Water Available for Replenishment

Appendix B. State Water Project and Central Valley Project: Reliability and Availability

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Contents

Overview

Water development projects in California have recognized, and often leveraged, the relationship between surface water and groundwater. This includes conjunctive management operations and the development of projects to store and deliver surface water throughout the state. Large surface water storage and conveyance projects, like the State Water Project (SWP) and federal Central Valley Project (CVP), were developed, in part, to make water available to areas that were over-reliant upon groundwater to meet demands for a growing population and economy. In many areas, local agencies use supplies from the CVP, SWP, and other locally developed supplies conjunctively to rely more upon surface water when available, and more upon groundwater during periods of limited surface water availability.

The water budget for many groundwater basins includes water deliveries from the federal CVP and California's SWP. As groundwater sustainability agencies (GSAs) develop water budgets and groundwater sustainability plans (GSPs), there is a need to understand the reliability of SWP and CVP deliveries and how reliability has changed through time. Additionally, there are several projects being studied that have the potential to make additional water available from the CVP/SWP, such as Sites Reservoir, an off-stream storage facility in northern California, and the California Water Fix, which increases flexibility in Delta conveyance. These new projects may provide future additional water supplies that could affect the water budgets of GSAs that receive supplies from the new projects.

This appendix provides historical information and context for the SWP and CVP as background to estimates of the current reliability of surface water deliveries for both projects. GSAs that receive deliveries from either project will find this information useful for developing water budgets. This appendix also includes a summary of results from surface water project investigations that quantify the additional surface water supplies that may be developed by enhancing California's water infrastructure. This appendix also includes information on how water supplies, particularly inflow to major reservoirs, may be affected by climate change.

Background on the Central Valley Project and State Water Project

The CVP was developed to protect the Central Valley from both water shortages and floods. Construction of the CVP began in 1937 with the Contra Costa Canal, and now includes 20 dams and reservoirs, over 500 miles of conveyance facilities, and approximately 13 million acre-feet (maf) of storage capacity (United States Bureau of Reclamation 2016). The SWP was authorized by the California legislature in 1951 as a water storage and supply system to capture and store rainfall and snowmelt runoff in Northern California for delivery to areas of need throughout the state. The SWP facilities include 30 dams, 20 reservoirs with an approximate capacity of 5.8 maf, 29 pumping and generating plants, and approximately 700 miles of aqueducts (California Department of Water Resources 2016).

Figure B-1 shows the timeline for the completion of the CVP and SWP surface storage projects and other local, non-project reservoirs. The United States Bureau of Reclamation (Reclamation) built the first CVP storage project, Friant Dam, in 1942. The construction of several large CVP storage projects followed in the next two decades, including: Shasta Dam (1945), Folsom Dam (1956), Trinity Dam (1962), San Luis Dam (1967 and a joint-use facility built in conjunction with the SWP), and New Melones Dam (1979). Construction of SWP storage projects spanned less than two decades, starting in 1961 with Frenchman Dam in the upper Feather River watershed. Oroville Dam and Reservoir, the largest SWP storage project, was completed in 1968. There have been no major CVP or SWP storage projects constructed after the completion of New Melones Dam in 1979. There have been local storage projects constructed more recently; notably, Diamond Valley Reservoir, with a capacity of 800,000 acre-feet, was constructed by Metropolitan Water District of Southern California in 2000, and the capacity of Los Vaqueros Reservoir, completed in 1998, was expanded by 60,000 acre-feet to a current capacity of 160,000 acre-feet by the Contra Costa Water District in 2012.

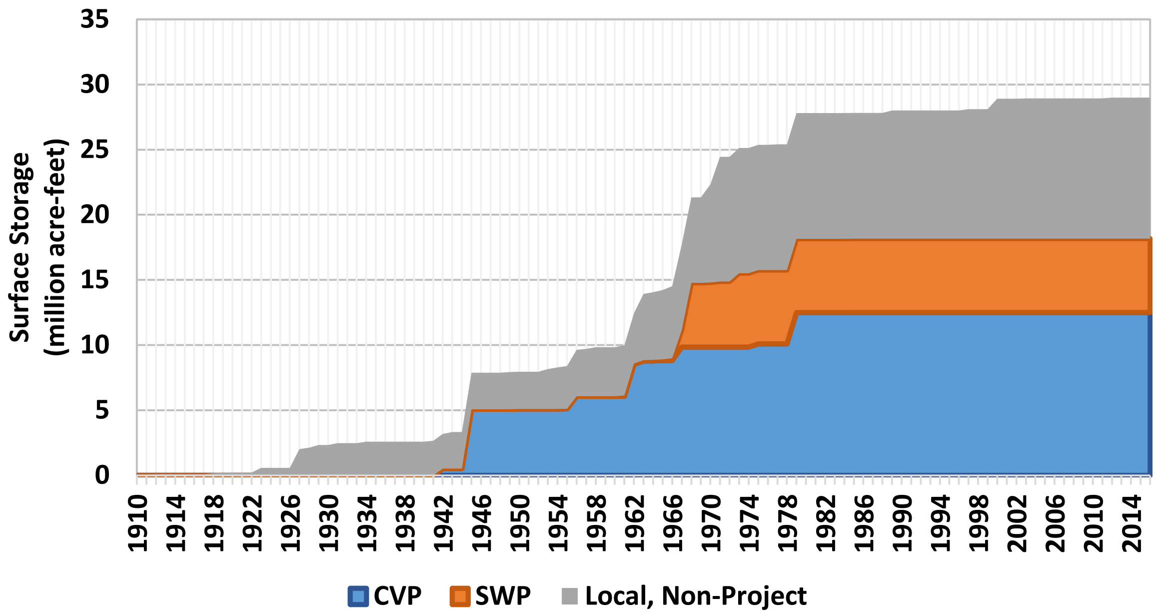


Figure B-1: Timeline of Major CVP, SWP, and Local Surface Storage Projects

The CVP and SWP were developed to address two important issues common to water resources management in California, the timing and location of precipitation. In other words, surface water availability. California's Mediterranean climate creates a wet winter season when water is available and demands are typically low, and a dry summer period when water is less available but demands are higher. The timing of surface water availability creates the need to capture and store water when it is available for delivery during times when demands are high. In California, water is stored primarily in aquifers, mountain snowpack, and surface water reservoirs. Both the CVP and SWP include numerous surface water reservoirs that store water when it is available for use during times when it is needed.

The second water management issue addressed by construction of the CVP and SWP is the proximity of available water supplies to water demand locations. The climate and geography of California contributed to development of demands for water located far from areas of the state where more water is available. Generally, the northern parts of California receive more precipitation and therefore have more water. Fertile soils and warmer climates in the San Joaquin Valley and Tulare Lake region provide prime areas for agriculture and the associated demands for irrigation water. Additionally, the climate and coastal areas of southern California have attracted people, and the associated development resulted in significant urban demand, despite limited locally available water. CVP and SWP conveyance infrastructure, such as canals and pumps, move water from areas where it is available to areas where it is needed and used.

In addition to these general water management issues, the CVP and SWP were also constructed to address problems with the way areas of California were managing groundwater in the early 20th century. Several regions south of the Sacramento - San Joaquin River Delta (Delta) began to experience groundwater overdraft and water scarcity problems in the first few decades of the 20th century. Agricultural development in the first decades of the 20th century in the southern San Joaquin and Tulare Lake basins resulted in depletion of local groundwater and significant land subsidence, threatening 200,000 acres of farmland with reversion to desert (Department of Energy 2016). The effects of unsustainable groundwater pumping in these areas prompted the ideas of large surface water projects to divert, store, and deliver surface water to areas that were heavily reliant upon groundwater to irrigate fertile soils. Groundwater level data in Figure B-2 illustrate the steady decline, starting in 1920 and continuing until approximately 1955, for a representative well located east of the City of Fresno. In 1935 and 1937, Congress authorized the U.S. Bureau of Reclamation to construct the Friant Division of the CVP to provide surface water to these areas. By the early 1950s, the first surface water deliveries were being made and groundwater levels stabilized and began to return to levels seen 70 years earlier.

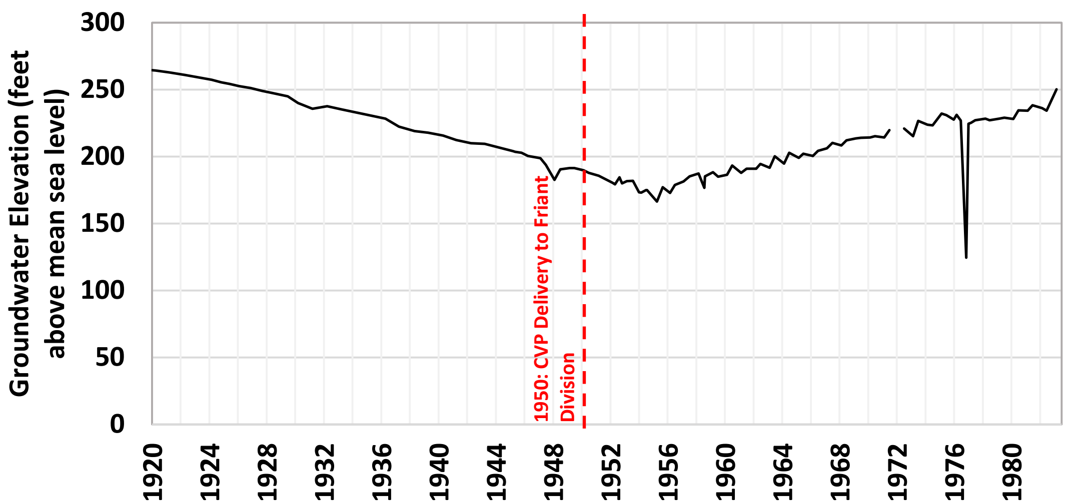


Figure B-2: Groundwater Levels at Well 13S23E30COO1M in the Kings River Basin near Fresno

A similar story unfolded in Santa Clara County. The Santa Clara region originally depended on small local rivers and groundwater for irrigation; however, increased population and industrial growth during the 1940s pushed demands beyond the locally developed water supplies and put a drain on groundwater resources (United States Geological Survey 2016). Figure B-3 shows the pattern of general decline in the groundwater levels before 1960. Land subsidence occurred during this same period of declining groundwater levels. Locally developed projects where able to slow declines for a period of time, but groundwater levels and land subsidence became issues again in the late 1950s. The recovery of the groundwater levels began with the availability of imported water supplies from the SWP through the South Bay Aqueduct. A second source of imported water was added in 1988, when CVP deliveries from the San Felipe Division began moving through the Pacheco Tunnel. Today, the Santa Clara Valley Water District operates and manages an extensive system of locally developed projects and imported supplies to keep pace with regional demands.

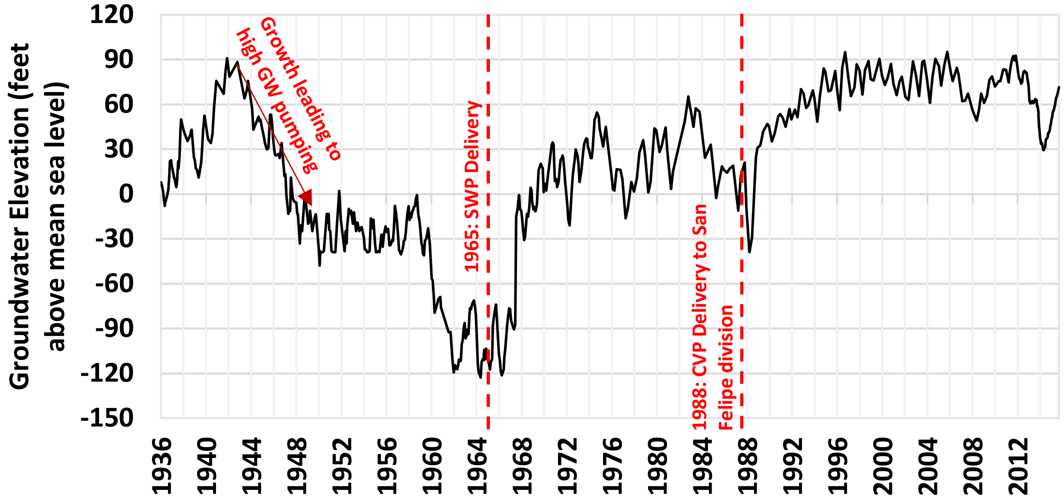


Figure B-3: Groundwater Levels at Well 07S01W25L001 in the Santa Clara Plain

While the CVP and SWP are two of the largest water projects in the world, these projects are considered by some to be unfinished when compared to their original designs. In 1961, DWR planners produced a blueprint for the state's water future called State Water Bulletin 76. This bulletin included a plan to divert water from the Eel River into the Sacramento River. Other ideas for developing storage projects on the Klamath, Mad, and Smith rivers of California's North Coast for diversion into the Sacramento River were also considered in some of the original concepts for the SWP. These proposals were later dismissed as a result of local opposition based on environmental impacts, concerns over economic feasibility, and because several of these rivers were designated as Wild and Scenic under California and federal law.

In 1977, DWR proposed construction of a 42-mile peripheral canal to bypass the Delta to move water from the Sacramento River. A decision on construction of the peripheral canal was made when voters rejected Proposition 9 (Peripheral Canal Act) in 1982. At present, the State has proposed the California WaterFix as a way to improve water supply reliability as well as protecting and enhancing the ecosystem.

Regulations Governing Operation of the CVP and SWP

As described above, the CVP and SWP were constructed over multiple decades. The demand for water, the recognition of ecosystem needs, the need to balance beneficial uses, and the resulting regulations governing SWP and CVP operations have all steadily increased through time. This section provides background on key regulations and the historical changes to regulations that continue to influence the reliability of the CVP/SWP system today.

Figure B-4 shows a timeline of key regulations that govern or affect the operation of the CVP/SWP system.

Figure B-4: Timeline of Major Regulations Affecting Operations of the CVP and SWP

State Water Resources Control Board Decision 1485

The State Water Resources Control Board (SWRCB) issued its water right Decision 1485 (D-1485) in 1978. D-1485 included the first comprehensive water operations criteria in the Delta to regulate CVP/SWP operations in order to maintain Delta water quality at levels where it would have been absent the projects. These water quality requirements were the primary regulatory requirements for CVP/SWP Delta operations for approximately two decades (Bay Delta Conservation Plan 2011).

Coordinated Operations Agreement

The Coordinated Operations Agreement (COA) was signed in 1986, establishing procedures to coordinate operations between the CVP and SWP. The COA set formulas for sharing the responsibilities for meeting D-1485 Delta standards, for other in-basin uses within the Sacramento Valley watershed, and for sharing unstored and unregulated water originating within the watershed. COA also defines several important terms, such as Delta “excess” and “balanced” conditions. As defined in COA, *Delta balanced conditions* occur when releases from upstream reservoirs and the unregulated flow downstream from the reservoirs approximately equal the water needed to meet Sacramento Valley in-basin uses, including Delta outflow, plus exports. The Delta is said to be “in balance” when CVP and SWP operators are controlling the volume of Delta outflow through the combination of upstream reservoir operations and export pumping. *Delta excess conditions* occur when upstream reservoir releases plus unregulated flows exceed Sacramento Valley in-basin uses, plus exports. Delta balanced or excess conditions are determined by agreement between CVP and SWP operators. The CVP and SWP continue to share responsibility for meeting in-basin uses, including Delta outflow, and water available for export from the Delta, based on rules established under COA.

Water Right Order 90-5

Water right order 90-5 established requirements on CVP operations of Keswick Dam, Shasta Dam, the Spring Creek Power Plant, and the Trinity River Division. These requirements are related to temperature control in the Upper Sacramento River for the protection of fishery resources, and thus require monitoring and reporting to evaluate compliance with those requirements (State Water Resources Control Board 2016).

Central Valley Project Improvement Act

The Central Valley Project Improvement Act (CVPIA) was enacted in 1992 and added the protection, restoration, and enhancement of fish and wildlife to the stated purposes of the CVP. Section 3406 (b)(2) of the CVPIA included the dedication of 800,000 acre-feet of CVP water toward the restoration of wetlands, protection of water quality in the Delta, flows for fish, and other related environmental uses. Additionally, CVPIA included providing water for State, federal and privately-managed wetlands.

1995 Bay-Delta Water Quality Control Plan and State Water Resources Control Board Decision 1641

The 1995 Bay-Delta Water Quality Control Plan (WQCP) was issued by SWRCB under the federal Clean Water Act. The plan required the CVP and SWP to meet flow objectives to maintain salinity conditions in the Delta, and included other actions to support fish and wildlife habitat. The SWRCB implemented the WQCP in Decision 1641. D-1641 included water quality standards for municipal, industrial, agricultural, and environmental protection. D-1641 also included minimum flows on the Sacramento and San Joaquin rivers, Delta outflow requirements for habitat protection, and a limitation on CVP/SWP Delta exports based on the ratio between inflow and exports.

Trinity Record of Decision

The Trinity Record of Decision was signed in 2001 and established actions to restore and maintain the anadromous fishery resources of the Trinity River. This decision addressed the concerns of decreased river flows in the Trinity River Basin caused by the Trinity River Division of the CVP. Flow criteria were prescribed for the Trinity River, which reduced the water available for diversion into the Sacramento River.

San Joaquin River Restoration Program

The San Joaquin River Restoration Program (SJRRP) is a comprehensive long-term effort to restore flows to the San Joaquin River, from Friant Dam to the confluence of the Merced River, as a result of a 2006 litigation settlement. The SJRRP would increase San Joaquin River inflows into the Delta, however, the additional restoration water reaching the Delta is protected for recapture and recirculation to CVP contractors in the Friant Division.

Consultation under the Endangered Species Act and Resulting Biological Opinions

In 2008 and 2009, the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) respectively issued two biological opinions (BiOps) that contained Reasonable and Prudent Alternatives (RPAs) for the Coordinated Long-Term Operation of the CVP and SWP. RPAs contained in the BiOps impose multiple new requirements on CVP and SWP operations in numerous areas, including reservoir operations for flow and

MAJOR RPA ACTIONS AFFECTING CVP/SWP OPERATIONS

<u>2008 USFWS BiOp:</u>

- Fall Delta Outflow requirements in Wet and Above Normal years.
- Limits on Old and Middle River reverse flows in the Delta from December through mid-June.

<u>2009 NMFS BiOp:</u>

- New temperature management requirements on the upper Sacramento River.
- Implementation of the American River Flow Management Standard and temperature management operations.
- Higher minimum flows and temperature management on the Stanislaus River.
- Additional Delta Cross Channel gate closures.
- Export limits as a ratio of San Joaquin River flow in April and May.
- Limits on Old and Middle River reverse flows from January through mid-June.
- Numerous fish passage projects and studies.

temperature management, Delta outflow, Delta Cross Channel gate closures, and restrictions on Delta exports (see box on Page 7 for more information).

In addition to changing regulations, demand for water in California has continued to increase for a variety of reasons, including dedicated water supply to wildlife refuges, increased agricultural lands in production, and increased population. These factors have increased pressure on the CVP and SWP. The annual water supply available from each project is based on contracts between the projects and individual contractors. Each year contractors are allocated a percentage of their contract volume. The current volume of water contracts for the CVP and SWP is similar to the original contract volumes; however, more contractors now take all of their annual allocation from the projects than when the CVP and SWP first began operations. Therefore, there is an increase in demand for delivered water from both the CVP and SWP than in previous decades. Increases in demand typically affect surface storage projects by increasing the average annual delivery, but decreasing dry-year water supply reliability. This occurs because higher demands and deliveries result in lower reservoir storage levels, and lower storage levels reduce reliability in years when reservoirs do not refill.

Reliability of CVP and SWP Water Supplies

An analysis was conducted to demonstrate how regulatory changes have affected the water supply reliability of contract supplies of the CVP and SWP. This analysis simulated the operation of the CVP/SWP system under the three different regulatory conditions described above: D-1485, D-1641, and the most recent BiOps. The results for D-1485 and D-1641 presented in this report are from the *Delivery Reliability Report* (2013), which was based on the CalSim II regulation studies. Results for the Biological Opinions study are from the “Existing Conditions Study” appendix within the *2015 SWP Delivery Capability Report*. All of these studies were performed using build-out demands in the CVP and SWP export service areas and with historical hydrology (i.e., no climate change). This information is provided as context to GSAs and others to understand how reliability has changed through time and to provide DWR’s best estimate of the current reliability of both projects. This information should assist GSAs in preparing water budgets that may include supplies from CVP or SWP contracts.

This analysis relies upon previously published SWP Delivery Reliability and SWP Delivery Capability reports and models from DWR’s Bay-Delta Office. DWR began publishing the delivery capability of the SWP in 2002. Previous CalSim II models were used in support of delivery capability reports, and included model code to simulate D-1485 and D-1641 conditions. Results from these models are summarized here to provide not only the current delivery capability, but also information on how the capability of the projects has changed under different regulatory settings. Additionally, information on the delivery reliability and capability of the CVP is also included. Results for the CVP are summarized from modeling conducted by DWR’s Bay-Delta Office, and may not represent the opinions of the U.S. Bureau of Reclamation.

Water Supply Reliability Metrics

Water supply reliability is a term with multiple meanings. Despite the frequent use of the term in water supply planning, there are no formal and agreed upon definitions for water supply reliability. Generally, water supply reliability is the degree to which water is available to meet demands. Water supply reliability is often calculated and reported in different ways. For example, average annual deliveries are one metric for the performance of a water project or contract. However, the use of only the average annual delivery does not provide a full understanding of reliability. Figure B-5 illustrates an example of annual water deliveries of two hypothetical projects. The average annual delivery is the same for both projects. Project A meets all demands in half of the years and provides no water in the remaining years. Project B meets half of the demand in every year. Most water supply planners recognize that the reliability of these two projects is significantly different, even if the average annual delivery is the same.

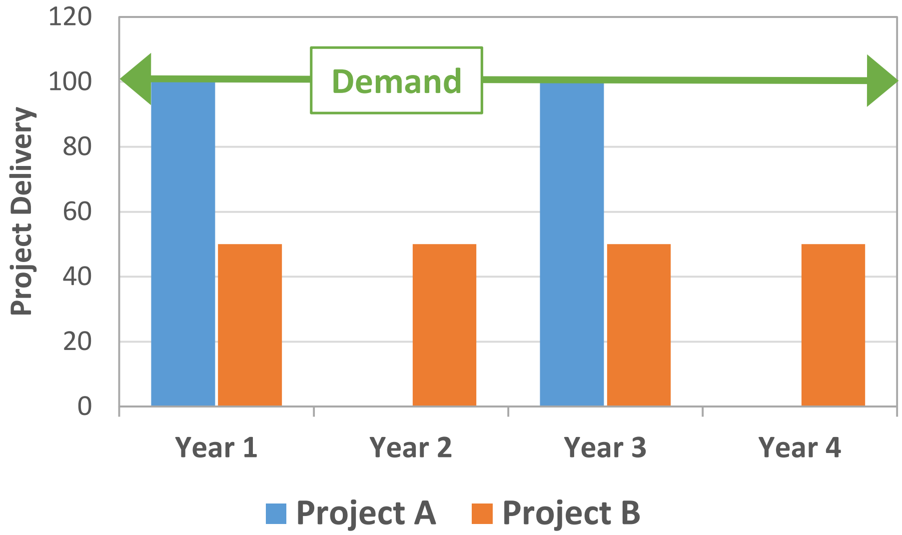


Figure B-5: Example Deliveries for Two Hypothetical Projects

As illustrated in Figure B-5, average annual delivery alone is not adequate to define the reliability of a project, particularly in California where there are frequently large variations in hydrology. Other useful metrics may include average annual delivery during a single, or multiple consecutive, dry years; deliveries during a wet year or period of wet years; or a probability distribution of deliveries over a wide range of different years and conditions.

This analysis reports similar metrics as the 2015 SWP Delivery Capability Report (2015 SWP DCR) and previous SWP Delivery Reliability Reports (California Department of Water Resources 2015b). These metrics include average annual deliveries across all years, annual deliveries during single wet and single dry years, and average annual deliveries over specific multi-year periods of both wet and dry conditions. Additionally, contract allocations to CVP and SWP contractors are presented as probability of exceedance figures and annual allocations for each year of analysis. This information is provided for GSAs whose water portfolios include CVP or SWP contracts, and need to estimate the reliability of contract supplies when developing water budgets.

Analytical Tool

Results for CVP/SWP system performance are based on modeling of the CVP/SWP system using the CalSim II model. CalSim II is a planning model designed to simulate the CVP and SWP water delivery systems while meeting regulatory requirements, including D-1641 and the most recent BiOps. CalSim uses an 82-year period of record of historical hydrology, from October of 1921 through September of 2003, for simulations. The historical hydrology includes inputs such as reservoir inflow, basin accretions and depletions, and demand estimates based on historical precipitation records. Historical hydrology is input to the model to simulate CVP/SWP operations under specific regulatory conditions. Model results for the existing level of development and regulatory conditions, without climate change, were used for the BiOps simulation that depicts the current CVP/SWP reliability. Appendix A of the 2015 DCR provides more detail on the CalSim II modeling assumptions.

The 2015 SWP DCR may be found at the following web location:
http://baydeltaoffice.water.ca.gov/swpreliability

The most current public version of the CalSim II model used by DWR to develop the 2015 DCR study is available for download from DWR's website at:
http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/Downloads/CalSimDownloads/CalSimIIStudies/SWPCapability2015/index.cfm

Current Reliability and Effects of Regulatory Requirements

The following sections provide the results that define the current reliability of CVP and SWP contract supplies and illustrate how reliability has been affected by changes in regulatory requirements that result from recognition of ecosystem needs and the need to balance all beneficial uses of water. Results include probability of exceedance for annual contract allocations, and annual deliveries for wet and dry periods.

State Water Project

SWP allocations are reported for Table A contractors located south of the Delta (SOD). Within the SWP, most Table A contractors receive the same allocation each year and there are no differences between agricultural and municipal and industrial (M&I) contractors.

Figure B-6 shows the probability of exceedance for SWP Table A allocations under the three different regulatory conditions. Results summarized in Figure B-6 show how changes in regulations, most notably the recent BiOps and the associated restrictions on CVP and SWP exports from the Delta, have reduced SWP Table A allocations. Table A allocations were reduced in approximately 20 percent of all years when regulations changed from D-1485 to D-1641. Table A allocations were reduced more significantly and more frequently with the implementation of the BiOps. Allocations were reduced in approximately 95 percent of all years. Additionally, the probability of a full allocation was reduced from approximately 35 percent to 9 percent when going from D-1641 to the current BiOps.

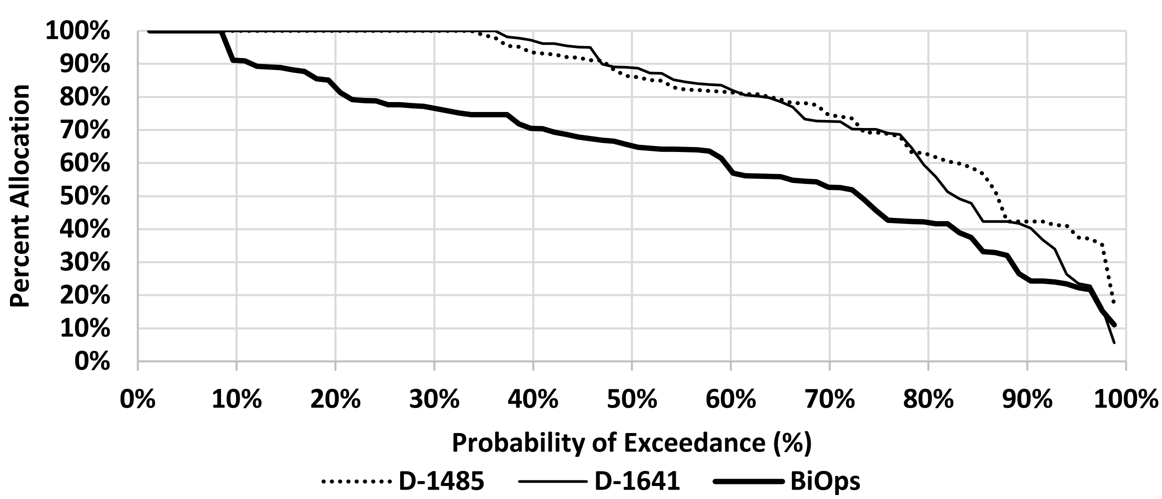


Figure B-6: Probability of Exceedance for SWP Table A Contract Allocations

Figure B-7 illustrates how annual SWP deliveries were affected by changes in regulatory conditions. Annual deliveries for a single wet year, a period of six wet years, an average across all years, a single dry year, and a 6-year drought are provided. It should be noted that the single years illustrated represent the most extreme single wet (1983) and single dry (1977) years in the period of analysis.

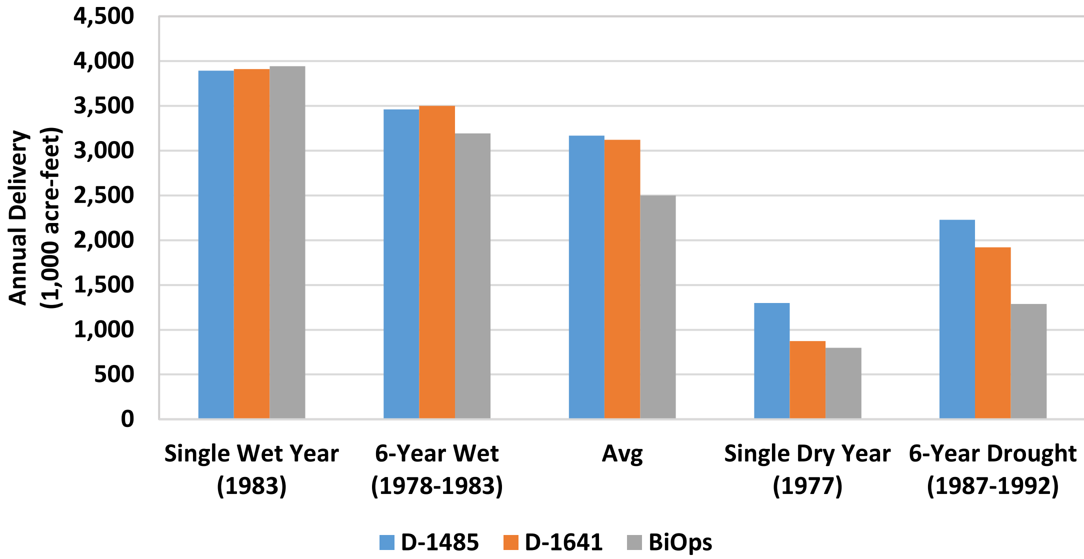


Figure B-7: Annual SWP Table A Deliveries

Results presented in Figure B-7 show similar annual deliveries between the D-1485 and D-1641 simulations in wet and average years, and a reduction in deliveries under D-1641 in single and multiple dry years. Annual deliveries are reduced in most years and periods under the BiOps. Results indicate that average annual SWP Table A deliveries under the BiOps are approximately 600,000 acre-feet less than under D-1641 conditions.

Central Valley Project

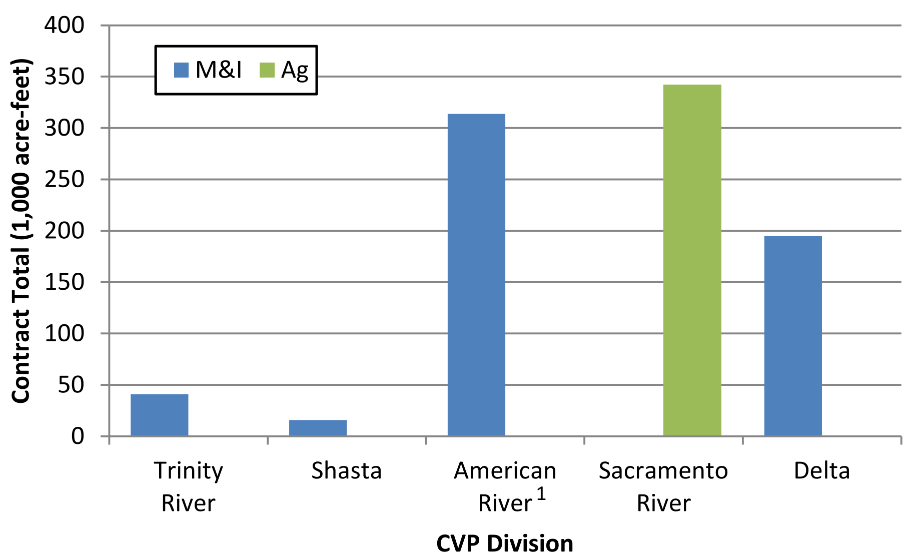
CVP allocations are reported for both agricultural and M&I water service contractors located both north of the Delta (NOD) and SOD. The CVP M&I Water Shortage Policy includes a tiered system of allocation reductions for years when project supplies are not adequate to provide a full allocation to all contractors. Table B-1 summarizes the CVP allocation reductions between agricultural and M&I contracts.

Table B-1: CVP Allocation Tiers for Agricultural and M&I Water Service Contractors

Agricultural Water Service Contract Allocation	M&I Water Service Contract Allocation
100% – 75%	100% of contract total
70%	95% of historical use
65%	90% of historical use
60%	85% of historical use
55%	80% of historical use
50% – 25%	75% of historical use
20%	70% of historical use
15%	65% of historical use
10%	60% of historical use
5%	55% of historical use
0%	50% of historical use

In addition to the tiered system, the CVP also may provide different allocations to different divisions based on the water supply available to the divisions. This occurs most frequently between contractors located NOD and contractors located SOD. NOD CVP contractors may receive a higher allocation than SOD contractors when limitations on the ability to convey water to SOD contractors cannot support a higher allocation.

CVP water service contracts located north of and within the Delta total approximately 900,000 acre-feet within five different divisions of the CVP, as shown in Figure B-8.



[1]M&I contracts in the American River Division include 133,000 acre-feet for EBMUD

Figure B-8: North of Delta CVP Contract Totals by Division

The next figures illustrate the probability of exceedance for CVP allocations for NOD M&I and agricultural water service contractors under the three different regulatory conditions. Results illustrated in these figures reflect the CVP's tiered system of allocation reductions to agricultural and M&I contractors.

Comparisons between expected allocations under the different regulatory conditions show similar allocations between the D-1485 and D-1641 simulations. Results show a slightly higher probability of receiving a 75 percent or higher M&I contract allocation under D-1641 than under D-1485 for NOD contractors. As discussed earlier, D-1485 was replaced by D-1641 in 2000. D-1641 imposed more severe restrictions on Delta exports and new requirements for Delta outflows that were frequently met through reductions in Delta exports. This change resulted in reduced water allocations to SOD contractors, as seen in Figure B-14 and Figure B-16, under D-1641 as compared with allocations under D-1485. Reductions to SOD contractors allowed for higher storage in NOD CVP reservoirs in some years, and a subsequent increase in deliveries to NOD contractors. Higher NOD allocations under D-1641 tend to occur more frequently in the wetter years of the model simulations. In drier years, when allocations are lower, the higher Delta outflow requirements under D-1641 tend to reduce allocations when compared with simulated operations under D-1485 conditions.

CVP NOD water service contract allocations were also reduced under the BiOps. The likelihood of a full allocation was reduced by approximately 15 percent for M&I contractors and 7 percent for agricultural contractors, as compared to D-1641 conditions. Additionally, minimum allocations under the BiOps were reduced approximately 10 percent for both contractor types, with M&I contractors going from 60 to 50 percent and agricultural contractors going from 10 to 0 percent, when compared with D-1485. These figures represent simulated operations with historical hydrology; however, we know, based on actual operations in 2015, that allocations under the current BiOps can be as low as 25 percent for NOD M&I contractors.

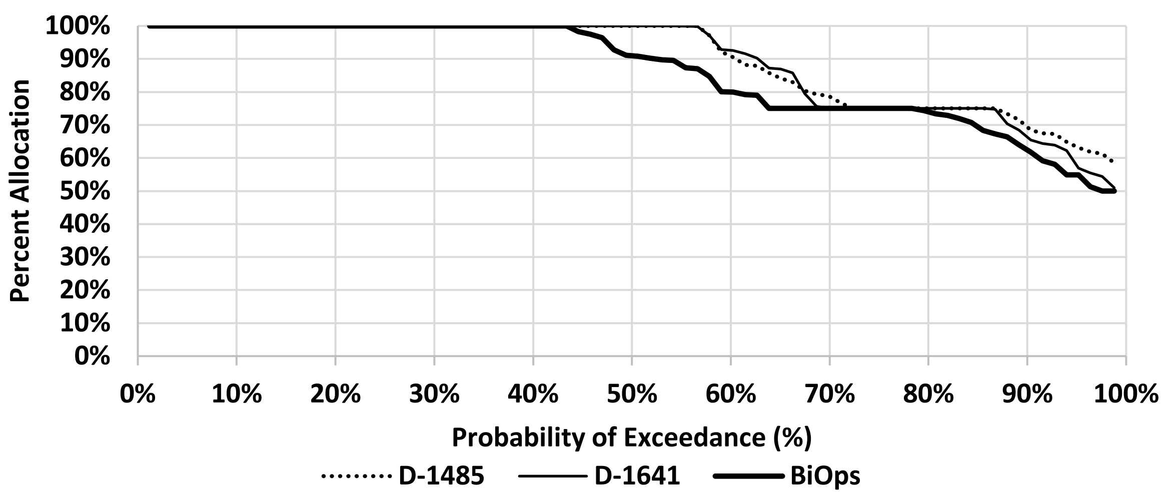


Figure B-9: Probability of Exceedance for CVP NOD M&I Water Service Contract Allocations

*Annual model demands for D-1485 and D-1641 conditions are approximately 125,000 acre-feet higher than for BiOps conditions. Differences in annual deliveries for these contractors reflect both changes in model demands and regulatory conditions.

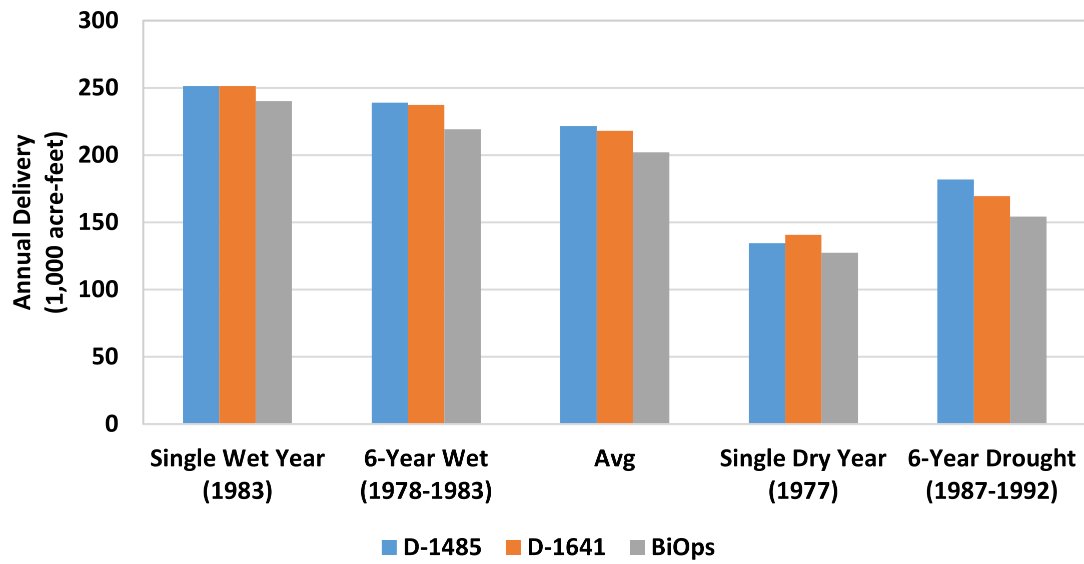


Figure B-10: CVP North of Delta M&I Water Service Contract Deliveries

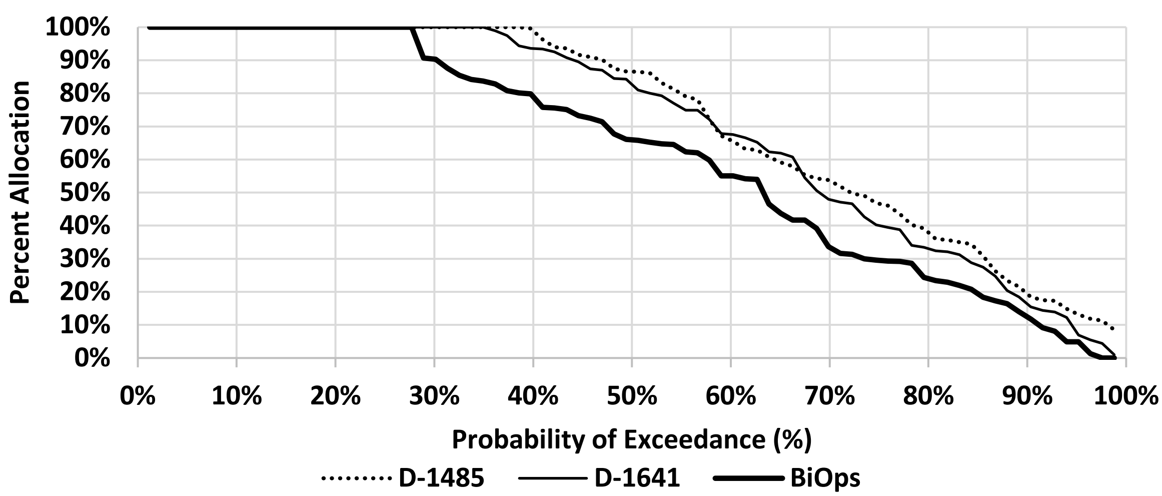


Figure B-11: Probability of Exceedance for CVP NOD Agricultural Water Service Contract Allocations

Results presented in Figure B-12 show similar annual deliveries between the D-1485 and D-1641 simulations in wet and average years, and lower deliveries under D-1641 in single and multiple dry years. Results show reductions in annual deliveries in most years and periods under the BiOps. The increase in deliveries in 1983 under the BiOps is the result of a change in the total CVP NOD contracts represented in the model, not an expected change in operations.

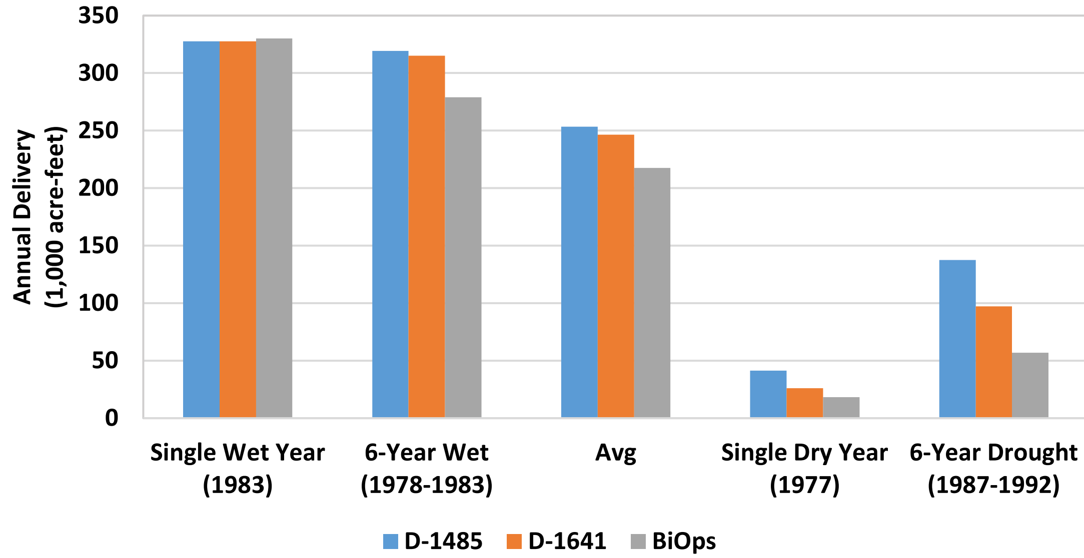


Figure B-12: CVP North of Delta Agricultural Water Service Contract Deliveries

CVP water service contracts located in the export service areas total approximately 2 maf, with the largest volume being agricultural contracts in the West San Joaquin Division. CVP contracts by division and use are summarized in Figure B-13.

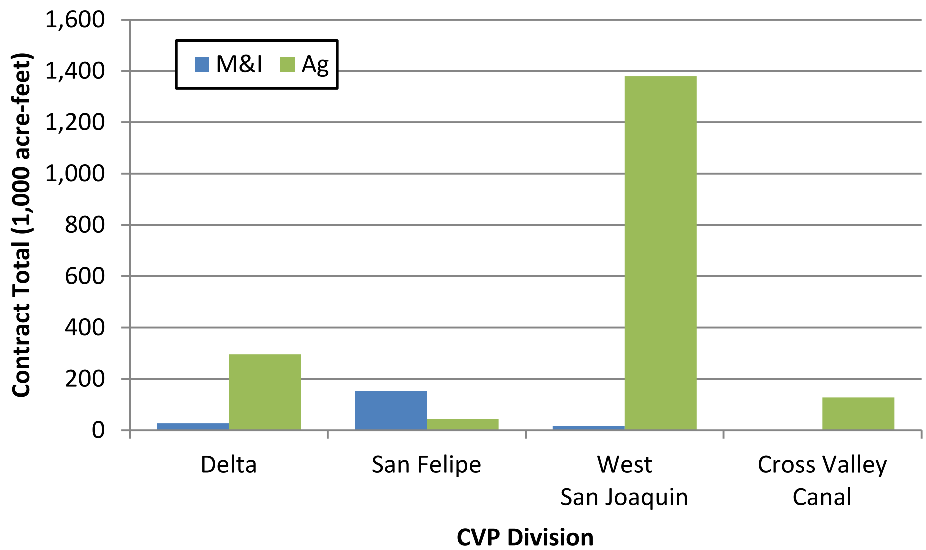


Figure B-13: South of Delta CVP Contract Totals by Division

The next figures illustrate CVP allocations and expected annual deliveries for SOD M&I and agricultural water service contractors, respectively. These figures illustrate the effects of additional regulations on the ability of the CVP to divert water, when it is available, from the Delta and convey previously stored CVP water through the Delta. Export restrictions in D-1641 reduced allocations to both M&I and agricultural contractors, and this had a more pronounced effect on agricultural contractors because of the CVP's tiered allocation procedures. The recent BiOps had a more significant and frequent effect on SOD CVP allocations to both types of contractors.

Results illustrated in Figure B-14 show the probability of exceedance for CVP SOD M&I allocations. Implementation of the BiOps reduced the likelihood of a full allocation from approximately 45 percent under D-1641 to approximately 25 percent.

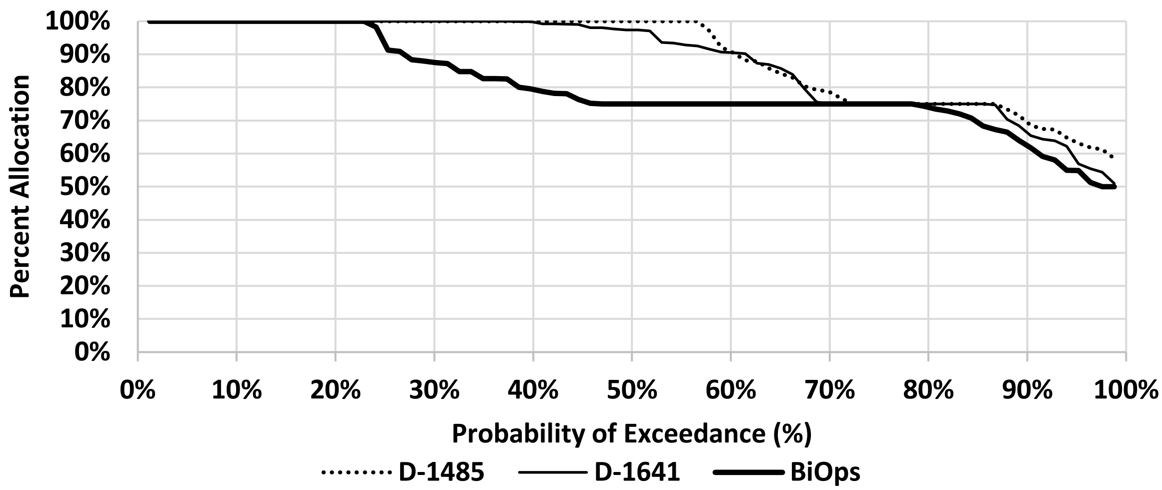


Figure B-14: Probability of Exceedance for CVP SOD M&I Water Service Contract Allocations

Figure B-15 illustrates the changes in expected annual deliveries across a variety of years. There are reductions of approximately 10,000 acre-feet in most years.

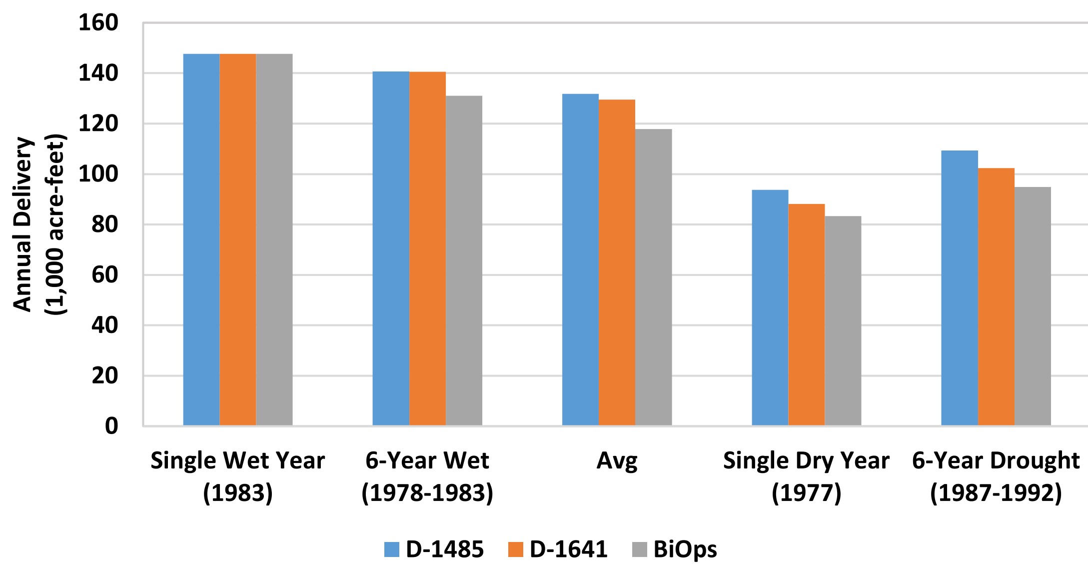


Figure B-15: CVP South of Delta M&I Water Service Contract Deliveries

Figure B-16 illustrates the simulated probability of exceedance for CVP SOD agricultural water service contractor allocations under the three different regulatory conditions. Agricultural contract allocations are affected more significantly than M&I allocations because of the CVP's tiered allocation process. The likelihood of a full contract allocation was reduced approximately 25 percent by D-1641 and approximately 30 percent by the BiOps when compared with a D-1485 condition. The BiOps also increased the likelihood of a zero allocation.

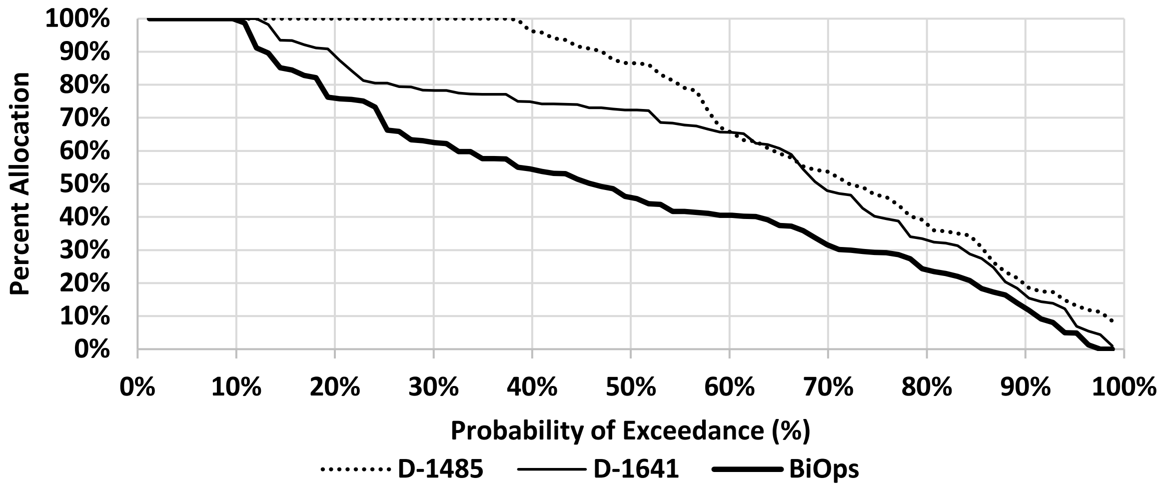


Figure B-16: Probability of Exceedance for CVP SOD Agricultural Water Service Contract Allocations

Figure B-17 illustrates the change in expected annual deliveries to CVP SOD agricultural contractors. While there is no expected change in the wettest year on record, 1983, there are large reductions in deliveries in most periods and years, including an average annual reduction of approximately 400,000 acre-feet when comparing a D-1485 regulatory condition with the current BiOps.

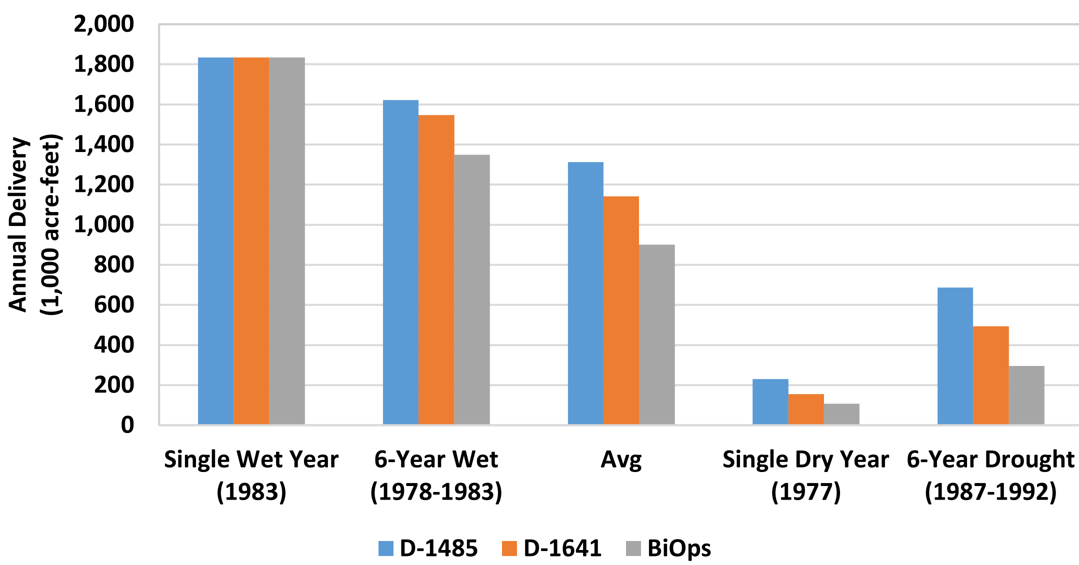


Figure B-17: CVP South of Delta Agricultural Water Service Contract Deliveries

CVP Friant Division

The Friant Division was the first division of the CVP constructed in California to address groundwater overdraft in the Tulare Lake region and surrounding areas by diverting San Joaquin River flows at Friant Dam into the Friant-Kern and Madera canals. The Friant Division is typically operated separately from the other divisions of the CVP because after construction of the Friant Division, the San Joaquin River did not typically flow into the Delta.

There are two classes of contracts within the Friant Division. Class 1 contracts total 800,000 acre-feet and were issued to water districts in areas that do not have access to groundwater. Class 2 contracts total approximately 1,400,000 acre-feet and were issued to districts in areas that have access to groundwater. Districts can hold both Class 1 and Class 2 contracts. In this way, the Friant Division was one of the first conjunctive management projects in California. In addition to contract supplies, Reclamation can make “unstorable” water available under Section 215 contracts at times when there is more water available than can be stored in Millerton Lake or delivered under existing contracts. In 2006, the U.S. Departments of the Interior and Commerce, the Natural Resources Defense Council, and the Friant Water Users Authority signed a settlement and agreed to implement the San Joaquin River Restoration Program. This agreement settled 18 years of litigation surrounding the effects of the Friant Division construction and operation on fishery resources in the San Joaquin River.

Figure B-18 and Figure B-19 show the probability of exceedance for Friant Division Class 1 and Class 2 allocations and the expected annual deliveries under a range of hydrologic conditions, respectively. These figures reflect Friant Division operations when meeting flows under the San Joaquin River Restoration Program.

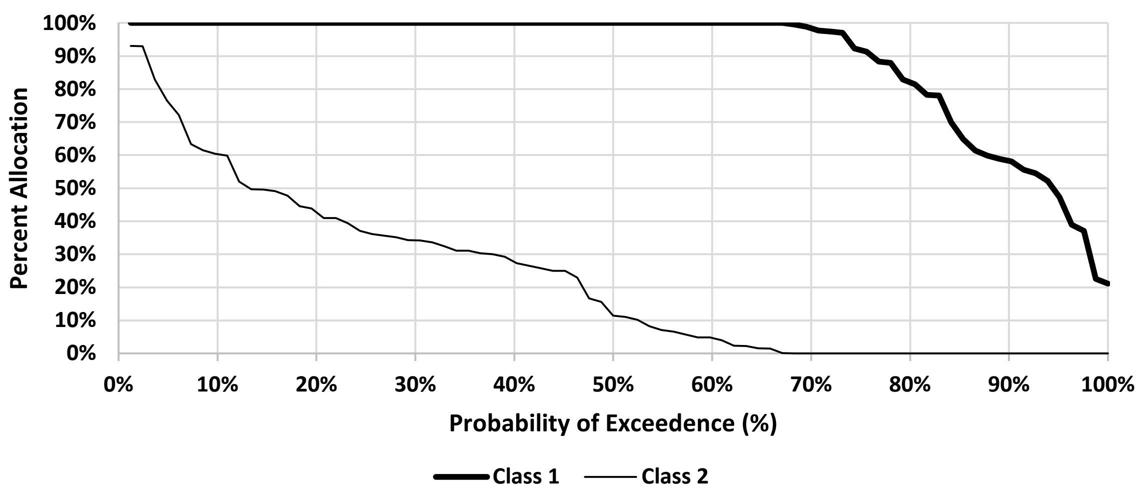


Figure B-18: Probability Exceedance of Friant Service Contract Allocations

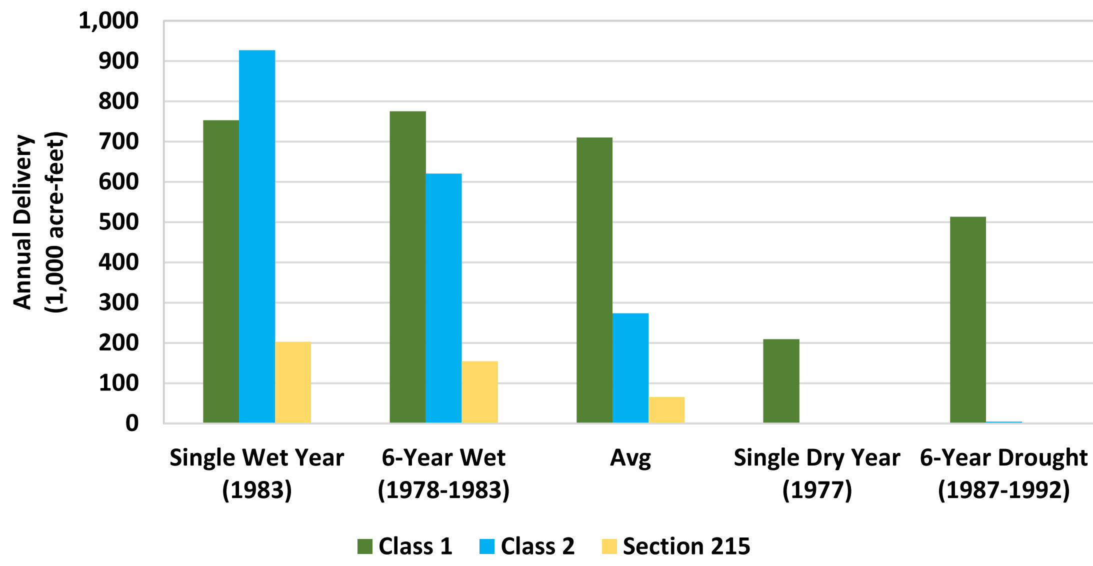


Figure B-19: Friant Division Deliveries

The data illustrated in the above figures are based on CalSim II model results; however, these results do not reflect operational constraints encountered during the recent drought. When the Friant Division was constructed, Reclamation diverted San Joaquin River flows being used for irrigation on lands near the existing Mendota Pool by senior water right holders. These senior water right holders agreed to exchange their San Joaquin River supplies for water delivered under Reclamation contracts from the Delta through the Delta-Mendota Canal. These senior water right holders on the San Joaquin River became the San Joaquin River Exchange Contractors (Exchange Contractors). The Exchange Contractors receive water from the Delta and their contract supplies can be reduced by up to 25 percent depending on inflow to Shasta Reservoir. However, the Exchange Contractors did not relinquish their rights to the San Joaquin River and are still entitled to call upon those rights in the event that Reclamation cannot fulfill their contracts.

The combination of increased regulatory restrictions on Delta exports with a multi-year drought that was particularly severe in the San Joaquin River Basin resulted in Reclamation not being able to meet the San Joaquin River Exchange Contracts from the Delta in 2014 and 2015. The Exchange Contractors then called upon their senior rights for San Joaquin River flow, resulting in a zero allocation to Friant Class 1 contracts. The potential for this type of operation and the resulting effect on the Friant Division is not captured in current models, but must be recognized when interpreting model results like those presented in Figure B-18 and Figure B-19.

CVP Eastside Division

The CVP Eastside Division delivers water to contractors from New Melones Reservoir on the Stanislaus River. Reclamation provides water to both agricultural and M&I water service contracts that total 155,000 acre-feet, with 49,000 acre-feet identified as *firm water supply* and the remaining 106,000 acre-feet identified as *interim supply*. Water is allocated to these contracts based on a New Melones Index that includes storage plus forecasted runoff from the Stanislaus River. These contracts were originally signed in 1983. The following figures illustrate the probability of exceedance for allocations under these contracts and the expected deliveries across a range of different water supply conditions based on operations in the current BiOps.

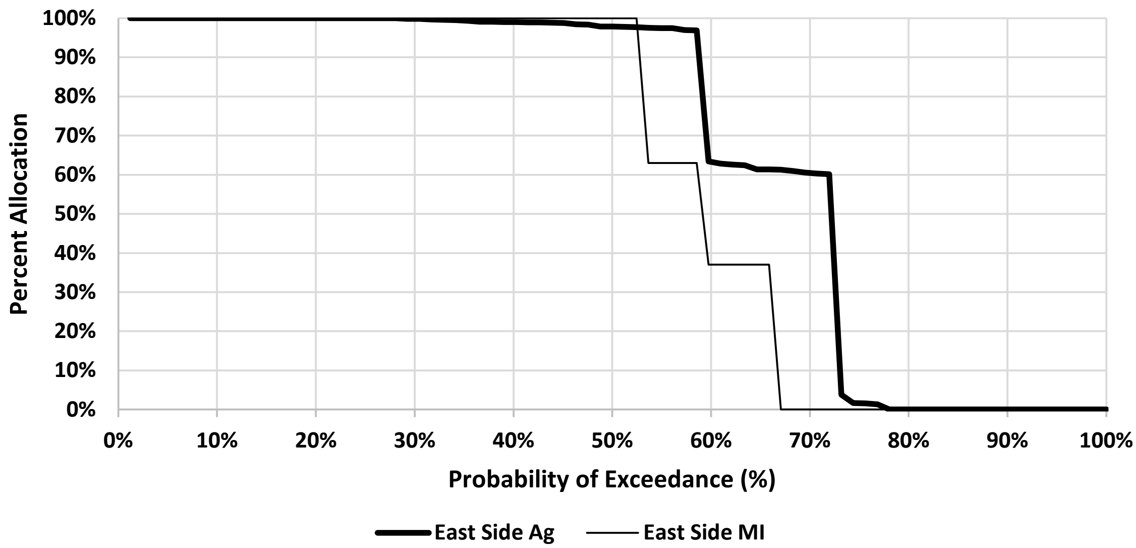


Figure B-20: Probability Exceedance of Eastside Division Contract Allocations

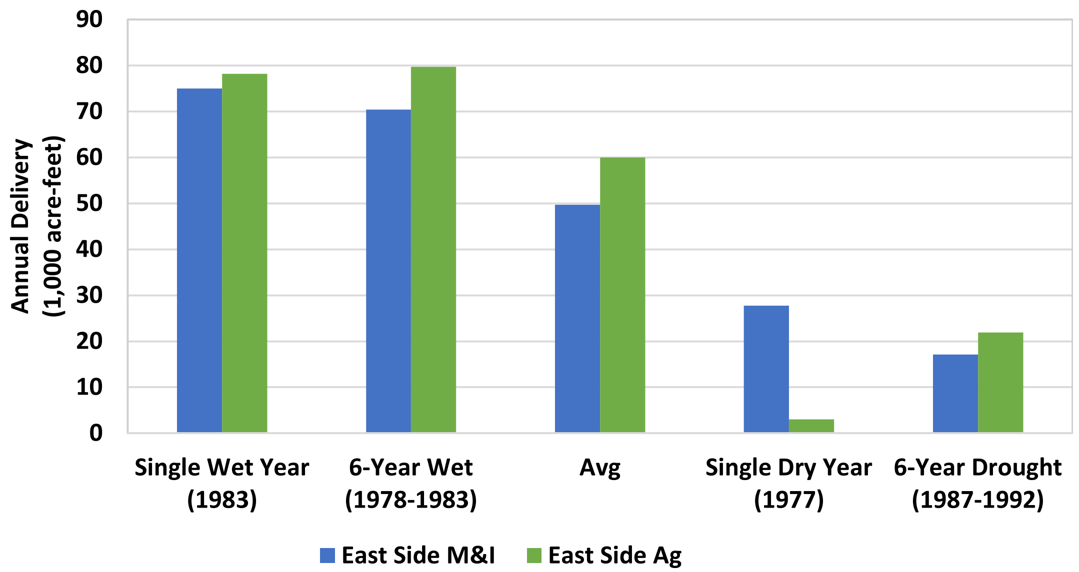


Figure B-21: Eastside Division Water Service Contract Deliveries

Figure B-22 is a summary graph showing total deliveries for CVP water service contractors (NOD, SOD, agricultural and M&I, but excluding Eastside and Friant divisions) for various year types, with D-1485, D-1641, and the BiOps.

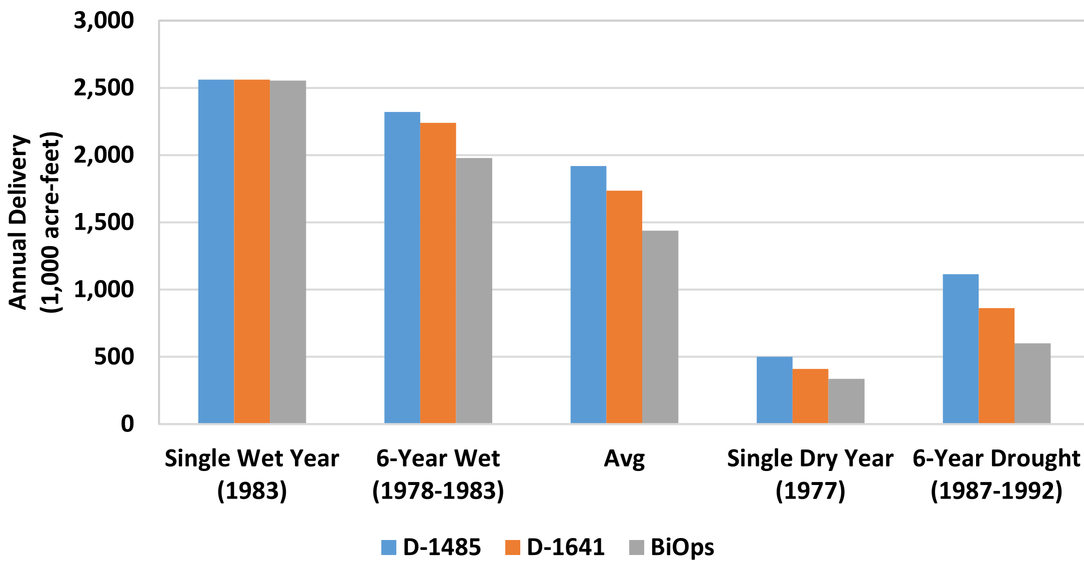


Figure B-22. Annual CVP Water Service Contract Deliveries

Figure B-22 illustrates how annual CVP deliveries were affected by changes in regulatory conditions. The results presented show reductions in annual deliveries between the D-1485 and D-1641 simulations, and further reductions in annual deliveries in most years and periods under the Biological Opinions (BiOps) simulation. Average annual CVP deliveries are reduced by approximately 500,000 acre-feet under the BiOps. When combined with effects to SWP contractors of 600,000 acre-feet, as shown in Figure B-7, the total reduction in deliveries to the two projects is approximately 1.1 maf.

Future Opportunities

California water development has always been an evolving process of re-aligning infrastructure and operations to changing water demands and conditions (Hanak et al. 2011). With a varying climate and hydrology, reliability depends on the ability to store water when available to effectively manage through periods when it is not. The previous sections describe CVP and SWP contractors' information that provides a basis for defining the reliability of their contracts when developing water budgets. Water that is provided through existing CVP/SWP contracts must be considered as part of a GSA's existing water budget. Water currently being provided and used under these contracts is not water available for replenishment. Existing CVP/SWP contracts may provide water available for replenishment only for contractors who have historically taken delivery of less than their allocated contract supply.

Several ideas have been proposed and analyzed to improve reliability and increase delivery of water from the CVP and SWP. Ideas include enhanced storage, additional conveyance, and other non-structural management options, such as expanded conjunctive management, changes in the operations of reservoirs, and improved integration between the CVP and SWP. These projects and concepts have the potential to increase CVP/SWP deliveries and thereby make additional water available for replenishment. The following sections provide an overview of different projects and operational strategies and the potential increases to CVP/SWP water supplies. In most cases, these projects and concepts have not been analyzed specifically for the purpose of making water available for groundwater replenishment. However, most have been evaluated to understand their potential to improve water supply reliability.

Enhanced Surface Storage and Conveyance

The CALFED Bay-Delta Programmatic Record of Decision (2000) identified five surface storage locations statewide for further consideration and analysis: Shasta Lake Water Resources Investigation (Shasta Enlargement), North-of-the-Delta Offstream Storage (Sites Reservoir), In-Delta Storage Project (IDSP), Upper San Joaquin River Basin Storage Investigation (Temperance Flat Reservoir), and Los Vaqueros Expansion (LVE). These storage projects are designed to capture and store surplus flows in the Sacramento and San Joaquin river basins for future delivery.

In addition to surface storage projects, water managers in California have long considered the potential to enhance the ability to convey water through or around the Delta. As described previously, a peripheral canal around the Delta and connecting the Sacramento River with the pumping plants in the south Delta was included in some of the early designs for the SWP. The current concept of this project, the California WaterFix, includes two tunnels to convey up to 9,000 cubic feet per second from three points of diversion on the Sacramento River near Clarksburg to the south-Delta pumping plants. This project has the potential to increase deliveries to CVP and SWP contractors and therefore potentially make more water available than results presented in previous sections. Later in this report, the "SWP and CVP Future Reliability and Availability" section describes analysis of similar storage and conveyance projects, as well as a range of potential future regulation and water supply reliability effects.

Reservoir Reoperation

There are numerous strategies for increasing the yield of the current CVP/SWP system through changes in reservoir operations. DWR's System Reoperation Study (SRS) investigated a variety of different operational strategies at different reservoirs in the state. Operational strategies can generally be classified as one of two types of projects: projects that create a more aggressive operation that draws the reservoir down more in the hopes that it will refill, and strategies that increase the ability to store more water in reservoirs. An example of a more aggressive operational strategy is increased conjunctive management. An example of a strategy that allows more water to be stored at certain times is a forecast-based flood space requirement.

Additional Conjunctive Management

One reoperation concept that is particularly applicable to SGMA, with respect to making water available for groundwater replenishment, is additional conjunctive management. As described above, addressing declining groundwater conditions was a primary rationale for constructing the CVP and SWP, and the projects have largely been operated conjunctively with groundwater resources. It may be possible to expand conjunctive management operations through closer coordination and agreements with existing CVP and SWP contractors who have access to other sources of supply, including groundwater. Through coordination and agreement it may be possible to deliver additional surface water from project reservoirs, in years of ample supply, to offset use of local groundwater under some conditions. This type of operation exercises the reservoir more aggressively and has the potential to increase the average annual yield of the CVP and SWP. It may also be possible to reduce deliveries from project reservoirs when surface water supplies are limited and contractors have access to other sources of supply.

The following figures illustrate these two different operations over a five-year period at a hypothetical reservoir. In Figure B-22, the reservoir is operated to maintain a higher carryover storage in most years. This operation produces an average annual yield of 65, with a minimum yield of 30.

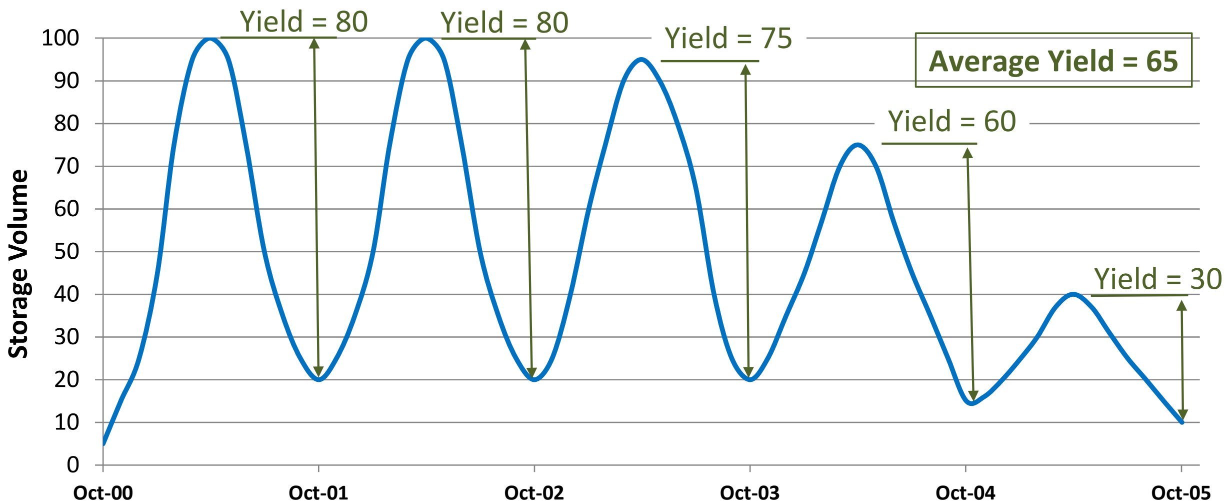


Figure B-22: Example Reservoir Operation with Higher Carryover Storage

In Figure B-23 the same reservoir is operated to a lower carryover storage in all years by expanding conjunctive management operations to deliver an additional volume of water when it is available in wet years. This operation increases the average annual yield to 69, but reduces the minimum yield to 25.

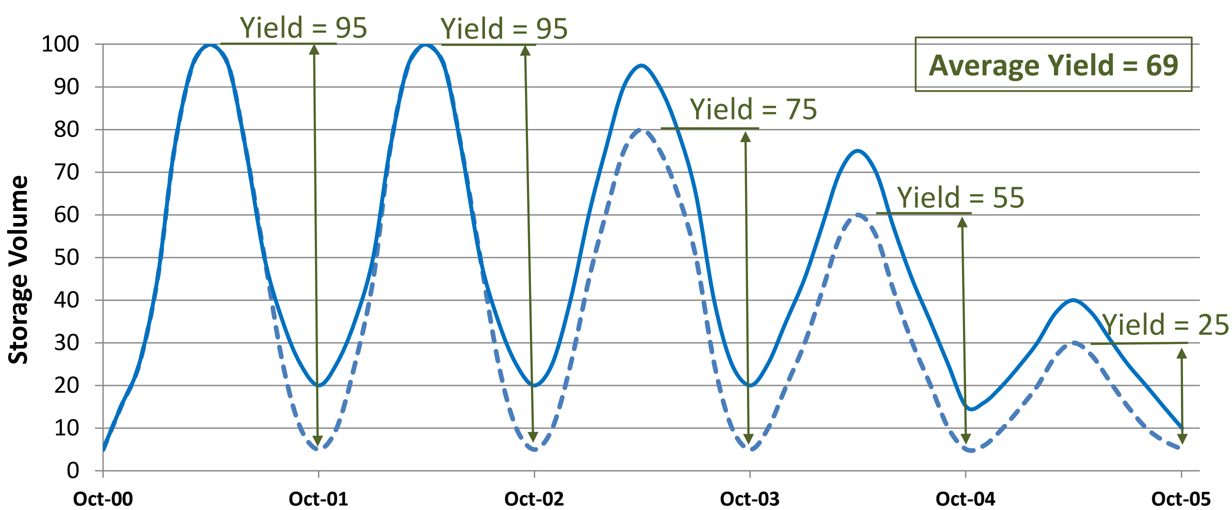


Figure B-23: Example Reservoir Operation with Lower Carryover Storage

This example illustrates how additional conjunctive management operations may affect the operation of the CVP and SWP. A more aggressive reservoir operation that delivers more water from reservoirs when ample surface water is available can increase the average annual deliveries, but typically comes as a trade-off to dry-year reliability. DWR's SRS demonstrated the benefits of additional conjunctive management in areas upstream of the Delta that may provide modest gains, on the order of 10,000 acre-feet, in CVP/SWP supply.

Forecast-Based Flood Space Requirements

Forecast-based flood space requirements leverage improved data availability and flood flow forecasts in the calculation of flood space requirements. Forecast-based operations (FBOs) can be applied to any reservoir with a traditional water supply and flood control space allocation paradigm, and is illustrated in Figure B-25. The incorporation of weather forecasts allows for greater flexibility in the management of the reservoir's space for water supply and flood control purposes. This flexibility can increase the opportunities for gaining additional water supply and flood control benefits.

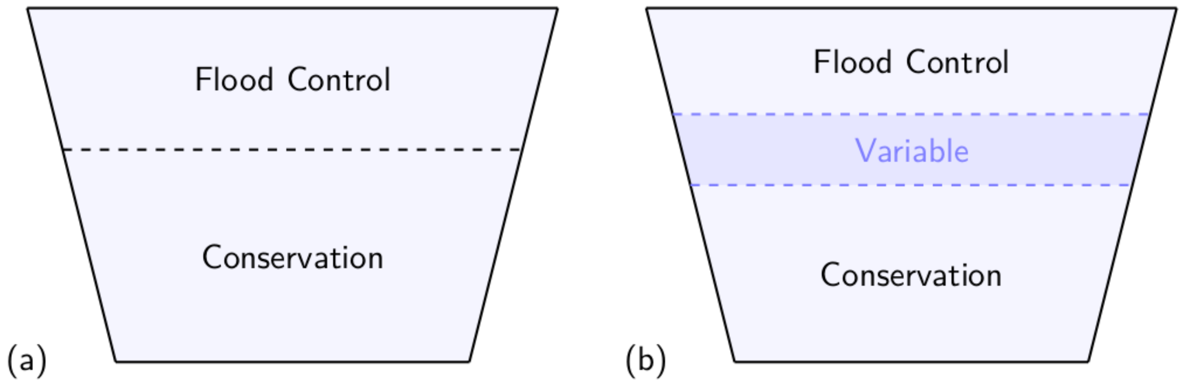


Figure B-24: Depiction of Reservoir Space Allocations under (a) Typical Operating Paradigm and (b) Forecast-based Operations

DWR's SRS evaluated the potential benefits of FBO at several reservoirs, including Shasta, Folsom, and Oroville. Results of these studies show it may be possible to increase average annual deliveries to CVP and SWP contractors on the order of 10,000 to 20,000 acre-feet through the implementation of FBO at these reservoirs (System Reoperation Study Phase 3 Technical Report 2015). Additionally, FBO can provide flood control benefits by evacuating additional reservoir space, beyond what is currently required in water control manuals, when forecasts predict large runoff events.

System Integration

It is recognized that there may be an ability to improve the operation of both the CVP and SWP through a more integrated operation of both projects. The CVP has a storage capacity of about 8 maf in the Sacramento River Basin, while the SWP storage capacity is about 3.5 maf. The CVP has a maximum Delta export capacity of about 4,600 cubic feet per second (cfs), while the SWP has a maximum export capacity of about 10,300 cfs, though these capacities are often restricted by regulations. Therefore, it may be possible to leverage each project's storage and export capacity through improved integration of project operations. However, it is important to emphasize that by definitions in the COA, the CVP and SWP are already operating in an integrated manner. The projects share available water supply and obligations to satisfy operational criteria. Additionally, the CVP and SWP have some limited flexibility in export operations through the Joint Point of Diversion allowed under D-1641.

Analysis conducted as part of DWR's SRS indicate that even though a great deal of benefit is already being realized through integrated operations, there may be some level of additional benefit derived by expanding the degree of integration. Modest increases in water supplies, on the order of 30,000 acre-feet on an average annual basis, may be possible through improved coordination.

Future Challenges

While there are a variety of projects and concepts being considered that may improve deliveries from the CVP and SWP, there are also future challenges to the projects' ability to deliver water. Future challenges include: climate change and associated effects on supply, demands for water, sea level rise, and changes in regulatory requirements in response to species decline or other environmental changes.

Climate Change

Climate change research is an evolving and expanding area of study, and much has been written regarding the potential effects of climate change on California water management. The DWR website on climate change (http://www.water.ca.gov/climatechange/) is a good resource for recent climate change studies and reports. The website includes links to publications on climate change, information on DWR's Climate Action Plan, and reports from the Climate Change Technical Advisory Group. Most of the information on the website is focused on the effect of climate change on water resources management.

Potential effects of climate change on the CVP and SWP are varied and include:

- Increased variability in floods and droughts.
- Shifts in the timing and volume of rain and snow-melt runoff into and downstream of reservoirs.
- Changes in timing and magnitude of demand for water.
- Challenges in managing Delta salinity levels and water quality with sea level rise.

The DWR report, *California Climate Science and Data for Water Resources Management*, includes information that helps illustrate the key issues surrounding the shifts in the timing of runoff into reservoirs and the resulting risk to water supply (California Department of Water Resources 2015a). Figure B-25 illustrates how the timing of peak monthly runoff in the Sacramento River basin between 1906 and 1955 (red line) and 1956 and 2007 (blue line) has shifted nearly a monthly earlier.

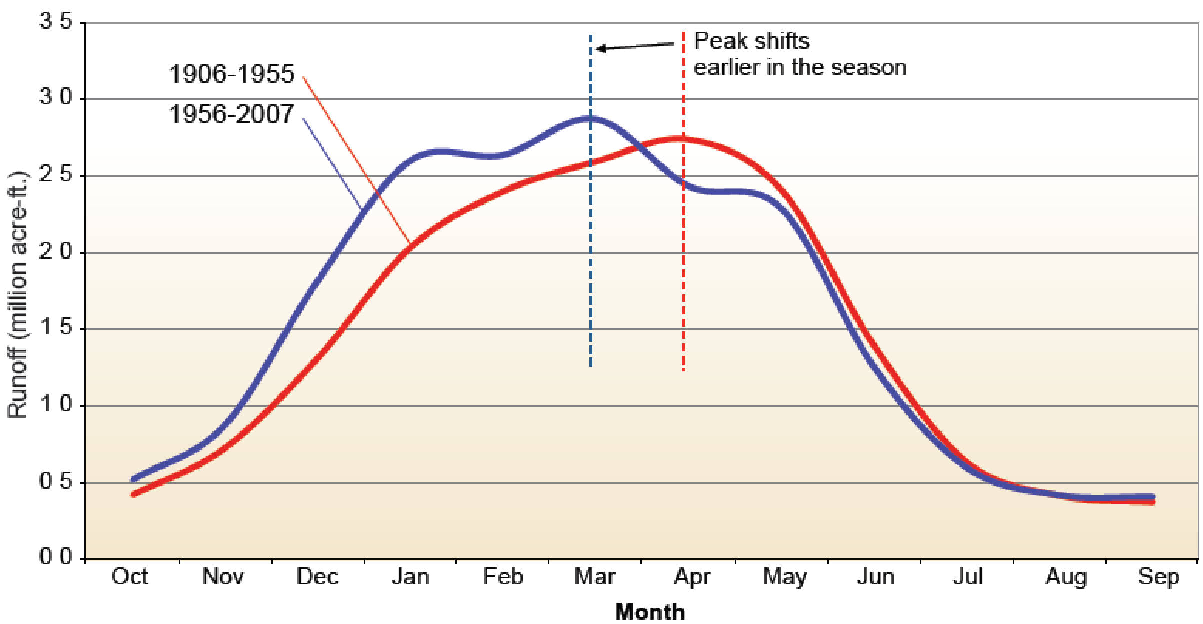


Figure B-25: Monthly Average Runoff of Sacramento River System; reproduced from California Climate Science and Data for Water Resources Management *(DWR, 2015a)*

The impacts of earlier runoff and increased summertime water demand are shown, conceptually, in Figure B-26. The curves show the general shape and timing of runoff and demand in California, with peak runoff in early spring and peak demand in early summer under Current Conditions (top figure). Under Current Conditions, much of the difference between high runoff and low demand in fall and winter can be captured and stored in existing reservoirs and groundwater banks for delivery in spring and summer. When the timing of both runoff and demand shift under Projected Conditions (bottom figure), runoff peaks in mid-winter when demands are low, and when CVP and SWP reservoirs are being managed for flood protection. When this occurs, runoff cannot be stored in reservoirs and must be released to maintain flood protection storage space. Additionally, summertime demand is higher as a result of higher temperatures and may last longer into early fall because of longer growing seasons. All of these factors stemming from changes in the timing and magnitude of runoff and demands will pose operational challenges for the CVP and SWP.

Another challenge to CVP and SWP operations presented by climate change is the management of salinity and water quality in the Delta with sea level rise. Sea level rise will affect Delta water quality as higher ocean levels increase seawater intrusion into the Delta. The CVP and SWP currently manage seawater intrusion and Delta water quality through a combination of releases from upstream reservoirs, Delta exports, and at times, operation of the Delta Cross Channel Gate. Additional seawater intrusion as a result of sea level rise will require changes in CVP and SWP operations if the existing water quality requirements are to be met. Changes in CVP and SWP operations, such as increases in reservoir releases or reductions in Delta exports, will have impacts on water supply.

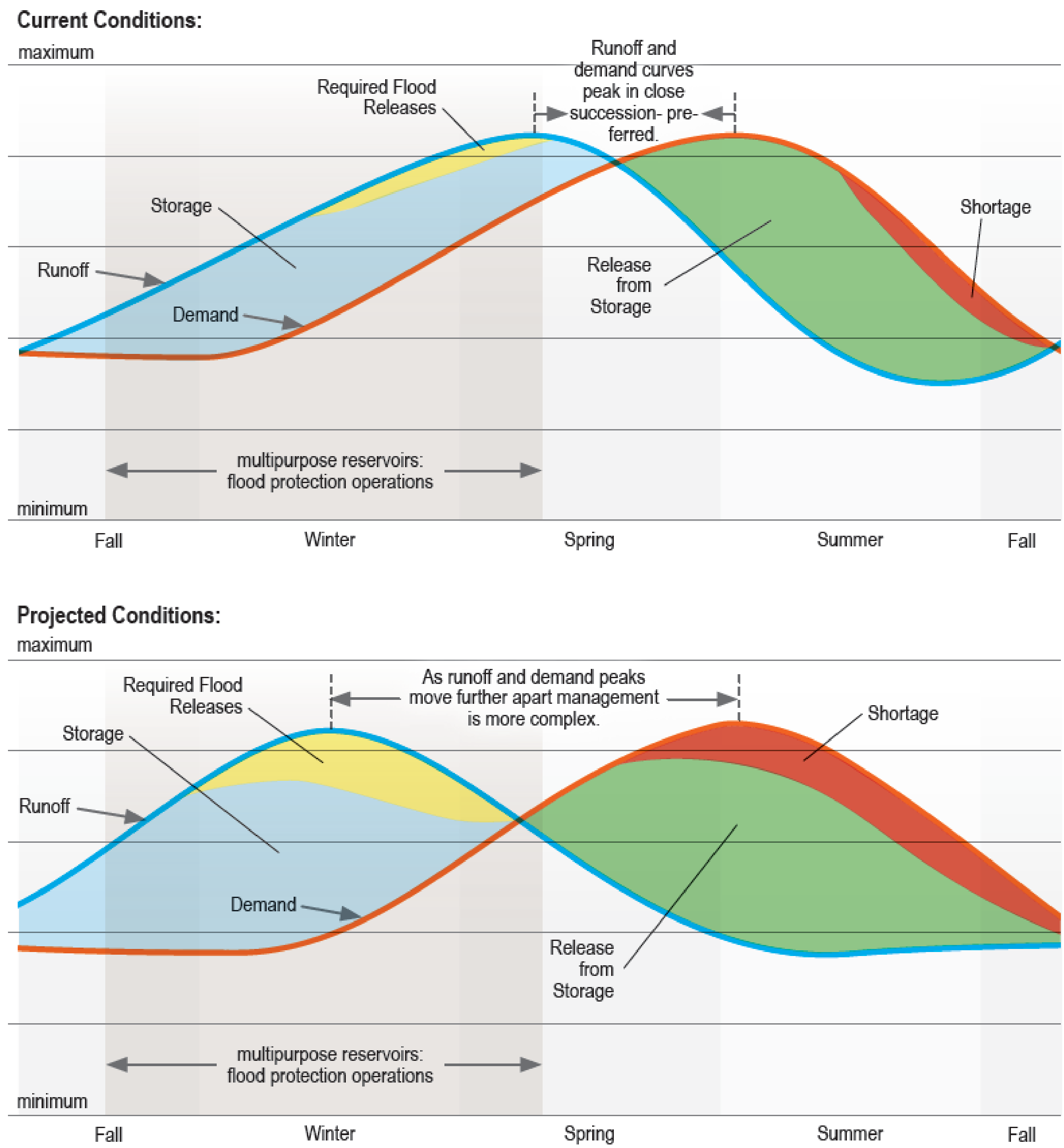


Figure B-26: Example Effect of Change in Runoff and Demand on Reservoir Operations and Water Supply; reproduced from California Climate Science and Data for Water Resources Management *(DWR, 2015a)*

The initial effects of climate change on CVP and SWP operations and water supplies have been studied for nearly a decade. DWR first published the potential effects of climate change on the SWP in the 2007 *SWP Delivery Reliability Report*. Reclamation published the potential effects of climate change on the long-term operation of the CVP in Appendix R to the *2008 Operations Criteria and Plan*. Recent reports on the effects of climate change on the CVP and SWP are the 2015 *SWP Delivery Capability Report* (DCR) and the *CVP Integrated Resource Plan* (IRP). The 2015 SWP DCR analyzed several scenarios under early long-term (ELT) climate change at a projected 2025 emission level and with 15 centimeters of sea level rise. The CVP IRP analyzed combinations of six different potential future climate conditions, including one condition representing historical hydrology, with three different future growth and development scenarios. The CVP IRP also evaluated several different portfolios of water management actions designed to achieve specific purposes within the CVP. Both of these reports provide an indication of the range of potential future water supply conditions for those who receive water from the CVP and SWP.

Regulatory Uncertainty

The regulatory requirements and associated operations of the CVP and SWP change. As illustrated and described in the preceding sections, there have been numerous changes in the regulations that govern the operations of these two projects since they were constructed. This trend will continue, particularly if recent declines in fishery resources continue in the Delta and tributary rivers and streams.

There are several ongoing actions that may add regulatory requirements to CVP/SWP operations, including California WaterFix, an update to the Bay-Delta Water Quality Control Plan, and ongoing litigation regarding Endangered Species Act (ESA) consultation.

Analysis of the California WaterFix and its predecessor project, the Bay-Delta Conservation Plan, has included several potential changes in regulatory requirements as the project has moved from conceptual design to environmental analysis and now ESA consultation. While many of these regulatory requirements have focused on specific operational criteria for the actual diversion facilities, other requirements have also included the potential for increases in Delta outflow requirements under certain conditions.

The SWRCB is in the process of a phased review and update to the 2006 Water Quality Control Plan for the Bay-Delta. The Bay-Delta Plan identifies beneficial uses of water in the Bay-Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives. The update to the Bay-Delta Plan is an ongoing process, but has the potential to change the current regulations that govern CVP/SWP operations by changing Delta outflow objectives, Delta Cross Channel Gate operations, export to inflow objectives, and reverse flows in the Old and Middle rivers. These and other potential changes may alter the ability of the two projects to provide water to existing contractors.

Declines in listed threatened and endangered fish species continue to be a concern to fisheries and water managers. Continued declines in species, such as Delta smelt, may trigger re-consultation under the ESA regarding the long-term operation of the CVP and SWP. There is ongoing litigation regarding several different legal issues and challenges to the existing consultation and operations of the CVP and SWP. New consultation may also be triggered by the listing of additional species, such as long-fin smelt or fall-run chinook. Consultation for newly listed species, or re-consultation for existing species that continue to decline, will likely result in additional regulatory restrictions on project operations.

SWP and CVP Future Reliability and Availability

California is close to making several important water resources investment decisions significantly related to the performance of the CVP and SWP. For example, California EcoRestore proposes to make major capital investments in the long-term health of the Delta ecosystem, including the development of more than 30,000 acres of habitat restoration. California WaterFix proposes new Delta conveyance investments to protect water supplies and fish. Also, as part of Proposition 1 (2014), California voters approved investment in water quality, water supply, and infrastructure improvement, including ecosystem benefits for the Bay-Delta and associated watersheds. The California Water Commission has established the Water Storage Investment Program to identify and fund storage projects that would maximize return on public investment. Many of these studies and others (e.g., the Bay-Delta Water Quality Control Plan) have considered a new regulatory future that would affect the reliability of the SWP and CVP. In addition, WaterFix conveyance studies and CALFED surface storage investigations have proposed new infrastructure to improve the state's water system, specifically the SWP and CVP. These proposed projects may, under certain conditions, improve the reliability of the CVP and SWP. Improved reliability may result in water available for replenishment in areas of the state that receive increased water supplies.

For purposes of this report, DWR completed cursory planning analyses to facilitate broad description and quantification of potential futures associated with the SWP and CVP. CalSim II was used to compare the potential effects of both changing Delta regulations related to the CVP and SWP, as well as potential new infrastructure. For purposes of comparison, Current Conditions and Future Without Action scenarios were defined to allow evaluation of a range of uncertainty in environmental water requirements and potential statewide projects. The Current Conditions scenario includes historical hydrology, current regulatory rules and operations, and current demands. The Future Without Action scenario includes a 2020 projected level of demand throughout the planning horizon, as well as an early long term climate change, which includes 2025 emission levels and climate, and 15 cm (5.9 inches) of sea level rise (State Water Project Delivery Capability Report 2015 Appendix, https://msb.water.ca.gov/documents/86800/c97c3baa-0189-4154-bf19-aa88392026ac). All remaining scenarios include these assumptions (i.e., demands, regulations, infrastructure, and climate change) unless the scenario designates a change.

For the following discussion, average South of Delta (SOD) exports and SWP and CVP reliability are used interchangeably. The current average reliability of combined (SWP and CVP) SOD exports is about 4.94 million acre feet (maf), as shown in Table 6. The average future reliability associated with combined SOD exports, with climate change, is about 4.63 maf (about a 6 percent reduction), indicating that the reliability of the projects are expected to be diminished solely by climate change, assuming no other system changes.

Table B-2. Baseline Operations and Delta Exports

Scenario Description	Operations	Climate	Delta Exports (CVP and SWP), maf
Current Conditions	Existing Infrastructure Current Regulatory	Historical Hydrology	4.94
Future Without Action	Existing Infrastructure Current Regulatory	Climate changed hydrology and Sea Level Rise	4.63

Note: maf = million acre feet.

The planning analyses completed for this report evaluates the combined South of Delta exports from the Central Valley Project and State Water Project under various future conditions, including two Delta water management regulation criteria scenarios (A and B), and with various potential statewide projects. The assumptions for criteria A and B and the Future Without Action scenario are shown in Table B-3. These analyses also include the effects of climate change.

Table B-3. Potential Future Regulatory Assumptions

Scenario Description	Fall X2	Delta Outflow Requirements	BiOps San Joaquin River inflow / export ratio	Old River and Middle River (OMR) Requirements	Head of Old River Barrier/Gate
Future Without Action	Yes	Per D-1641	Yes	Yes; per BiOps	Temporary barrier installed in fall months
Criteria A	Yes	Per D-1641 and increased Delta Outflow requirements in all months	No	Yes; more restrictive of either BiOps or new OMR requirements identified in the WaterFix RDEIR/SDEIS Appendix C	Permanent gate operating in fall, winter and spring months (full closure)
Criteria B	No	Per D-1641	No	Yes; per BiOps	Permanent gate operating in fall months consistent with Future Without Action

Table B-4 includes a description of the model assumptions associated with the potential statewide project investments evaluated. These analyses also include the effects of climate change, and so can be compared against the Future Without Action scenario's reliability of 4.63 maf.

Table B-4. Model Assumptions for Proposed Statewide Projects

Proposed Facilities Scenario	Model Assumptions
SOD Storage	2.0 maf additional storage south of Delta, at San Luis Reservoir.
NOD Storage	2.4 maf additional storage north of Delta, similar to Sites Reservoir and Shasta Enlargement
Delta Conveyance	9,000 cfs Conveyance Facility, similar to California WaterFix
Delta Conveyance + SOD Storage	See Delta Conveyance and SOD Storage above
Delta Conveyance + NOD Storage	See Delta Conveyance and NOD Storage above
Delta Conveyance + SOD Storage + NOD Storage	See Delta Conveyance, SOD Storage, and NOD Storage above

In addition, various statewide projects might have water available that could be used for replenishment by GSAs in certain locations. Meanwhile, many of these proposed statewide projects are currently developing more refined analyses of project performance than are reflected in the preliminary results shown in Figure B-27.

Changes in future reliability are depicted in the various bar values of Figure B-27, and are either associated with changes in Delta water management regulations or proposed statewide projects, or both.

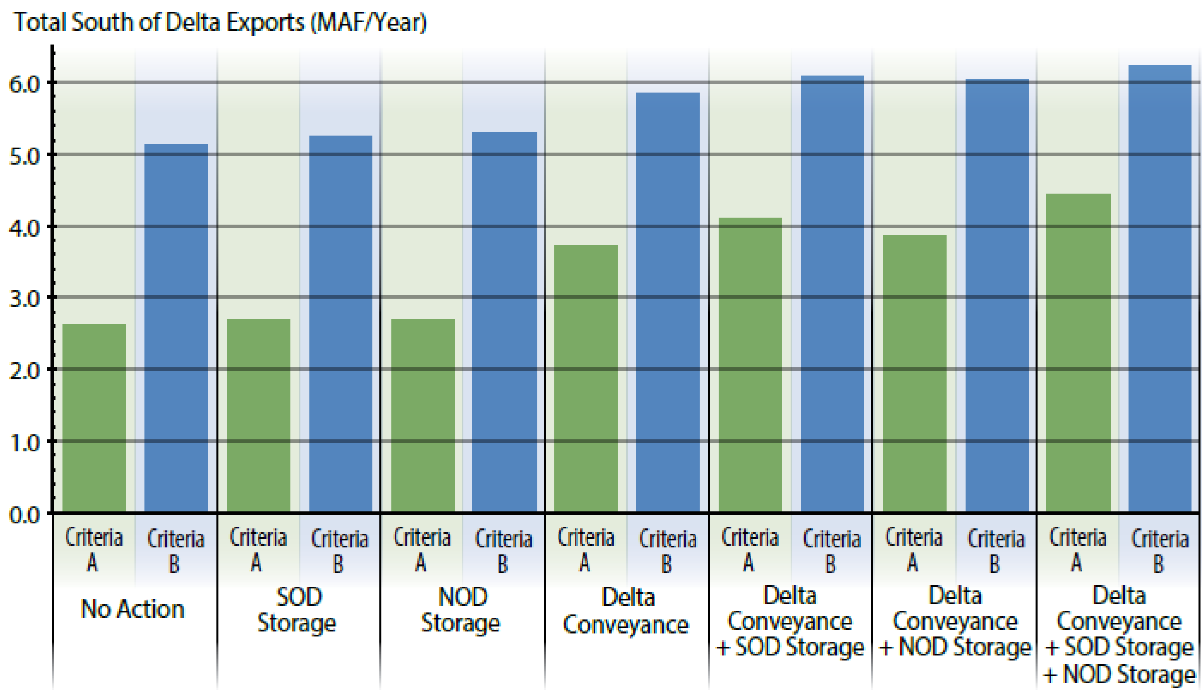


Figure B-27. Average Annual South of Delta Exports under Alternative Regulatory and Management Scenarios

No Action — Criteria A assumes the existing infrastructure and a more restrictive Delta regulatory future, resulting in average reliability of 2.61 maf (about a 44 percent reduction) for the combined SOD exports, indicated by the first green bar. No Action — Criteria B assumes the existing infrastructure and a less restrictive Delta regulatory future, resulting in average reliability of 5.13 maf (about a 11 percent increase) for the combined SOD exports, indicated by the first blue bar.

The remaining green and blue bars show the combined South of Delta exports, again assuming Criteria A or B, with various new statewide infrastructure projects, including SOD storage, North Of Delta (NOD) storage, Delta Conveyance, Delta Conveyance and SOD storage, Delta Conveyance and NOD storage, and Delta Conveyance with both NOD and SOD storage. With Criteria A, combined exports range from 2.61 to 4.41 maf (a 44-percent to 5-percent reduction, respectively, when compared to the Future Without Action scenario). With project investments in all new infrastructure options considered, plus Criteria A, exports and reliability are still less than the Future Without Action scenario. With Criteria B, exports range from 5.13 to 6.28 maf (an 11-percent to 36-percent increase, respectively, when compared with the Future Without Action scenario). With project investments in all new infrastructure options considered, plus Criteria B, exports and reliability are increased in all possible infrastructure scenarios, including No Action — Criteria B.

The range of uncertainty in the results presented in Figure 11 shows how environmental requirements and new project capacity (i.e., diversion capacity and storage) influence the water reliability and associated availability to SOD SWP and CVP contractors. This uncertainty is especially important for affected GSAs to understand when developing and planning water portfolio options and groundwater replenishment. Consistent with previously stated assumptions in this report, improvements in reliability of the CVP and SWP may be considered as water available for replenishment, depending on how water managers use the new water.

As noted previously, many statewide projects are being evaluated by project-specific analysis. For project-specific results and statuses, please examine the more refined and detailed project information from the various websites shown below.

Websites with refined and project-specific information for statewide projects:

- http://www.water.ca.gov/storage/index.cfm
- http://www.usbr.gov/mp/slwri/
- https://www.usbr.gov/mp/nodos/index.html
- https://www.sitesproject.org/
- https://www.californiawaterfix.com/
- https://www.usbr.gov/mp/vaqueros/index.html
- http://www.lvstudies.com/
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