The State Water Project

DRAFT Delivery Reliability Report 2011

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Director's Message

The *State Water Project Delivery Reliability Report 2011* (2011 Report) is the latest update to a biannual report that describes the existing and future conditions for State Water Project (SWP) water supply that are expected if no significant improvements are made to convey water past the Sacramento–San Joaquin Delta (Delta) or to store the more variable runoff that is expected with climate change.

This report is presented in a different format than previous versions. The four previous reports were written for a dual audience—both the general public and those interested in a greater level of technical detail, such as the SWP contractors. By contrast, this report is written primarily with the public in mind. As a result, it not only provides updated information about the SWP's water delivery reliability, but is also designed to educate Californians about the SWP and its operations. This report presents a concise description of the historical events leading to the construction of the SWP and describes the SWP's facilities and operations. It then defines and explains the concept of water delivery reliability and the types of SWP water available to contractors, and describes various factors that affect the reliability of water deliveries. Because of the public interest in water project pumping from the Delta and the dependence of SWP water supply on Delta pumping, a new chapter has been added that focuses specifically on SWP pumping (exports) at the Harvey O. Banks Pumping Plant in the Delta.

The 2011 Report shows that the SWP continues to be subject to reductions in deliveries similar to those contained in the *State Water Project Delivery Reliability Report 2009* (2009 Report), caused by the operational restrictions of biological opinions (BOs) issued in December 2008 and June 2009 by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) to govern SWP and Central Valley Project operations. Federal court decisions have remanded the BOs to USFWS and NMFS for further review and analysis. We expect that the current BOs will be replaced sometime in the future. The operational rules defined in the 2008 and 2009 BOs, however, continue to be legally required and are the rules used for the analyses supporting the 2011 Report.

The following "Summary" includes key findings of the analyses in the 2011 Report. A technical addendum is also available which provides detail on the assumptions of the analyses and the results for the 2011 Report. The results of the studies, as presented in this report and the technical addendum, are designed to assist water planners and managers in updating their water management and infrastructure development plans. These results emphasize the need for local agencies to develop a resilient and robust water supply, and a distribution and management system to maximize the efficient use of our variable supply. They also illustrate the urgent need to improve the method of conveying water past the Delta in a more sustainable manner that meets the dual goals of increasing water delivery reliability and improving conditions for endangered and threatened fish species.

Mark Cowin
Director
California Department of Water Resources
January 2012

Summary

This report is intended to inform the public about key factors important to the operation of the SWP and the reliability of its water deliveries.

California faces a future of increased population growth coupled with the potential for water shortages and pressures on the Delta. For many SWP water contractors, water provided by the SWP is a major component of all the water supplies available to them. SWP contractors include cities, counties, urban water agencies, and agricultural irrigation districts. These local utilities and other public and private entities provide the water that Californians use at home and work every day and that helps to nourish the state's bountiful crops. Thus, the availability of water to the SWP becomes a planning issue that ultimately affects the amount of water that local residents and communities can use.

The availability of these water supplies may be highly variable. A wet water year may be followed by a dry or even critical year. Knowing the probability that they will receive a certain amount of SWP water in a given year—whether it be a wet water year, a critical year, or somewhere in between—gives contractors a better sense of the degree to which they may need to implement increased conservation measures or plan for new facilities.

The Delta is the key to the SWP's ability to deliver water to its agricultural and urban contractors. All but three of the 29 SWP contractors receive water deliveries from the Delta (pumped by either the Harvey O. Banks or Barker Slough Pumping Plant).

Yet the Delta faces numerous challenges to its long-term sustainability. Among these are continued subsidence of Delta islands, many of which are already below sea level, and the related threat of a catastrophic levee failure as water pressure increases on fragile levees. Climate change poses the threat of increased variability in floods and droughts, and sea level rise complicates efforts to manage salinity levels and preserve water quality in the Delta so that the water remains suitable for urban and agricultural uses.

Protection of endangered and threatened fish species, such as the delta smelt, is also an important factor of concern for the

Delta. Ongoing regulatory restrictions, such as those imposed by federal biological opinions on the effects of SWP and CVP operations on these species, also contribute to the challenge of determining the SWP's water delivery reliability.

The analyses in this report factor in all of the regulations governing SWP operations in the Delta and upstream, and assumptions about water uses in the upstream watersheds.

Modeling was conducted that considered the amounts of water that SWP contractors use and the amounts of water they choose to hold for use in a subsequent year.

Many of the same specific challenges to SWP operations described in the *State Water Project Delivery Reliability Report 2009* (2009 Report) remain in 2011. Most notably, the effects on SWP pumping caused by issuance of the 2008 and 2009 federal biological opinions, which were reflected in the 2009 Report, continue to affect SWP delivery reliability today. The analyses in this report factor in climate change and the effects of sea level rise on water quality, but do not incorporate the probability of catastrophic levee failure. The resulting differences between the 2009 and 2011 Reports can be attributed primarily to updates in the modeling assumptions and inputs.

As noted in the discussion of SWP exports in Chapter 5 of this report, Delta exports (that is, SWP water of various types pumped by and transferred to contractors from the Banks Pumping Plant) have decreased since 2005, although the bulk of the change occurred by 2009 as the federal BOs went into effect, restricting operations. These effects are also reflected in the SWP delivery estimates provided in Chapters 6 and 7 of this report. Chapters 6 and 7 characterize the SWP's water delivery reliability under existing conditions and future conditions, respectively. The following are a few of the key points from Chapters 5, 6, and 7:

- Estimates of average annual SWP exports under conditions that exist for 2011 are 2,607 taf, 350 taf or 12% less than the estimate under 2005 conditions.
- The estimated average annual SWP exports decrease from 2,607 taf/year to 2,521 taf/year (86 taf/year or about 3%) between the existing- and future-conditions scenarios.
- Under existing conditions, the average annual delivery of Table A water estimated for this 2011 Report is 2,524 taf/year, 41 taf (2%) more than the 2,483 taf/year estimated for the 2009 Report.
- Under future conditions, the average annual delivery of Table A water estimated for this 2011 Report is 2,466 taf/year, about 1% less than the 2,487-taf/year estimate for the future-conditions scenario presented in the 2009 Report.
- The likelihood of SWP Article 21 deliveries (supplemental deliveries to Table A water) being equal to or less than 20 taf/year has increased relative to that estimated in the 2009 Report. However, both this report and the 2009 Report show a high likelihood that Article 21 water deliveries will be equal to or less than 20 taf/year, ranging between 71% and 78% for both existing and future conditions.

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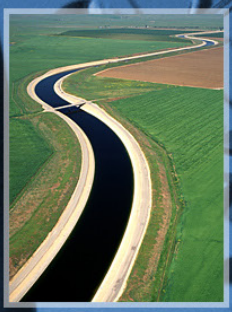

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Chapter 1

Water Delivery Reliability: A Concern for Californians

California's water supplies are crucial to maintaining a high quality of life for the state's residents. The State Water Project (SWP), operated by the California Department of Water Resources (DWR), is an integral part of the effort to ensure that business and industry, urban and suburban residents, and farmers throughout much of California have sufficient water at all times. This *State Water Project Delivery Reliability Report 2011* describes the expected existing and future SWP water deliveries.

The term "water delivery reliability," as used in this report, is defined as the annual amount of SWP water that can be expected to be delivered with a certain frequency. To put this another way: What is the likelihood, or probability, that a certain amount of water will be delivered by the SWP in a year?

Reasons to Assess SWP Water Delivery Reliability

Let's look at two important factors that underscore the importance of assessing the SWP's water delivery reliability: the effects of population growth on California's water supply, and State legislation intended to help maintain a reliable water supply.

Population Growth, Land Use, and Water Supply

Water and development have had a close yet complex relationship since California's early days. Indeed, the SWP was established in the wake of a second economic "gold rush" that began after the end of World War II. Increased statewide population and commerce made it clear to water managers that local water supplies (including groundwater) would not be sufficient to meet their communities' future needs.

Population growth and resulting development in California since World War II have been substantial, fueling the need for increased water supply.

California's population has grown rapidly in recent years, with resulting changes in land use. This growth is expected to continue. From 1990 to 2005, California's population increased from about 30 million

to about 36.5 million. Based on this trend, California's population has been projected to be more than 47.5 million by 2020. The "current trends" scenario depicted in the *California Water Plan 2009* for year-2050 conditions assumed a population of nearly 60 million—double the 1990 population.

The amount of water available in California—or in different parts of the state—can vary greatly from year to year. Some areas may receive 2 inches of rain a year, while others are deluged with 100 inches or more. As land uses have changed, population centers have grown up in many locations where there is not a sufficient local water supply. Thus, Californians have always been faced with the problem of how best to conserve, control, and move water from areas of abundant water to areas of water need and use.

To help assure that their water supply is sufficient to meet their demands, water districts develop "water management portfolios" that reflect diversity in water sources and locations. Components of a sustainable water portfolio include conservation, improved efficiency in use, rainwater and runoff capture, use of groundwater aquifers for storage and treatment, improved water treatment, desalination, and a water recycling program.

Legislation on Ensuring a Reliable Water Supply

The laws described below impose specific requirements on both urban and agricultural water suppliers. These laws increase the importance to water suppliers of estimates of SWP water delivery reliability.

California Urban Water Management Planning Act

The California Urban Water Management Planning Act was enacted in 1983. As amended, this law (California Water Code, Sections 10610–10656) requires urban water suppliers to adopt water management plans every 5 years and submit those plans to DWR. Adoption of the most recent (2010) round of urban water management plans was required by July 1, 2011; the plans were due to DWR by August 1, 2011.

In their water management plans, urban water suppliers must assess whether their current and planned water supplies will be enough to meet the water demands expected during the next 20 years. The plans also consider various drought scenarios and the proper ways to respond in case of an unexpected water shortage.

DWR is required to review local water management plans and report on the status of these plans. DWR published a guidebook to preparing urban water management plans in March 2011. Guidance documents are available at http://www.water.ca.gov/urbanwatermanagement.

Water Conservation Act

The Water Conservation Act of 2009 (Senate Bill X7.7, Steinberg), enacted in November 2009, includes distinct requirements related to both urban and agricultural water use.

This law requires that the State of California reduce urban per capita water use statewide by 10% by the end of 2015 and 20% by the end of 2020. DWR is required to report on progress toward meeting these urban per capita water use goals.

In addition, agricultural water suppliers must adopt agricultural water management plans by the end of 2012, then update the plans by the end of 2015 and every 5 years thereafter.

Through its Agricultural Water Management Planning & Implementation Program (http://www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm), DWR helps water districts develop agricultural water management plans and implement cost-effective, efficient water management practices. DWR is currently preparing a guidebook for developing agricultural water management plans.

Background of This Report

This *State Water Project Delivery Reliability Report 2011* is the fifth in a series of reports on the SWP's water delivery reliability. DWR is legally required to prepare and distribute this report every 2 years to all SWP contractors (recipients of SWP water), city and county planning departments, and regional and metropolitan planning departments in the SWP's service area. Reports were previously produced for 2002, 2005, 2007, and 2009.

The requirement for a biennial water delivery reliability report was established in a settlement agreement among the Planning and Conservation League, DWR, SWP contractors, and others that was approved by the 3rd Circuit Court of Appeals in May 2003. The settlement agreement was reached in the aftermath of the "Monterey Amendments" case, which resolved a dispute about the environmental analysis of amendments to the long-term water supply contracts for the SWP that were entered into by DWR and most of the SWP contractors in the 1990s. The terms of the SWP contracts were amended after water shortages during the 1987–1992 drought drastically reduced SWP water deliveries to SWP contractors in the San Joaquin Valley and Southern California.

Attachment B to the settlement agreement specifies that each SWP delivery reliability report must include all of the following information:

- the overall water delivery capacity of the SWP facilities at the time of the report;
- the allocation of that SWP water to each SWP contractor;
- a discussion of the range of hydrologic conditions, which must include the historic extended dry cycle and long-term average; and
- the total amount of SWP water delivered to all contractors and the amount of SWP water delivered to each contractor during each of the 10 years immediately preceding the report.

DWR's water delivery reliability reports are used by various entities for water planning purposes. The reports must be presented in a format understandable by the public. The information presented in the reports is intended to help local agencies, cities, and counties that use SWP water to develop adequate, affordable water supplies for their communities.

Contents and Use of This Report

The following topics are addressed in this *State Water Project Delivery Reliability Report 2011*:

- The Summary at the front of this report briefly summarizes the updated findings on water delivery reliability detailed in previous chapters.
- Chapter 1, "Water Delivery Reliability: A Concern for Californians," summarizes important issues (including selected State legislation) that underlie the need to assess the SWP's water delivery reliability, provides background on DWR's water delivery reliability reports, and defines key terms.
- Chapter 2, "A Closer Look at the State Water Project," describes the SWP's purpose, background, and facilities. This chapter also introduces factors that interact in the Sacramento–San Joaquin Delta (Delta) to affect SWP operations: precipitation and snowmelt patterns, variable river inflows, operations of the federal Central Valley Project (CVP), Delta water quality concerns, regulatory requirements, and the Delta's physical conditions.
- Chapter 3, "SWP Contractors and Water Contracts," lists the SWP water contractors and shows where they are located, and describes the different types of SWP water allocations.
- Chapter 4, "Factors that Affect Water Delivery Reliability," explains generally how water delivery reliability is calculated. The chapter then describes a variety of factors that make forecasting water delivery

reliability inherently challenging. Among these complicating factors are climate change, environmental and policy planning efforts pertaining to the Delta, and the potential for levee breaches in the Delta.

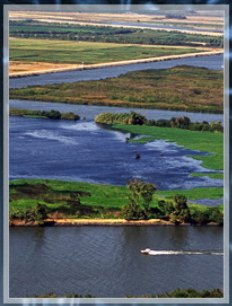
- Chapter 5, "SWP Exports," discusses how the delivery estimates for the SWP have been reduced as a result of more restrictive operational rules. This chapter also presents the results of DWR's modeling of SWP exports from the Harvey O. Banks Pumping Plant for existing conditions (2011) and future conditions (2031).
- Chapter 6, "Existing SWP Water Delivery Reliability (2011)," estimates the SWP's delivery reliability for existing conditions (2011) and compares these estimates with the existing-condition results presented in the *State Water Project Delivery Reliability Report 2009*.
- Chapter 7, "Future SWP Water Delivery Reliability (2031)," estimates the SWP's delivery reliability for conditions 20 years in the future (2031), reflecting potential hydrologic changes that could result from climate change. This chapter also compares these estimates with the future-condition results presented in the *State Water Project Delivery Reliability Report 2009*.
- Appendix A, "Historical SWP Delivery Tables for 2001–2012," presents the historical deliveries for SWP contractors over the last 10 years.

In addition, a technical addendum has been prepared for this report and includes more specific details of the technical analyses and results. Urban and agricultural water suppliers can use the information in this report and the technical addendum when they prepare or amend their water management plans. These details will help them decide whether they need new facilities or programs to meet future water demands. The technical addendum is available upon request and is posted online, along with this report, at http://baydeltaoffice.water.ca.gov.

Urban water suppliers can also use this information when, as required by the California Environmental Quality Act, they analyze whether enough water is available for proposed subdivisions or development projects.

Chapter 2

A Closer Look at the State Water Project



Northern California typically receives abundant rainfall and runoff from mountain snowpack. However, a larger percentage of California's population lives in Southern California and most irrigated farmland lies in Central California. These regions are mostly arid, and local water suppliers cannot fully meet the needs of many of their communities. These areas rely on additional imported water, especially to meet shortages during dry years and the demands of increasing populations. The SWP was constructed to help meet these needs.

Purpose and Background of the SWP

The SWP is the largest state-built, multipurpose, user-financed water project in the United States. More than two-thirds of California's residents—25 million people—receive at least part of their water from the SWP. Project water also supplies thousands of industries and irrigates about 750,000 acres of California farmland. Of the SWP's contracted water supply, 70% goes to urban users and 30% goes to agricultural users.

The primary purpose of the SWP is to provide a water supply—that is, to divert and store water during wet periods in Northern and Central California and distribute it to areas of need in Northern California, the San Francisco Bay area, the San Joaquin Valley, the Central Coast, and Southern California. Other SWP purposes include flood control, power generation, recreation, fish and wildlife enhancement, and water quality improvement in the Delta.

These purposes have been discussed at length for many decades. The concept of a statewide water development project was first raised in 1919 when Lt. Robert B. Marshall of the U.S. Geological Survey proposed transporting water from the Sacramento River system to the San Joaquin Valley, then moving it over the Tehachapi Mountains into Southern California.

In the 1930s, State Engineer Edward Hyatt proposed the "State Water Plan," which identified the facilities needed and economic means to transfer water from

north to south. The California Legislature authorized the project in the Central Valley Act of 1933, and a $170 million bond act was approved by California voters in December 1933. However, the Great Depression precluded the State from obtaining the necessary funding. The U.S. government funded the construction of major components of the plan, which became the federal CVP. (See "The Central Valley Project and Its Relationship to the SWP" later in this chapter.)

As California's population grew after World War II, investigations of statewide water resources resumed. In 1945, DWR's predecessor, the Division of Water Resources of the Department of Public Works, conducted a variety of studies that culminated in the Feather River Project, presented to the State Legislature in 1951 by State Engineer A. D. Edmonston. A revised project proposal was presented in 1955. The Legislature appropriated funds for detailed studies of the Feather River Project, which evolved to become the SWP.

In 1959, the Legislature passed the California Water Resources Development Bond Act. This law, also known as the Burns-Porter Act, authorized $1.75 billion in bonds to build the SWP's initial facilities, contingent on voter approval. After California voters approved the Burns-Porter Act in November 1960, construction of the SWP by DWR began in the early 1960s, with water deliveries following.

SWP Facilities

Today, the SWP includes 33 storage facilities, 21 reservoirs and lakes, 20 pumping plants, four pumping-generating plants, five hydroelectric power plants, and about 700 miles of canals and pipelines. Figure 2-1 shows the primary SWP facilities.

Facilities North of the Delta

The SWP's watershed encompasses the mountains and waterways around the Feather River in Plumas County. Rain and melting snow run off mountainsides and into waterways that flow into Lake Oroville, where the SWP officially begins. With a capacity of about 3.5 million acre-feet, Lake Oroville is the SWP's largest storage facility. The water management facilities of Lake Oroville are designed to maximize energy production and include six power generating units and six pumping/generating units. Three hydroelectric power plants operate at Oroville.

Oroville Dam.

When water is needed, Oroville Dam releases water into the Feather River, which converges with the Sacramento River north of the city of Sacramento. Releases from Shasta and Folsom Reservoirs, facilities of the federal CVP, also flow into the Sacramento River. The Sacramento River flows into the Delta, where it mixes with water from the San Francisco Bay and is influenced by the tides. From the Delta, some of this water is pumped by the Barker Slough Pumping Plant into the North Bay Aqueduct for municipal use by Napa and Solano Counties.

Figure 2-1. Primary State Water Project Facilities

Facilities in the Delta and Central California

The SWP's primary pumping plant, the Harvey O. Banks Pumping Plant, is located in the south Delta in Alameda County. The pumps at the Banks Pumping Plant lift Delta water stored in the Clifton Court Forebay into the California Aqueduct, which at 444 miles long is the longest water conveyance system in California. At Bethany Reservoir, some SWP water is diverted from the California Aqueduct into the South Bay Aqueduct, which serves urban and agricultural uses in Alameda and Santa Clara Counties.

Harvey O. Banks Pumping Plant.

Water in the California Aqueduct flows into the San Luis Joint-Use Complex located in Merced County, which is jointly owned by the SWP and the CVP. Among the facilities at the complex is San Luis Reservoir, which is the world's largest offstream reservoir, with storage space for more than 2 million acre-feet of water. (An "offstream reservoir" is a water body that does not impede and store natural flows directly within a stream course, but instead is located "offstream"; stored water is diverted elsewhere and conveyed to the offstream reservoir by a pipeline or aqueduct.) Generally, water is pumped into San Luis Reservoir from late fall through early spring and is stored temporarily before being released back to the California Aqueduct to meet the higher summertime water demands of SWP (and CVP) contractors.

Facilities in the San Joaquin Valley and Southern California

After leaving the San Luis Joint-Use Complex, water travels through the central San Joaquin Valley via a jointly owned federal/State portion of the California Aqueduct. Along the way, deliveries are made to San Joaquin Valley contractors of both the SWP and the CVP. Near Kettleman City in Kings County, the SWP's Coastal Branch Aqueduct branches off to serve SWP contractors in San Luis Obispo and Santa Barbara Counties. The California Aqueduct continues southeast until, at the base of the Tehachapi Mountains, it reaches the A. D. Edmonston Pumping Plant, the SWP's largest pumping station.

A. D. Edmonston Pumping Plant.

The Edmonston Pumping Plant, located in Kern County, is an engineering marvel. It is the highest single-lift pumping plant in the world. The 14 pumps at this facility, each weighing

more than 400 tons and powered by 80,000-horsepower motors, raise water from the California Aqueduct 1,926 feet—more than one and one-half times the height of New York's Empire State Building—to enter 10 miles of tunnels and siphons that cross the Tehachapi Mountains.

After crossing the mountains, the water splits into two branches, the West Branch and East Branch, and is delivered to SWP contractors in Southern California. The southernmost SWP facility, located at the end of the East Branch, is Lake Perris in Riverside County.

The Delta and Factors Affecting SWP Operations and Deliveries

The Delta forms the eastern portion of the San Francisco estuary. It is composed of 738,000 acres of land interlaced with hundreds of miles of waterways that receive runoff from about 40% of the state's land area. The Delta is one of the few estuaries in the world that is used as a major source of drinking water supply. The Delta is important not only to SWP operations, but to California's economy. About $400 billion of California's $1.5 trillion economy is supported by water from the Delta, as noted by DWR and the California Department of Fish and Game (DFG) in the 2008 report, *Risks and Options to Reduce Risks to Fishery and Water Supply Uses of the Sacramento/San Joaquin Delta*.

Numerous competing demands converge in the Delta—especially the need to provide water for both agricultural and urban uses and the desire to protect habitat for endangered species.

In the SWP conveyance system, the Delta is the critical link between the water supplies in the Sacramento Valley and the water demands of, and deliveries to, the rest of the Central Valley and Southern California. Physically, the Delta is the focal point for water distribution in California because most of the SWP contractors are located at points south of the Delta.

However, the Delta has long been an area of numerous competing demands; for example, the Delta provides water for millions of Californians, but also serves as important habitat for hundreds of animal, plant, and fish species, some of which are listed under the federal Endangered Species Act (ESA) and/or California Endangered Species Act (CESA) as threatened or endangered. It also supports a local population of more than 500,000 and millions of visitors who use the Delta's recreational areas, navigable waterways, and marinas. Further, not only do SWP and CVP contractors use Delta water for agriculture, but local farmers within the Delta itself use its water to irrigate their crops planted on the numerous Delta islands.

The SWP's ability to pump water from the Delta is not affected only by the physical size and capacity of the pumps at the Banks Pumping Plant. As described below, the Delta is affected by numerous factors that interact to affect SWP operations and water deliveries:

- Delta inflows (i.e., the combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways),
- beneficial uses and water rights,
- Delta water quality standards,
- regulatory requirements,
- concurrent CVP operations and pumping, and
- physical factors.

Delta Inflows

Delta inflow varies considerably from year to year. Levels of development upstream of the Delta along the rivers and their watersheds—in the areas from which the water originates—affect Delta inflows. In an average year, 85% of the total Delta inflow comes from the Sacramento River, 10% to 15% comes from the San Joaquin River, and the rest comes from three eastside Delta tributaries (the Mokelumne, Cosumnes, and Calaveras Rivers) (Figure 2-2).

The type of water year is also an important factor affecting the volume of Delta inflows. When hydrology is analyzed, water years are designated by DWR as "wet," "above normal," "below normal," "dry," or "critical" based on the amount of rain and snow that fell during the preceding period of October 1–September 30. DWR hydrologists and meteorologists measure snowpack in the northern Sierra Nevada on or about the first of January, February, March, April, and May, in the watersheds where most of the state's water supply originates, to forecast snowmelt runoff—and thus available water supply—for the coming spring and summer.

All other factors (such as upstream development) being equal, much less water will flow into the Delta during a dry or critical water year—that is, during a drought—than during a wet or above normal water year. Fluctuations in inflows are a substantial overall concern for the Delta, and a specific concern for the SWP; such fluctuations affect Delta water quality and fish habitat, which in turn trigger regulatory requirements that constrain SWP Delta pumping. For example:

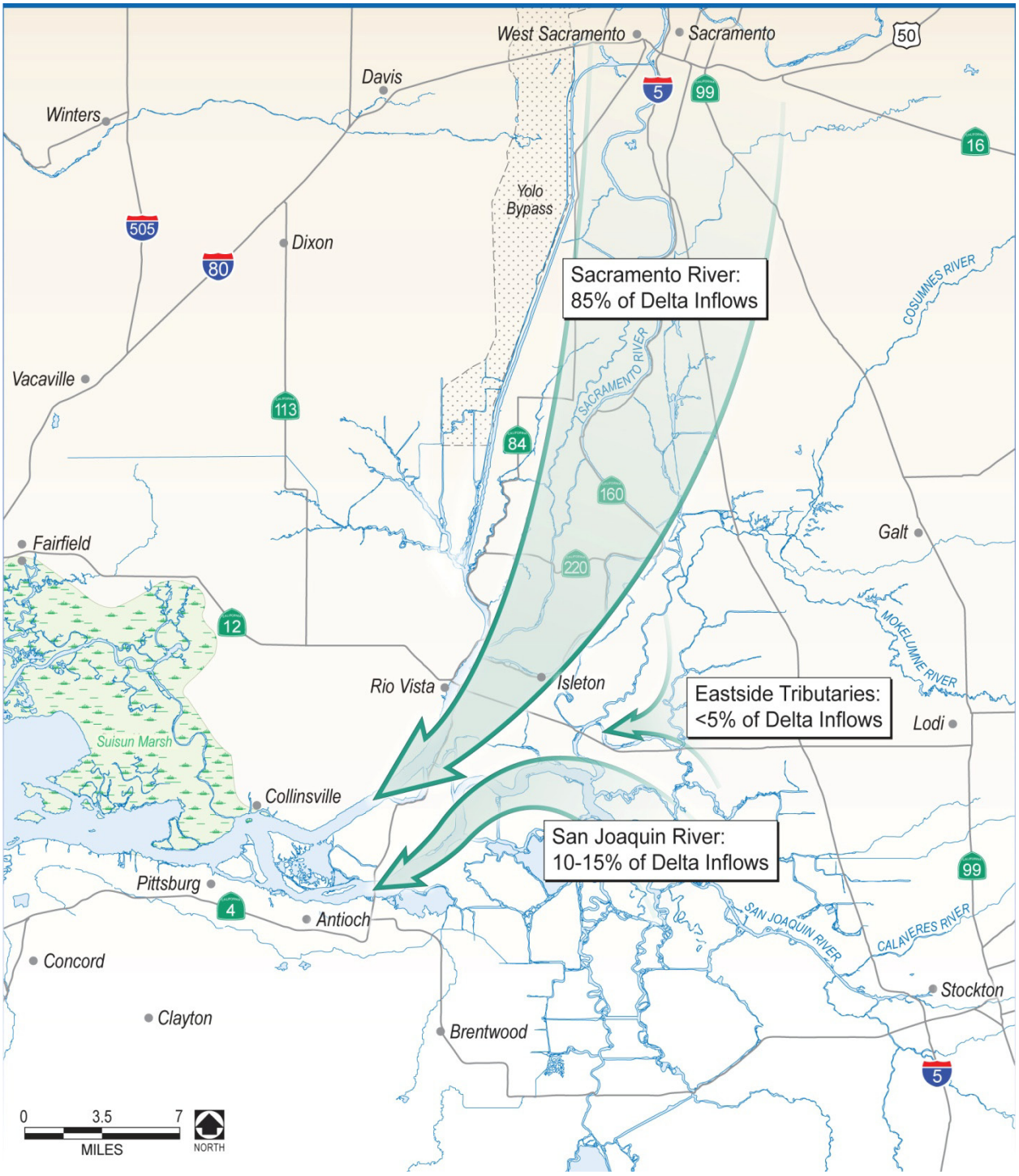
- As discussed below under "Delta Water Quality Standards," lower inflows can cause Delta water to become increasingly saline and trigger additional upstream reservoir releases and/or reduced Delta pumping to meet regulatory requirements.
- Conditions for fish in the Delta are less suitable in drier years, as seen during California's 1987–1992 drought, which can also trigger regulatory requirements that reduce SWP pumping.

Delta inflows will also vary by time of year because the amount of precipitation varies by season. About 80% of annual precipitation occurs between November and March, and very little rain typically falls from June through September. A seasonal mismatch of water supply and demand typically exists; runoff is greatest in winter and spring, but water demands peak in summer. Upstream reservoirs dampen this variability by reducing flood flows and storing water to be released later in the year to meet water demands and flow and water quality requirements.

Delta Water Quality Standards

Water quality standards for the Delta also affect SWP operations. The Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code) defines "beneficial uses" of waters of the State (both surface water and groundwater) that must be protected against quality degradation. These beneficial uses include domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves. The criteria based on those uses, called "water quality objectives," are found in the water quality control plans adopted by the State Water Resources Control Board and the nine regional water quality control boards. The SWP and CVP must meet specific criteria for salinity during certain times of the year at various locations in the Delta, as described further under "Factors that Can Influence the SWP's Water Delivery Reliability" in Chapter 4.

Salinity levels can be affected by the water year type: Inflows into the Delta decline in dry and



Source: DWR 2011a

Figure 2-2. Origins of Delta Inflows

critical water years, but daily tidal inflow of salty water into the Delta from the Pacific Ocean remains generally the same, thus increasing Delta salinity. Excessive salinity may adversely affect crop yields and require more water for salt leaching, may require additional municipal and industrial treatment, may increase salinity levels in agricultural soils and groundwater, and is the primary water quality constraint to recycling wastewater. Salty water is both undrinkable and unusable for irrigation (and thus unsuitable for SWP and CVP contractors and farmers in the Delta), and is harmful to fish inhabiting the Delta, including endangered and threatened species. Climate change is also causing sea level rise, which is projected to substantially increase Delta salinities. Generally, Delta water quality is best during winter and spring and poorer through the summer irrigation season and early fall.

SWP operations are closely regulated by the water quality standards contained in State Water Resources Control Board Water Right Decision 1641 (D-1641). D-1641 was issued in December 1999 (with a revised version issued in March 2000) to implement the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* (1995 WQCP). The 1995 WQCP established beneficial uses of Delta water, associated water quality objectives for the reasonable protection of beneficial uses, and an implementation program to achieve the water quality objectives.

D-1641 assigned primary responsibility for meeting many of the water quality objectives established in the 1995 WQCP to the SWP (thus, to DWR) and the CVP (thus, to Reclamation). To meet these objectives, D-1641 limits or curtails SWP and CVP pumping operations in certain parts of the year. For example, D-1641 imposed limits on the ratio of SWP and CVP exports to total inflow into the Delta. This "export-inflow ratio" varies by time of year.

Regulatory Requirements

The Delta provides important habitat for fish species listed as threatened or endangered under either the federal ESA or the CESA, or both. Several resource agencies have taken actions under their authorities to protect these species. Regulatory requirements based on recent biological opinions (BOs) issued by the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) for CVP and SWP operations are a particularly important factor affecting SWP operations. DFG also regulates the protection of species under the CESA, and has issued consistency determinations in the past when it has found federal BOs to be consistent with CESA for State-listed species.

Delta smelt.

A BO is a determination by USFWS or NMFS on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated critical habitat. If jeopardy is determined, certain actions are required to protect species of concern. Usually BOs apply specifically to federal actions, but DWR coordinates with Reclamation in the agencies' operation of the SWP and federal CVP. Since the passage of the federal ESA in 1973, various BOs have been issued by USFWS and NMFS for the effects on federally listed endangered species of these coordinated operations.

NMFS administers the ESA for marine fish species, including anadromous salmonids (those that spend a part of their life cycle in the sea and return to freshwater streams to spawn), such as

Central Valley steelhead, winter-run and spring-run Chinook salmon, and green sturgeon. USFWS administers the ESA for nonanadromous and nonmarine fish species, such as delta smelt and longfin smelt. Both anadromous and nonanadromous fish species are found in the Delta and are federally listed under the ESA.

If USFWS or NMFS finds that a proposed action is likely to jeopardize a listed species or adversely modify its critical habitat, the agency is required to identify "reasonable and prudent alternatives" (defined in Title 50, Section 402.02 of the Code of Federal Regulations) that it has determined would enable the project to go forward in compliance with the ESA.

Especially important to the SWP are the BOs issued by USFWS and NMFS in 2008 and 2009, respectively, for the coordinated operations of the CVP and SWP. Both of these BOs, which DFG found consistent with the CESA for State-listed species, have directly and substantially affected SWP operations and pumping levels in recent years: They incorporate terms that directly or indirectly limit the amount of CVP and SWP Delta pumping under certain conditions. Relative to prior years, SWP water deliveries estimated in the *State Water Project Delivery Reliability Report 2009*—the last edition of this report—were, in general, reduced by the operational restrictions of these BOs.

Concurrent Central Valley Project Operations and Pumping

CVP operations also affect the Delta as Reclamation diverts water for agricultural and urban uses. To make the most efficient use of the common water supply available to the CVP and SWP, Reclamation and DWR must work as closely as possible to coordinate their respective reservoir releases and Delta pumping operations.

Subsidence (sinking) of islands in the Delta places even more pressure on already fragile Delta levees.

The two projects share some of their facilities in the San Joaquin Valley—most notably the San Luis Unit, for which the major storage reservoir is San Luis Reservoir, and more than 100 miles of the California Aqueduct. In addition, the CVP and SWP are allowed to use each other's export pumping facilities in the south Delta—to pump water for each other—when operation of one set of pumps is affected by facility maintenance, capacity limitations, or fish protection requirements. Use of this "joint point of diversion" is subject to an operations plan that protects fish and wildlife and other legal users of water.

Physical Factors

The stability and reliability of SWP water deliveries can be threatened by physical factors affecting facilities or water quality anywhere in the SWP system. The Delta is particularly vulnerable. Delta islands have been subsiding and in some places the land has sunk to 20 feet below sea level. This places extra pressure on the Delta's levees because it means they must hold back water constantly rather than only during peak-flow periods.

Climate change is causing sea level to rise, increasing pressure on Delta levees even further. Delta levees are also vulnerable because they were built 150 years ago and could be affected if an earthquake were to strike anywhere near the Delta.

THE CENTRAL VALLEY PROJECT AND ITS RELATIONSHIP TO THE SWP

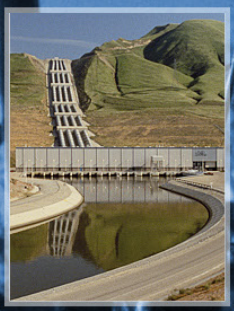
The federal Central Valley Project, operated by the U.S. Bureau of Reclamation, was originally conceived as a State of California project to protect the Central Valley from water shortages and floods. During the Great Depression, however, the State was unable to sell bonds to finance project construction, and beginning in the late 1930s, the U.S. government constructed the CVP as a public works project.

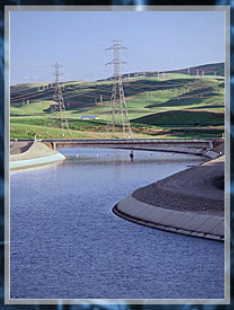
The CVP operates 18 dams and reservoirs, 11 powerplants, and 500 miles of canals and other facilities between the Cascade Range near Redding and the Tehachapi Mountains near Bakersfield. It serves agricultural, municipal, and industrial needs in the Central Valley and urban centers in parts of the San Francisco Bay Area, and is the primary water source for many Central Valley wildlife refuges. In an average year the CVP delivers about 7 million acre-feet of water for agriculture, urban, and wildlife use, irrigating about one-third (3 million acres) of California's agricultural lands and supplying water for nearly 1 million households (Reclamation 2009).

The CVP and SWP share some of their facilities, especially the San Luis Unit, and their respective operations staffs work closely together. The Coordinated Operations Agreement between the CVP and SWP, signed in 1986, outlines the shared responsibilities of each project to meet Delta water quality and flow objectives and provides for equitable sharing of surplus water that enters the Delta.

Chapter 3

SWP Contractors and Water Contracts





During the 1960s, as the SWP was created, long-term contracts were signed by DWR and 29 urban and agricultural water suppliers in various locations within California. The contracts are essentially uniform and will expire in 2035. These urban and agricultural water suppliers are referred to in this report as the "SWP contractors" or "contractors." This chapter introduces the SWP contractors, explains the basics of SWP water contracts, and describes the various types of project water, especially "Table A" water. The discussion also outlines some of the factors that influence delivery of Table A water.

About the SWP Contractors

The SWP contractors are located in the south San Francisco Bay Area, along the Central Coast, in the San Joaquin Valley, and in Southern California. They include cities, counties, urban water agencies, and agricultural irrigation districts. Most contractors use the project water they receive for municipal purposes; a few use the water for agriculture. The SWP contractors mostly use project water to supplement local supplies, including groundwater, or other imported water. The 29 SWP contractors are listed below and their locations are shown in Figure 3-1.

Upper Feather River Area Contractors

- Butte County
- Yuba City
- Plumas County Flood Control and Water Conservation District

North Bay Area Contractors

- Napa County Flood Control and Water Conservation District
- Solano County Water Agency

South Bay Area Contractors

- Alameda County Flood Control and Water Conservation District, Zone 7
- Alameda County Water District
- Santa Clara Valley Water District

San Joaquin Valley Area Contractors

- Dudley Ridge Water District
- Empire West Side Irrigation District
- Kern County Water Agency
- Kings County
- Oak Flat Water District
- Tulare Lake Basin Water Storage District

Figure 3-1. State Water Project Contractors

Central Coastal Area Contractors

- San Luis Obispo County Flood Control and Water Conservation District
- Santa Barbara County Flood Control and Water Conservation District

Southern California Area Contractors

- Antelope Valley–East Kern Water Agency
- Castaic Lake Water Agency
- Coachella Valley Water District
- Crestline–Lake Arrowhead Water Agency
- Desert Water Agency
- Little Rock Creek Irrigation District
- Metropolitan Water District of Southern California
- Mojave Water Agency
- Palmdale Water District
- San Bernardino County Municipal Water District
- San Gabriel Valley Municipal Water District
- San Gorgonio Pass Water Agency
- Ventura County Flood Control District

How Water Contracts Work

Under the terms of their long-term water supply contracts with DWR, the 29 SWP contractors receive specified amounts of water from the SWP each year, called "annual allocations."

The SWP's long-term water supply contracts define the terms and conditions governing water delivery and repayment of project costs. In return for the allocated water, the SWP contractors repay principal and interest on both the bonds that initially funded construction of the SWP and the bonds that paid for additional facilities. The contractors also pay all costs, including labor and power, to maintain and operate project facilities. They also pay transportation charges based on the distance between the Delta and each contractor's water delivery point.

In addition, recreational facilities at many SWP reservoirs (such as Lake Oroville and San Luis Reservoir) are funded by SWP contractors. The contractors also contribute mitigation costs for any environmental impacts of SWP operations on fish and wildlife.

"Table A" Water

Table A is an exhibit to the SWP's water supply contracts. This section explains Table A water and outlines the primary factors that influence the amount of such water actually delivered to SWP contractors.

What Is Table A Water?

The water supply–related costs of the SWP are paid for by SWP contractors. All water contracts signed in the 1960s included an estimate of the date that SWP water would first be delivered and a schedule of the amount of water the contractor could expect to be delivered annually. That amount of water, known as the contractor's annual Table A amount, was designed to increase gradually until the designated maximum for that SWP contractor was reached.

The total combined maximum Table A amount for all SWP contractors was initially 4,230 thousand acre-feet per year (taf/year), assuming full development of the SWP. At that time, this amount was referred to as the "maximum project yield." As a result of amendments to the water supply contracts in the 1990s, the current combined maximum Table A amount is 4,173 taf/year. Of this amount, 4,133 taf/year is the maximum Table A water available for delivery from the Delta. It is recognized that deliveries will be less than the established maximum Table A amount in some years and more than this amount in other years.

The maximum Table A amount is the basis for apportioning water supply and costs to the SWP contractors. Once the total amount of water to be delivered is determined for the year, all available water is allocated in proportion to

each contractor's annual maximum SWP Table A amount. To reiterate, however, in some years the SWP cannot deliver the maximum amount of 4,133 taf from the Delta, but in other years, project supply exceeds that amount. In years when the project supply from the Delta exceeds 4,133 taf, contractors may also receive other classifications of water from the SWP, such as Article 21 water and turnback pool water. (See "Other Types of SWP Water" later in this chapter.)

The established maximum Table A amounts for the 29 SWP contractors vary widely (Table 3-1). The median is 42 taf; thus, the maximum allocations of Table A water for half of the SWP contractors exceed this amount, and for the other half they are less. As shown in Table 3-1, the largest Table A amount is held by the Metropolitan Water District of Southern California at 1,911,500 acre-feet; the smallest is held by the Little Rock Creek Irrigation District at 2,300 acre-feet.

The maximum Table A amount listed in any particular contract should not be read as a guarantee that the SWP contractor will receive that amount. Rather, the maximum Table A amount is the tool in an allocation process that defines an individual contractor's "slice of the pie" (and a factor in allocating each contractor's share of the SWP's costs).

SWP contractors will receive a certain percentage of the maximum Table A amounts in their contracts. As discussed below, the water year type and the contractors' demand levels are among the factors involved in determining the amount of Table A water that will be delivered by DWR to each contractor. At various times of the year, DWR issues projections of anticipated Table A allocations based on then-current conditions, and updates those projections as warranted. The deliveries of Table A water to each of the SWP contractors in the last 10 years are shown in Appendix A.

Factors Influencing Percentages of Table A Water Delivery Amounts

The percentage of its maximum Table A amount that an SWP contractor will receive in any given year will vary depending on a variety of factors. The discussion below presents basic questions underlying these factors, which are described in greater detail later in this report.

Winter snowpack is an important factor determining annual Table A water deliveries.

Physical Availability of Water from Precipitation and Runoff

The amount and timing of precipitation and ensuing runoff to streams are important in determining how much water will be physically available to the SWP to pump and export from the Delta. The type of precipitation matters as well, along with anticipated patterns of use and consumption of the source water by entities other than the SWP.

The answers to the following questions influence the amount of water delivered to contractors each year:

- How much rain and snow fell within the last year?
- Which parts of California received the precipitation, and how much runoff resulted?
- Did rain come as a short intense storm or a long wet spell?
- Was snowmelt fast or gradual, and when did the bulk of the runoff occur?

Table 3-1. Maximum Annual SWP Table A Water Delivery Amounts for SWP Contractors	
Contractor	Maximum Table A Delivery Amounts (acre-feet)
Upper Feather River Area Contractors	
Butte County	27,500
Yuba City	9,600
Plumas County Flood Control and Water Conservation District	2,700
Subtotal	**39,800**
North Bay Area Contractors	
Napa County Flood Control and Water Conservation District	29,025
Solano County Water Agency	47,756
Subtotal	**76,781**
South Bay Area Contractors	
Alameda County Flood Control and Water Conservation District, Zone 7	80,619
Alameda County Water District	42,000
Santa Clara Valley Water District	100,000
Subtotal	**222,619**
San Joaquin Valley Area Contractors	
Dudley Ridge Water District	57,343
Empire West Side Irrigation District	3,000
Kern County Water Agency	998,730
Kings County	9,305
Oak Flat Water District	5,700
Tulare Lake Basin Water Storage District	95,922
Subtotal	**1,170,000**
Central Coastal Area Contractors	
San Luis Obispo County Flood Control and Water Conservation District	25,000
Santa Barbara County Flood Control and Water Conservation District	45,486
Subtotal	**70,486**
Southern California Area Contractors	
Antelope Valley–East Kern Water Agency	141,400
Castaic Lake Water Agency	95,200
Coachella Valley Water District	121,100
Crestline–Lake Arrowhead Water Agency	5,800
Desert Water Agency	50,000
Little Rock Creek Irrigation District	2,300
Metropolitan Water District of Southern California	1,911,500
Mojave Water Agency	75,800
Palmdale Water District	21,300
San Bernardino Valley Municipal Water District	102,600
San Gabriel Valley Municipal Water District	28,800
San Gorgonio Pass Water Agency	17,300
Ventura County Flood Control District	20,000
Subtotal	**2,593,100**
TOTAL TABLE A AMOUNTS	**4,172,786**

For example, if substantial snowfall occurs late in the wet season, Sierra Nevada rivers can be full of melting snow later than usual in the year, as occurred in 2011. This allows the SWP's Delta pumping to continue at or near capacity for an extended duration, increasing the percentage of Table A water delivered. Conversely, if rain falls on snow early in the year, the resulting early snowmelt results in less water available for Delta pumping later in the year. Other factors affecting SWP delivery reliability are discussed in Chapter 4.

Local Facilities and Demands

A contractor's local diversion, storage, and conveyance facilities are important considerations in receiving water and in storing the water it receives. A contractor's water demands can also be affected by local weather patterns and water conservation measures. In some years, some contractors may rely more on water from sources such as groundwater or the Colorado River, while in other years they may rely more on the SWP.

The pattern of water demand on a water system can greatly affect the system's reliability. For example, if the demand occurs for only 3 months in summer, a water system with sufficient annual supply but insufficient water storage may not be able to reliably meet its customers' demands. If, however, the demand is distributed over the year, the system can more easily meet the demand because the need for water storage is reduced or storage could be increased.

Other Types of SWP Water

Regardless of water year type, Table A water is given first priority for delivery over other types of SWP water. Contractors have several options for what to do with the water that is allocated to them: use it, store it for later use, or transfer it to another contractor. Each long-term water contract describes several types of SWP water that are available to SWP contractors to supplement Table A water: "Article 21" water, carryover water, and turnback pool water. These other types of project water are discussed below and the related deliveries that occurred in each of the last 10 years are shown in Appendix A.

Article 21 Water

Article 21 water (so named because it is described in Article 21 of the water contracts) is surplus water that SWP contractors may receive on a short-term basis in addition to their Table A water, if they request it. Article 21 water is available to an SWP contractor only if the following conditions are met:

- "Excess water" is flowing through the Delta—that is, when releases from SWP and CVP reservoirs and unregulated flows into the Delta exceed Sacramento Valley water diversions, Delta exports, and flows needed to meet Delta water quality and flow requirements. If this scenario occurs, it is usually during December through May.
- The contractor is able to use the surplus water, such as by offsetting the use of groundwater that would otherwise occur, or can store it in its own system. (That is, the water will not be stored in an SWP facility, such as San Luis Reservoir.)
- Delivering this water would not interfere with Table A allocations, other SWP deliveries, or SWP operations.

SWP contractors requesting Article 21 water receive this water in the same proportion as their Table A water. Article 21 water becomes available only during wet months of the year, generally December through March. Unless the SWP contractor has facilities to routinely store or manage the Article 21 water it receives, such water is not likely to contribute significantly to local water supply reliability.

Carryover Water

"Carryover water" is SWP water that is allocated to an SWP contractor and approved for delivery to that contractor in a given year,

but not used by the end of the year. (Note that SWP water deliveries are managed by calendar year, January 1–December 31, while hydrology is measured by water year, October 1–September 30.) This water is exported from the Banks Pumping Plant, but instead of being delivered to the contractor, it is stored in the SWP's share of San Luis Reservoir, when space is available, for the contractor to use in the following water year.

Carryover water is like a water savings account that allows water managers flexibility in tough times—such as if the next year is a drought year and the contractor's allocation of SWP water is small. Carryovers were designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year.

With advance notice, SWP contractors can carry over water when they submit their initial request for Table A water, or within the last 3 months of the delivery year. They might do this for various reasons, such as local wet conditions and exchange and transfer arrangements. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs.

Carryover water is stored in San Luis Reservoir.

Turnback Pool Water

SWP contractors may offer the portion of their allocated Table A water that exceeds their needs in a "turnback pool," where another contractor may purchase this water. DWR sets the price for water offered in turnback pools, which are established in February and March. Contractors that sell their extra Table A water in a turnback pool are charged less for the water they receive, and contractors that buy water through the turnback pool pay extra.

Historical SWP Deliveries (2001–2010)

Please see Appendix A for tables listing annual historical deliveries from the Delta by various water classifications for each SWP contractor for 2001–2010. Similar delivery tables for years 1999–2008 are included in the 2009 Report.

Figure 3-2 shows that deliveries of SWP Table A water from the Delta for 2001–2010 range from an annual minimum of 1,049 taf to a maximum of 2,963 taf, with an average of 2,087 taf. Historical deliveries of SWP Table A water from the Delta over this 10-year period are less than the maximum of 4,133 taf/year.

Total historical SWP deliveries from the Delta, including Table A, Article 21, turnback pool, and carryover water, range from 1,236 to 3,727 taf/year, with an average of 2,524 taf/year for the period of 2001–2010 (Figure 3-3).

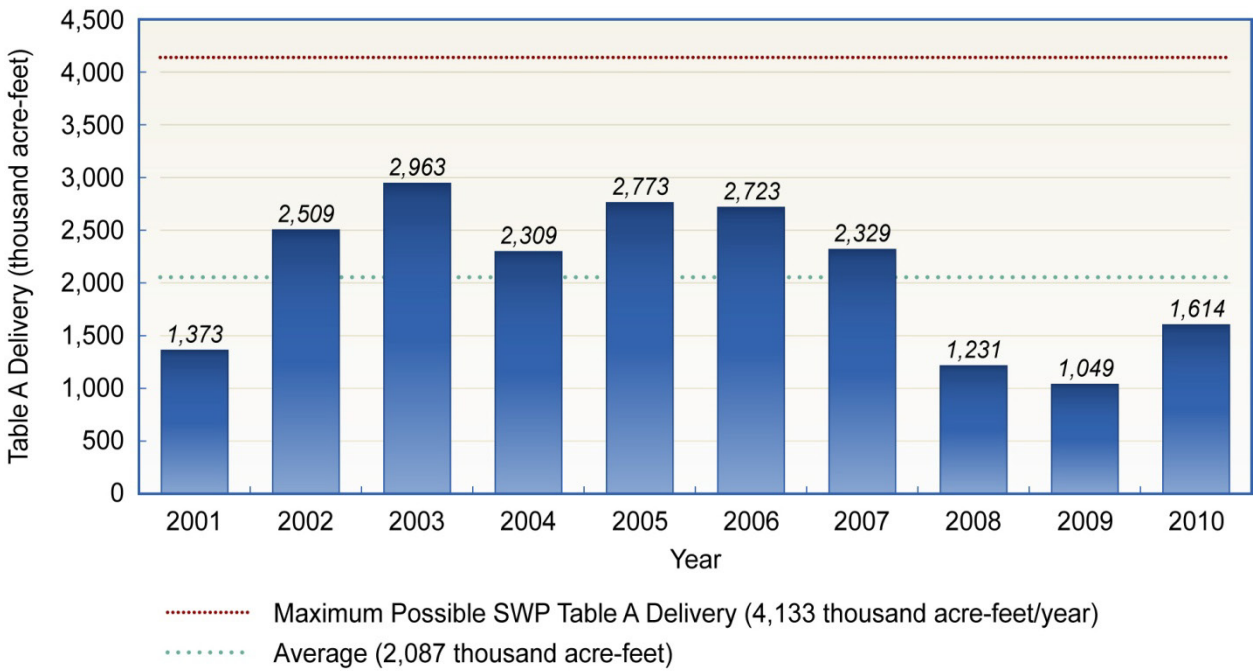
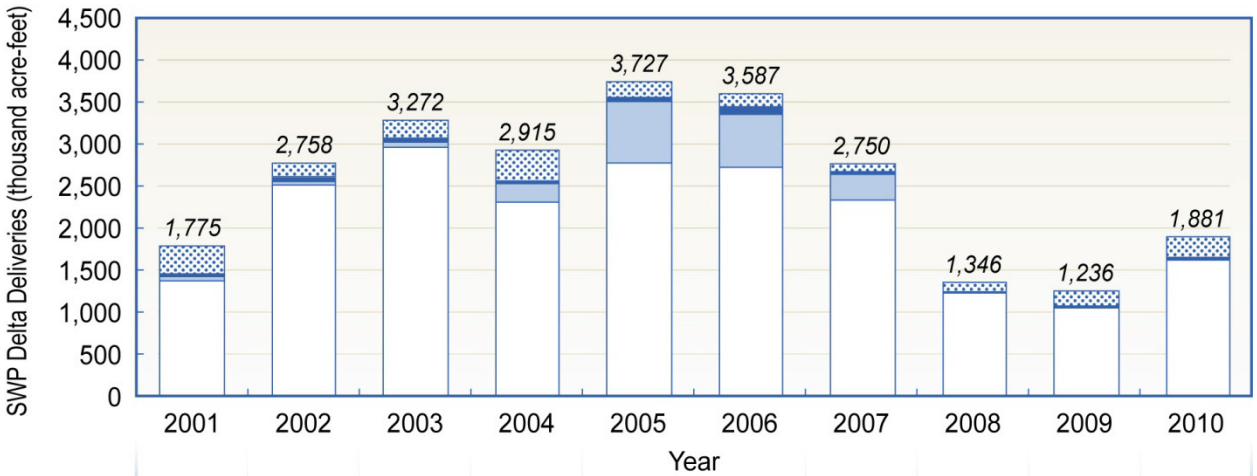


Figure 3-2. Historical Deliveries of SWP Table A Water from the Delta, 2001–2010



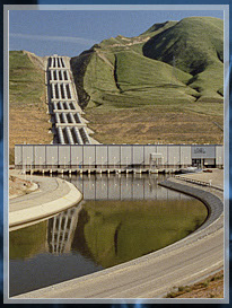
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Carryover	335	161	220	370	185	160	94	110	180	248
Turnback	18	45	30	17	38	73	16	3	2	11
Article 21	48	43	60	218	731	631	310	3	6	8
Table A	1,373	2,509	2,963	2,309	2,773	2,723	2,329	1,230	1,049	1,614

Note: Due to rounding, the total delivery may not equal the sum of individual delivery type line items.

Figure 3-3. Total Historical SWP Deliveries from the Delta, 2001–2010 (by Delivery Type)

Chapter 4

Factors that Affect Water Delivery Reliability



This chapter explains the concept of SWP water delivery reliability and how it is calculated by DWR. Some of the factors that influence the percentages of SWP Table A deliveries were introduced in Chapter 3, "SWP Contractors and Water Contracts." This chapter builds on that discussion, describing the most important factors that combine to affect SWP water delivery reliability. Among these natural and human-created factors are the availability of source water, regulatory restrictions on SWP operations, and the effects of climate change.

Uncertainty also exists because of the potential for an emergency such as an earthquake striking in or near the Delta, which, if substantial enough, could interrupt SWP exports from the Delta. This chapter describes various statewide efforts by DWR and other agencies to reduce risks to the Delta and enhance emergency response capabilities.

What Water Delivery Reliability Means to SWP Contractors

Water delivery reliability is the annual amount of SWP water that can be expected to be delivered to SWP contractors with a certain frequency. But what does that actually mean in practice?

In essence, it is a matter of probability—specifically, the likelihood that a contractor will receive a certain amount of water from the SWP in a particular year. From the contractor's perspective, water delivery reliability indicates an acceptable or desirable level of dependability of water deliveries to the people receiving the water. This information is vitally important to SWP contractors for their water planning and operations. Will farmers have the amount of water they will need to plant and grow crops and avoid fallowing their fields? Will urban and suburban water districts have sufficient water to serve current and planned future development, or will they need to call for greater conservation measures by residents and businesses? These are examples of critical questions to which SWP contractors must have answers on an annual basis to serve their customers.

Usually, a local water agency, in coordination with the public it serves, determines the level of water delivery reliability that it considers acceptable. The water agency then plans for new facilities,

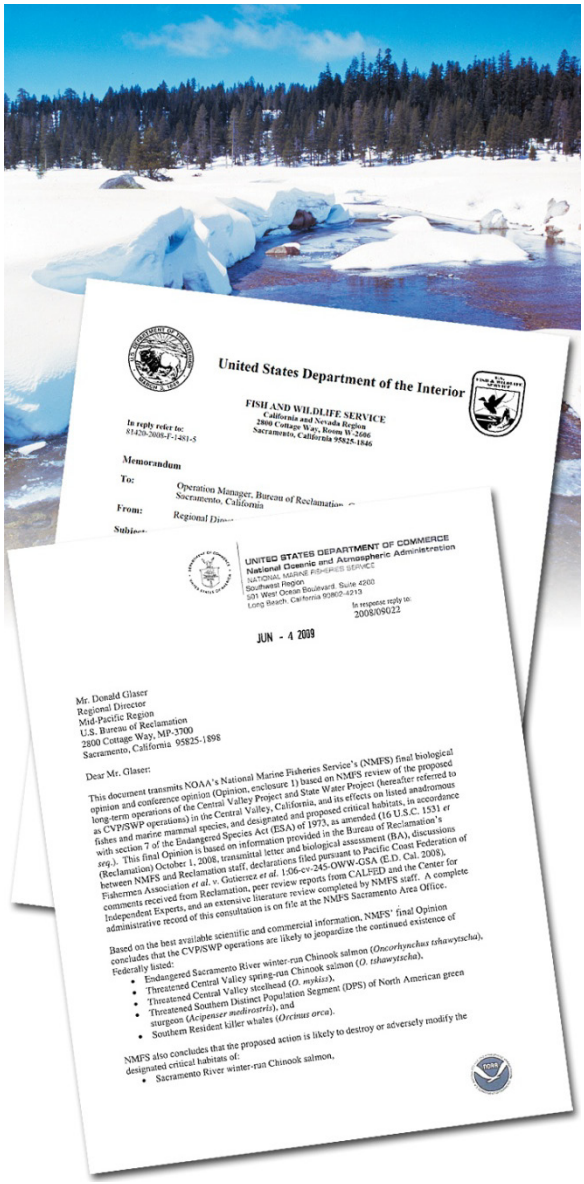
programs, or additional sources of water to meet or maintain this level of reliability.

Calculating SWP Water Delivery Reliability

DWR calculates the water delivery reliability of the SWP using the CalSim-II computer model, which simulates existing and future operations of the SWP. No model or tool can predict what actual, natural water supplies will be for any year or years, but a system of probability can be used to calculate water delivery reliability. The analyses of SWP delivery reliability contained in Chapters 6 and 7 of this report are based on modeling conducted using 82 years of historical data (water years 1922–2003) for rainfall and runoff. Those data were adjusted to reflect current and future levels of development in the source areas. The resulting data were then used to forecast the amount of water available to the SWP under current and future conditions (with the effects of climate change factored into the modeling for future conditions). The annual amounts of estimated SWP water deliveries are ranked from smallest to largest and the probability that various quantities of SWP Table A water will be delivered to each SWP contractor is estimated.

Factors that Can Influence the SWP's Water Delivery Reliability

Forecasting water delivery reliability is a difficult task because California is such a large state with numerous microclimates. In a typical year, some areas receive as little as 2 inches of rain, while others receive more than 100 inches. In addition, the determinants of water delivery for a specific water supply system continually change over time and can be difficult to determine and/or model. For example, water use in Sacramento River watersheds has increased over time. The historical data upon which a water supply forecast is based must be adjusted to reflect the current and, if necessary, future use in these watersheds.



Natural factors such as snowmelt and human influences such as federal biological opinions can both influence the SWP's water delivery reliability.

The following factors affect the ability to estimate existing and especially future water delivery reliability:

- water availability at the source,
- water rights with priority over the SWP,
- regulatory restrictions on SWP Delta exports (imposed by federal biological opinions [BOs] and State water quality plans),
- climate change,

- ongoing environmental and policy planning efforts, and
- Delta levee failure.

Water Availability at the Source

This factor affects the SWP's water delivery reliability because it is inherently variable; availability of water at the source depends on the amount and timing of rain and snow that fall in any given year, the amount and timing of runoff, and the level of development (that is, the use of water) in the SWP's source areas. The location, amount, and form of precipitation in California in any given year cannot be accurately predicted, introducing the greatest uncertainty to the availability of future SWP source water and hence future SWP deliveries.

Generally, during a single dry year or two, surface water and groundwater storage can supply most water deliveries, but dry years can result in critically low water reserves.

DWR measures the water content of snowpack in the northern Sierra Nevada to forecast snowmelt runoff.

Greater reliance on groundwater during dry years results in high costs for many users and increases groundwater overdraft. Further, the ability of some contractors to use local groundwater may be limited; some groundwater basins may be contaminated by toxins such as methyl tertiary butyl ether (commonly known as MBTE), an ingredient in gasoline, and other aquifers may be too deep to reach economically. This makes the availability of the SWP's surface water to contractors especially important.

DWR manually measures snowpack in the northern Sierra Nevada monthly between early January and early May to forecast snowmelt runoff. These surveys and real-time electronic measurements taken throughout the winter measure the snowpack's water content. The size of the snowpack in the Feather River watershed on April 1—when snowpack water content normally is at its peak before the spring runoff—and the storage in Lake Oroville are key components of the SWP's delivery capabilities from April through September.

However, in some years, even measurements taken in the northern Sierra Nevada earlier in the year can demonstrate an apparent trend in water delivery reliability for the rest of the year (assuming that the weather follows typical patterns in spring). For example, manual readings conducted by DWR on December 28, 2010, off U.S. Highway 50 near Echo Summit showed snow-water equivalents in the state's northern mountains at 169% of normal for that date and 57% of the normal value for April 1. By contrast, the readings taken on the same date in 2009 had indicated snow-water equivalents in the northern mountains at 77% of normal for the date and 26% of the normal value for April 1. These findings indicated the potential for SWP deliveries in 2011 to increase relative to deliveries that occurred in 2010, a below-normal water year.

Water Rights with Priority Over the SWP

California's water rights system affects the SWP indirectly. There are two types of legally protected rights to surface water in California:

- *Appropriative* water rights allow the user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board (State Water Board), unless the appropriative water right predates 1914. Appropriative water rights may be lost if the water has gone unused for 5 years. The SWP diverts water from the Delta under appropriative water rights.
- *Riparian* water rights apply to lands traversed by or bordering on a natural watercourse. No permit is required to use this water, which must be used on riparian (adjacent) land and cannot be stored for later use.

Generally, the priority of an appropriative water right in California is "first in time, first in right"; therefore, an appropriative water right is subordinate to all prior water rights, whether appropriative or riparian. This means that if another entity with a prior water right increases its use of one of the SWP's sources of water supply—the Delta, the upstream Sacramento or San Joaquin River, or a tributary to either river—the overall amount of water available to the SWP will decrease. Thus, water users with prior water rights are assigned top priority for water in DWR's modeling of the SWP's water delivery reliability, even ahead of SWP Table A water deliveries.

Regulatory Restrictions on SWP Delta Exports

Multiple needs converge in the Delta: the need to protect a fragile ecosystem, to support Delta recreation and farming, and to provide water for agricultural and urban needs throughout much of California. Various regulatory requirements are placed on the SWP's Delta operations to protect special-status species such as delta smelt and spring- and winter-run Chinook salmon. As a result, as described below, restrictions on SWP operations imposed by State and federal agencies contribute substantially to the challenge of accurately determining the SWP's water delivery reliability in any given year.

Biological Opinions on Effects of Coordinated SWP and CVP Operations

Several fish species listed under the federal Endangered Species Act (ESA) as endangered or threatened are found in the Delta. The continued viability of populations of these species in the Delta depends in part on Delta flow levels. For this reason, the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) have issued several BOs since the 1990s on the effects of coordinated SWP/CVP operations on several species.

These BOs affect the SWP's water delivery reliability for two reasons. Most obviously, they include terms that specifically restrict SWP pumping levels in the Delta at certain times under certain conditions. In addition, the BOs' requirements are based on physical and biological phenomena that occur daily while DWR's water supply models are based on monthly data.

The first BOs on the effects of SWP (and CVP) operations were issued in February 1993 (NMFS BO on effects of project operations on winter-run Chinook salmon) and March 1995 (USFWS BO on project effects on delta smelt and splittail). Among other things, the BOs contained requirements for Delta inflow, Delta outflow, and reduced export pumping to meet specified incidental take limits. These fish protection requirements imposed substantial constraints on Delta water supply operations. Many were incorporated into the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* (1995 WQCP), as described in the "Water Quality Objectives" section later in this chapter.

The terms of the USFWS and NMFS BOs have become increasingly restrictive in recent years. In December 2008, USFWS issued a new BO

covering effects of the SWP and CVP on delta smelt, and in June 2009, NMFS issued a BO covering effects on winter-run and spring-run Chinook salmon, steelhead, green sturgeon, and killer whales. These BOs replaced BOs issued earlier by the federal agencies.

The USFWS BO includes additional requirements in all but 2 months of the year. The BO calls for "adaptively managed" (adjusted as necessary based on the results of monitoring) flow restrictions in the Delta intended to protect delta smelt at various life stages. USFWS determines the required target flow, with the reductions accomplished primarily by reducing SWP and CVP exports. Because this flow restriction is determined based on fish location and decisions by USFWS staff, predicting the flow restriction and corresponding effects on export pumping with any great certainty poses a challenge. The USFWS BO also includes an additional salinity requirement in the Delta for September and October in wet and above-normal water years, calling for increased releases from SWP and CVP reservoirs to reduce salinity. Among other provisions included in the NMFS BO, limits on total Delta exports have been established for the months of April and May. These limits are mandated for all but extremely wet years.

The 2008 and 2009 BOs were issued shortly before and shortly after the Governor proclaimed a statewide water shortage state of emergency in February 2009, amid the threat of a third consecutive dry year. NMFS calculated that implementing its BO would reduce SWP and CVP Delta exports by a combined 5% to 7%, but DWR's initial estimates showed an impact on exports closer to 10% in average years, combined with the effects of pumping restrictions imposed by BOs to protect delta smelt and other species. The 2008 USFWS and 2009 NMFS BOs have been subject to considerable litigation. Recent decisions by U.S. District Judge Oliver Wanger changed specific operational rules for the fall/winter of 2011–2012, and both the USFWS BO and NMFS BO have been remanded to the agencies for further review and analysis. However, the operational rules specified in the 2008 and 2009 BOs continue to be legally required and are the rules used in the analyses presented in Chapters 5, 6, and 7 of this report. Chapter 5 presents a comparison of monthly Delta exports as estimated for this 2011 Report with those estimated for the 2005 Report, illustrating how the 2008 and 2009 BOs have affected export levels from the Delta.

The California Department of Fish and Game (DFG) issued consistency determinations for both BOs under Section 2080.1 of the California Fish and Game Code. The consistency determinations stated that the USFWS BO and the NMFS BO would be consistent with the California Endangered Species Act (CESA). Thus, DFG allowed incidental take of species listed under both the federal ESA and CESA to occur during SWP and CVP operations without requiring DWR or the U.S. Bureau of Reclamation to obtain a separate State-issued permit.

Specific restrictions on Delta exports associated with the USFWS and NMFS BOs and their effects on SWP pumping levels are described further in Chapter 5, "SWP Exports," of this report.

Water Quality Objectives

Because the Delta is an estuary, salinity is a particular concern. In the 1995 WQCP, the State Water Board set water quality objectives to protect beneficial uses of water in the Delta and Suisun Bay. The objectives must be met by the SWP (and federal CVP), as specified in the water right permits issued to DWR and the U.S. Bureau of Reclamation. Those objectives—minimum Delta outflows, limits on SWP and CVP Delta exports, and maximum allowable salinity levels—are enforced through the provisions of the State Water Board's Water Right Decision 1641 (D-1641), issued in December 1999 and updated in March 2000.

DWR and Reclamation must monitor the effects of diversions and SWP and CVP operations to ensure compliance with existing water quality standards. Monitoring stations are shown in Figure 4-1.

Among the objectives established in the 1995 WQCP and D-1641 are the "X2" objectives. D-1641 mandates the X2 objectives so that the State Water Board can regulate the locations of the Delta estuary's salinity gradient during the months of February–June. X2 is the position in the Delta where the electrical conductivity (EC) level, or salinity, of Delta water is 2 parts per thousand. The location of X2 is used as a surrogate measure of Delta ecosystem health. For the X2 objective to be achieved, the X2 position must remain downstream of Collinsville in the Delta (shown in Figure 4-1) for the entire 5-month period, and downstream of other specific locations in the Delta on a certain number of days each month from February through June. This means that Delta outflow must be at certain specified levels at certain times—which can limit the amount of water the SWP may pump at those times at its Harvey O. Banks Pumping Plant in the Delta. Because of the relationship between seawater intrusion and interior-Delta water quality, meeting the X2 objective also improves water quality at Delta drinking-water intakes; however, meeting the X2 objectives can require a relatively large volume of water for outflow during dry months that follow months with large storms.

The 1995 WQCP and D-1641 also established an export/inflow (E/I) ratio. The E/I ratio, presented in Table 3 of the 1995 WQCP (SWRCB 1995:18–22), is designed to provide protection for the fish and wildlife beneficial uses in the Bay-Delta estuary (SWRCB 1995:15). The E/I ratio limits the fraction of Delta inflows that are exported. When other restrictions are not controlling, Delta exports are limited to 35% of total Delta inflow from February through June and 65% of inflow from July through January.

Climate Change

The *California Water Plan Update 2009* identified climate change as a key consideration in planning for the State's water management. California's reservoirs and water delivery systems were developed based on historical hydrology; future weather patterns have long been assumed to be similar to those in the past. However, as climate change continues to affect California, past hydrology is no longer a reliable guide to future conditions. This section discusses effects on the SWP that could result from specific aspects of climate change.

Decreased Water Availability with Reduced Snowpack

As the effects of climate change continue, mean temperatures are predicted to increase, both globally and regionally. Climate projections used to assess the reliability of California's future water supply forecast average air temperature increases for the Sacramento region of 1.3 to 4.0 degrees Fahrenheit by the middle of the 21st century and 2.7 to 8.1 degrees by the end of the century (California Climate Change Center 2009a:8). Climate change is anticipated to bring warmer storms that result in less snowfall at lower elevations, reducing total snowpack. Loss of snowpack is projected to be greater in the northern Sierra Nevada—and thus closer to the Feather River watershed, the origin of SWP water—than in the southern Sierra Nevada because of the relative proportions of land at low and middle elevations.

Snowmelt provides an average of 15 million acre-feet of water for California per year, slowly released from about April to July each year (DWR 2006:2-22). Much of the state's water infrastructure, including the SWP, was designed to capture slow spring runoff and deliver it during the drier summer and fall months. However, during the 20th century, the average early-spring

Figure 4-1. Delta Salinity Monitoring Locations of Importance to the SWP

snowpack in the Sierra Nevada decreased by about 10%, resulting in the loss of 1.5 million acre-feet of snowpack storage (DWR 2008:3). Using historical data and modeling, DWR projects that by 2050 the Sierra snowpack will be reduced from its historical average by 25% to 40% (DWR 2008:4). Increased precipitation falling as rain instead of snow during winter could result in a larger number of "rain-on-snow" events. This would cause the snow to melt earlier in the year and over fewer days than historically, thus adversely affecting availability of water for pumping by the SWP during summer.

Such reductions in snowpack could have dire consequences. Under climate change and in some years, water levels in Lake Oroville, the SWP's main supply reservoir, could fall below the lowest release outlets, making the system vulnerable to operational interruption. DWR expects that a water shortage worse than the one during the 1977 drought could occur in 1 out of every 6–8 years by the middle of the 21st century and in 1 out of every 3–4 years at the end of the century (California Climate Change Center 2009a:46). In those years, it is estimated that an additional 575,000–850,000 acre-feet per year of water would be needed to meet current regulatory requirements and to maintain minimum system operations. This could preclude the SWP from pumping as much water as it would otherwise.

Climate change is also expected to reduce the SWP's median reservoir carryover storage. Carryover water is like a water savings account for water managers to use during shortage periods. Thus, a climate change–generated reduction in the amount of carryover water available to SWP contractors would reduce the system's flexibility during dry and critical water years.

Increased SWP Water Demands

Even as water shortages may result from reduced snowpack, climate change may also cause water demand by SWP contractors to increase. Warmer temperatures may increase rates of evapotranspiration (loss of water from soil by evaporation and plant transpiration) and may extend growing seasons. A larger amount of water may be needed for irrigation of certain crops, urban landscaping, and environmental needs. Warmer temperatures will also increase evaporation from surface reservoirs. Reduced soil moisture and surface flow will disproportionately affect the environment and other water users that rely heavily on annual rainfall such as rainfed agriculture, livestock grazing on nonirrigated rangeland, and recreation.

Sea Level Rise

During the last century, sea level rose 7 inches along California's coast. Estimates of future sea level rise range from 4 to 16 inches by the middle of the 21st century and 7–55 inches by 2100 (DWR 2009b:4-37). The increases in sea level that are expected to continue could affect SWP water delivery reliability in several ways:

- Most of the land in the Delta is below sea level—by as much as 20 feet—as a consequence of ongoing subsidence (Figure 4-2). Increases in sea level could place more pressure on the Delta's already fragile levee system and, as a consequence, cause levee breaches that could threaten SWP Delta exports.
- As salty water from the Pacific Ocean moves farther upstream into the Delta, DWR could be required to increase the amounts of freshwater released from Lake Oroville to maintain compliance with Delta water quality standards.
- Sea level rise is expected to cause salt water to flow farther inland. The resulting increase in saltwater intrusion into coastal aquifers would make increasing amounts of groundwater unsuitable for water supply or irrigation (California Climate Change Center 2009b:80–81). The reduced availability of groundwater would likely contribute to further increases in demands for surface water from the SWP, especially by the coastal SWP contractors.

Source: DWR 1995:28

Figure 4-2. Areas of the Delta that Have Subsided to Below Sea Level

Adapting to Climate Change Effects in Forecasting Water Delivery Reliability

Chapter 7, "Future SWP Water Delivery Reliability (2031)," of this report estimates the SWP's delivery reliability for conditions 20 years in the future (2031), reflecting potential hydrologic changes that could result from climate change. Further details on these future projections are included in a technical addendum to this report (posted on the Internet and available upon request).

For purposes of this report and the technical addendum, the 2031 delivery estimates are based on a single median-impact future climate projection. To identify this projection, DWR analyzed the 12 climate projections for midcentury that were used in *Using Future Climate Projections to Support Water Resources Decision Making in California* (California Climate Change Center 2009a). The resulting water supply effects were examined to determine which one most closely represented the "central" or "median" projection. The analysis examined the following projected climate and hydrology variables and their effects on SWP exports: temperature, precipitation, total inflow to major reservoirs, shifts in timing of runoff, and Delta exports.

Ongoing Environmental and Policy Planning Efforts

As discussed earlier, the Delta is an essential part of the conveyance system for the SWP. SWP pumping at the Banks Pumping Plant is regulated to protect the many uses of the Delta. However, today's uses in the Delta are not sustainable over the long term under current management practices and regulatory requirements. As discussed below, two large-scale plans for the Delta that are in development could affect SWP water delivery reliability: the Delta Plan and the Bay Delta Conservation Plan (BDCP).

Delta Plan

After years of concern about the Delta amid rising water demand and habitat degradation, the Delta Stewardship Council was created in legislation to achieve State-mandated coequal goals for the Delta. As specified in Section 85054 of the California Water Code:

> "Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

The draft Delta Plan seeks to reduce reliance on Delta water supplies. In a series of policies and recommendations, the draft plan aims to encourage farms and cities to increase conservation and become more self-sufficient, particularly in the event of a disaster in the Delta. It calls for agricultural water agencies to change pricing to encourage conservation. It also urges the State Water Board to set enforceable flow objectives for the Delta and its tributaries that take into account wildlife and habitat needs. In the future, government projects in the Delta must prove they are consistent with the Delta Plan.

The Delta Stewardship Council is preparing the draft Delta Plan and environmental impact report. Scheduled for adoption and implementation in 2012, the Delta Plan is intended to serve as California's guiding policy document for the Delta and Suisun Marsh for the next 88 years (that is, through the year 2099), with frequent updates.

Bay Delta Conservation Plan

The BDCP is being prepared by a group of local water agencies, environmental and conservation organizations, State and federal agencies, and other interest groups. An outgrowth of the CALFED Bay-Delta Plan's Ecosystem Restoration Program Conservation Strategy, the BDCP has been in development since 2006. The heart of the BDCP is a long-term conservation strategy that sets forth actions needed for a healthy Delta. The BDCP would do all of the following:

- identify conservation strategies to improve the overall ecological health of the Delta;
- identify ecologically friendly ways to move freshwater through and/or around the Delta;
- address toxic pollutants, invasive species, and impairments to water quality; and
- establish a framework and funding to implement the plan over time.

A draft environmental impact report is planned to be released for public review in mid-2012. The report is targeted to be final in 2013, after which a decision to proceed with the program would be made. Upon adoption, the BDCP would provide the basis for issuance of endangered species permits for the continued operation of the SWP and CVP. The plan would be implemented over a 50-year period.

Delta Levee Failure

The fragile Delta faces a multitude of risks that could affect millions of Californians. Foremost among those risks, as they could affect the SWP's water delivery reliability, are the potential for levee failure and the ensuing flooding and water quality issues.

The Delta Risk Management Strategy (DRMS) was initiated in response to Assembly Bill 1200 (2005), which directed DWR to use 50-, 100-, and 200-year projections to evaluate the potential impacts on Delta water supplies associated with continued land subsidence, earthquakes, floods, and climate change. The discussions below describe DRMS Phase 1, which evaluated the risks, and DRMS Phase 2, which is proposing various solutions. Also discussed are other efforts currently being undertaken by DWR and other agencies to reduce risks to the Delta, enhance emergency response capabilities, and reduce the risk of interruption of Delta water exports by the SWP and CVP.

Effects of Emergencies on Water Supplies: Delta Risk Management Strategy, Phase 1

Phase 1 of the DRMS, completed in 2008, assessed the performance of Delta and Suisun Marsh levees under various stressors and hazards and evaluated the consequences of levee failures to California as a whole.

The Delta is protected by levees built about 150 years ago. The levees are vulnerable to failure because most original levees were simply built with soils dredged from nearby channels, and were never engineered. Most islands in the Delta have flooded at least once over the past 100 years. For example, on June 3, 2004, a huge dry-weather levee failure occurred without warning on Upper Jones Tract in the south Delta, inundating 12,000 acres of farmland with about 160,000 acre-feet of water. Because many Delta islands are below sea level, deep and prolonged flooding could occur during a levee failure event, which could disrupt the quality and use of Delta water.

Levee failure can result from the combination of high river inflows, high tide, and high winds; however, levees can also fail in fair weather—even in the absence of a flood or seismic event—in a so-called "sunny day event." Damage caused by rodents, piping (in which a pipe-like opening develops below the base of the levee), or foundation movement could cause sunny-day levee breaches.

Many vulnerable Delta levees require installation of rock revetments, riprap, or other engineered structures along eroding banks to reduce erosion and protect levee foundations.

A breach of one or more levees and island flooding may affect Delta water quality and SWP operations. Depending on the hydrology and the size and locations of the breaches and flooded islands, a large amount of salt water may be pulled into the interior Delta from Suisun and San Pablo Bays. When islands are flooded, DWR may need to drastically decrease or even cease SWP Delta exports to evaluate the distribution of salinity in the Delta and avoid drawing saltier water toward the pumps.

Delta levees are prone to failure, increasing risks to State water supplies.

An earthquake could also put Delta levees, and thus SWP water supplies, at risk. In 2008, the 2007 Working Group on California Earthquake Probabilities estimated a probability of 63% that a magnitude 6.7 or greater earthquake would strike the San Francisco Bay Area in the next 30 years (Working Group 2008:6). An earthquake could severely damage Delta levees, causing islands to flood with salty water. The locations most likely to be affected by an earthquake are the west and southwest portions of the Delta because these areas are closer to potential earthquake sources. Flooding of the west and southwest Delta is also more likely to interfere with conveyance of freshwater to export pumps (DWR 2007:17).

Modeling of the effects of earthquakes on Delta islands was conducted by DWR for the DRMS Phase 1 report. Described in the *California Water Plan Update 2009*, the assessment found a 40% probability that a major earthquake occurring between 2030 and 2050 would cause 27 or more islands to flood at the same time. If 20 islands were flooded as a result of a major earthquake, the export of freshwater from the Delta could be interrupted by about a year and a half (DWR 2009b:5-15). Water supply losses of up to 8 million acre-feet would be incurred by SWP (and CVP) contractors and local water districts.

Managing and Reducing Risks: Delta Risk Management Strategy, Phase 2

The Phase 2 report for the DRMS, issued in June 2011, evaluates alternatives to reduce the risk to the Delta and the state from adverse consequences of levee failure (DWR 2011b). "Building blocks" (individual improvements or projects, such as improving levees or raising highways) and trial scenarios (various combinations of building blocks) were developed for the DRMS Phase 2 report. The building blocks fall into three main categories:

- conveyance improvements/ flood risk reduction and life safety,
- infrastructure risk reduction, and
- environmental risk mitigation.

The first of these categories is most relevant to the SWP in terms of reducing the risk of disruption of SWP Delta exports, but the environmental risk mitigation category includes a building block (Building Block 3.6) calling for reduction of water exports from the Delta.

Four trial scenarios were developed to represent a range of possible risk reduction strategies:

- *Trial Scenario 1—Improved Levees:* Improve the reliability of Delta levees against flood-induced failures by providing up to 100-year flood protection.
- *Trial Scenario 2—Armored Pathway (Through-Delta Conveyance):* Improve the reliability of water conveyance by creating a route through the Delta that has high reliability and the ability to minimize saltwater intrusion into the south Delta.
- *Trial Scenario 3—Isolated Conveyance Facility:* Provide high reliability for conveyance of export water by building an isolated conveyance facility on the east side of the Delta.
- *Trial Scenario 4—Dual Conveyance:* Improve reliability and flexibility for conveyance of export water by constructing an isolated conveyance facility and a through-Delta conveyance. (This scenario would be much like a combination of Trial Scenarios 2 and 3.)

The findings of the DRMS Phase 2 report on these scenarios, as they apply to seismic risk and potential for disruption of SWP Delta exports, are as follows:

- Trial Scenario 1 (Improved Levees) would not reduce the risk of potential water export interruptions, nor would it change the seismic risk of most levees.
- Trial Scenario 2 (Armored Pathway [Through-Delta Conveyance]) would have the joint benefit of reducing the likelihood of levee failures from flood events and earthquakes and of significantly reducing the likelihood of export disruptions.
- The effects of Trial Scenario 3 (Isolated Conveyance) would be similar to those for the Armored Pathway scenario, but Trial Scenario 3 would not reduce the seismic risk of levee failure on islands that are not part of the isolated conveyance facility.
- Trial Scenario 4 (Dual Conveyance) would avoid the vulnerability of water exports associated with Delta levee vulnerability and would offer flexibility in water exports from the Delta and/or the isolated conveyance facility. However, seismic risk would not be reduced on islands not part of the export conveyance system or infrastructure pathway.

As noted in the discussion of the "enhanced emergency preparedness/response" building block in the DRMS Phase 2 report, analyses on resuming water exports after a levee failure were conducted by the Metropolitan Water District of Southern California, an SWP contractor. The studies found that a promising way to resume water exports would be to place structural barriers at selected channel locations in the Delta and complete strategic levee repairs, thus isolating an emergency freshwater conveyance "pathway" through channels that may be surrounded by islands flooded with saline water (Moffatt and Nichol 2007, cited in DWR 2011b:5-1).

Delta Flood Emergency Preparedness, Response, and Recovery Program and Delta Multi-Hazard Coordination Task Force

In the last 5 years, DWR has worked to improve its ability to respond quickly and effectively to simultaneous levee failures on multiple islands within the Delta. The *Delta Emergency Operations Plan Concept Paper* released in April 2007 (DWR 2007) was the initial product of this effort. To enhance the State's ability to prepare for, respond to, and recover from a catastrophic Delta levee failure, DWR subsequently began development of the Delta Flood Emergency Preparedness, Response, and Recovery Program. This program is intended to supplement DWR's emergency operations plan. The goal is to protect lives, property, and critical infrastructure in the Delta while minimizing impacts on the ecosystem. The program consists of three components:

- develop DWR's Delta response and recovery plan,
- coordinate DWR's plan with other Delta flood emergency response agencies, and

- design and implement flood emergency response facilities within the Delta.

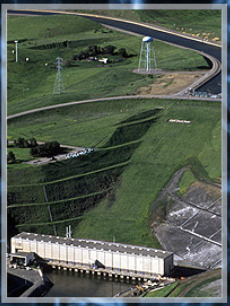
The flood emergency response plan for the Delta will describe the actions DWR will take before, during, and after a levee-endangering event or levee failure in the Delta. The Delta Flood Emergency Preparedness, Response, and Recovery Program is conducting an extensive effort to model water quality implications of levee failure and salinity changes associated with different levee repair strategies. DWR is coordinating this effort with the U.S. Army Corps of Engineers and expects to reach out to the five Delta counties during plan development.

DWR is also a member of the Sacramento–San Joaquin Delta Multi-Hazard Coordination Task Force, which was created in 2008 in the wake of passage of the Sacramento–San Joaquin Delta Emergency Preparedness Act of 2008. The task force is led by the California Emergency Management Agency (CalEMA); in addition to DWR, the Delta Protection Commission and representatives from each of the five Delta counties also participate in task force activities. An Emergency Preparedness and Response White Paper was prepared for the Delta Stewardship Council on November 8, 2010, describing the operations of this task force.

The Sacramento–San Joaquin Delta Multi-Hazard Coordination Task Force was created to make recommendations to CalEMA on creating a framework for an interagency unified command system, coordinate the development of a draft emergency preparedness and response strategy for the Delta region, and develop and conduct an all-hazards emergency response exercise in the Delta. The task force's draft emergency preparedness and response strategy includes a process for allocating scarce resources and a statement of priorities agreed to by the members of the task force. The original deadline for the task force's report has been legislatively extended to January 1, 2013.

Chapter 5

SWP Exports



The purpose of this chapter is to illustrate the effects of factors described in Chapter 4, "Factors that Affect Water Delivery Reliability," on SWP Delta exports from the Harvey O. Banks Pumping Plant in the south Delta. Past SWP delivery reliability reports characterized SWP deliveries in their entirety but did not focus specifically on Delta exports. This chapter describes SWP Delta exports to illustrate how regulatory requirements and climate change have affected or will affect the SWP's Delta water supplies, and to describe the general pattern of monthly SWP exports from the Delta.

This chapter focuses only on Delta exports that are associated with the SWP, not on CVP water that may have been exported through the Banks Pumping Plant via the CVP/SWP joint point of diversion.

This chapter briefly explains the difference between Delta exports and SWP deliveries, then describes trends in projected average annual exports and SWP Table A water deliveries under various recent existing-conditions scenarios. In addition, monthly exports estimated for this *State Water Project Delivery Reliability Report 2011* (2011 Report) are compared with those estimated for the *State Water Project Delivery Reliability Report 2005* (2005 Report) to illustrate the effect of regulatory restrictions.

This chapter also summarizes the primary factors influencing the SWP's Delta export operations and deliveries, presents estimates of exports for the existing-conditions and future-conditions scenarios, and characterizes the likelihood of such exports. Estimated SWP Delta exports by water year type are depicted relative to exports that were estimated for the existing-conditions and future-conditions scenarios in the *State Water Project Delivery Reliability Report 2009* (2009 Report).

SWP Delta Exports versus SWP Deliveries

SWP Delta exports and SWP deliveries are characterized in separate chapters (this chapter for exports, Chapters 6 and 7 for SWP deliveries) because these two terms are not one and the same.

The amount of water pumped from the Delta is the only source of SWP supply for 24 of the 29 SWP water contractors listed in Chapter 3, "SWP Contractors and Water

Contracts." Delta exports are the water supplies that are transferred ("exported") to SWP contractors or San Luis Reservoir storage via the Banks Pumping Plant. SWP Delta exports do not include deliveries of SWP water to the two North Bay Area contractors, which receive SWP water pumped by the Barker Slough Pumping Plant and conveyed by the North Bay Aqueduct. (Water conveyed to the SWP's three Upper Feather River Area contractors, also not exported via the Banks Pumping Plant, is not the focus of this chapter or of Chapters 6 and 7.)

By contrast, SWP Table A water deliveries include both water pumped by the Banks Pumping Plant and conveyed by the California Aqueduct and water pumped by the Barker Slough Pumping Plant and conveyed by the North Bay Aqueduct. Thus, Table A water deliveries, as described in Chapters 6 and 7, also include deliveries to the two North Bay Area contractors, for a total of 26 SWP contractors.

SWP Delta exports include nearly all types of SWP water, not merely Table A water (see the explanation of SWP water types in Chapter 3). As allowed under the SWP's water supply contracts, the amount pumped from the Delta can be exported in the same year as Table A water, or can be exported as Article 21 (surplus) water if available. A contractor can opt to have exported Delta water held in San Luis Reservoir as carryover water—that is, as part of the contractor's supply for a subsequent year. Turnback pool water is included in the tabulation of Table A water.

Recent Trends in SWP Delta Exports and Table A Deliveries

SWP Delta exports and Table A deliveries estimated for this 2011 Report are reduced by the operational restrictions imposed on the SWP by the biological opinions (BOs) issued by the U.S. Fish and Wildlife Service (USFWS) in December 2008 and the National Marine Fisheries Service (NMFS) in June 2009. This same scenario occurred in the 2009 Report. By contrast, the *State Water Project Delivery Reliability Report 2007* (2007 Report) incorporated interim, less restrictive operational rules established by U.S. District Judge Oliver Wanger in December 2007 while the USFWS and NMFS BOs were rewritten. The 2005 Report was based on much less restrictive operational rules contained in the BOs that had been issued in late 2004 and 2005.

Overall trends in both SWP Delta exports and Table A deliveries under existing conditions are summarized below. (For further detail on estimated SWP Table A deliveries for the existing-conditions and future-conditions scenarios, respectively, see Chapters 6 and 7.)

Annual Exports and Table A Deliveries—2005–2011 Scenarios

Figure 5-1 illustrates the effect of the operational restrictions imposed by the USFWS and NMFS BOs on estimated average annual Delta exports and Table A water deliveries. The figure depicts the average values estimated for existing conditions in the 2005, 2007, 2009, and 2011 Reports.

As shown in Figure 5-1, estimated average annual Delta exports and SWP Table A water deliveries have generally decreased since 2005, when rules affecting SWP pumping operations began to become more restrictive. Under existing conditions, average annual Delta exports have decreased since 2005 from 2,958 thousand acre-feet per year (taf/year) to 2,607 taf/year in 2011, a decrease of 351 taf or 11.9%; average annual Table A deliveries have decreased since 2005 from 2,818 taf/year to 2,524 taf/year in 2011, a decrease of 294 taf or 10.4%. The reasons for these decreases are described under "Primary Factors Affecting SWP Delta Export Operations and Table A Water Deliveries," below.

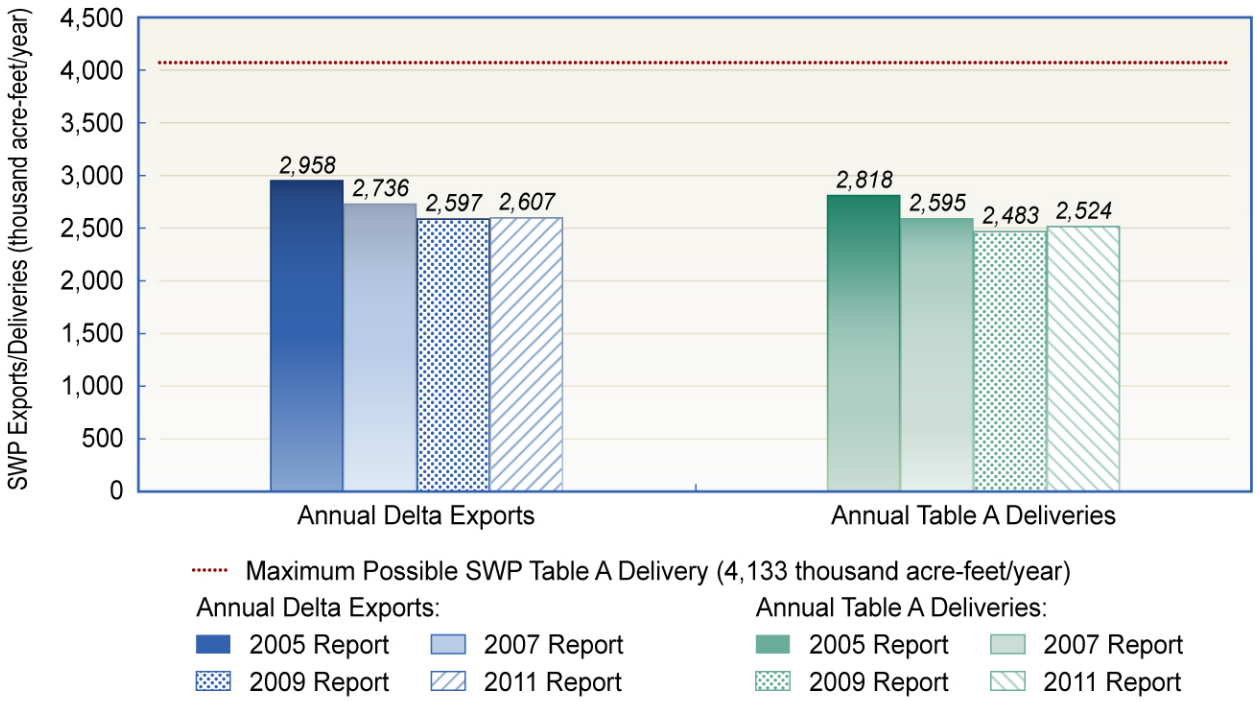


Figure 5-1. Trends in Estimated Average Annual Delta Exports and SWP Table A Water Deliveries (Existing Conditions)

Monthly Delta Exports—2011 Scenario versus 2005 Scenario

Figure 5-2 illustrates the effects of the operational restrictions imposed by the BOs on SWP Delta exports since 2005 by comparing monthly existing-conditions exports estimated for this 2011 Report with those estimated for the 2005 Report. The bar charts show the average exports for each month under each scenario estimated for both reports.

As shown in Figure 5-2, average monthly SWP Delta exports estimated for the 2011 Report are lower than those estimated for the 2005 Report both in the first half of the year and from October through December. The reductions in exports for January through June are substantial, ranging from 22% in June to 58% in April. Exports for July and August as estimated for the 2011 Report exceed those estimated for the 2005 Report, but the increases (17% in August and approximately 45% in July) are generally smaller than the reductions seen earlier in the year.

Compiling the monthly average values for exports for the entire year under each scenario reveals that, as indicated previously in the description of annual exports, the average annual exports estimated for the 2011 Report are 11.9% less than those estimated for the 2005 Report.

Primary Factors Affecting SWP Delta Export Operations and Table A Water Deliveries

Under current operational constraints on the SWP, maximum exports from the Banks Pumping Plant are generally limited to 6,680 cubic feet per second, except between December 15 and March 15, when exports can be increased by one-third of the San Joaquin River flow at the Vernalis gauge (when the Vernalis flow is greater than 1,000 cubic feet per second). As explained previously in Chapter 4, regulatory restrictions on the SWP's Delta operations have been among the major factors affecting SWP water delivery reliability. Several of those influence SWP exports from the Banks Pumping

Figure 5-2. Estimated Monthly SWP Delta Exports (Existing Conditions), 2011 Scenario versus 2005 Scenario

Plant and, at times, impose particular limitations on exports. These limits are summarized here to illustrate how they affect the values shown in Figure 5-2:

- *2008 USFWS and 2009 NMFS BOs:* These BOs are much more restrictive than the BOs they replaced. The USFWS BO includes flow restrictions to protect delta smelt, with requirements in all but 2 months of the year. The NMFS BO contains similar limits for January through mid-June, but the greatest restriction imposes limits on total Delta exports in the months of April and May in most years to protect salmon and steelhead.
- *X2:* The "X2" objective mandated by the State Water Resources Control Board (State Water Board) regulates Delta salinity levels in the months of February–June. For the X2 position to be located in the appropriate location to achieve the State Water Board's salinity objective, Delta outflow must be at certain specified levels at certain times between February and June—which can constrain SWP pumping at the Banks Pumping Plant at those times.
- *Export/inflow ratio:* The 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta* and State Water Board Decision 1641 (D-1641) limits Delta exports to 35% of total Delta inflow from February through June. Thus, even if substantial runoff occurs during those months (such as during a year with considerable rain-on-snow events, projected to be more likely as the effects of climate change increase), the SWP is limited in its ability to benefit from the availability of that extra water in the Delta by increasing its pumping beyond this limit. Allowable exports increase to 65% of inflow from July through January.
- *Spring Export Limitations:* Spring is an important time in the life cycles of fish protected by the USFWS and NMFS BOs. As a result, requirements for Delta exports exist in several places. D-1641 limits SWP and CVP exports to 100% of the base flow of the San Joaquin River for 31 days during the April/May period. The NMFS BO limits the combined exports during all of April and

May to a given percentage of the flow: 25% during above-normal and wet years to 100% in critical years. Finally, the previously mentioned flow requirements contained in the USFWS BO to protect delta smelt can also restrict exports during this time.

Figure 5-2 shows reductions in the values estimated for the 2011 Report during January through June and October through December that result from these restrictions. The period of July through September is the time when exports are less restricted. As a result—and to recover some of the water supply lost during the other months—the exports estimated for the 2011 Report for July–September are higher than those estimated for the 2005 Report.

Another factor described in Chapter 4, climate change, is expected to substantially affect the Delta—and SWP exports from the Banks Pumping Plant—under future conditions. The effects of climate change on SWP operations have been factored into DWR's modeling for future conditions.

Estimated SWP Export Amounts—Existing Conditions and Future Conditions

This section provides estimates of average, maximum, and minimum annual Delta exports for both existing and future conditions. It also summarizes SWP Delta exports by month and by water year type, demonstrating the effects of the USFWS and NMFS BOs and other influencing factors on SWP Delta exports.

Average, Maximum, and Minimum Annual Delta Exports

Figure 5-3 presents the estimated average, maximum, and minimum annual SWP Delta exports for the existing-conditions and future-conditions scenarios.

As shown in Figure 5-3, estimated maximum annual SWP exports increase by 40 taf/year (1%) under the future-conditions scenario, relative to existing conditions. However, the average export decreases by 86 taf/year (more than 3%) between the existing- and future-conditions scenarios, and the minimum export is 66 taf/year (7.6%) lower under future conditions.

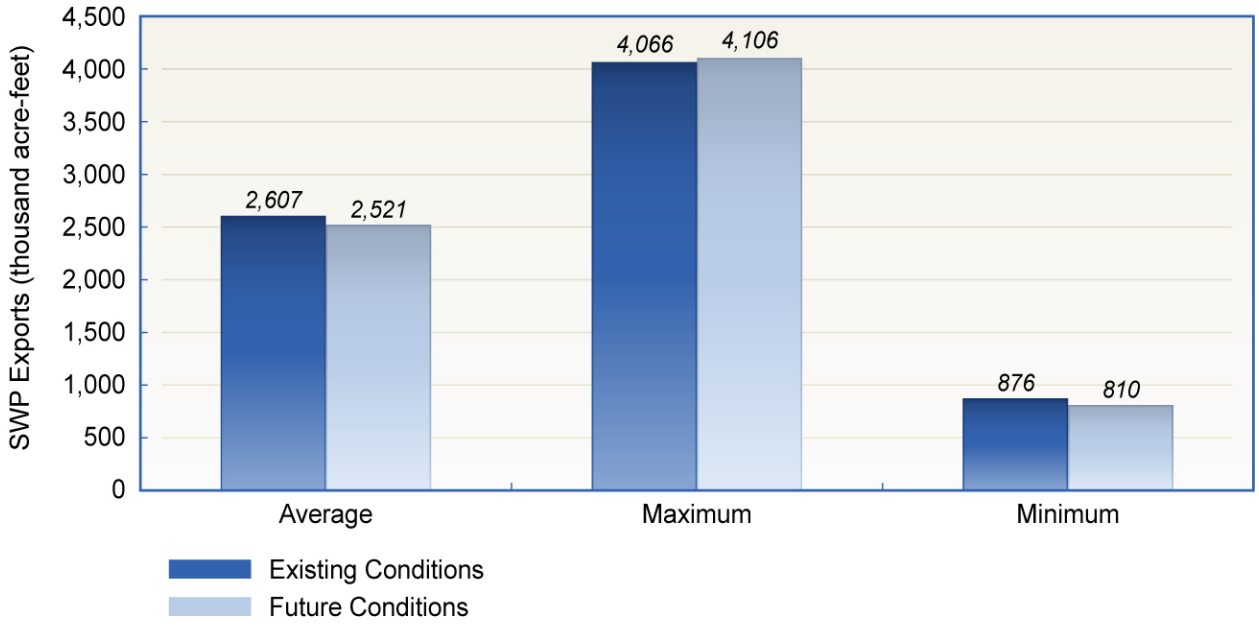


Figure 5-3. Estimated Average, Maximum, and Minimum Annual SWP Exports (Existing and Future Conditions)

Exports by Month

Table 5-1 and Figures 5-4 and 5-5 show the range of estimated SWP exports from the Delta by month under existing and future conditions. The figures also depict the maximum and minimum estimated exports for each month under each scenario. (Please note that although the data in Figures 5-4 and 5-5 seem identical at first glance, they are not. As shown in Table 5-1, estimated existing and future SWP exports are generally similar, within 9% of each other in all months except October, but are not exactly the same.)

As shown in Figures 5-4 and 5-5 and Table 5-1, estimated SWP exports are highest on average in July, averaging 365 taf under existing conditions and 352 taf under future conditions. Exports are consistently lowest in April and May, averaging 60 taf in April and 65 taf in May for 2011, and 65 taf in April and 67 taf in May for 2031.

As shown in Table 5-1, in most months, the average estimated monthly SWP exports for future conditions are generally similar to or slightly lower than the estimated monthly exports for existing conditions. The most notable exceptions are in April and May. Under both existing and future conditions, the values for those months are essentially the same, reflecting the regulations in place during that time of the year.

Exports by Water Year Type

Table 5-2 and Figure 5-6 compare SWP exports by water year type under existing conditions, as estimated for the 2009 Report and for this 2011 Report. As shown, the existing SWP exports estimated for this 2011 Report are roughly similar to the existing SWP exports estimated for the 2009 Report for most water year types. The largest difference is an increase in exports of about 2% in the critical-year scenario. Estimated exports in both years under existing conditions were found to be similar on average.

Table 5-1. Average Estimated SWP Exports by Month (Existing and Future Conditions)

Month	Estimated SWP Exports (thousand acre-feet)		Difference, Existing vs. Future Conditions (thousand acre-feet and %)
	Existing	Future	
January	214	217	+4 (+2%)
February	228	217	-10 (-5%)
March	232	228	-5 (-2%)
April	60	65	+5 (+8%)
May	65	67	+2 (+4%)
June	145	131	-14 (-9%)
July	365	352	-12 (-3%)
August	316	311	-6 (-2%)
September	268	271	+3 (+1%)
October	223	186	-37 (-16%)
November	174	169	-5 (-3%)
December	317	305	-12 (-4%)

Table 5-2. Estimated SWP Exports by Water Year Type—Existing Conditions

Water Year Type	Estimated Existing SWP Exports (thousand acre-feet)		Difference, 2009 Report vs. 2011 Report (thousand acre-feet and %)
	2009 Report	2011 Report	
Wet	3,233	3,210	-23 (- <1%)
Above Normal	2,774	2,784	+10 (+ <1%)
Below Normal	2,617	2,643	+26 (+1%)
Dry	2,290	2,320	+30 (+1.3%)
Critical	1,486	1,512	+26 (+1.7%)
Average	*2,598*	*2,607*	*+9 (+ <1%)*

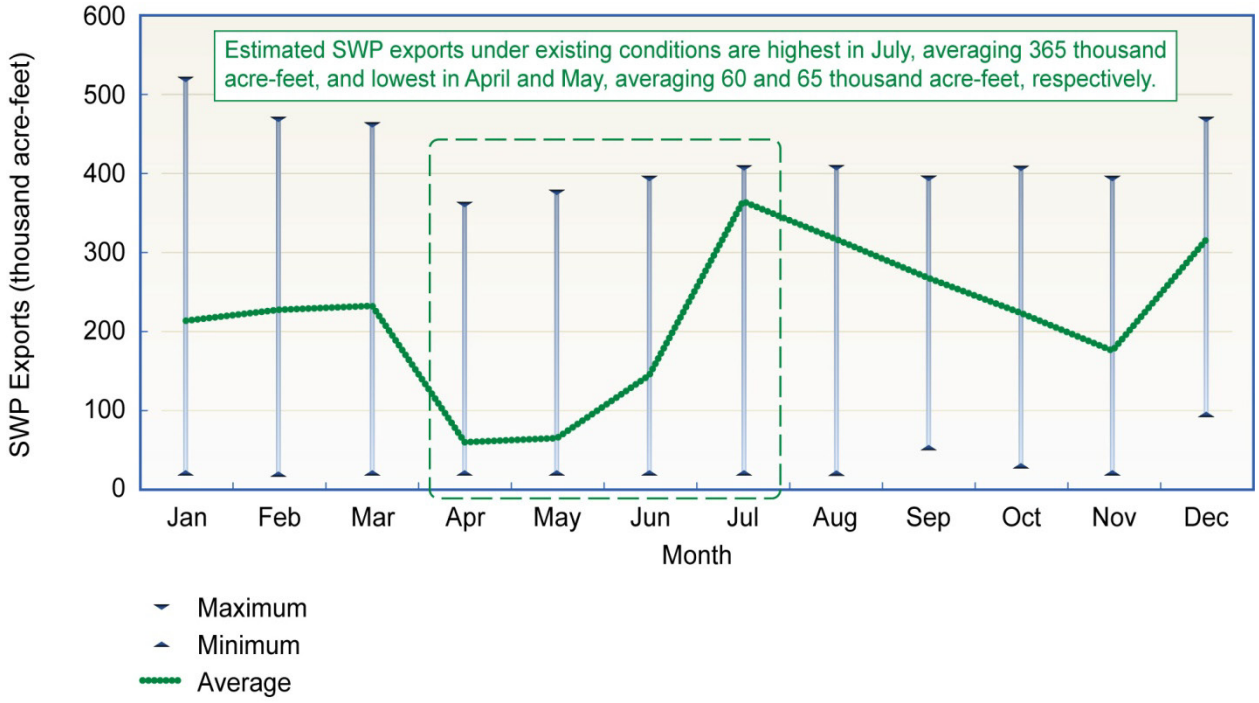


Figure 5-4. Monthly Range of Estimated SWP Exports (Existing Conditions)

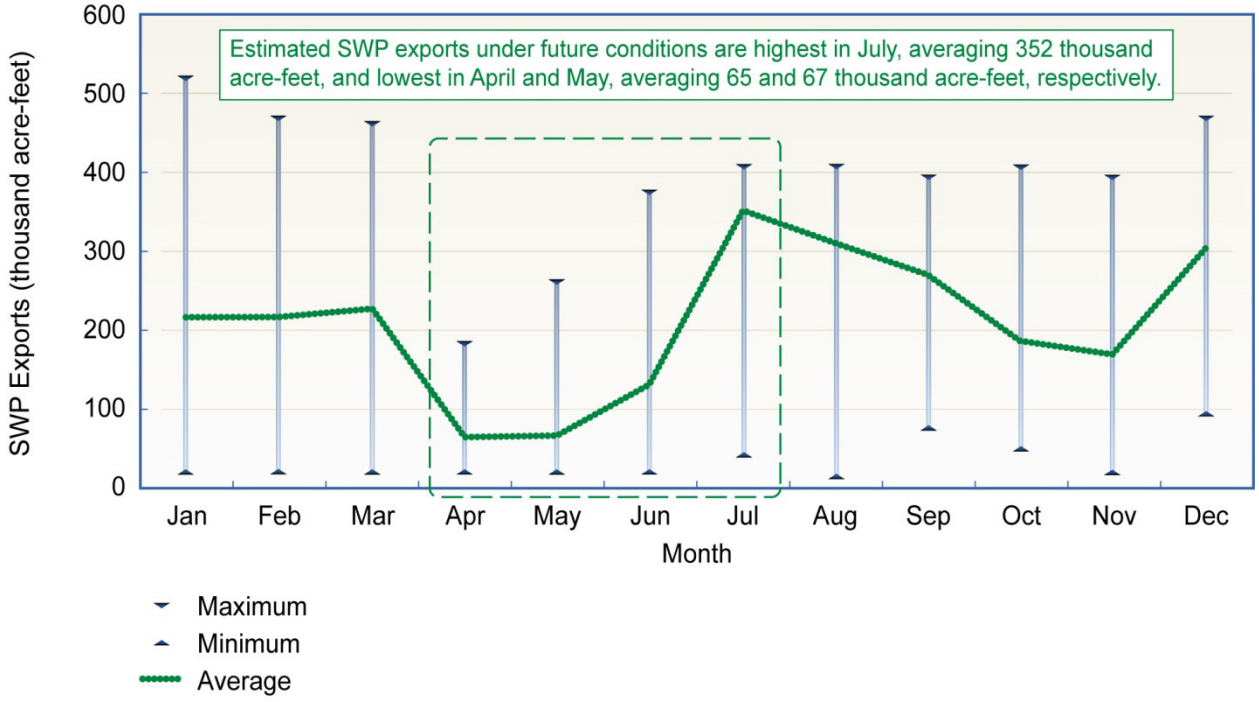


Figure 5-5. Monthly Range of Estimated SWP Exports (Future Conditions)

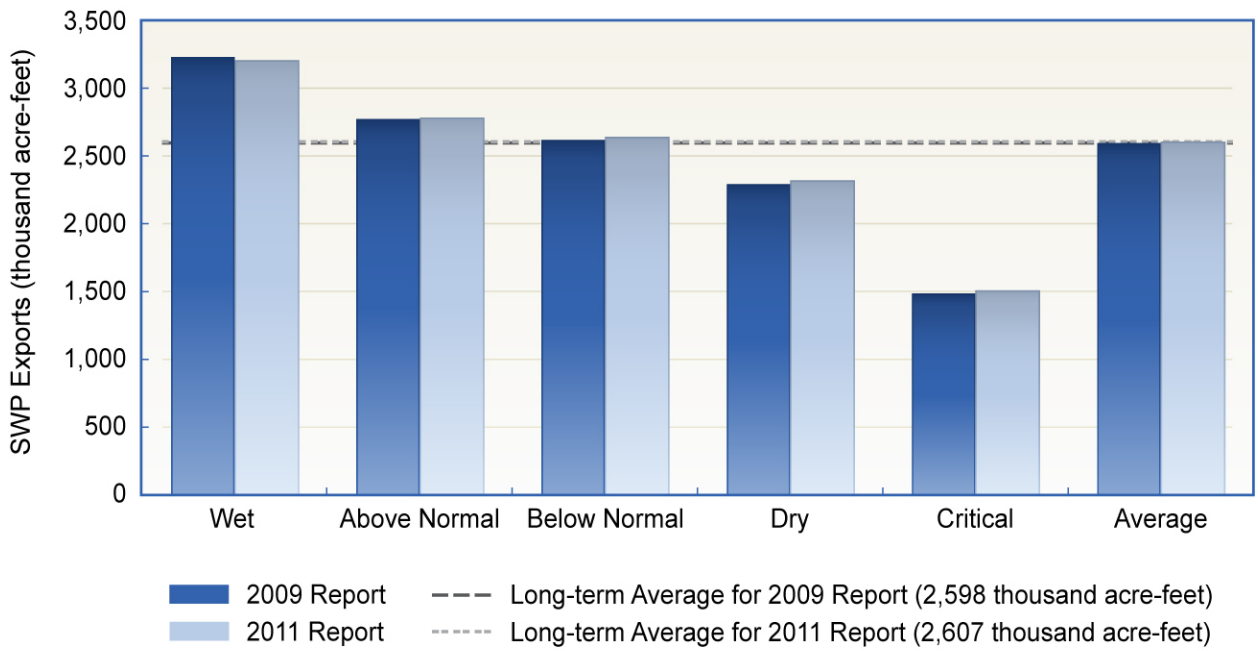


Figure 5-6. Comparison of Estimated SWP Exports by Water Year Type (Existing Conditions)

Table 5-3 and Figure 5-7 compare SWP exports by water year type under future conditions, as estimated for the 2009 Report and this 2011 Report. As shown, the future SWP exports estimated for this 2011 Report are roughly similar to or slightly (less than 7.5%) lower than the future exports estimated for the 2009 Report for all water year types, with the exception of the above-normal year scenario, where there is an increase in exports of about 0.7%. Future SWP exports estimated for this 2011 Report are slightly lower (about 1.1%) on average than future exports estimated for the 2009 Report.

Table 5-3. Estimated SWP Exports by Water Year Type—Future Conditions

Water Year Type	Estimated Future SWP Exports (thousand acre-feet)		Difference, 2009 Report vs. 2011 Report (thousand acre-feet and %)
	2009 Report	2011 Report	
Wet	3,196	3,182	-14 (- <1%)
Above Normal	2,734	2,753	+19 (+ <1%)
Below Normal	2,557	2,556	-1 (0%)
Dry	2,173	2,120	-53 (-2.4%)
Critical	1,526	1,414	-112 (7.4%)
Average	*2,550*	*2,521*	-29 (-1.1%)

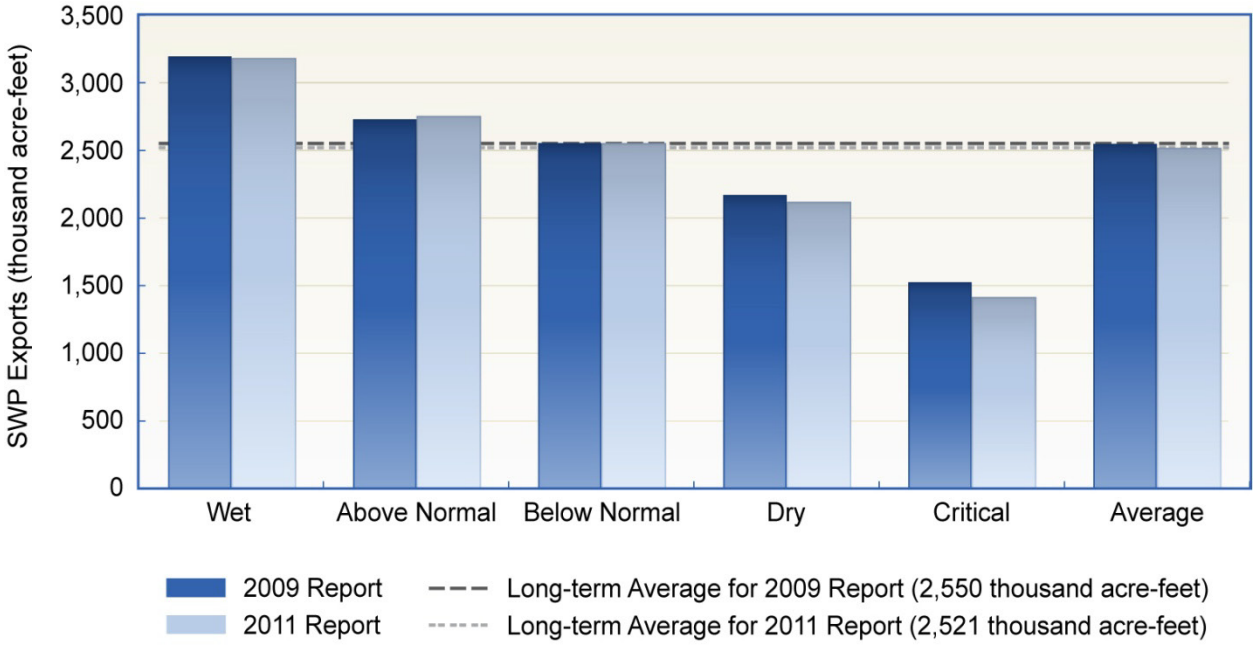


Figure 5-7. Comparison of Estimated SWP Exports by Water Year Type (Future Conditions)

Likelihood of SWP Exports—Existing and Future Conditions

The estimated likelihood of a given level of SWP exports under existing conditions and under future conditions is presented in Figure 5-8 and Table 5-4. As shown in the figure and table, 4,106 taf is the largest export amount that was modeled for the 2011 Report.

As shown in Figure 5-8, in 79% of simulated cases for existing conditions, estimated SWP exports are between 2,000 and 3,500 taf/year. SWP exports of other amounts are less likely, with the next most likely export amount being between 1,000 and 1,500 taf/year (Table 5-4).

By comparison, in about 76% of simulated cases for future conditions, estimated SWP exports are between 2,000 and 3,500 taf/year (Figure 5-8). SWP exports of other amounts are less likely, with the next most likely export amount again being between 1,000 and 1,500 taf/year. Annual exports of 1,000–1,500 taf/year are more likely under future conditions than under existing conditions (10% versus 9%) (Table 5-4).

Table 5-4. Estimated Likelihood of SWP Annual Export Amounts—Existing and Future Conditions

SWP Export Amount (thousand acre-feet)	Percentage Chance of Export of This Amount	
	Existing Conditions	Future Conditions
0–500	0%	0%
500–1,000	1%	2%
1,000–1,500	9%	10%
1,500–2,000	6%	7%
2,000–2,500	21%	22%
2,500–3,000	34%	34%
3,000–3,500	24%	20%
3,500–4,000	2%	2%
4,000–4,106	2%	2%
More than 4,106	0%	0%

As shown in Table 5-4, the likelihood of total annual SWP exports of less than 2,000 taf/year is greater under future conditions than under existing conditions (nearly 20% versus 16%), and the likelihood of exports exceeding 3,500 taf/year is nearly the same under both scenarios (nearly 5% for both existing and future conditions).

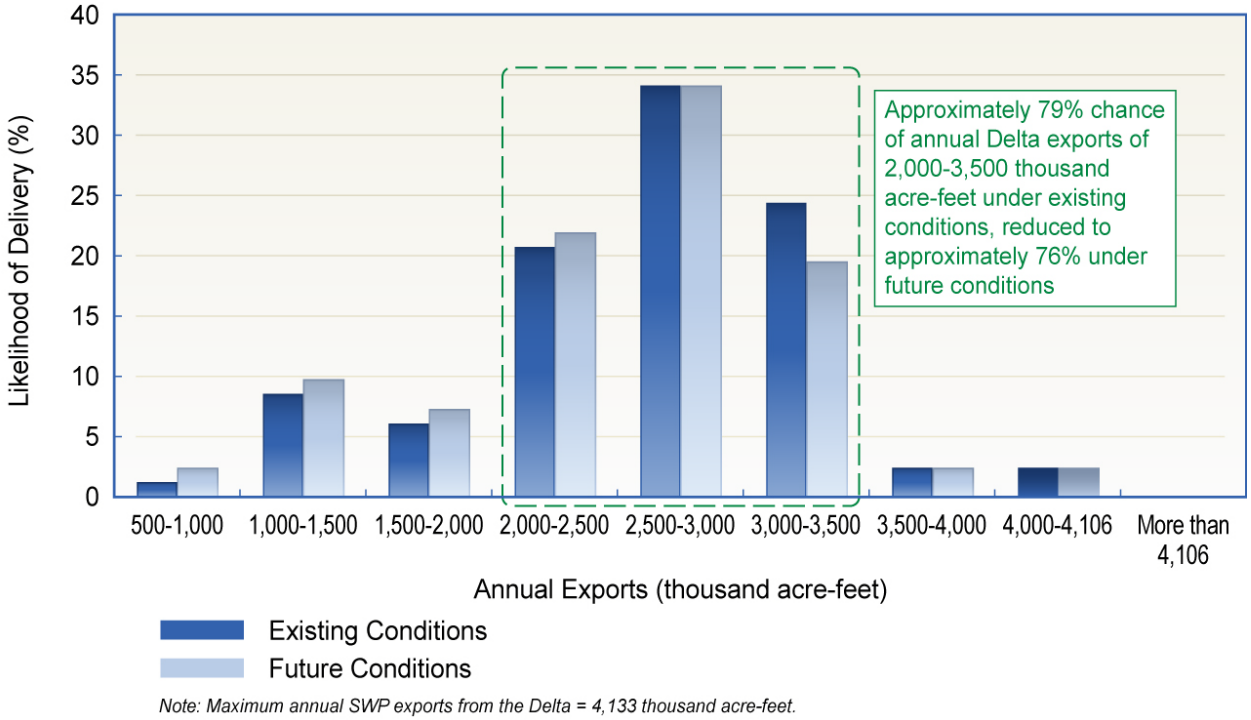
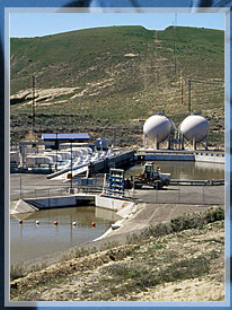


Figure 5-8. Estimated Likelihood of SWP Exports, by Increments of 500 Acre-Feet (under Existing and Future Conditions)



Chapter 6

Existing SWP Water Delivery Reliability (2011)

This chapter presents estimates of the SWP's existing (2011) water delivery reliability. The estimates are presented below, alongside the reliability results obtained from the *State Water Project Delivery Reliability Report 2009* (2009 Report). Like this *State Water Project Delivery Reliability Report 2011* (2011 Report), the 2009 Report incorporated into its results the requirements of biological opinions issued by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) in December 2008 and June 2009, respectively, on the effects of coordinated operations of the SWP and Central Valley Project. These BOs are discussed in detail in Chapter 2, "A Closer Look at the State Water Project," and Chapter 4, "Factors that Affect Water Delivery Reliability."

The discussions of SWP water delivery reliability in this chapter and Chapter 7 are presented in a different format than the results presented in previous SWP delivery reliability reports, which were written for both the public and the SWP contractors. By contrast, this chapter and Chapter 7 are written primarily with the public in mind. Thus the results of DWR's updated modeling of the SWP's water delivery reliability are presented in a more graphical manner. For consistency with previous SWP delivery reliability reports, a tabular summary of the modeling results is presented in the technical addendum to this report, which is available online at http://baydeltaoffice.water.ca.gov. The technical addendum also contains distribution curves of annual delivery probability (i.e., exceedence plots) to visually show the estimated percentage of years in which a given annual delivery is equaled or exceeded.

Hydrologic Sequence

SWP delivery amounts are estimated in this 2011 Report for existing conditions using computer modeling that incorporates the historic range of hydrologic conditions (i.e., precipitation and runoff) that occurred from water years 1922 through 2003. The historic hydrologic conditions are adjusted to account for land-use changes (i.e., the current level of development) and upstream flow regulations that characterize 2011. By using this 82-year historical flow record, the delivery estimates modeled for existing conditions reflect a reasonable range of

potential hydrologic conditions from wet years to critically dry years.

Existing Demand for Delta Water

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors themselves. The amount of water that SWP contractors request each year (i.e., demand) is related to:

- the magnitude and types of water demands,
- the extent of water conservation measures,
- local weather patterns, and
- water costs.

The existing level of development (i.e., the level of water use in the source areas from which the water supply originates) is based on recent land uses, and is assumed to be representative of existing conditions for the purposes of this 2011 Report.

SWP Table A Water Demands

The current combined maximum Table A amount is 4,173 thousand acre-feet per year (taf/year). See "'Table A' Water" in Chapter 3, "SWP Contractors and Water Contracts," for a full discussion of Table A, which is a table within each water supply contract. Of the combined maximum Table A amount, 4,133 taf/year is the SWP's maximum Table A water available for delivery from the Delta. The estimated demands by SWP contractors for deliveries of Table A water from the Delta under existing conditions, as determined for the 2011 Report and previously for the 2009 Report, are shown in Figure 6-1. The estimated average demand for SWP Table A water, as well as maximum and minimum demands, is displayed because demands vary annually depending on local hydrologic patterns and other factors (e.g., water conservation efforts).

As estimated for the 2011 Report, annual demands for SWP Table A water range between 3,043 taf and 4,120 taf under existing conditions, with an average demand of 3,722 taf. There is a 95% likelihood that more than 3,200 taf/year will be requested (i.e., demanded) for delivery under existing conditions. The estimated maximum SWP Table A water demand in the 2011 Report is very near the maximum possible Table A water delivery amount of 4,133 taf/year; however, the average annual demand of 3,722 taf is approximately 400 taf less than the possible maximum annual delivery.

Figure 6-2 shows that estimated annual demands for deliveries of SWP Table A water, as calculated for the 2009 and 2011 Reports, are similar. The differences range from 5 to 36 taf (0.12% to 1.19%). Demands calculated for both reports range between 3,000 and 4,120 taf/year, regardless of whether a year is critical, wet, or anywhere in between.

SWP Article 21 Water Demands

Under Article 21 of the SWP's long-term water supply contracts, contractors may receive additional water deliveries only under the following specific conditions:

- such deliveries do not interfere with SWP Table A allocations and SWP operations;
- excess water is available in the Delta;
- capacity is not being used for SWP purposes or scheduled SWP deliveries; and
- contractors can use the SWP Article 21 water directly or can store it in their own system (i.e., the water cannot be stored in the SWP system).

The demand for SWP Article 21 water by SWP contractors is assumed to vary depending on the month and weather conditions (i.e., amounts of precipitation and runoff). For the purposes of this discussion of SWP Article 21 water demands, a Kern wet year is defined as a year when the annual Kern River flow is projected to be greater than 1,500 taf. As shown in Figures 6-3 and 6-4, existing demands for SWP Article

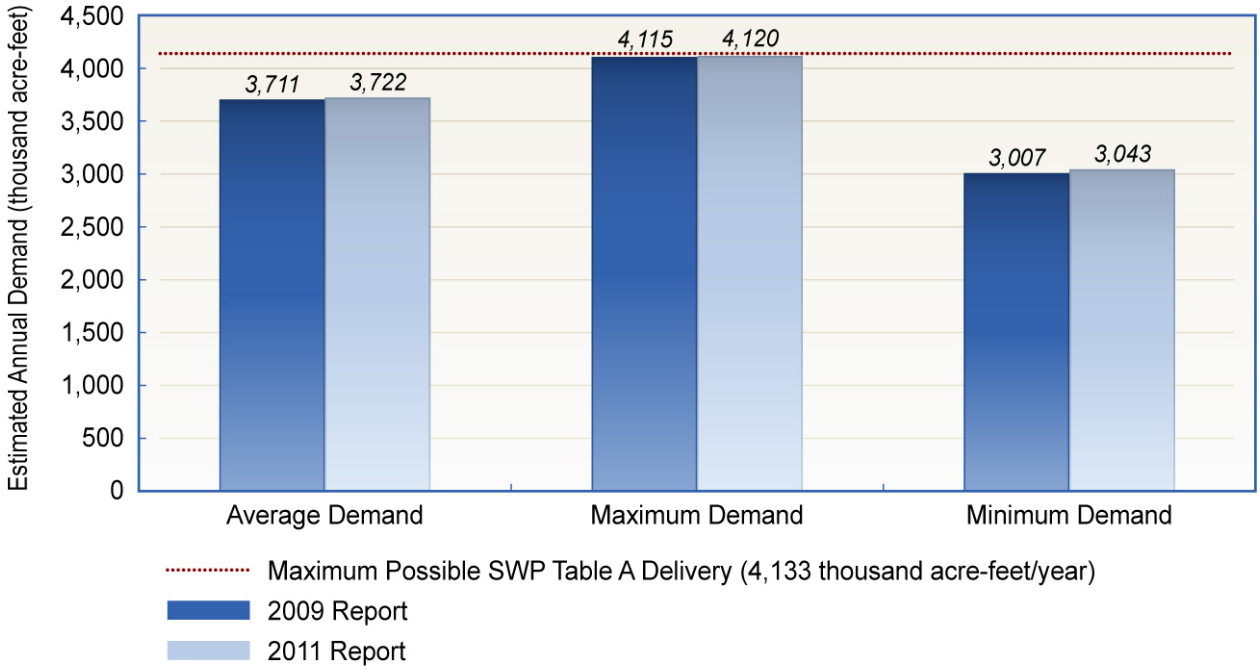


Figure 6-1. Comparison of Estimated Average, Maximum, and Minimum Demands for SWP Table A Water (Existing Conditions)

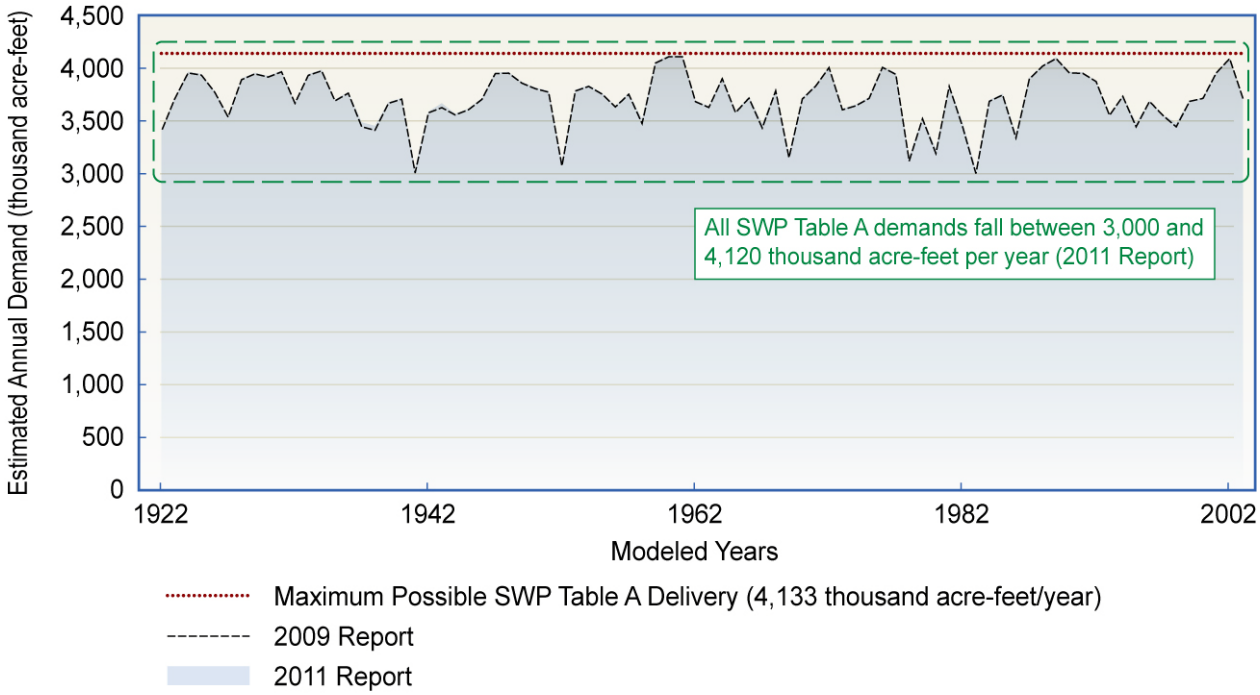


Figure 6-2. Comparison of Estimated Demands for SWP Table A Water on an Annual Basis, Using 82 Years of Hydrology (Existing Conditions)

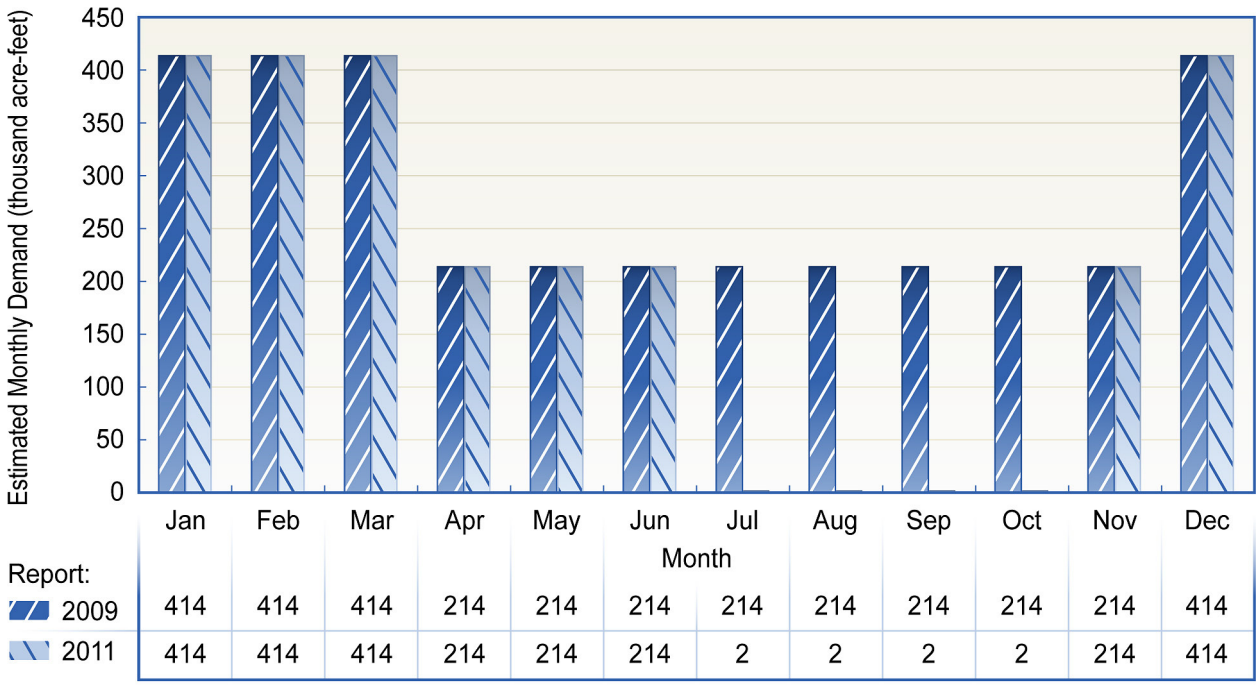


Figure note: Values shown are the maximum amount that can be delivered monthly. However, the actual capability of SWP water contractors to take this amount of SWP Article 21 water is not the sum of these maximum monthly values.

Figure 6-3. Estimated Demands for SWP Article 21 Water in Years When Kern River Flow is Less than 1,500 Thousand Acre-Feet (Existing Conditions)

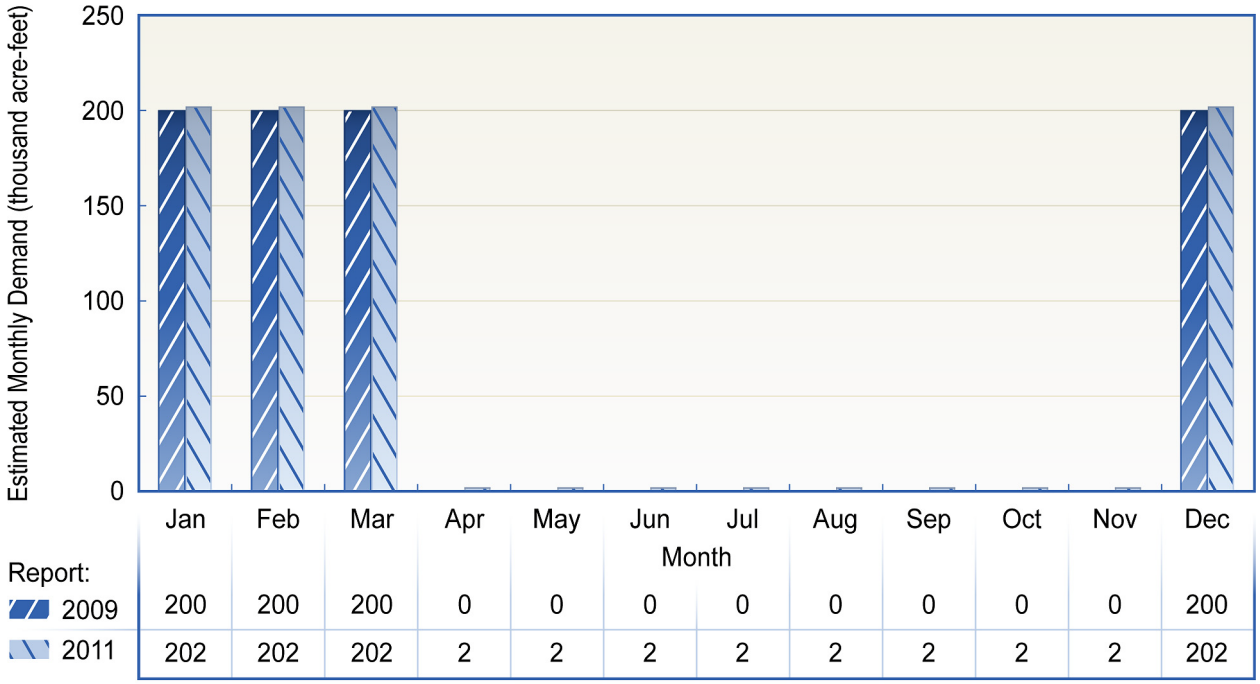


Figure note: Values shown are the maximum amount that can be delivered monthly. However, the actual capability of SWP water contractors to take this amount of SWP Article 21 is not the sum of these maximum monthly values.

Figure 6-4. Estimated Demands for SWP Article 21 Water in Years When Kern River Flow is Greater than 1,500 Thousand Acre-Feet (Existing Conditions)

21 water estimated for this 2011 Report are assumed to be high during the spring and late fall in non–Kern wet years (214 taf/month), as well as during the winter months of December through March in all weather year types (202 taf in Kern wet years and 414 taf in other years). Demands for SWP Article 21 water are assumed to be very low (2 taf/month) from April through November of Kern wet years and from July through October of other years .

Relative to levels of demand for SWP Article 21 water presented in the 2009 Report for existing conditions, the monthly existing-conditions demands for Article 21 water are 212 taf lower from July through October in normal weather years. This reduction in demand occurs because the modeling was revised for the 2011 Report to assume that only SWP contractors receiving water from the North Bay Aqueduct will have SWP Article 21 water demands during those months. A second revision to the modeling assumptions relative to the 2009 Report resulted in the addition of a year-round demand for 2 taf/month through the North Bay Aqueduct in 2011 during wet weather years.

The estimated reduction in existing-conditions demand for SWP Article 21 water in this 2011 Report relative to the 2009 Report is the result of discussions with DWR's Operations and Maintenance staff and State Water Contractors staff, and it represents their best estimates of current practices. The SWP Article 21 water demands used in the 2009 Report, on the other hand, match the demands assumed in the studies conducted for the 2008 USFWS BO and 2009 NMFS BO, and those demands capture the upper boundary of the potential impact of SWP Article 21 exports on the Delta ecosystem. This assumption reflects a condition in which SWP contractors are able to use essentially any available SWP Article 21 water when capacity for moving that water exists in the SWP delivery system.

Estimates of SWP Deliveries

As described previously, SWP deliveries are categorized under several different water classifications (e.g., Table A, Article 21), each available for delivery to water contractors under specific circumstances. Many contractors frequently use these additional water types to increase or reduce the amount available to them under SWP Table A.

SWP Table A Water Deliveries

Figure 6-5 presents the annual average, maximum, and minimum estimates of SWP Table A deliveries from the Delta for existing conditions, as calculated for the 2009 and 2011 Reports. The maximum Table A deliveries are similar between the 2009 and 2011 Reports, increasing by 27 taf (1%) in 2011, and the average annual delivery of Table A water estimated for the 2011 Report is 41 taf (2%) larger than the corresponding delivery estimated for the 2009 Report. The minimum Table A delivery estimated for the 2011 Report is 79 taf/year greater than the minimum delivery estimated for the 2009 Report, which equates to a 26% increase. The increase in minimum Table A deliveries under existing conditions between the 2009 Report and the 2011 Report can be attributed primarily to changes in the modeling assumptions. Assumptions about Table A and Article 21 water demands, along with Article 56 carryover operations, have been updated in the model based on discussions with State Water Contractors staff and DWR's Operations and Control Office.

The estimated likelihood of delivery of a given amount of SWP Table A water under the existing conditions scenario, as estimated for both the 2009 and 2011 Reports, is presented in Figure 6-6. Figure 6-6 shows that the likelihood that 2,000–3,365 taf/year of Table A water will be delivered is now 82%. There is a 48% likelihood that 2,500–3,000 taf of Table A water will be delivered, a 5% likelihood of delivery of less than 1,000 taf, and 0% likelihood of delivery

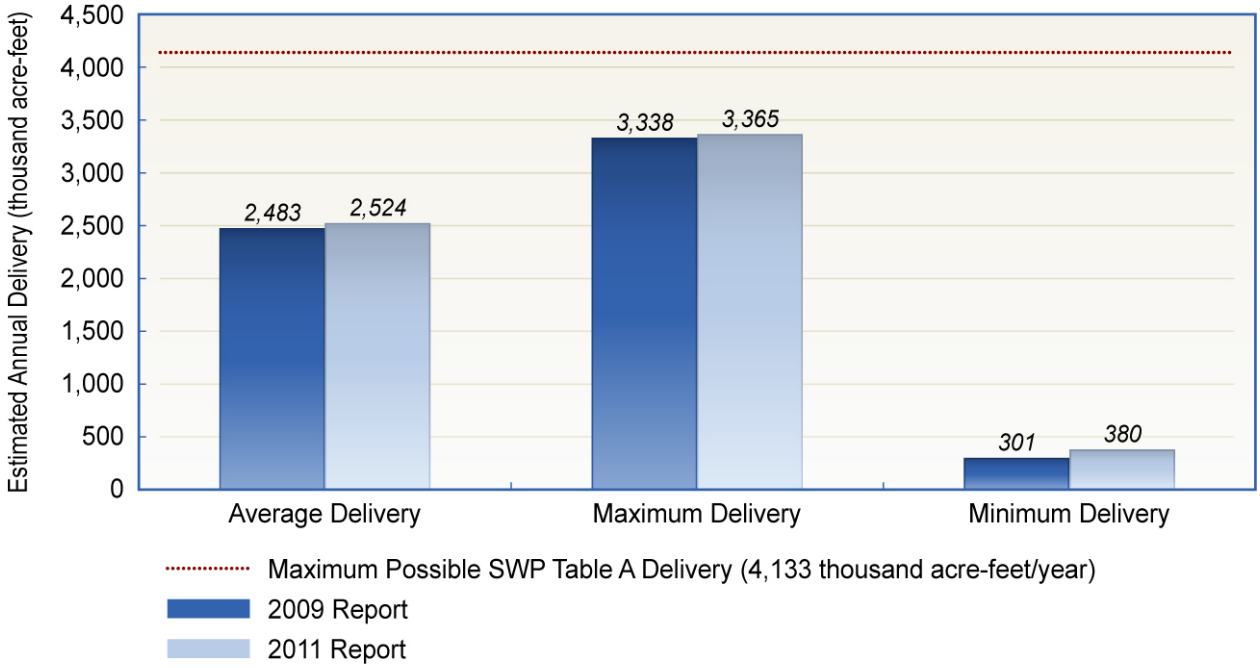


Figure 6-5. Comparison of Estimated Average, Maximum, and Minimum Deliveries of SWP Table A Water (Existing Conditions)

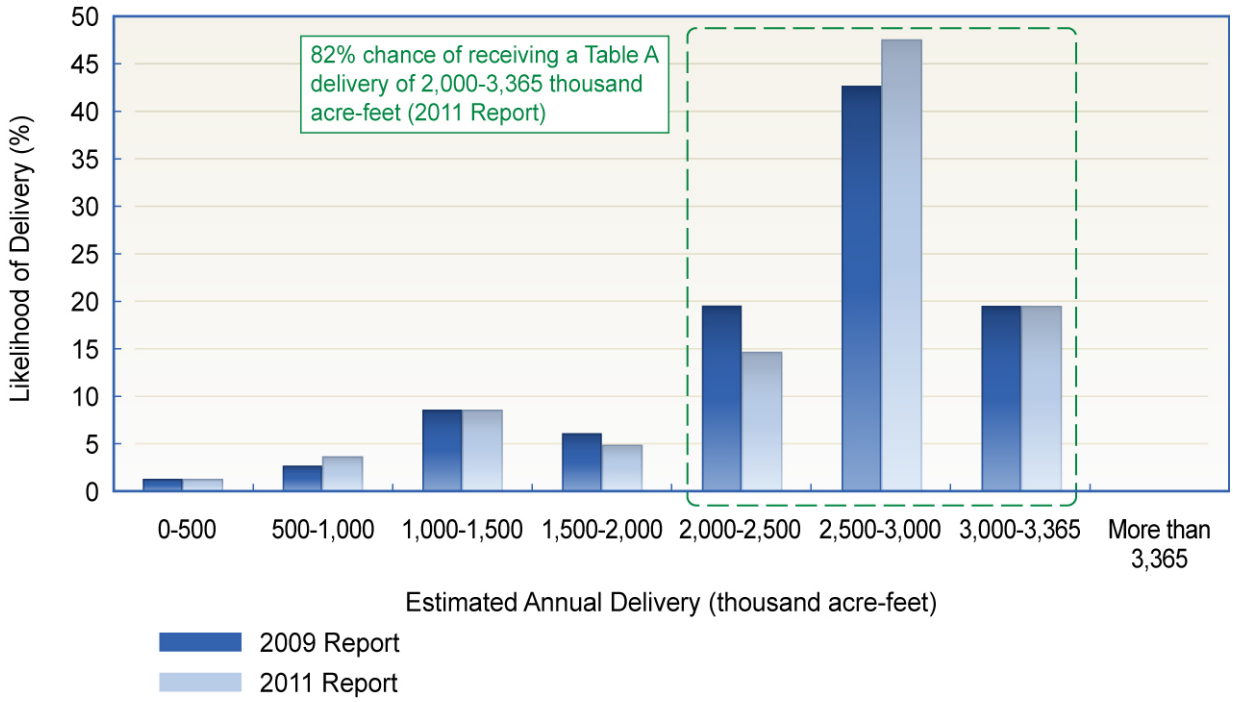


Figure 6-6. Estimated Likelihood of SWP Table A Water Deliveries (Existing Conditions)

of more than 3,365 taf in a given year. To compare the results estimated for this 2011 Report with results from the 2009 Report, an SWP contractor is just slightly more likely to receive a larger Table A water delivery under the current estimates.

Figure 6-7 illustrates that SWP contractors have a similar or greater likelihood of receiving larger Table A water deliveries under the scenario for the 2011 Report, relative to the scenario presented in the 2009 Report. For example, there is a 67% likelihood of receiving more than 2,500 taf/year of Table A water under the current scenario, while there was a 62% likelihood of receiving more than 2,500 taf/year under the scenario presented in the 2009 Report.

Dry-Year Deliveries of SWP Table A Water

Figure 6-8 displays estimates of SWP Table A water deliveries under existing conditions during possible drought conditions and compares them with the corresponding delivery estimates calculated for the 2009 Report. Droughts are analyzed using the historical drought-period precipitation and runoff patterns from 1922 through 2003 as a reference, although existing 2011 conditions (e.g., land use, water infrastructure) are also accounted for in the modeling. For reference, the worst multiyear drought on record was the 1929–1934 drought, although the brief drought of 1976–1977 was more intensely dry.

The results of modeling existing conditions for potential drought-year scenarios indicate that SWP Table A water deliveries during dry years can be expected to range from between 380 and 1,573 taf/year. This is a 38% to 85% decrease in Table A water deliveries from the average estimated delivery calculated for this report.

Figure 6-8 shows that current estimates of SWP deliveries for existing conditions during dry periods increase relative to the corresponding deliveries estimated for the 2009 Report. For example, deliveries of 1,573 taf/year of SWP Table A water are currently estimated for the 2-year drought scenario, an increase of 77 taf/year (5%) relative to the delivery estimate calculated for the 2009 Report. The most striking change in drought-year delivery is for the single-year drought scenario, in which the estimated SWP Table A water delivery increases by 79 taf/year (26%) relative to the corresponding delivery estimated for the 2009 Report. These changes in estimated deliveries of SWP Table A water during drought years, relative to the estimates from the 2009 Report, can be attributed to recent model and assumption changes, as described previously in this chapter.

Wet-Year Deliveries of SWP Table A Water

Figure 6-9 presents estimates of SWP Table A water deliveries in the case of a wet year and compares them with the corresponding delivery estimates calculated for the 2009 Report. Wet periods for 2011 are modeled using historical precipitation and runoff patterns from 1922–2003 as a reference, although existing 2011 conditions (e.g., land use, water infrastructure) are also accounted for in the modeling. For reference, the wettest single year on record was 1983.

The results of modeling existing conditions for potential wet periods indicate that estimated SWP Table A water deliveries during wet years can be expected to range between 2,833 and 2,958 taf/year. This is a 12% to 17% increase in Table A water deliveries from the average estimated delivery calculated for this report.

Figure 6-9 shows that current estimates of SWP deliveries for existing conditions during wet periods increase slightly (by between 1% and 3%) relative to the corresponding deliveries estimated for the 2009 Report. For example, the current results indicate delivery of an estimated 2,958 taf of SWP Table A water for the 2-year-wet-period scenario, an increase of 23 taf/year (1%) relative to the delivery estimate calculated for the 2009 Report. The current results also

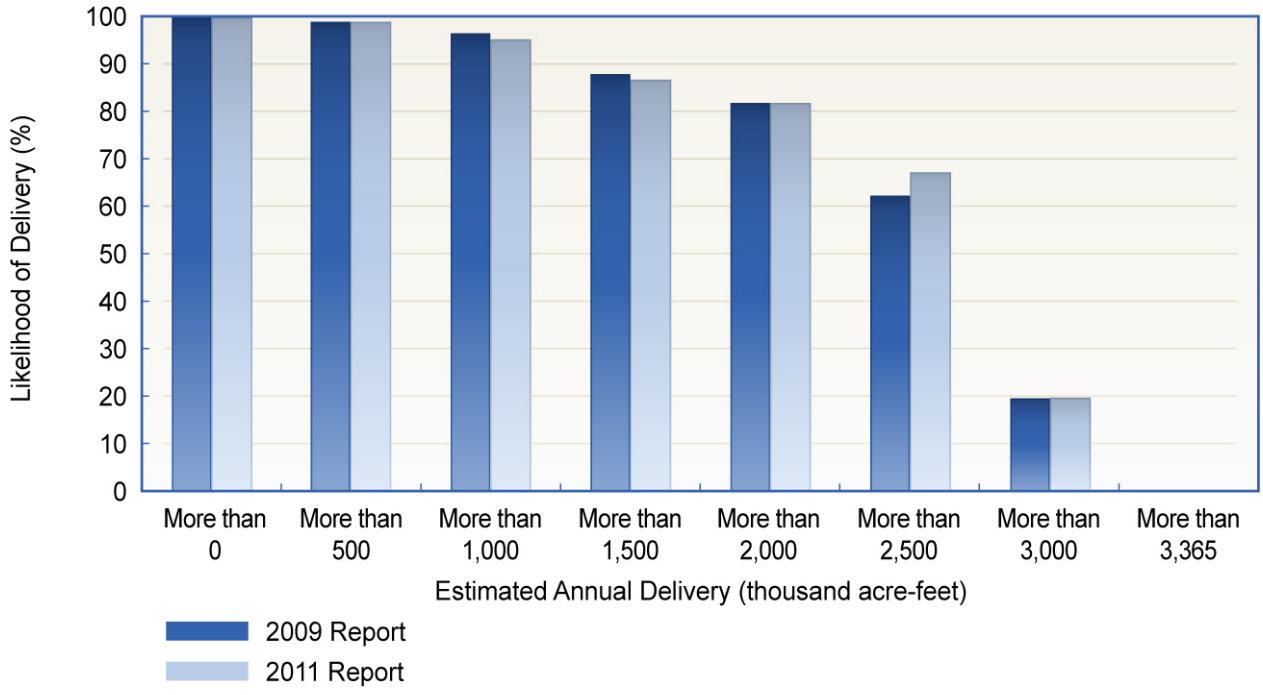


Figure 6-7. Estimated Cumulative Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Existing Conditions)

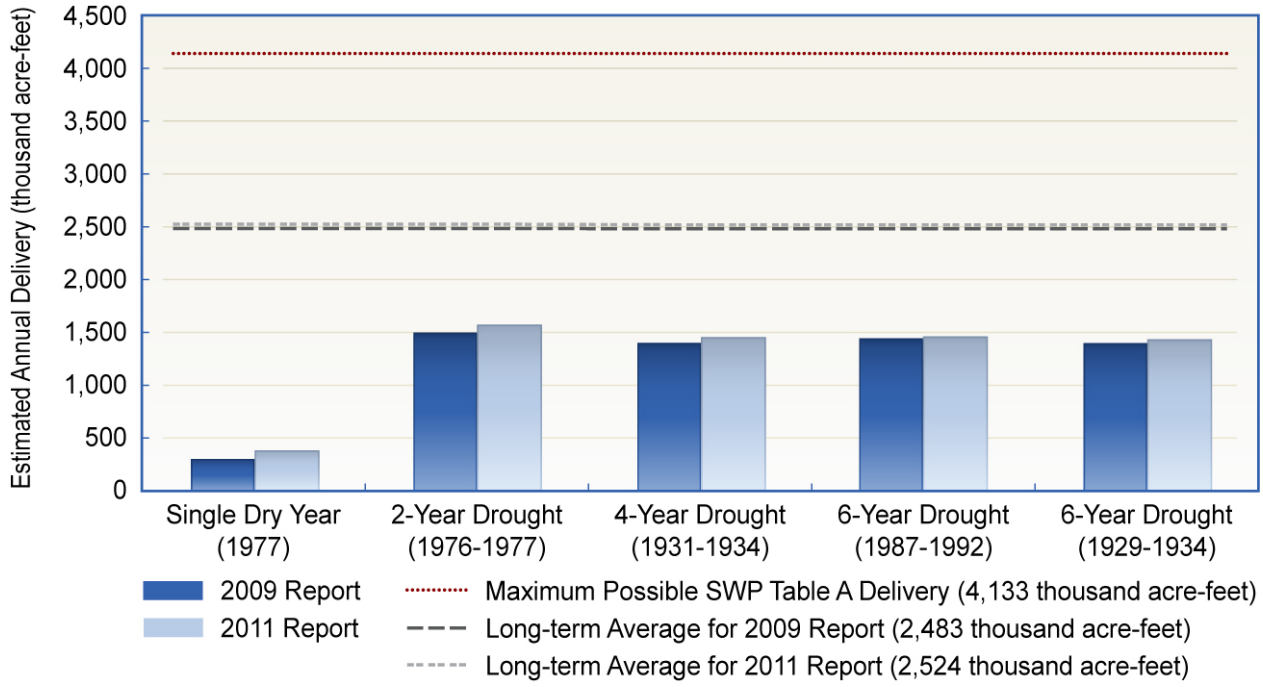


Figure 6-8. Estimated Average and Dry-Period Deliveries of SWP Table A Water (Existing Conditions)

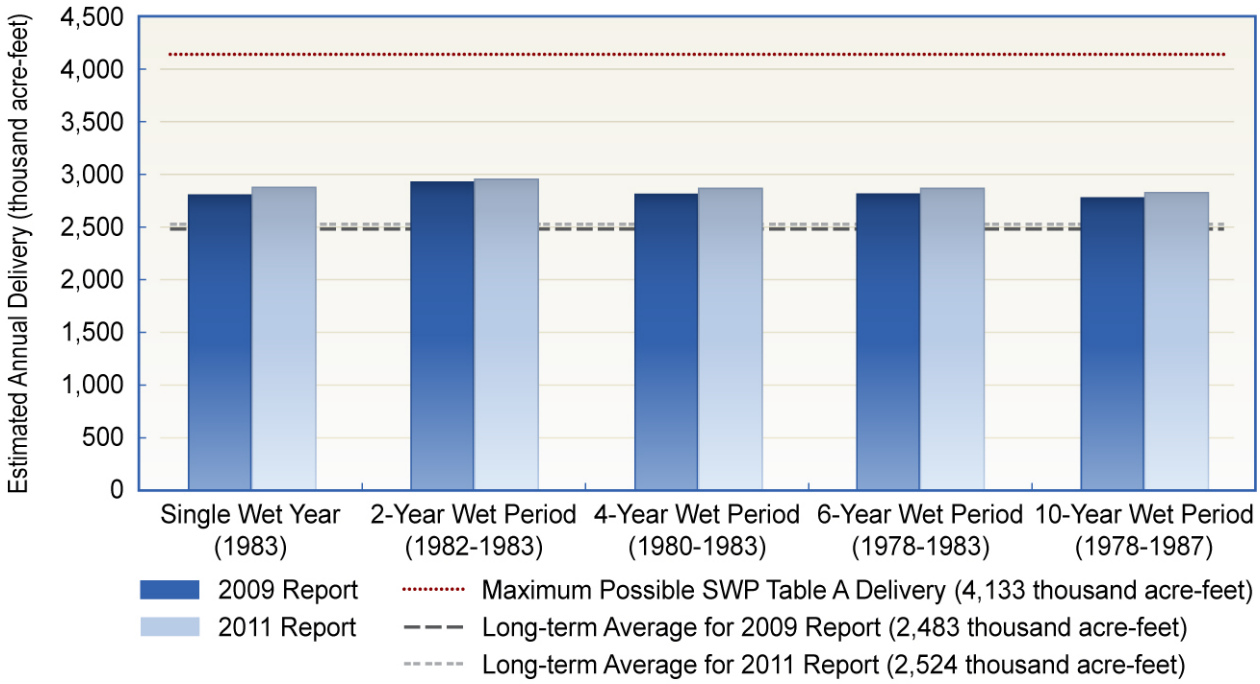


Figure 6-9. Estimated Average and Wet-Period Deliveries of SWP Table A Water (Existing Conditions)

indicate that an estimated 2,886 taf/year of SWP Table A water will be delivered during the single-year wet-period scenario, an increase of 73 taf/year (3%) relative to the corresponding delivery estimated for the 2009 Report. This small but consistent increase in SWP Table A wet-year deliveries in 2011 can be attributed to an assumed incremental increase in demand relative to the demand estimated for the 2009 Report.

SWP Article 21 Water Deliveries

SWP water delivery is a combination of deliveries of Table A water and Article 21 water. Some SWP contractors store Article 21 water locally when extra water and capacity are available beyond that needed by normal SWP operations. Deliveries of SWP Article 21 water vary not only by year, but also by month. In the summer and early fall months (July through October), a maximum of approximately 2 taf and a minimum of 0 taf/month can be delivered. From November through June, maximum deliveries of SWP Article 21 water can be as high as 299 taf and as low as 2 taf in a given month; however, water deliveries average in the range of 0.3 to 30 taf. The estimated range of monthly deliveries of SWP Article 21 water is displayed in Figure 6-10.

The estimated likelihood that a given amount of SWP Article 21 water will be delivered is presented in Figure 6-11. Currently, there is a 26% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under existing conditions. There is a 74% likelihood that less than 20 taf/year of SWP Article 21 water will be delivered.

To compare these results to the results from the 2009 Report, the likelihood of larger deliveries of SWP Article 21 water is lower under the current scenario. In the 2009 Report, there is a 29% likelihood that more than 20 taf/year of SWP Article 21 water will be available for delivery, compared to a 26% likelihood in the results calculated for this 2011 Report. There is a 22% likelihood that more than 100 taf/year of SWP Article 21 water will be available for delivery in the 2009 Report, compared to a 20% likelihood

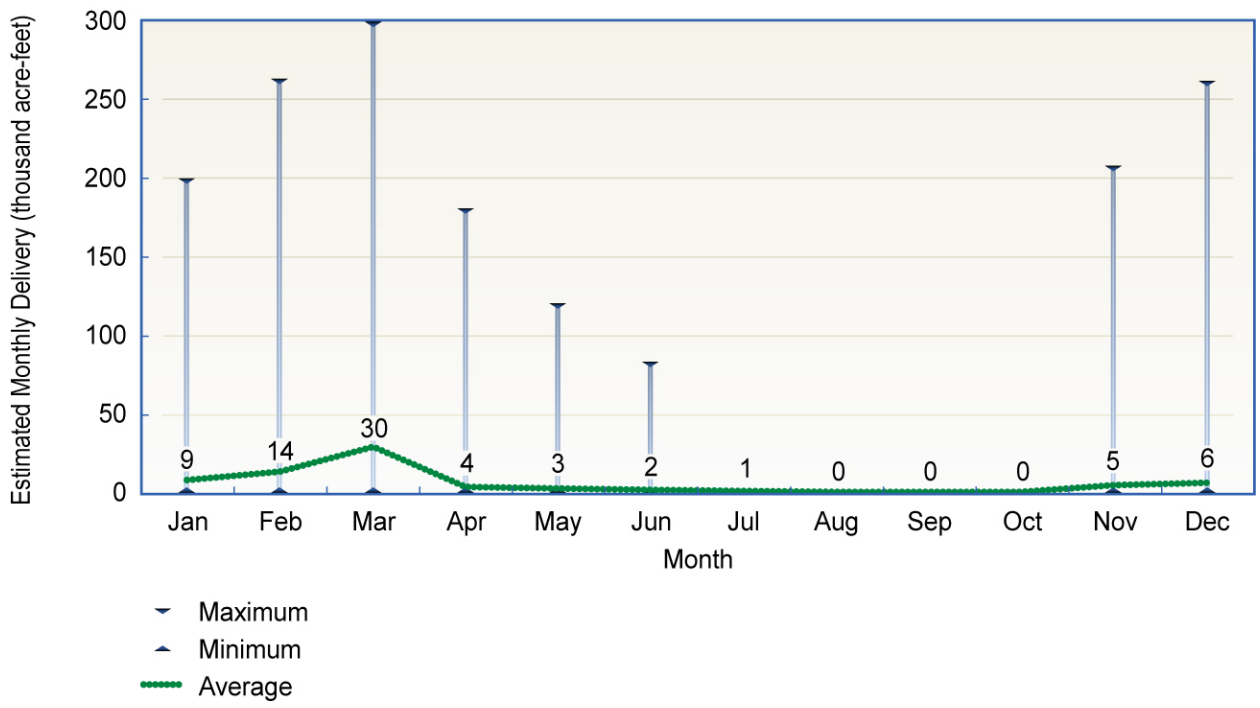


Figure 6-10. Estimated Range of Monthly Deliveries of SWP Article 21 Water (2011 Report—Existing Conditions)

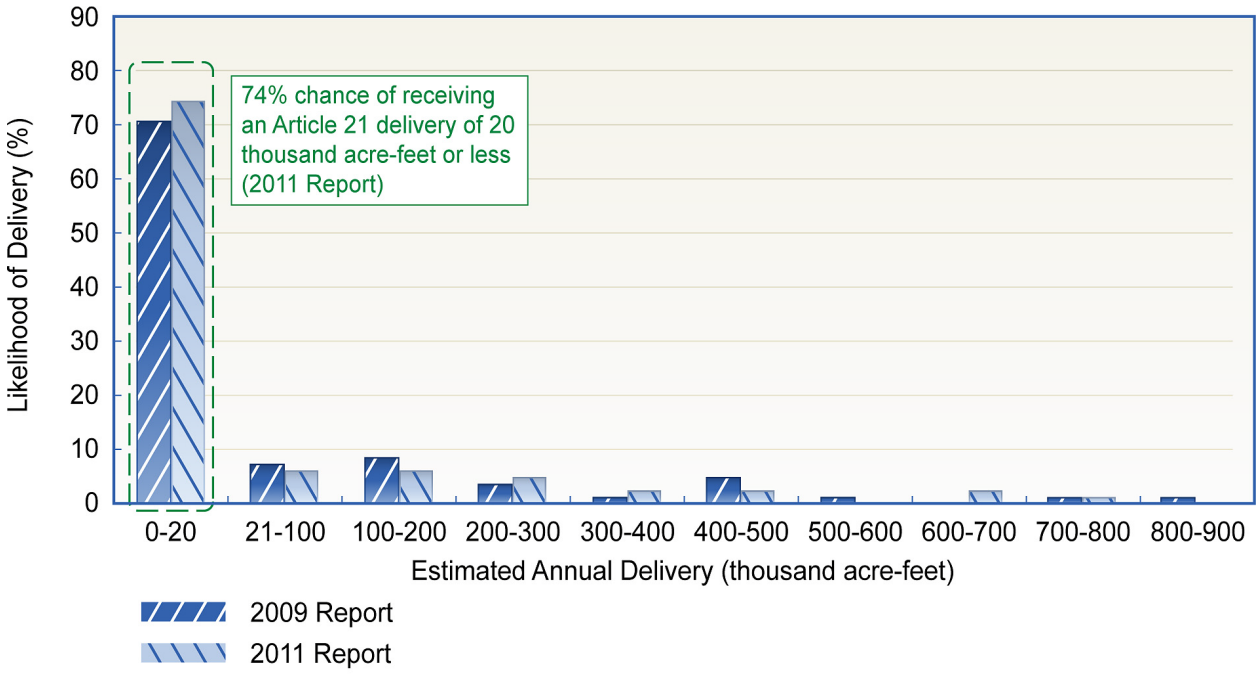


Figure 6-11. Estimated Probability of Annual Deliveries of SWP Article 21 Water (Existing Conditions)

in the current estimates. Thus, the estimated likelihood of larger Article 21 deliveries is greater in the 2009 Report than in this 2011 Report.

In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water are generally less than 20 taf/year (71% and 74% likelihood, respectively).

Dry-Year Deliveries of SWP Article 21 Water

Although deliveries of SWP Article 21 water are smaller during dry years than during wet ones, opportunities exist to deliver SWP Article 21 water even during multiyear drought periods. For example, when looking at the periods in the modeling scenario that are known to be dry, it is apparent that SWP Article 21 water is still delivered during those times. Deliveries in dry years can often be small (less than 5 taf), ranging from 9% to 96% less than the average SWP Article 21 delivery estimated for this 2011 Report.

Figure 6-12 shows the estimates of deliveries of SWP Article 21 water during dry periods under existing conditions. To compare the results calculated for this 2011 Report to the results from the 2009 Report, deliveries during dry years in the current scenario are slightly higher (1 taf) for the single-year drought scenario, but are much lower in others (e.g., the 4-year drought scenario, for which the estimate calculated for this 2011 Report is 73 taf lower).

Wet-Year Deliveries of SWP Article 21 Water

Figure 6-13 shows the estimates of deliveries of SWP Article 21 water during wet periods under existing conditions. Estimated deliveries in wet years are approximately 1.75 to seven times larger than the average delivery of SWP Article 21 water.

Although wet-period deliveries are estimated to be larger than those in normal and dry years, wet-year deliveries estimated for this 2011 Report are consistently smaller than the wet-period deliveries estimated for the 2009 Report. Current estimates of deliveries during wet years are up to 242 taf lower in a given year than the corresponding estimates calculated for the 2009 Report.

Summary of Results

SWP Table A Water Demands and Deliveries

The estimates of existing-conditions demand for deliveries of SWP Table A water as presented in the 2009 and 2011 Reports are very similar; this 2011 Report shows only a slight increase in the estimate relative to the previous report, with average demand at 3,722 taf/year, maximum demand at 4,120 taf/year, and minimum demand at 2,512 taf/year. The current estimates of existing SWP Table A water deliveries are slightly higher than the delivery estimates presented in the 2009 Report during all potential precipitation conditions (average, wet, and dry years), with average deliveries at 2,524 taf/year, maximum deliveries at 3,365 taf/year, and minimum deliveries at 380 taf/year. Not only are the estimated delivery amounts larger, but the likelihood that an SWP contractor will receive those larger Table A water deliveries is greater in the current estimate, with an 82% chance of receiving an annual Table A delivery of 2,000–3,365 taf.

SWP Article 21 Water Demands and Deliveries

The demands for SWP Article 21 water estimated for the 2011 Report are lower than those estimated for the 2009 Report in all types of precipitation conditions except the driest years, for which the current demand estimates are slightly (2 taf/month) higher. This 2011 Report shows demands ranging from 2 to 202 taf/month in wet years and from 2 to 414 taf/month in normal years. The comparison of deliveries of SWP Article 21 water between the 2009 and 2011 Reports is nuanced, depending on precipitation. Estimates of maximum and average deliveries of SWP Article 21 water as calculated for the 2011 Report are lower than the corresponding deliveries calculated for the 2009

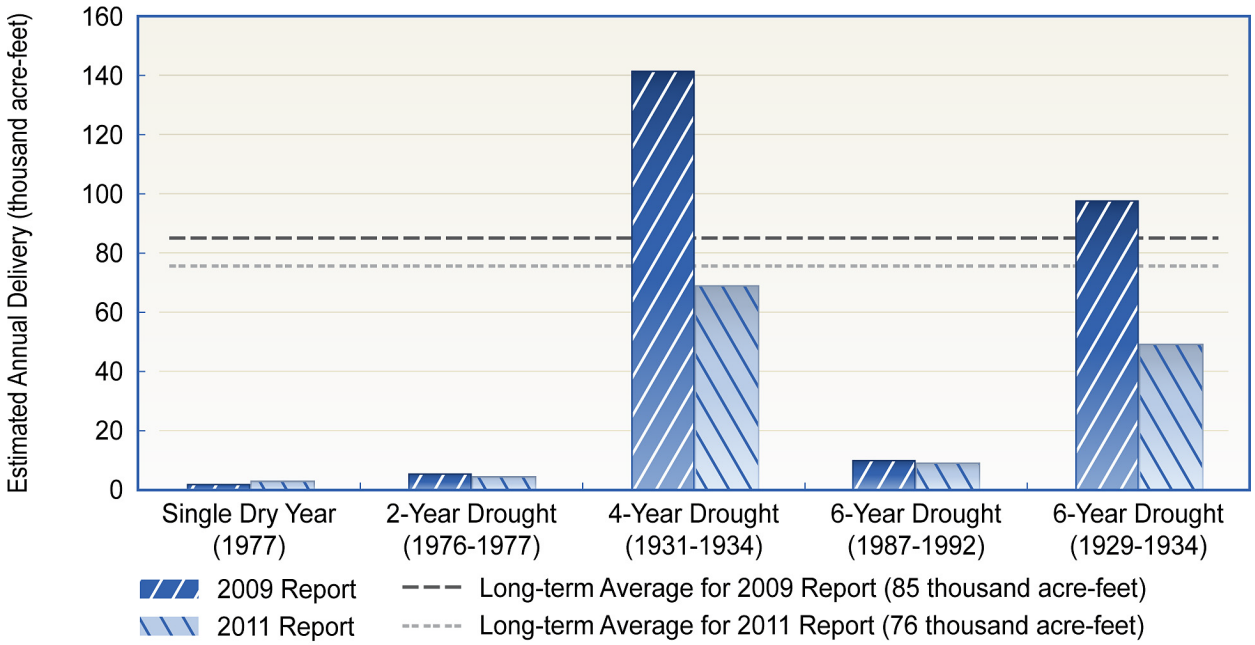


Figure 6-12. Estimated Average and Dry-Period Deliveries of SWP Article 21 Water (Existing Conditions)

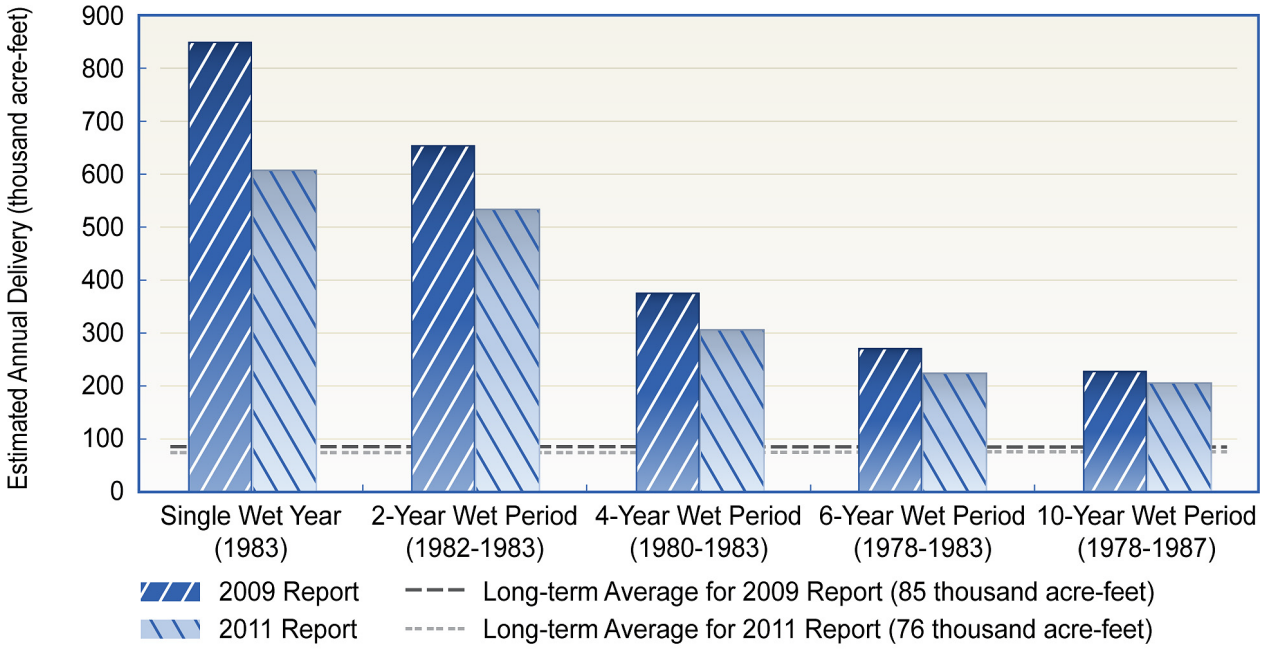


Figure 6-13. Estimated Average and Wet-Period Deliveries of SWP Article 21 Water (Existing Conditions)

Report. However, current estimates of minimum deliveries are slightly larger, leading to an overall smaller range of possible SWP Article 21 deliveries (a range of 2,708 taf/year calculated for the 2011 Report versus 2,850 taf/year for the 2009 Report).

Overall, estimated deliveries of SWP Article 21 water generally declined between the 2009 and 2011 Reports. The estimated likelihood of annual deliveries being greater than 20 taf is higher in the 2009 Report than the 2011 Report (29% versus 26%). Conversely, the likelihood annual deliveries will be 20 taf or less is 74% for the 2011 Report and 71% for the 2009 Report.

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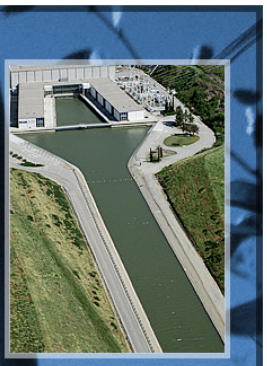
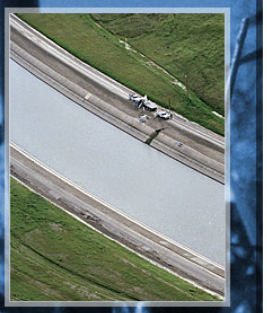
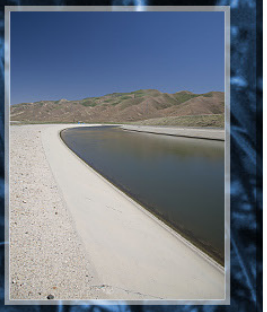
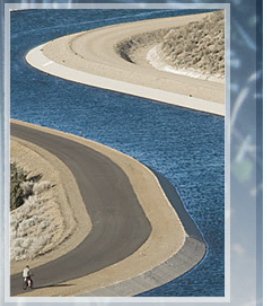
Chapter 7

Future SWP Water Delivery Reliability (2031)









This chapter presents estimates of the SWP's delivery reliability for conditions 20 years in the future (2031). These estimates reflect hydrologic changes that could result from climate change, but they incorporate the same requirements that are assumed under existing conditions, including the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) biological opinions (BOs).

This chapter also compares these estimates of future conditions with the future-condition results presented in the *State Water Project Delivery Reliability Report 2009* (2009 Report) for the year 2029.

As described in Chapter 6, "Existing SWP Water Delivery Reliability (2011)," the discussions of SWP water delivery reliability in this *State Water Project Delivery Reliability Report 2011* (2011 Report) are presented in a different format than the results presented in previous SWP delivery reliability reports. For consistency with previous reports, a tabular summary of the modeling results for the future conditions scenario is presented in the technical addendum to this report. The technical addendum also contains distribution curves of annual delivery probability (i.e., exceedence plots) to visually show the estimated percentage of years in which a given annual delivery is equaled or exceeded.

Future Demand for Delta Water

Demand levels for the SWP water users in this report are derived from historical data and information from the SWP contractors themselves. The 2031 level of development (i.e., the level of water use in the source areas from which the water supply originates) is based on the projected assumptions for land use for that year, and is assumed to be representative of future conditions for the purposes of this 2011 Report.

SWP Table A Water Demands

Future demands for SWP Table A water, as calculated for this 2011 Report, are assumed to be the maximum possible annual amount of 4,133 thousand acre-feet (taf). There is no assumed variation in demand as a result of different annual precipitation and runoff conditions; it is assumed that by 2031, the maximum amount of SWP Table A water will be requested every year. As a reminder, 4,133 taf/year is the maximum Delta SWP Table A amount.

The SWP Table A water demands under future conditions as presented in the 2009 Report are also assumed to be the maximum amount of 4,133 taf/year.

SWP Article 21 Water Demands

The assumed future demands for SWP Article 21 water are the same as those assumed for existing conditions (see Chapter 6, "Existing SWP Water Delivery Reliability [2011]"). Relative to the future SWP Article 21 water demands estimated for the 2009 Report, the current estimates of monthly demands for SWP Article 21 water under future conditions are 212 taf lower from July through October in normal water years.

The estimated reduction in future-conditions demand for SWP Article 21 water in this 2011 Report relative to the 2009 Report is the result of discussions with DWR's Operations and Maintenance staff and State Water Contractors staff, and it represents their best estimates of current and future practices. The SWP Article 21 water demands used in the 2009 Report, on the other hand, match the demands assumed in the studies conducted for the 2008 USFWS BO and 2009 NMFS BO, and those demands capture the upper boundary of the potential impact of SWP Article 21 exports on the Delta ecosystem. This assumption reflects a condition in which SWP contractors are able to use essentially any available SWP Article 21 water when capacity for moving that water exists in the SWP delivery system.

Estimates of Future SWP Deliveries

When modeling water supply deliveries 20 years in the future, the unknowns are considerable and many assumptions must be made. As was assumed for existing conditions (see Chapter 6), modeling of SWP deliveries for 2031 take into account current Delta water quality regulations and the requirements of the USFWS and NMFS BOs. Climate change as well as changes to water uses in the upstream watersheds (i.e., source watersheds) are also taken into account when modeling water supply deliveries under future conditions. Additional discussion of how the modeling of SWP water delivery reliability is adjusted to account for climate change is provided in Chapter 4, "Factors that Affect Water Delivery Reliability."

One of the most important assumptions when modeling SWP water delivery under future conditions is that the rules and facilities related to Delta conveyance will remain at the status quo. That is, in the future-conditions scenario, no new facilities to convey water through or around the Delta are assumed to be in place because no new programs have been sufficiently developed that can be assumed with certainty.

Future Deliveries of SWP Table A Water

Figure 7-1 presents the annual average, maximum, and minimum estimates of SWP Table A water deliveries from the Delta for future conditions, as calculated for the 2009 and 2011 Reports. The SWP Table A water deliveries under future conditions are similar between the 2009 and 2011 Reports, with estimated average and minimum annual deliveries decreasing by 1% and 3%, respectively. The estimated maximum future annual delivery of SWP Table A water presented in this 2011 Report is 64 taf (2%) greater than the corresponding future delivery estimated for the 2009 Report. The changes between the 2009 Report and the 2011 Report can be attributed primarily to updates in the modeling assumptions made based on discussions with State Water Contractors staff and DWR's Operations and Control Office. The maximum possible delivery of SWP Table A water, 4,133 taf/year, is not reached under future conditions.

The estimated likelihood that a given amount of SWP Table A water will be delivered under future conditions is presented in Figure 7-2. Currently, there is a 70% likelihood that 2,000–3,500 taf of SWP Table A water will be delivered under the future-conditions scenario. There is a 17% likelihood of an SWP Table A water delivery of 1,000–2,000 taf, a 7% likelihood of less than 1,000

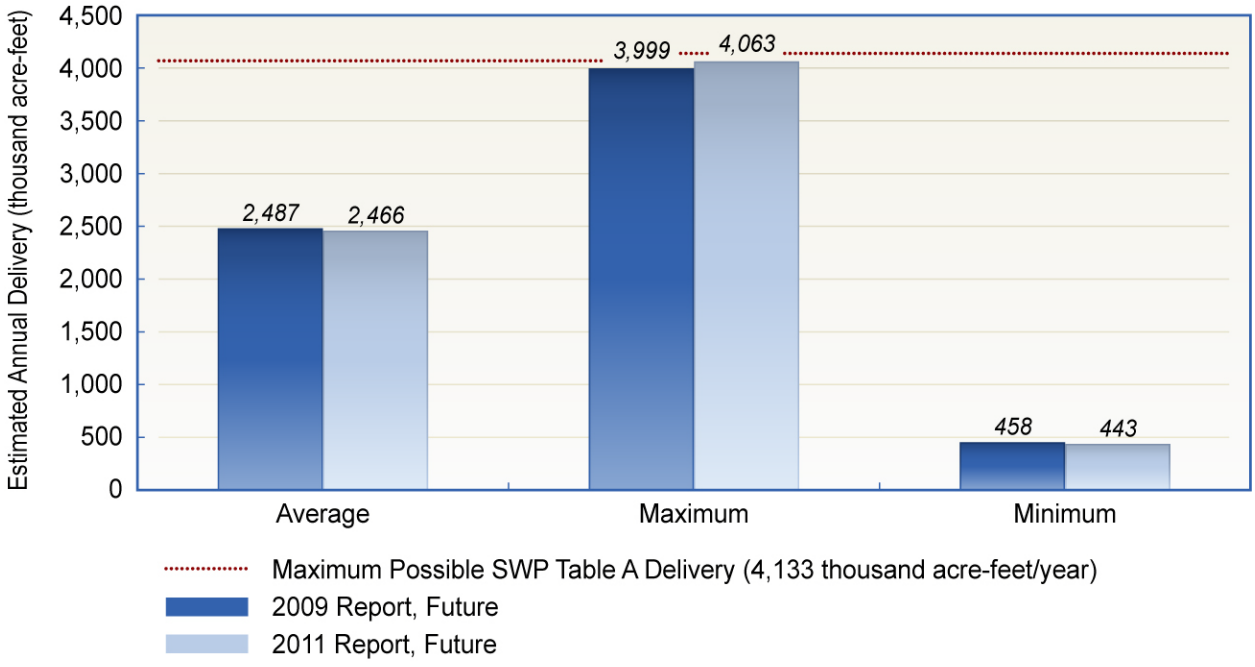


Figure 7-1. Comparison of Estimated Average, Maximum, and Minimum Deliveries of SWP Table A Water (Future Conditions)

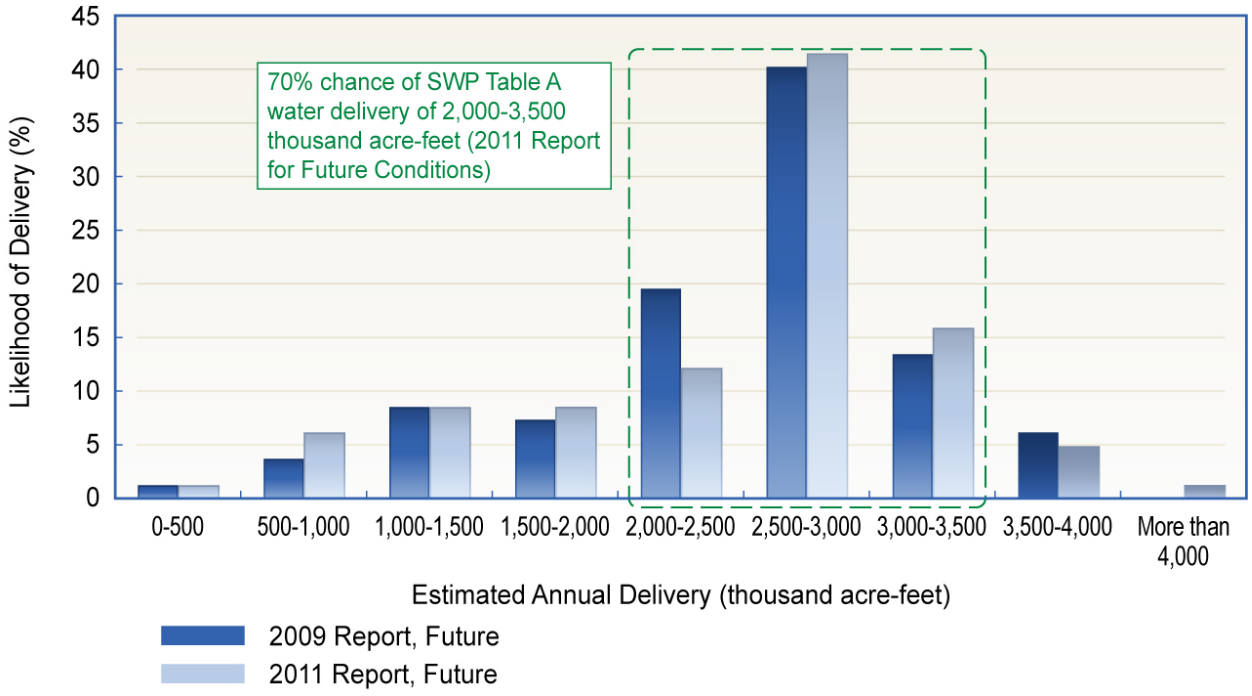


Figure 7-2. Estimated Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Future Conditions)

taf, and a 6% likelihood of more than 3,500 taf. The estimates of the likelihood that an SWP contractor will receive a specific amount of SWP Table A water under future conditions, as presented in the 2009 and 2011 Reports, are very similar.

As illustrated in Figure 7-3, the current likelihood that SWP contractors will receive larger deliveries of SWP Table A water under future conditions is similar to, although slightly higher than, the likelihood of larger future deliveries forecasted in the 2009 Report. For example, as estimated for this 2011 Report, there is a 22% likelihood that a contractor will receive more than 3,000 taf under future conditions, while the 2009 Report estimates a 20% likelihood that a contractor will receive more than 3,000 taf.

Dry-Year Deliveries of SWP Table A Water under Future Conditions

Figure 7-4 presents estimates of future SWP Table A water deliveries during possible drought conditions and compares them with the corresponding delivery estimates calculated for the 2009 Report. Drought scenarios for future conditions in this 2011 Report are modeled using the historical drought-period precipitation and runoff patterns from 1922–2003 as a reference; future 2031 conditions (e.g., land use, climate change) are also accounted for in the modeling.

The results of modeling future conditions under potential drought-year scenarios indicate that estimated dry-year SWP deliveries can be expected to range between 443 and 1,457 taf/year. This is a 41% to 82% decrease in SWP Table A water deliveries from the average estimated future delivery calculated for this report.

Figure 7-4 shows that estimates of future-conditions deliveries of SWP Table A water during dry periods are consistently less than the estimates of future deliveries presented in the 2009 Report by 15–114 taf/year (2% to 8% less). For example, the current estimate of SWP Table A water that will be delivered in the 6-year drought scenario (1929–1934) is approximately 114 taf (8%) less than the corresponding delivery estimate in the 2009 Report for that future-conditions drought scenario.

Wet-Year Deliveries of SWP Table A Water under Future Conditions

Figure 7-5 presents estimates of future SWP Table A water deliveries during a wet year and compares them with the corresponding delivery estimates calculated for the 2009 Report. Wet periods were modeled for this 2011 Report using historical precipitation and runoff patterns from 1922–2003 as a reference; 2031 future conditions were also accounted for in the modeling.

The results of modeling future conditions for potential wet periods indicate that estimated SWP Table A water deliveries during wet years can be expected to range between 2,972 and 4,063 taf/year. This is a 21% to 65% increase in SWP Table A water deliveries from the average estimated delivery under future conditions calculated for this report.

Deliveries of SWP Table A water under future conditions, as estimated for this report, are just slightly lower (by 2–5 taf) for the 4-, 6-, and 10-year wet-period scenarios than the estimates of such deliveries presented in the 2009 Report. Deliveries of SWP Table A water under future conditions are higher for the other wet-period scenarios (i.e., the single-wet-year and 2-year wet-period scenarios), with the largest increase being for the single wet year (a 2% increase relative to the corresponding delivery estimated for the 2009 Report).

SWP Article 21 Water Deliveries under Future Conditions

Estimated deliveries of SWP Article 21 water under future conditions vary not only by year, depending on the precipitation and runoff, but also by month. In the spring, summer, and early fall months (May through October), deliveries of SWP Article 21 water under future conditions are estimated to be low, with a maximum of

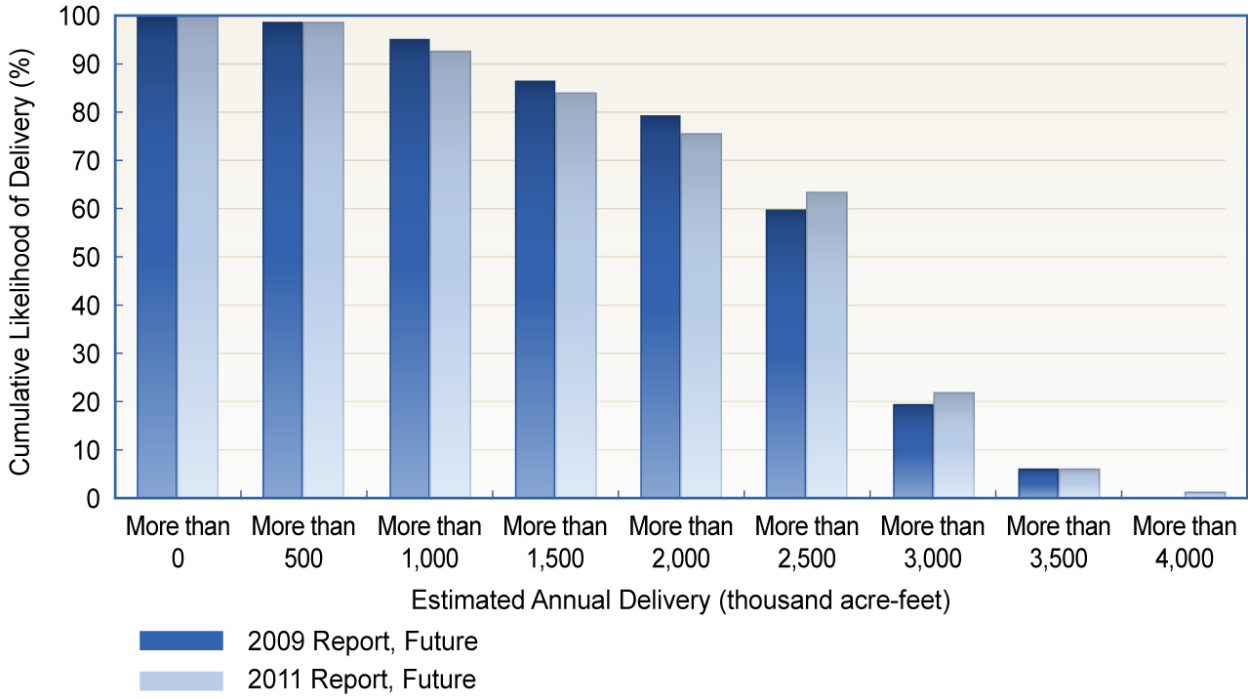


Figure 7-3. Estimated Cumulative Likelihood of SWP Table A Water Deliveries, by Increments of 500 Thousand Acre-Feet (Future Conditions)

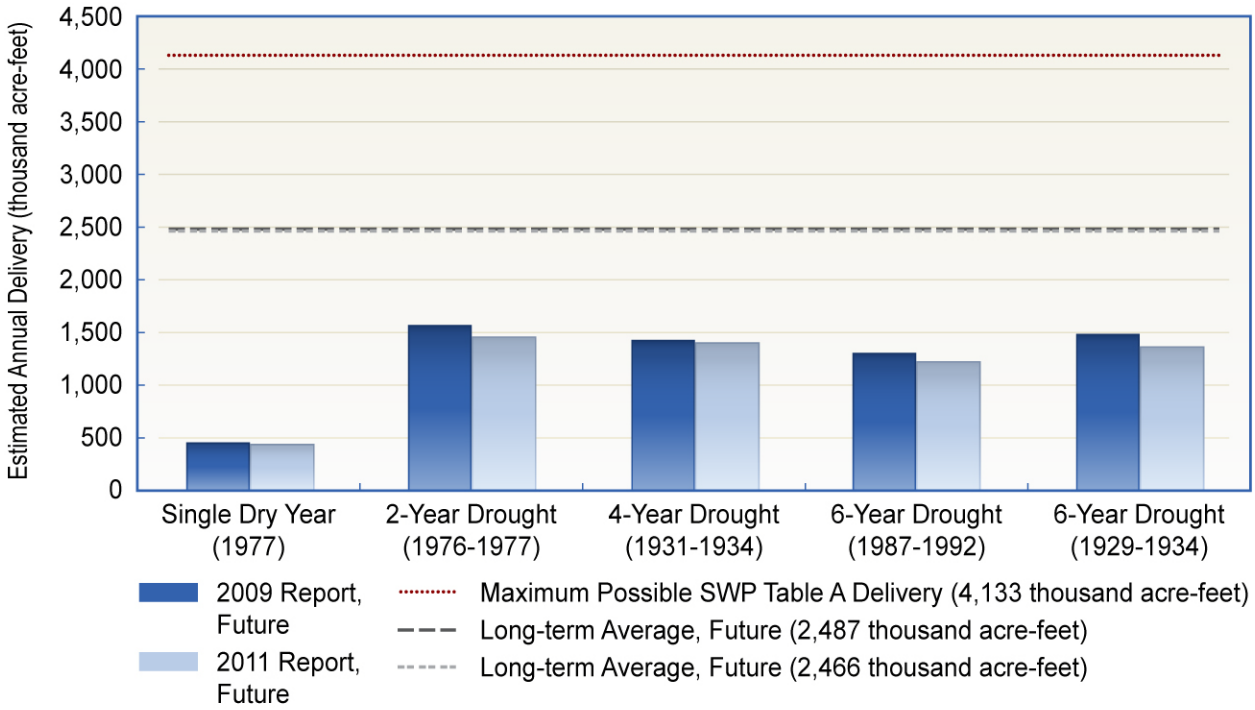


Figure 7-4. Estimated Average and Dry-Period SWP Table A Water Deliveries (Future Conditions)

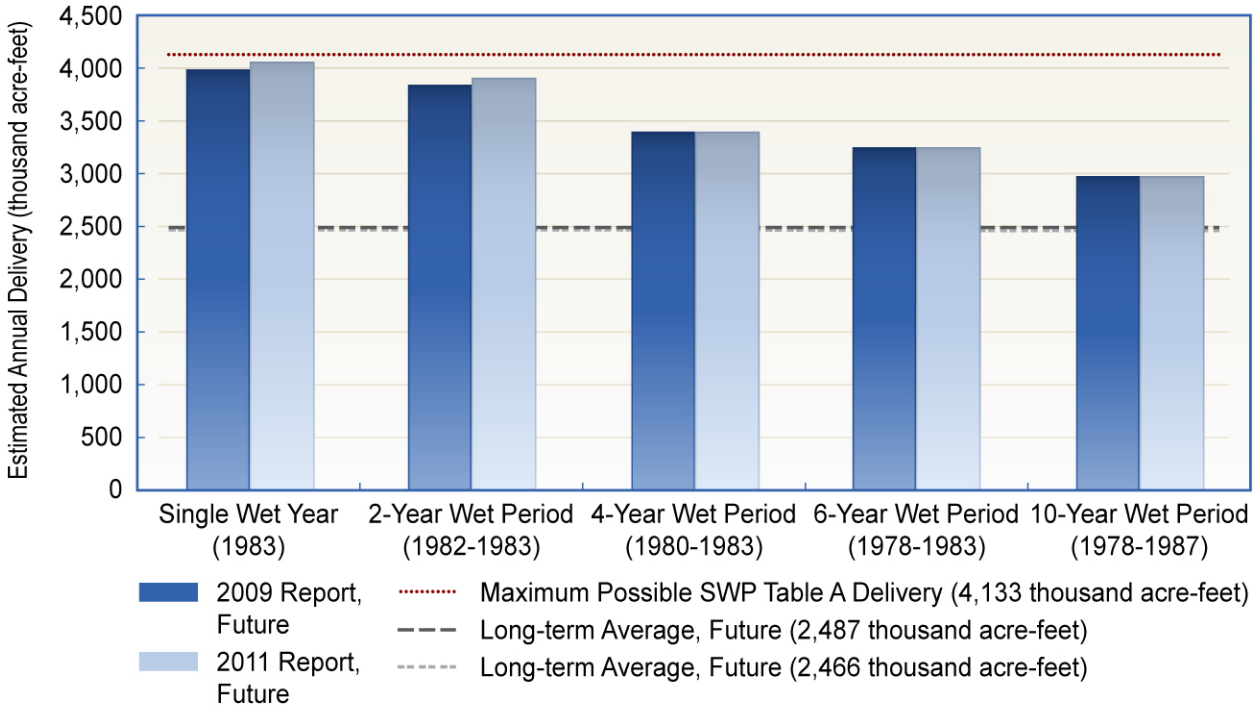


Figure 7-5. Estimated Average and Wet-Period SWP Table A Water Deliveries (Future Conditions)

approximately 10 taf/month and a minimum of 0 taf/month. From November through April, maximum estimated future deliveries of SWP Article 21 water can be as high as 251 taf and as low as 0 taf in a given month; however, water deliveries average in the range of 2–22 taf. The estimated range of monthly deliveries of SWP Article 21 water is displayed in Figure 7-6.

The estimated likelihood that a given amount of SWP Article 21 water will be delivered under future conditions is presented in Figure 7-7. Currently, there is a 22% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under future conditions, and a 78% likelihood that 20 taf/year or less will be delivered.

To compare these results to the results from the 2009 Report, the likelihood of larger deliveries of SWP Article 21 water declined in the current update. For example, the 2009 Report estimated a 28% likelihood that more than 20 taf/year of SWP Article 21 water will be delivered under future conditions, compared to a 22% likelihood estimated for this 2011 Report. Thus, larger future SWP Article 21 water deliveries were estimated to be more likely by the 2009 Report than by this 2011 Report.

In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water under future conditions are generally 20 taf/year or less (72% and 78% likelihood, respectively).

Dry-Year Deliveries of SWP Article 21 Water under Future Conditions

Figure 7-8 shows the estimates of future deliveries of SWP Article 21 water during dry periods. The results of modeling future conditions for potential drought scenarios indicate that deliveries of SWP Article 21 water during dry years can be expected to range between 4 and 50 taf/year. This is a 0% to 92% decrease in Article 21 water deliveries from the average estimated future-conditions delivery calculated for this report. Although drought-period deliveries are typically less than deliveries in average years, Figure 7-8 shows that opportunities to deliver SWP Article 21 water exist even during multiyear drought periods.

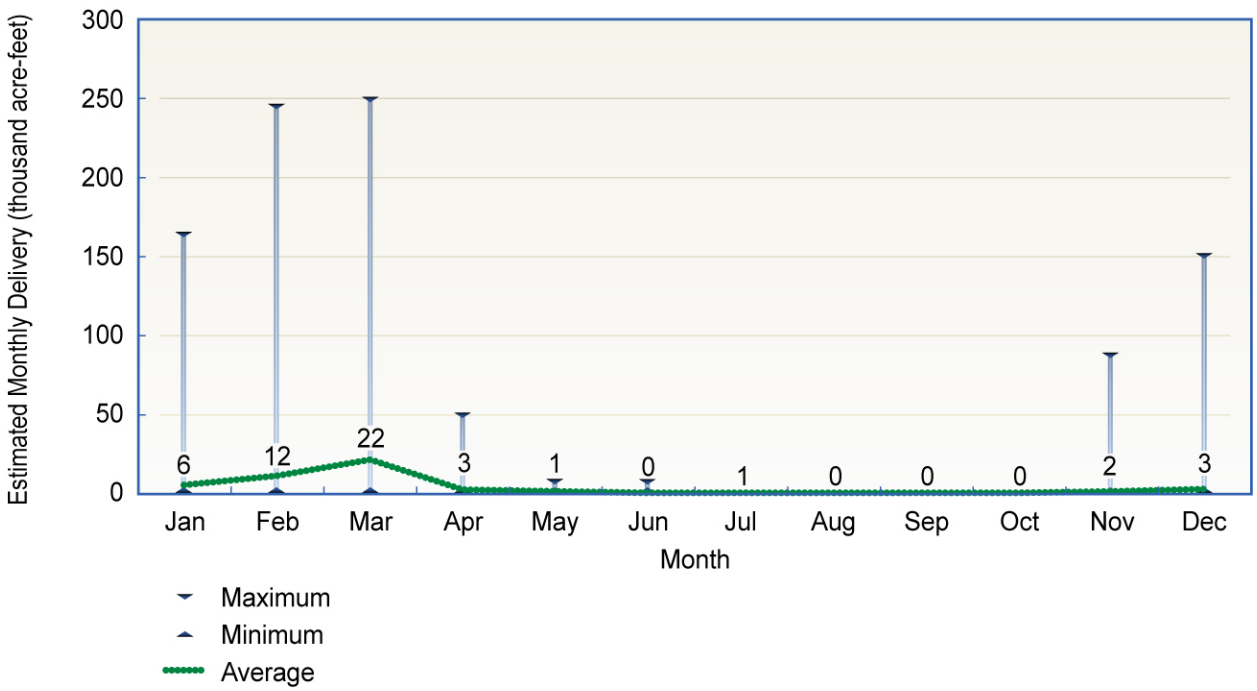


Figure 7-6. Estimated Range of Monthly Deliveries of SWP Article 21 Water (2011 Report—Future Conditions)

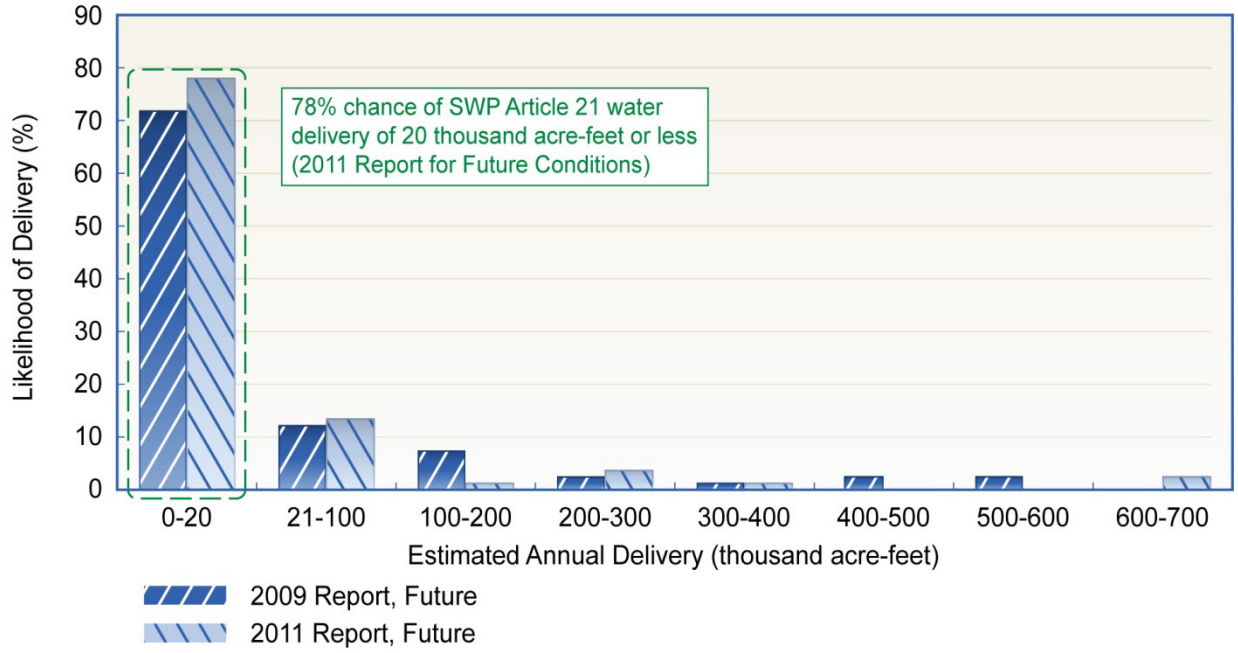


Figure 7-7. Estimated Probability of Annual Deliveries of SWP Article 21 Water (Future Conditions)

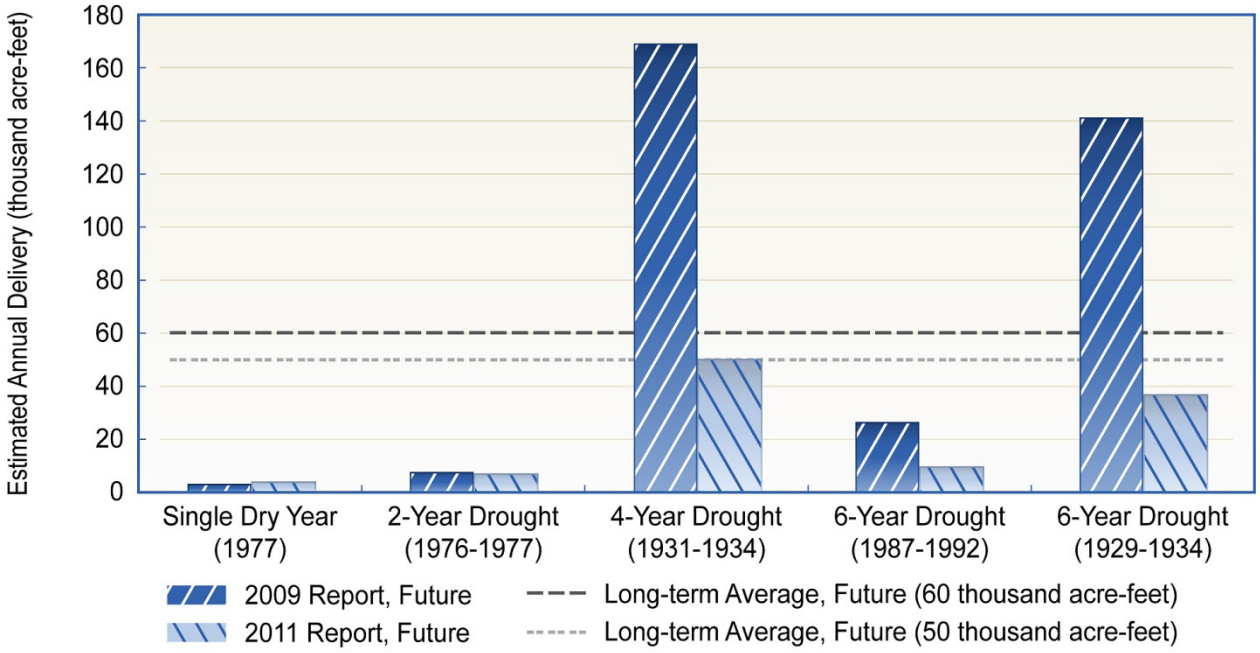


Figure 7-8. Estimated Average and Dry-Period Deliveries of SWP Article 21 Water (Future Conditions)

To compare the results for future conditions calculated for this 2011 Report to the results from the 2009 Report, deliveries during dry years in the current scenario are slightly higher in some cases, but are much lower in others (e.g., the 4-year drought scenario, for which the estimate calculated for this 2011 Report is 119 taf (70%) lower).

Wet-Year Deliveries of SWP Article 21 Water under Future Conditions

Figure 7-9 shows the estimates of deliveries of SWP Article 21 water during wet periods under future conditions. The results of modeling future conditions for potential wet periods indicate that wet-year SWP deliveries can be expected to range between 83 and 291 taf. This is a 66% to 483% increase in deliveries of SWP Article 21 water from the average estimated future-conditions delivery calculated for this report.

Deliveries of SWP Article 21 water in wet years under future conditions, as estimated for this 2011 Report, are consistently lower in wet years than the estimates of such deliveries presented in the 2009 Report. These reductions in estimated SWP Article 21 water deliveries under future conditions range from approximately 18 to 219 taf/year, with the largest reduction being for the single-wet-year scenario (a 43% decrease in deliveries).

Summary of Results

Assumptions about how the climate will have changed by 2031 and the assumption that no new facilities will be in place to move water through the Delta were used to estimate deliveries reflecting future conditions.

SWP Table A Water Demands and Deliveries

The estimated demand for deliveries of SWP Table A water under future conditions is assumed to be the maximum possible annual amount of 4,133 taf/year. The same assumption was made for future conditions in the 2009 Report.

Most of the current estimates of future deliveries of SWP Table A water are slightly lower than the delivery estimates for future conditions presented in the 2009 Report, with average deliveries at 2,466 taf/year, maximum deliveries at 4,063 taf/year, and minimum deliveries at 443 taf/year. One exception is the current estimate of maximum possible delivery, which is 64 taf higher

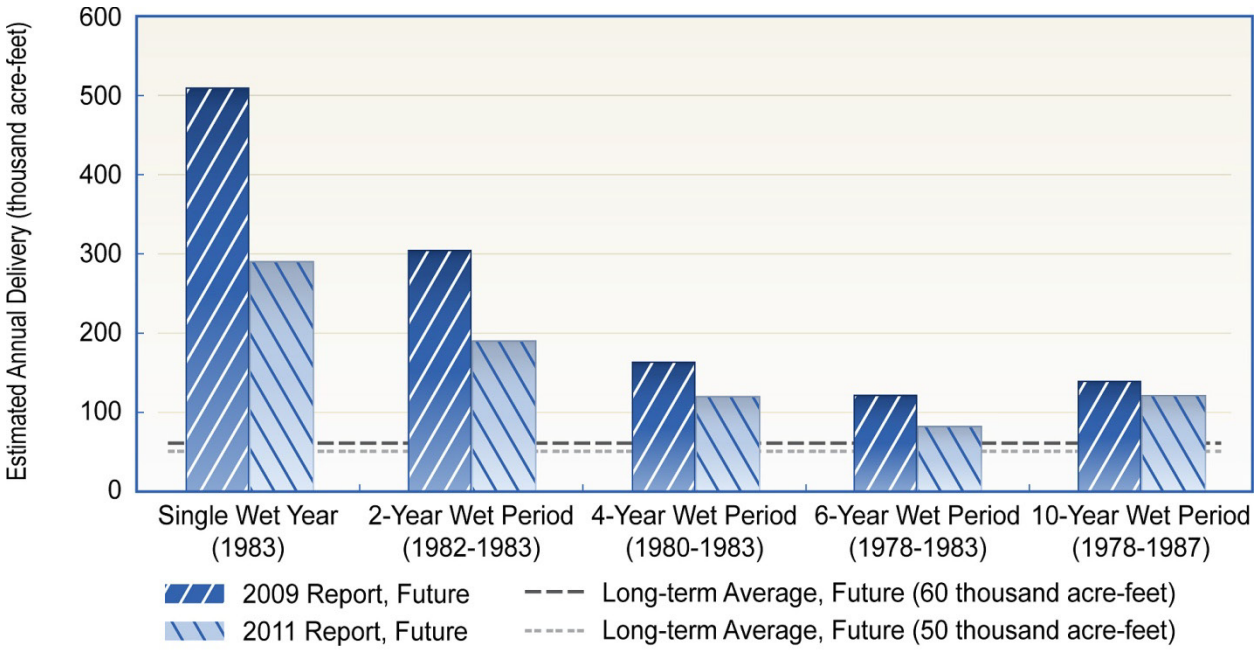


Figure 7-9. Estimated Average and Wet-Period Deliveries of SWP Article 21 Water (Future Conditions)

than the estimate from the 2009 Report. In addition, estimates of wet-year deliveries for the single-wet-year and 2-year wet-period scenarios are also higher (by 73 and 65 taf/year, respectively) than the estimates from the 2009 Report. During dry-period scenarios, this 2011 Report estimates delivery of less water (a reduction of 15–114 taf/year) under future conditions than was estimated for the 2009 Report.

The likelihood that an SWP contractor will receive larger SWP Table A water deliveries under future conditions is generally similar under both the 2009 and 2011 Report scenarios, or is only slightly higher as calculated for this 2011 Report. (For example, based on current calculations, there is a 22% likelihood of receiving a Table A water delivery of more than 3,000 taf, compared to a 20% likelihood as calculated for the 2009 Report.)

SWP Article 21 Water Demands and Deliveries

The current estimate of annual demand for SWP Article 21 water under future conditions is 200–600 taf lower than the estimate of future demand presented in the 2009 Report. Even though the future demands estimated for this 2011 Report are lower than those previously estimated, they are still very high, indicating an assumed strong desire for additional supply in the future.

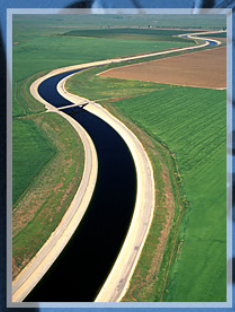
Most of the current estimates of future deliveries of SWP Article 21 water are lower than the delivery estimates for future conditions presented in the 2009 Report. The nature of SWP Article 21 water deliveries is sporadic. Deliveries estimated for this 2011 Report are estimated to typically be very small, averaging 0–22 taf/month. SWP Article 21 water deliveries are very small between May and October, with maximum deliveries ranging from 1 to 10 taf/month; however, they are estimated to be larger between November and April, with a maximum monthly delivery of 251 taf.

Current estimates of wet-period deliveries of SWP Article 21 water under future conditions are lower by 18–219 taf/year than the estimates of such deliveries presented in the 2009 Report. In addition, current estimates of Article 21 water deliveries in some future drought scenarios are

substantially lower (by 17–119 taf/year) than the corresponding estimates presented in the 2009 Report. However, in other future drought scenarios, the deliveries of SWP Article 21 water estimated for this 2011 Report are very similar to the corresponding estimates presented in the 2009 Report (by approximately 1 taf/year).

Overall, the estimated likelihood of larger Article 21 deliveries under future conditions is greater in the 2009 Report than in this 2011 Report, with a 28% chance of receiving an annual Article 21 delivery of more than 20 taf, compared to a 22% likelihood estimated for this 2011 Report. In both the 2009 and 2011 Reports, however, estimated deliveries of SWP Article 21 water under future conditions are generally 20 taf/year or less (72% and 78% likelihood, respectively).

Glossary



acre-foot The volume of water (about 325,900 gallons) that would cover an area of 1 acre to a depth of 1 foot. This is enough water to meet the annual needs of one to two households.

agricultural water supplier As defined by the California Water Code, a public or private supplier that provides water to 2,000 or more irrigated acres per year for agricultural purposes or serves 2,000 or more acres of agricultural land. This can be a water district that directly supplies water to farmers or a contractor that sells water to the water district.

annual Delta exports The total amount of water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP) in 1 year.

appropriative water rights Rights allowing a user to divert surface water for beneficial use. The user must first have obtained a permit from the State Water Resources Control Board, unless the appropriative water right predates 1914.

Article 21 water Surplus water that a contractor can receive in addition to its allocated Table A water. This water is only available if several conditions are met: (1) excess water is flowing through the Delta; (2) the contractor can use the surplus water or store it in the contractor's own system; and (3) delivering this water will not interfere with Table A allocations, other SWP deliveries, or SWP operations.

biological opinion A determination by the U.S. Fish and Wildlife Service or National Marine Fisheries Service on whether a proposed federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of designated "critical habitat." If jeopardy is determined, certain actions are required to be taken to protect the species of concern.

CALSIM II A computer model, jointly developed by DWR and the U.S. Bureau of Reclamation, that simulates existing and future operations of the SWP and CVP. The hydrology used by this model was developed by adjusting the historical flow record (1922–2003) to account for the influence of changes in land uses and regulation of upstream flows.

Among the SWP's facilities are more than 700 miles of canals that distribute water to urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California.

carryover deliveries See "carryover water."

carryover water A water supply "savings account" for SWP water that is allocated to an SWP contractor in a given year, but not used by the end of the year. Carryover water is stored in the SWP's share of San Luis Reservoir, when space is available, for the contractor to use in the following year.

Central Valley Project (CVP) Operated by the U.S. Bureau of Reclamation, the CVP is a water storage and delivery system consisting of 20 dams and reservoirs (including Shasta, Folsom, and New Melones Reservoirs), 11 power plants, and 500 miles of major canals. CVP facilities reach some 400 miles from Redding to Bakersfield and deliver about 7 million acre-feet of water for agricultural, urban, and wildlife use.

cubic feet per second (cfs) A measure of the rate at which a river of stream is flowing. The flow is 1 cfs if a cubic foot (about 7.48 gallons) of water passes a specific point in 1 second. A flow of 1 cubic foot per second for a day is approximately 2 acre-feet.

Delta exports Water transferred ("exported") to areas south of the Delta through the Harvey O. Banks Pumping Plant (SWP) and the C. W. "Bill" Jones Pumping Plant (CVP). The SWP's Delta exports are the primary component of total SWP deliveries.

Delta inflow The combined total of water flowing into the Delta from the Sacramento River, San Joaquin River, and other rivers and waterways.

exceedence curve For the SWP, a chart showing SWP delivery probability (especially for Table A water)—specifically, the likelihood that SWP contractors will receive a certain volume of water under current or future conditions.

existing-conditions scenario For the SWP delivery reliability reports, the results of modeling for SWP Delta exports or deliveries for the year the report was written.

future-conditions scenario For the SWP delivery reliability reports, the results of modeling for SWP Delta exports or SWP deliveries for 20 years into the future.

incidental take permit A permit issued by the U.S. Fish and Wildlife Service, under Section 10 of the federal Endangered Species Act, to private nonfederal entities undertaking otherwise lawful projects that might result in the "take" of an endangered or threatened species. In California, take may be authorized under Section 2081 of the California Fish and Game Code through issuance of either an incidental take permit or a consistency determination. The California Department of Fish and Game is authorized to accept a federal biological opinion as the take authorization for a State-listed species when a species is listed under both the federal and California Endangered Species Acts.

riparian water rights Water rights that apply to lands traversed by or bordering on a natural

watercourse. No permit is required to use this water, which must be used on riparian (adjacent) land and cannot be stored for later use.

State Water Project (SWP) Operated by DWR, a water storage and delivery system of 33 storage facilities, 701 miles of open canals and pipelines, five hydroelectric power plants, and 20 pumping plants that extends for more than 600 miles in California. Its main purpose is to store and distribute water to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California. The SWP provides supplemental water to approximately 25 million Californians (two-thirds of California's population) and about 750,000 acres of irrigated farmland. Water deliveries have ranged from 1.4 million acre-feet in a dry year to more than 4.0 million acre-feet in a wet year.

SWP contractors Twenty-nine entities that receive water for agricultural or municipal and industrial uses through the SWP. Each contractor has executed a long-term water supply contract with DWR. Also sometimes referred to as "State Water Contractors."

Table A water (Table A amounts) The maximum amount of SWP water that the State agreed to make available to an SWP contractor for delivery during the year. Table A amounts determine the maximum water a contractor may request each year from DWR. The State and SWP contractors also use Table A amounts to serve as a basis for allocation of some SWP costs among the contractors.

turnback pool water Allocated water that individual SWP contractors may offer early in the year for other SWP contractors to buy later at a set price.

urban water supplier As defined by the California Water Code, a public or private supplier that provides water for municipal use directly or indirectly to more than 3,000 customers or supplies more than 3,000 acre-feet of water in a year. This can be a water district that provides the water to local residents for use at home or work, or a contractor that distributes or sells water to that water district.

Water Rights Decision 1641 (D-1641) A regulatory decision issued by the State Water Resources Control Board in 1999 (updated in 2000) to implement the 1995 *Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta*. D-1641 assigned primary responsibility for meeting many of the Delta's water quality objectives to the SWP and CVP, thus placing certain limits on SWP and CVP operations.

water year In reports on surface water supply, the period extending from October 1 through September 30 of the following calendar year. The water year refers to the September year. For example, October 1, 2010, through September 30, 2011 is the 2011 water year.

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DWR. *See* California Department of Water Resources.

DWR and DFG. *See* California Department of Water Resources and California Department of Fish and Game.

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Appendix A

Historical SWP Delivery Tables for 2001–2010

The State Water Project (SWP) contracts define several types of SWP water available for delivery to contractors under specific circumstances: Table A water, Article 21 water, turnback pool water, and carryover water. (See the glossary for definitions of these terms; Chapter 3 describes each type of SWP water in greater detail.) Many SWP contractors frequently use Article 21, turnback pool, and carryover water to increase or decrease the amount of water available to them under SWP Table A.

The Sacramento River Index, previously referred to as the "4 River Index" or "4 Basin Index," is the sum of the unimpaired runoff of four rivers: the Sacramento River above Bend Bridge near Red Bluff, Feather River inflow to Lake Oroville Reservoir, Yuba River at Smartville, and American River inflow to Folsom Lake. The five water year types used in the Sacramento River Index are as follows:

Sacramento River Index	Water Year Type
1	Wet
2	Above Normal
3	Below Normal
4	Dry
5	Critical

Tables A-1 through A-10 list annual historical deliveries by SWP water type for each contractor for 2001 through 2010. The Sacramento River Index and water year type are presented along with the delivery results for each year. Similar delivery tables are presented for years 1999–2008 in the *State Water Project Delivery Reliability Report 2009*. SWP contractors are listed in Tables A-1 through A-10 by location, as follows:

- *Upper Feather River Area:* Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District (FCWCD)
- *North Bay Area:* Napa County FCWCD and Solano County Water Agency (WA)
- *South Bay Area:* Alameda County FCWCD, Zone 7; Alameda County Water District (WD); and Santa Clara Valley WD
- *San Joaquin Valley Area:* Dudley Ridge WD, Empire West Side Irrigation District (ID), Kern County WA, Kings County, Oak Flat WD, and Tulare Lake Basin Water Storage District (WSD)

- *Central Coastal Area:* San Luis Obispo County FCWCD and Santa Barbara County FCWCD
- *Southern California Area:* Antelope Valley–East Kern WA, Castaic Lake WA, Coachella Valley WD, Crestline–Lake Arrowhead WA, Desert Water Agency, Little Rock Creek ID, Metropolitan WD of Southern California, Mojave WA, Palmdale WD, San Bernardino County Municipal Water District (MWD), San Gabriel Valley MWD, San Gorgonio Pass WA, and Ventura County Flood Control District (FCD)

Table A-1. Historical State Water Project Deliveries, 2001
Sacramento River Index = 4, Water Year Type = Dry

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	513	–	–	–	513
	Yuba City	1,065	–	–	–	1,065
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	4,293	996	1,723	82	7,094
	Solano County WA	17,756	2,304	1,021	–	21,081
South Bay Area	Alameda County FCWCD, Zone 7	22,307	–	5,990	308	28,605
	Alameda County WD	13,695	10	4,192	107	18,004
	Santa Clara Valley WD	35,689	–	12,233	–	47,922
San Joaquin Valley Area	Dudley Ridge WD	18,467	933	6,815	347	26,562
	Empire West Side ID	–	253	1,107	–	1,360
	Kern County WA	363,204	23,233	92,052	6,502	484,991
	Kings County	1,560	–	–	–	1,560
	Oak Flat WD	2,089	–	101	22	2,212
	Tulare Lake Basin WSD	40,830	8,755	7,889	769	58,243
Central Coastal Area	San Luis Obispo County FCWCD	4,184	–	–	99	4,283
	Santa Barbara County FCWCD	14,285	396	–	296	14,977
Southern California Area	Antelope Valley–East Kern WA	45,071	–	–	899	45,970
	Castaic Lake WA (+Rch 31A, 5 & 7)	30,471	850	–	618	31,939
	Coachella Valley WD	9,009	–	–	91	9,100
	Crestline–Lake Arrowhead WA	1,057	–	–	–	1,057
	Desert WA	14,859	–	–	151	15,010
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	686,545	10,415	200,000	7,949	904,909
	Mojave WA	4,433	–	–	–	4,433
	Palmdale WD	8,170	–	2,257	–	10,427
	San Bernardino Valley MWD	26,488	–	–	–	26,488
	San Gabriel Valley MWD	6,534	–	–	–	6,534
	San Gorgonio Pass WA	–	–	–	–	–
	Ventura County FCD	1,850	–	–	–	1,850
	Total SWP Deliveries	**1,374,424**	**48,145**	**335,380**	**18,240**	**1,776,189**
	Total Deliveries from the Delta**	**1,372,846**	**48,145**	**335,380**	**18,240**	**1,774,611**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-2. Historical State Water Project Deliveries, 2002
Sacramento River Index = 4, Water Year Type = Dry

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	419	–	–	–	419
	Yuba City	1,181	–	–	–	1,181
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	2,022	827	3,743	283	6,875
	Solano County WA	28,223	2,242	–	–	30,465
South Bay Area	Alameda County FCWCD, Zone 7	40,707	1,484	8,113	556	50,860
	Alameda County WD	24,250	83	2,331	862	27,526
	Santa Clara Valley WD	55,896	202	3,311	2,053	61,462
San Joaquin Valley Area	Dudley Ridge WD	38,688	1,861	1,994	1,177	43,720
	Empire West Side ID	1,278	26	101	–	1,405
	Kern County WA	670,884	21,951	15,680	20,543	729,058
	Kings County	2,800	–	–	54	2,854
	Oak Flat WD	3,841	50	134	76	4,101
	Tulare Lake Basin WSD	73,785	3,749	5,385	2,289	85,208
Central Coastal Area	San Luis Obispo County FCWCD	4,355	–	–	–	4,355
	Santa Barbara County FCWCD	24,166	436	3,455	324	28,381
Southern California Area	Antelope Valley–East Kern WA	53,907	–	3,256	1,008	58,171
	Castaic Lake WA (+Rch 31A, 5 & 7)	61,880	280	6,657	–	68,817
	Coachella Valley WD	16,170	111	–	474	16,755
	Crestline–Lake Arrowhead WA	2,189	–	–	–	2,189
	Desert WA	26,670	189	–	781	27,640
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	1,273,205	9,624	97,940	14,335	1,395,104
	Mojave WA	4,346	–	–	–	4,346
	Palmdale WD	8,359	–	–	437	8,796
	San Bernardino Valley MWD	68,268	–	3,801	–	72,069
	San Gabriel Valley MWD	18,353	–	4,698		23,051
	San Gorgonio Pass WA	–	–	–	–	–
	Ventura County FCD	4,998	–	–	–	4,998
	Total SWP Deliveries	**2,510,840**	**43,115**	**160,599**	**45,252**	**2,759,806**
	Total Deliveries from the Delta**	**2,509,240**	**43,115**	**160,599**	**45,252**	**2,758,206**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-3. Historical State Water Project Deliveries, 2003
Sacramento River Index = 2, Water Year Type = Above Normal

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	551	–	–	–	551
	Yuba City	1,324	–	–	–	1,324
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	6,026	376	1,055	180	7,637
	Solano County WA	25,135	2,280	1,918	–	29,333
South Bay Area	Alameda County FCWCD, Zone 7	30,695	–	13,099	656	44,450
	Alameda County WD	31,086	–	5,150	354	36,590
	Santa Clara Valley WD	90,620	936	14,104	841	106,501
San Joaquin Valley Area	Dudley Ridge WD	49,723	1,928	1,452	482	53,585
	Empire West Side ID	1,074	175	187	–	1,436
	Kern County WA	841,697	27,891	22,380	8,419	900,387
	Kings County	3,600	58	–	34	3,692
	Oak Flat WD	4,059	19	140	48	4,266
	Tulare Lake Basin WSD	94,376	6,243	4,284	938	105,841
Central Coastal Area	San Luis Obispo County FCWCD	4,417	36	–	–	4,453
	Santa Barbara County FCWCD	24,312	339	2,274	43	26,968
Southern California Area	Antelope Valley–East Kern WA	52,730	–	7,049	250	60,029
	Castaic Lake WA (+Rch 31A, 5 & 7)	49,895	991	4,760	90	55,736
	Coachella Valley WD	14,045	204	–	194	14,443
	Crestline–Lake Arrowhead WA	1,563	–	–	–	1,563
	Desert WA	23,168	330	–	321	23,819
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	1,550,356	17,622	134,845	16,920	1,719,743
	Mojave WA	10,907	–	3,528	–	14,435
	Palmdale WD	9,701	–	1,846	–	11,547
	San Bernardino Valley MWD	25,371	200	1,844	–	27,415
	San Gabriel Valley MWD	13,034	200	–	–	13,234
	San Gorgonio Pass WA	116	–	–	–	116
	Ventura County FCD	5,000	–	–	–	5,000
	Total SWP Deliveries	**2,964,581**	**59,828**	**219,915**	**29,770**	**3,274,094**
	Total Deliveries from the Delta**	**2,962,706**	**59,828**	**219,915**	**29,770**	**3,272,219**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-4. Historical State Water Project Deliveries, 2004
Sacramento River Index = 3, Water Year Type = Below Normal

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	1,440	–	–	–	1,440
	Yuba City	1,434	–	–	–	1,434
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	5,030	1,450	1,602	52	8,134
	Solano County WA	17,991	7,787	47	–	25,825
South Bay Area	Alameda County FCWCD, Zone 7	39,898	–	11,466	–	51,364
	Alameda County WD	20,956	–	6,714	214	27,884
	Santa Clara Valley WD	52,867	2,983	–	508	56,358
San Joaquin Valley Area	Dudley Ridge WD	36,377	7,393	2,185	291	46,246
	Empire West Side ID	1,310	626	1,626	–	3,562
	Kern County WA	640,190	86,513	40,120	5,075	771,898
	Kings County	5,850	3,157	–	46	9,053
	Oak Flat WD	4,324	–	276	29	4,629
	Tulare Lake Basin WSD	58,575	15,299	5,638	489	80,001
Central Coastal Area	San Luis Obispo County FCWCD	4,096	69	–	–	4,165
	Santa Barbara County FCWCD	29,566	–	–	122	29,688
Southern California Area	Antelope Valley–East Kern WA	50,532	–	9,199	–	59,731
	Castaic Lake WA (+Rch 31A, 5 & 7)	46,358	1,618	35,785	–	83,761
	Coachella Valley WD	8,631	–	6,745	89	15,465
	Crestline–Lake Arrowhead WA	2,006	–	–	–	2,006
	Desert WA	9,966	–	11,122	102	21,190
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	1,195,807	91,601	215,000	10,223	1,512,631
	Mojave WA	11,176	–	–	–	11,176
	Palmdale WD	10,549	–	1,613	–	12,162
	San Bernardino Valley MWD	35,522	–	20,631	–	56,153
	San Gabriel Valley MWD	15,600	–	–	–	15,600
	San Gorgonio Pass WA	841	–	–	–	841
	Ventura County FCD	5,250	–	–	–	5,250
	Total SWP Deliveries	**2,312,142**	**218,496**	**369,769**	**17,240**	**2,917,647**
	Total Deliveries from the Delta**	**2,309,268**	**218,496**	**369,769**	**17,240**	**2,914,773**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-5. Historical State Water Project Deliveries, 2005
Sacramento River Index = 2, Water Year Type = Above Normal

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	527	–	–	–	527
	Yuba City	1,894	–	–	–	1,894
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	5,322	606	1,741	–	7,669
	Solano County WA	24,515	10,421	83	–	35,019
South Bay Area	Alameda County FCWCD, Zone 7	38,388	–	7,849	275	46,512
	Alameda County WD	36,469	846	6,341	943	44,599
	Santa Clara Valley WD	89,476	6,298	11,899	342	108,015
San Joaquin Valley Area	Dudley Ridge WD	51,609	28,197	821	1,286	81,913
	Empire West Side ID	1,448	1,799	587	–	3,834
	Kern County WA	893,439	453,078	9,851	22,397	1,378,765
	Kings County	8,100	11,504	–	202	19,806
	Oak Flat WD	4,067	–	–	127	4,194
	Tulare Lake Basin WSD	86,604	47,267	3,973	2,158	140,002
Central Coastal Area	San Luis Obispo County FCWCD	4,006	245	–	–	4,251
	Santa Barbara County FCWCD	22,981	–	–	155	23,136
Southern California Area	Antelope Valley–East Kern WA	57,205	–	2,626	–	59,831
	Castaic Lake WA (+Rch 31A, 5 & 7)	54,303	2,451	2,702	–	59,456
	Coachella Valley WD	26,984	–	12,819	2,716	42,519
	Crestline–Lake Arrowhead WA	807	–	–	–	807
	Desert WA	33,168	–	14,799	1,122	49,089
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California**	1,269,291	168,300	106,032	6,530	1,550,153
	Mojave WA	10,360	–	1,201	–	11,561
	Palmdale WD	10,174	–	1,538	–	11,712
	San Bernardino Valley MWD	31,211	56	283	–	31,550
	San Gabriel Valley MWD	10,500	–	–	–	10,500
	San Gorgonio Pass WA	655	15	–	22	692
	Ventura County FCD	1,665	–	–	–	1,665
	Total SWP Deliveries	**2,775,168**	**731,083**	**185,145**	**38,275**	**3,729,671**
	Total Deliveries from the Delta* **	**2,772,747**	**731,083**	**185,145**	**38,275**	**3,727,250**

* Table A = State Water Project Analysis Office current-year deliveries + Next year's Article 14B carryover water

** Metropolitan Water District of Southern California 2005 Table A deliveries have been updated to reflect the addition of Article 14B carryover water that was previously omitted.

*** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-6. Historical State Water Project Deliveries, 2006
Sacramento River Index = 1, Water Year Type = Wet

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	468	–	–	–	468
	Yuba City	4,148	1,194	–	–	5,342
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	7,312	300	172	–	7,784
	Solano County WA	12,070	18,195	390	–	30,655
South Bay Area	Alameda County FCWCD, Zone 7	50,785	–	2,252	491	53,528
	Alameda County WD	–	2,375	1,331	39,373	43,079
	Santa Clara Valley WD	47,344	26,769	524	–	74,637
San Joaquin Valley Area	Dudley Ridge WD	55,343	18,515	–	1,068	74,926
	Empire West Side ID	1,500	1,124	658	–	3,282
	Kern County WA	961,882	256,634	5,418	18,610	1,242,544
	Kings County	8,991	366	–	173	9,530
	Oak Flat WD	4,118	–	17	107	4,242
	Tulare Lake Basin WSD	48,361	59,424	–	1,787	109,572
Central Coastal Area	San Luis Obispo County FCWCD	3,382	827	–	–	4,209
	Santa Barbara County FCWCD	19,255	4,020	–	–	23,275
Southern California Area	Antelope Valley–East Kern WA	76,623	–	3,761	–	80,384
	Castaic Lake WA (+Rch 31A, 5 & 7)	56,758	2,089	3,905	–	62,752
	Coachella Valley WD	121,100	–	–	–	121,100
	Crestline–Lake Arrowhead WA	257	–	–	–	257
	Desert WA	50,000	–	–	–	50,000
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	1,103,538	238,478	136,424	11,638	1,490,078
	Mojave WA	32,496	–	1,518	–	34,014
	Palmdale WD	10,374	1,653	335	130	12,492
	San Bernardino Valley MWD	31,902	–	3,427	–	35,329
	San Gabriel Valley MWD	13,524	–	–	–	13,524
	San Gorgonio Pass WA	4,262	–	–	–	4,262
	Ventura County FCD	1,850	–	–	–	1,850
	Total SWP Deliveries	**2,727,643**	**631,963**	**160,132**	**73,377**	**3,593,115**
	Total Deliveries from the Delta**	**2,723,027**	**630,769**	**160,132**	**73,377**	**3,587,305**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-7. Historical State Water Project Deliveries, 2007
Sacramento River Index = 4, Water Year Type = Dry

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	956	–	–	–	956
	Yuba City	2,327	–	–	–	2,327
	Plumas County FCWCD	–	–	–	–	–
North Bay Area	Napa County FCWCD	6,362	3,597	998	–	10,957
	Solano County WA	14,892	8,217	1,822	–	24,931
South Bay Area	Alameda County FCWCD, Zone 7	32,972	912	2,895	378	37,157
	Alameda County WD	16,541	550	2,103	197	19,391
	Santa Clara Valley WD	38,812	4,840	8,161	469	52,282
San Joaquin Valley Area	Dudley Ridge WD	28,457	8,953	2,000	269	39,679
	Empire West Side ID	397	1,172	515	–	2,084
	Kern County WA	592,423	99,861	19,645	4,683	716,612
	Kings County	4,924	474	–	43	5,441
	Oak Flat WD	3,430	41	69	27	3,567
	Tulare Lake Basin WSD	57,272	12,902	16,459	450	87,083
Central Coastal Area	San Luis Obispo County FCWCD	3,752	24	–	–	3,776
	Santa Barbara County FCWCD	24,760	1,070	1,390	–	27,220
Southern California Area	Antelope Valley–East Kern WA	74,459	–	4,364	–	78,823
	Castaic Lake WA (+Rch 31A, 5 & 7)	44,974	–	4,216	–	49,190
	Coachella Valley WD	72,660	–	–	568	73,228
	Crestline–Lake Arrowhead WA	1,768	–	–	–	1,768
	Desert WA	30,000	–	–	234	30,234
	Little Rock Creek ID	1,380	–	–	–	1,380
	Metropolitan WD of Southern California	1,146,900	166,517	28,098	8,962	1,350,477
	Mojave WA	45,372	–	737	–	46,109
	Palmdale WD	12,780	843	985	100	14,708
	San Bernardino Valley MWD	57,116	–	–	–	57,116
	San Gabriel Valley MWD	10,000	–	–	–	10,000
	San Gorgonio Pass WA	4,009	–	–	–	4,009
	Ventura County FCD	3,000	–	–	–	3,000
	Total SWP Deliveries	**2,332,695**	**309,973**	**94,457**	**16,380**	**2,753,505**
	Total Deliveries from the Delta**	**2,329,412**	**309,973**	**94,457**	**16,380**	**2,750,222**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-8. Historical State Water Project Deliveries, 2008
Sacramento River Index = 5, Water Year Type = Critical

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	9,436	–	–	–	9,436
	Yuba City	1,923	–	–	–	1,923
	Plumas County FCWCD	243	–	–	–	243
North Bay Area	Napa County FCWCD	3,636	1,219	7,363	21	12,239
	Solano County WA	10,436	1,510	12,389	–	24,335
South Bay Area	Alameda County FCWCD, Zone 7	13,633	–	15,400	–	29,033
	Alameda County WD	4,206	–	8,659	37	12,902
	Santa Clara Valley WD	11,133	–	21,188	88	32,409
San Joaquin Valley Area	Dudley Ridge WD	12,260	–	5,949	51	18,260
	Empire West Side ID		–	915	–	915
	Kern County WA	271,636	–	6,815	883	279,334
	Kings County	3,187	–	–	8	3,195
	Oak Flat WD	1,929	–	–	5	1,934
	Tulare Lake Basin WSD	32,302	–	281	85	32,668
Central Coastal Area	San Luis Obispo County FCWCD	8,512	–	–	–	8,512
	Santa Barbara County FCWCD	11,311	–	2,532	40	13,883
Southern California Area	Antelope Valley–East Kern WA	31,082	–	10,381	125	41,588
	Castaic Lake WA (+Rch 31A, 5 & 7)	18,710	–	12,146	–	30,856
	Coachella Valley WD	42,385	–	–	107	42,492
	Crestline–Lake Arrowhead WA	1,159	–	689	–	1,848
	Desert WA	17,500	–	–	44	17,544
	Little Rock Creek ID	805	–	–	–	805
	Metropolitan WD of Southern California	654,304	–	–	1,689	655,993
	Mojave WA	26,288	–	108	–	26,396
	Palmdale WD	4,226	–	–	19	4,245
	San Bernardino Valley MWD	30,562	–	4,444	–	35,006
	San Gabriel Valley MWD	10,080	–	–	–	10,080
	San Gorgonio Pass WA	5,419	–	300	–	5,719
	Ventura County FCD	3,798	–	–	–	3,798
	Total SWP Deliveries	**1,242,101**	**2,729**	**109,559**	**3,202**	**1,357,591**
	Total Deliveries from the Delta**	**1,230,499**	**2,729**	**109,559**	**3,202**	**1,345,989**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-9. Historical State Water Project Deliveries, 2009
Sacramento River Index = 4, Water Year Type = Dry

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	581	–	–	–	581
	Yuba City	2,114	–	–	–	2,114
	Plumas County FCWCD	200	–	–	–	200
North Bay Area	Napa County FCWCD	2,723	1,588	4,475	13	8,799
	Solano County WA	8,618	4,444	3,123	–	16,185
South Bay Area	Alameda County FCWCD, Zone 7	12,093	–	14,584	–	26,677
	Alameda County WD	5,911	–	10,494	8	16,413
	Santa Clara Valley WD	9,188	–	23,867	54	33,109
San Joaquin Valley Area	Dudley Ridge WD	13,185	–	7,810	32	21,027
	Empire West Side ID	1,034	–	–	–	1,034
	Kern County WA	226,631	–	56,367	544	283,542
	Kings County	3,153	–	70	5	3,228
	Oak Flat WD	1,825	–	66	1	1,892
	Tulare Lake Basin WSD	35,160	–	1,271	52	36,483
Central Coastal Area	San Luis Obispo County FCWCD	3,799	–	–	–	3,799
	Santa Barbara County FCWCD	12,746	–	4,523	25	17,294
Southern California Area	Antelope Valley–East Kern WA	14,419	–	18,408	77	32,904
	Castaic Lake WA (+Rch 31A, 5 & 7)	14,858	–	9,529	52	24,439
	Coachella Valley WD	40,845	–	–	66	40,911
	Crestline–Lake Arrowhead WA	–	–	893	–	893
	Desert WA	16,865	–	–	27	16,892
	Little Rock Creek ID	–	–	–	–	–
	Metropolitan WD of Southern California	544,304	–	10,721	1,042	556,067
	Mojave WA	21,312	–	242	–	21,554
	Palmdale WD	12,095	–	3,229	–	15,324
	San Bernardino Valley MWD	26,785	–	9,348	–	36,133
	San Gabriel Valley MWD	11,516	–	–	–	11,516
	San Gorgonio Pass WA	5,612	–	480	–	6,092
	Ventura County FCD	3,890	–	–	–	3,890
	Total SWP Deliveries	**1,051,462**	**6,032**	**179,500**	**1,998**	**1,238,992**
	Total Deliveries from the Delta**	**1,048,567**	**6,032**	**179,500**	**1,998**	**1,236,097**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)

Table A-10. Historical State Water Project Deliveries, 2010
Sacramento River Index = 3, Water Year Type = Below Normal

Contractor Location	SWP Contractor	SWP Water Type Delivered (acre-feet)				Total SWP Deliveries (acre-feet)
		Table A*	Article 21	Carryover	Turnback	
Upper Feather River Area	Butte County	807	–	–	–	807
	Yuba City	2,331	–	–	–	2,331
	Plumas County FCWCD	243	–	–	–	243
North Bay Area	Napa County FCWCD	7,275	2,207	2,845	90	12,417
	Solano County WA	16,793	5,298	3,661	–	25,752
South Bay Area	Alameda County FCWCD, Zone 7	28,694	–	12,756	249	41,699
	Alameda County WD	11,668	–	10,889	14	22,571
	Santa Clara Valley WD	6,068	–	10,741	34	16,843
San Joaquin Valley Area	Dudley Ridge WD	15,833	–	9,752	156	25,741
	Empire West Side ID	380	–	–	–	380
	Kern County WA	375,426	–	55,419	3,044	433,889
	Kings County	4,094	–	522	29	4,645
	Oak Flat WD	2,412	–	455	18	2,885
	Tulare Lake Basin WSD	35,985	–	3,199	275	39,459
Central Coastal Area	San Luis Obispo County FCWCD	3,480	–	277	–	3,757
	Santa Barbara County FCWCD	8,640	–	7,134	140	15,914
Southern California Area	Antelope Valley–East Kern WA	36,462	–	20,813	438	57,713
	Castaic Lake WA (+Rch 31A, 5 & 7)	37,054	–	14,501	295	51,850
	Coachella Valley WD	69,175	–	7,595	429	77,199
	Crestline–Lake Arrowhead WA	357	–	–	–	357
	Desert WA	27,875	–	3,135	173	31,183
	Little Rock Creek ID		–	–	–	–
	Metropolitan WD of Southern California	817,765	–	67,783	5,922	891,470
	Mojave WA	35,241	–	20	–	35,261
	Palmdale WD	5,585	–	5,325	59	10,969
	San Bernardino Valley MWD	37,733	–	11,273	–	49,006
	San Gabriel Valley MWD	19,180	–	–	–	19,180
	San Gorgonio Pass WA	6,626	–	–	6	6,632
	Ventura County FCD	4,075	–	–	–	4,075
	Total SWP Deliveries	**1,617,257**	**7,505**	**248,095**	**11,371**	**1,884,228**
	Total Deliveries from the Delta**	**1,613,876**	**7,505**	**248,095**	**11,371**	**1,880,847**

* Table A = State Water Project Analysis Office current-year deliveries + next year's Article 14B carryover water

** Total deliveries from the Delta = Total SWP deliveries – Feather River Service Area deliveries (Butte County, Yuba City, and Plumas County Flood Control and Water Conservation District)