residents to evacuate their homes, and caused an estimated $2 million in damage to vineyards.. Significant flooding also occurred on Nathanson Creek in Sonoma.

1987 and 1988. Coyote Creek flow exceeded those of 1982, causing damage upstream of Alviso. Flood protection works protected downstream areas in Alviso.

January and March 1995. Unusually large amounts of rain caused severe flooding in towns within Napa Valley, especially within Napa's large downtown area. The Guadalupe River overflowed in both months, damaging downtown San Jose and Alviso again. The March event, combined with high water in Los Gatos Creek, flooded about 300 homes and businesses and caused $10 million in damages.

February 1988. Record flooding of San Francisco Creek inundated 11,000 acres in Palo Alto, East Palo Alto, and Menlo Park, damaging about 1,700 homes and businesses. Damages were estimated at $28 million.

December 2002. Floodwaters from the Napa River invaded 100 structures and caused an estimated $1 million in damages.

January 2006. Flooding on Corte Madera Creek caused more than $70 million in damages to the area. Losses were estimated at $135 million due to flood damage by the Napa River in Napa County. Sonoma Creek damaged a mobile home park, bridge, and pipeline, and Nathanson Creek flooded 27 classrooms at Sonoma Valley High School.

Flood Governance

Many federal, State, and local agencies have responsibilities in the overall effort to manage floods. The principal participants in the San Francisco Bay Hydrologic Region and their activities are listed in Table SFA-2, Flood management participants. Most listed activities are self-explanatory. Descriptions of some are:

- **Flood project development.** Performing feasibility studies, planning, and design of constructed facilities.
- **Encroachment control.** Establishing, financing, and operating a system of permitting and enforcing permits to encroach on constructed facilities.
- **Floodplain conservation or restoration.** Any overt activity causing part of a floodplain to remain in effect or to be reinstated as a watercourse overflow area.
- **Flood insurance administration or participation.** Contribution to the management of or acting as a sponsor and cooperator in the National Flood Insurance Program including the Community Rating System.
- **Hydrologic analysis.** Hydrologic or statistical analysis of collected hydrometeorological data.
- **Flood education.** Informing the general public about any aspect of flood management; publishing or broadcasting collected hydrometeorological data or other flood-related material.
- **Recovery operations.** Financing or performing any activity intended to return flood-impacted facilities or persons to normal status.
- **Event management system administration.** Oversight of the National Incident Management System/Standardized Emergency Management System (NIMS/SEMS) as applied to California.

Table SFA-2 Flood management participants, San Francisco Bay Hydrologic Region

Note: FCWCD=Flood Control and Water Conservation District	Structural approaches						Land use management								Preparedness, response and recovery										
	Flood projects						Floodplains			Flood insurance			Regulation		Data management				Event management						
	Financing	Development	Construction	Operation	Encroachment control	Maintenance	Conservation	Restoration	Delineation	Administration	Participation	FIRM mapping	Building permits	Designated floodways	Data collection	Hydrologic analysis	Data station maintenance	Flood education	Preparedness	Response management	Response personnel	System administration	Recovery funding	Recovery operations	Mitigation
Federal agencies																									
Federal Emergency Management Agency										●		●											●		●
National Weather Service															●	●	●	●	●	●	●				
Natural Resources Conservation Service	●	●	●															●							
US Geological Survey															●	●	●								
US Army Corps of Engineers	●	●	●	●	●	●									●	●	●	●	●	●	●		●	●	●
State agencies																									
California Conservation Corps																				●	●				
Department of Corrections																					●				
Department of Forestry and Fire Protection																				●					
Department of Water Resources	●	●	●	●	●	●			●	●		●			●	●	●	●	●	●	●		●	●	
Office of Emergency Services																			●	●	●	●	●		●
Local agencies																									
County emergency services units																			●	●	●				
County planning departments														●											
County building departments													●												
Local conservation corps																				●	●				
Local initial responders to emergencies																			●	●	●				
Alameda County FCWCD	●	●			●	●																			
Contra Costa County FCWCD	●	●			●	●									●	●	●								
Marin County FCWCD	●	●			●	●									●		●								
Napa County FCWCD	●	●	●	●	●	●																			
San Francisco Department of Public Works																		●	●						
San Francisquito Creek Joint Powers Authority	●	●																							
San Mateo County Flood Control District	●																								
Santa Clara Valley Water Agency	●	●	●	●	●	●	●	●			●							●	●	●	●				
Sonoma County Water Agency	●	●	●	●	●	●												●							
Zone 7 Water Agency	●	●	●	●	●	●												●							

Flood Risk Management

Structural Approaches

The principal reservoirs and non-storage facilities contributing to flood control are listed below in Table SFA-3, Flood control facilities.

Disaster Preparation, Response, and Recovery

Management of flood emergencies is the responsibility of many organizations and individuals. Response is required by law to conform to the Standardized Emergency Management System, under which action is taken by levels of organization. It is begun by the person or organization on the site. That entity resists personal injury and property damage to the best of its ability, only calling on the next level when its resources become insufficient, and succeeding levels follow the same procedure. Table SFA-4 (Flood emergency responders) indicates the responsible entities at successive levels of response.

Table SFA-5, Advanced Hydraulic Prediction Service stream forecast points, is a list of forecast points that can be used in the Advanced Hydrologic Prediction Service of National Weather Service.

Integrated Regional Water Management

Of five IRWMPs that encompass the San Francisco Hydrologic Region, four specifically address flood control. Though the Solano Agencies IRWMP lists no flood control infrastructure to be constructed in the near term, it does discuss updating its flood control plan and flood-hazard maps; establishing more clearly its flood control duties with other agencies; and evaluating the safety of its major structures, such as Monticello Dam, which impounds Lake Berryessa. The Bay Area IRWMP discusses flooding in depth; 48 flood control projects are identified, with 22 short-term projects providing direct flood control benefits. The East Contra Costa County IRWMP emphasizes the relationship of flood control and ecosystem benefits, and identifies eight flood control projects. The Tomales Bay Watershed Integrated Coastal Water Management Plan lists four flood control projects, two of which could be completed by 2010.

Table SFA-3 Flood control facilities, San Francisco Bay Hydrologic Region

Facility	Stream	Owner (Sponsor)	Description	Protects
RESERVOIRS AND LAKES				
L. Chesbro	Llagas Cr.	Santa Clara Valley WD	3 taf flood control	San Jose
L. Del Valle	Arroyo Valle	DWR	38 taf flood control	Pleasanton, Fremont, Niles, Union City
Cull Cr.	Cull Cr.	Alameda Co. FCWCD (NRCS)	310 AF flood control	Castro Valley
NON-STORAGE FLOOD CONTROL FACILITIES				
Alameda Cr.	Alameda Cr.	USACE	Channel Improvement	Livermore Valley, Niles Canyon, coastal plain
Emeryville Marina—Point Park	San Francisco Bay	USACE	Bank protection	Emeryville
Fairfield Streams	Ledgewood Cr., Laurel Cr., McCoy Cr., Pennsylvania Ave. Cr., Union Ave. Cr.	USACE	Channel enlargement, creek diversion	Fairfield and vicinity
San Lorenzo Cr.	San Lorenzo Cr.	USACE	Levees, concrete channel	San Lorenzo, Hayward
Walnut Cr.	Walnut Cr., San Ramon Cr., Grayson Cr., Pacheco Cr., Pine Cr., Galindo Cr.	USACE	Levees, channel stabilization, channel improvement	Walnut Creek, Concord, Pacheco, Vine Hill, Pleasant Hill
Corte Madera Cr.	Corte Madera Cr. and tributaries	USACE (Marin Co. FCWCD)	Channel improvement	San Anselmo, Ross, Kentfield, Larkspur, Corte Madera, Greenbrae, Fairfax
Novato Cr.	Novato Cr., Warner Cr., Avichi Cr.	Marin Co. FCWCD	Channel improvement	Novato
Coyote and Berryessa Crs.	Coyote Cr. (Santa Clara Co.), Berryessa Cr.	USACE (Santa Clara Valley WD)	Channel improvement	Alviso, Milpitas, San Jose
Guadalupe R.	Guadalupe R.	USACE (Santa Clara Valley WD)	Channel improvement, bypass tunnel	San Jose
San Francisquito Cr.	San Francisquito Cr.	San Francisquito Creek JPA	Levee restoration	East Palo Alto, Menlo Park
Napa R. Basin	Napa R., Napa Cr.	USACE (Napa Co. FCWCD)	Levees, floodwalls, bypass, channel improvements	Napa, St. Helena
Petaluma R.	Petaluma R.	Sonoma Co. WA	Floodwalls	Petaluma
Wildcat and San Pablo Crs.	Wildcat Cr., San Pablo Cr.	USACE (Contra Costa Co. FCWCD)	Levees, channel, channel improvements, sedimentation basins	San Pablo, Richmond
Coyote Cr.	Coyote Cr. (Marin Co.)	USACE	Lined and unlined channels	Tamalpais Valley
Green Valley Cr.	Green Valley Cr., Dan Wilson Cr.	USACE	Realigned and enlarged channel	Agricultural and urbanizing lands north of Suisun Bay
Pinole Cr.	Pinole Cr.	USACE	Unlined channel	Pinole
Rheem Cr.	Rheem Cr.	USACE	Lined and unlined channels	San Pablo

Table SFA-3 Flood control facilities, San Francisco Bay Hydrologic Region (continued)

Facility	Stream	Owner (Sponsor)	Description	Protects
Rodeo Cr.	Rodeo Cr.	USACE	Lined and unlined channels	Rodeo
San Leandro Cr.	San Leandro Cr.	USACE	Lined and unlined channels	Oakland, San Leandro
Lower Pine Cr.	Pine Creek	Contra Costa FCWCD (NRCS)	Detention basin	Concord
Napa R.	Napa R.	Napa Co. FCWCD (NRCS)	Contributions to Napa R. Basin Project	Napa, St. Helena
Lower Silver Cr.	Silver Cr.	Santa Clara Valley WD (NRCS)	Channel improvement	San Jose

taf=thousand acre-feet

Table SFA-4 Flood emergency responders, San Francisco Bay Hydrologic Region

Responder	Level	Comment
Person(s) or organization(s) on the site	0	Any emergency
Emergency services units of the 86 cities in the region	1	Any emergency
Emergency services units of the 9 counties in the region	1 or 2	Any emergency, and by request from Level 1 responders
Department of Water Resources	2	Flood Operations Center, flood fight, and Corps liaison
California Emergency Management Agency, Coastal Region	3	Any emergency, entire hydrologic region by request of the county (operational area)
U. S. Army Corps of Engineers	3	Specified water-related emergencies at request of DWR
California Conservation Corps	3	Personnel and equipment for flood fight
Department of Forestry and Fire Protection	3	Personnel and equipment for flood fight
California Emergency Management Agency Headquarters	4	All emergencies, entire hydrologic region, by request of Cal EMA Region

Table SFA-5 AHPS stream forecast points, San Francisco Bay Hydrologic Region

River Basin	Stream	Location
Coyote Creek	Coyote Creek	Coyote Reservoir
Guadalupe River	Los Gatos Creek	Lexington Reservoir
Napa River	Napa River	Napa
Napa River	Napa River	Saint Helena

Appendix B. Water Quality

Surface Water Pollution Issues and Priorities

The main pollution challenges are associated with legacy and emerging toxic pollutants and urban and rural runoff.

Toxic Pollutants. San Francisco Bay and a number of the surface water streams, lakes, and reservoirs around the San Francisco Bay Hydrologic Region are impaired because of elevated levels of mercury in fish tissue. The major source of the mercury is local mercury mining and past mining activities in the Sierra Nevada and coastal mountains. Large amounts of contaminated sediments were discharged into the Bay from Central Valley streams as well as from local mines in the Bay Area. Significant impaired waterbodies include the Bay, the Guadalupe River in Santa Clara County (New Almaden Mine) and Walker Creek in Marin County (Gambonini Mine). Wastewater treatment plants and urban runoff are also a source of mercury, and some wetlands may contain significant amounts of methylmercury (the bioavailable form of mercury in the aquatic environment) from contaminated sediments. The San Francisco Bay Water Board has adopted Basin Plan amendments to implement Total Maximum Daily Loads (TMDLs) for mercury in San Francisco Bay, the Guadalupe River and Walker Creek.

San Francisco Bay Seaport/Vessel Wastes. Non-native invasive species are considered a growing pollution threat as they have reduced or eliminated populations of many native species, disrupted food webs, eroded marshes, and interfered with boating and other water contact recreation — San Francisco Bay is considered one of the most highly invaded estuaries in the world. In particular, the San Francisco Estuary Project worked with the Department of Fish and Game and other agencies to develop the recent *California Aquatic Invasive Species Management Plan* signed by the Governor in January 2008. The plan focuses on early detection and rapid response actions, risk assessment of the primary introduction vectors, and improved coordination among agency partners.

San Francisco Estuary, Water Diversions and Delta Issues. The rate and timing of freshwater flows are among the most important factors influencing physical, chemical, and biological conditions in the Estuary. Much of the freshwater inflow, however, is trapped upstream by the dams, canals, and reservoirs of California's water diversion projects, which provide vital water to industries, farms, homes, and businesses throughout the state. The San Francisco Bay Water Board along with the State Water Board, the Central Valley Water Board (Region 5), and other stakeholders are working together to maximize positive results for Bay water quality in solutions to the diversion issues, which are complex and statewide.

Staffs from the State Water Board and the San Francisco Bay and Central Valley Water Boards have formed the *Bay-Delta Team* to improve coordination of the Water Boards'

activities in the San Francisco Bay and Sacramento-San Joaquin Delta. The Bay-Delta Team has begun developing and implementing a long-term program for addressing impacts to beneficial uses of water in the Bay-Delta, as well as identifying actions that should be implemented in the short-term to address known or suspected impairments. In addition, to help reduce the need for fresh water imports, the San Francisco Bay Water Board works with local water districts and sanitary districts to maximize recycling of wastewater and to promote environmentally sound stormwater retention (e.g., cisterns, groundwater recharge, local retention basins) for safe uses in the Bay Area. The San Francisco Bay Water Board believes that treated wastewater and stormwater should be seen as valuable resources, rather than as wastes to be disposed of.

Runoff Pollution and Hydromodification. One example problem is erosion in streams around the region — although naturally occurring, erosion is accelerated by urbanization and increased impervious surfaces, land use conversion, rural development, and grazing. Erosion contributes to downstream water quality problems, including siltation, loss of riparian vegetation, increased water temperatures, and changes in stream geomorphology. Many of the region's watersheds are impaired due to impacts of excessive sedimentation, lack of large woody debris, and lack of spawning gravels. The Water Board addresses these issues through its storm water program, which regulates construction activities and control of erosion from development; the TMDL program, which sets implementation actions and schedules for runoff sources such as road runoff, confined animal facilities, and grazing in specific watersheds; and by directing technical assistance and grant funding to locally managed watershed programs working on restoration projects and education and outreach efforts.

Wetland Restoration

Some of these projects include the South Bay Saltponds, Napa Sonoma Marsh, Napa River Flood Control Project, Bair Island, Sonoma Baylands, and the Montezuma Wetland Project. The Water Board is also working on many projects on U.S. Department of Defense (DOD) sites such as the Hamilton Air Force Base and Mare Island Naval Base wetland restoration projects. In addition to providing increased habitat values, these wetlands may act as groundwater recharge areas, flood storage areas, and buffers to sea level rise. Sediment threatens water quality and habitat in Bolinas Lagoon, the only wetland on the West Coast designated as a Wetland of International Significance by USFWS.

Groundwater Pollution Issues and Priorities

Groundwater Protection. A variety of historical and ongoing industrial, urban, and agricultural activities and their associated discharges have degraded groundwater quality, including industrial and agricultural chemical spills, underground and above-ground tank and sump leaks, landfill leachate, septic tank failures, and chemical seepage via shallow drainage wells and abandoned wells. There are over 800 groundwater cleanup cases in the region, about half of which are fuel cases. In many cases, the treated

groundwater is discharged to surface waters via storm drains. The Water Board has adopted general NPDES permits for discharge of treated groundwater polluted by fuel leaks and other related wastes at service stations and similar sites and for groundwater polluted by VOCs (volatile organic compounds), as well as permits for aquifer protection and salinity barrier wells, reverse osmosis concentrate from aquifer protection wells, and high volume structure dewatering requiring treatment. As additional discharges are continually being identified, source removal, pollution containment, and cleanup must be undertaken as quickly as possible, and activities that may potentially pollute groundwater must be managed to ensure that groundwater quality is protected.

Several high priorities for the Water Board include cleanup of DOD sites such as Hunter's Point, Pt. Molate, and Pt. Isabel, cleanup at "Brownfields" sites (in general, these are contaminated former industrial sites in urban areas that are suitable for redevelopment), increased enforcement against dischargers, technical input on cleanup, and working closely with their sister agency the Department of Toxic Substances Control (DTSC).

Future Water Quality Priorities and Actions

Total Maximum Daily Load (TMDL). The TMDL process involves: determining a safe level of loading for each problem pollutant, determining the pollutant sources, allocating loads to all the different sources, and implementing the load allocations. The State Water Board is taking a watershed management approach to runoff source issues, including TMDL implementation, by engaging all affected stakeholders in designing and implementing goals for the watershed to protect water quality. Representatives from all levels of government, public interest groups, industry, academic institutions, private landowners, concerned citizens and others are involved in creating watershed action plans that include a wide range of actions such as improving coordination between regulatory and permitting agencies, increasing citizen participation in watershed planning activities, improving public education on water quality and protection issues, and enforcing current regulations on a more consistent and prioritized basis.

Riparian Habitat. The Water Board will continue its program of regulating wetland fills and requiring mitigation. Watershed efforts will continue and expand, and habitat preservation and re-creation are expected to be a major focus of any watershed management plan. In conjunction with the North Coast Water Board, a Stream and Wetland Systems Protection Policy is being developed to protect and restore the physical characteristics of streams and wetlands (stream channels, wetlands, riparian areas, and floodplains), including connectivity and natural hydrologic regimes, in order to achieve water quality standards and protect beneficial uses.

Low Impact Development. Associated with or included in low impact development is the support of infill development on Brownfields sites, multi-objective floodplain management projects that allow for natural geomorphic processes, fishery enhancement, floodplain connectivity, riparian habitat enhancement, floodwater storage and

groundwater recharge, increased water recycling and reclamation as well as stormwater capture through local rainwater capture systems (e.g., rain gardens), grassy swales, floodplain and wetland restoration and creation, and onsite retention basins. For more information on low impact development the reader is directed to the Urban Runoff Management Resource Management Strategy in Volume 2.

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The California Water Plan provides a framework for resource managers, legislators, Tribes, other decision-makers, and the public to consider options and make decisions regarding California's water future. Our goal is that this document meet Water Code requirements, receive broad support among those participating in California's water planning, and be a useful document. With its partners, DWR completed the final Update 2009 volumes and Highlights in December 2009.

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