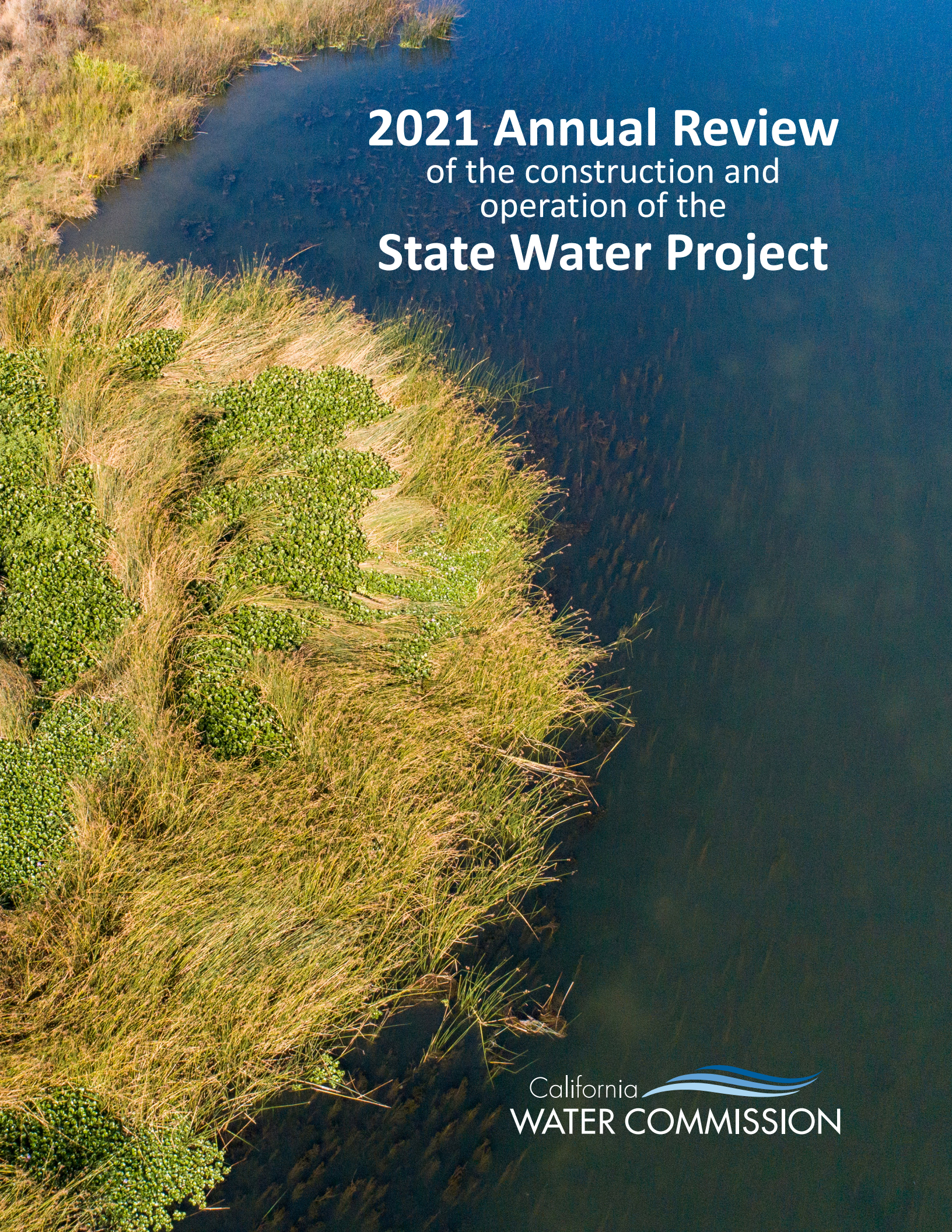

2021 Annual Review
of the construction and
operation of the
State Water Project

California
WATER COMMISSION

TABLE OF CONTENTS

On the cover: Tule and water hyacinth grow in the habitat surrounding the future location of the Lookout Slough Tidal Restoration Project, located in the Cache Slough complex within the southern part of the Yolo Bypass in Solano County. Approximately 3,000 acres of tidal wetlands will be restored through California EcoRestore. The levee will be breached in several places to create an open water habitat for fish and wildlife in the Sacramento-San Joaquin Delta. This project helps mitigate the impacts of the State Water Project. Photo by Florence Low/Department of Water Resources.

2021 CALIFORNIA WATER COMMISSION

Teresa Alvarado, Chair
Matthew Swanson, Vice-Chair
Samantha Arthur
Amy Cordalis
Danny Curtin
Kimberly Gallagher
Alexandre Makler
Jose Solorio
Fern Steiner

Introduction

Planned, constructed, and operated by the Department of Water Resources (DWR), the California State Water Project (SWP) is the nation's largest state-built, multi-purpose, user-financed water project. Built in the 1960s, the system consists of 36 water storage facilities and 700 miles of rivers, pipelines, and canals that supply water to 27 million people and irrigate 750,000 acres of farmland. Thirty percent of SWP water is used for irrigation, mostly in the San Joaquin Valley, and the other 70 percent is used for residential, municipal, and industrial use. In addition to its primary purpose of supplying water, the SWP also provides flood protection, offers recreational opportunities such as boating and hiking, and generates hydroelectric power. Twenty-three pumping plants move water around the state, powered by a system of power-generation and power-recovery plants. The State Water Project is the fourth largest power generator in the state, and by 2045 will be 100 percent zero emissions. DWR operates the SWP in coordination with the federal U.S. Bureau of Reclamation's Central Valley Project, which also moves water throughout California.

It is generally accepted that, under a changing climate, California will experience bigger floods and more extreme droughts. At almost 60 years old, the SWP requires maintenance to aging infrastructure and innovative solutions to meet the challenges of the 21st century, especially how it operates in these more extreme scenarios brought on by a changing climate. The potential impacts of climate change on water resources include an increased ratio of rain to snow in mountainous regions, causing earlier runoff and reduced natural storage in snowpack; increased evaporation and transpiration due to warmer temperatures; increased frequency and intensity of both droughts and floods due to increased variability; and an increased demand for water due to higher temperatures. The SWP is not impervious to these

California Water Commission

The nine-member California Water Commission uses its public forum to explore water management issues from multiple perspectives and to formulate recommendations to advise the director of the California Department of Water Resources, and as appropriate, the California Natural Resources Agency, the Governor and Legislature on ways to improve water planning and management in response to California's changing hydrology. For more information regarding the California Water Commission, visit cwc.ca.gov.

impacts, nor to the wildfires and sea level rise that accompany global climate change. When the SWP was built, there were 16 million people in California, and water was considered more abundant in relation to the population it needed to support. Today, there are 40 million Californians and an increased demand for scarcer water supplies in the state. The role of the SWP is more critical than ever and will continue to be hugely important for supplying water for agriculture, urban areas, and ecosystems in a changing climate.

While the SWP was under construction, the public agencies and local water districts that receive water from the SWP signed long-term water supply contracts with DWR. Today, these 29 public agencies and local water districts are collectively known as the SWP water contractors, and they serve communities in the Central Valley, desert, and coast of California, providing the water on which agriculture, industry, and households depend. The water supply contracts that were signed six decades ago specify the maximum amount of SWP water a contractor may request annually. However, the amount of SWP water available for delivery varies, based on rainfall, snowpack, runoff, water in reservoirs, pumping capacity in the Sacramento-San Joaquin Delta (Delta), and operating constraints that protect fish, wildlife, and Delta water quality. As the climate continues to change, California's hydrologic patterns will shift, and water deliveries will become increasingly variable, impacting water supply reliability for the SWP's users.

The SWP is an important foundation for an entire suite of water supply and resiliency programs implemented by local water agencies that build their water portfolios on dependable water imported from the SWP. From recycling and conservation to water quality management and groundwater recharge, the continued stability of the SWP helps these agencies develop and maintain these important programs and provides a high-quality water source for blending with local resources. Reinvestment in the SWP should fit with local water supply plans and make water supply sources more reliable and sustainable.

DWR Dam Safety Engineer Collin Anderson looks over paperwork during this inspection of a tunnel to the Edward Hyatt Power Plant near Oroville Dam in Butte County, California. This State Water Project facility was completed in 1967, and maximizes power production through a pumped-storage operation where water, released for power in excess of local and downstream needs, is returned to storage in Lake Oroville during off-peak periods and used for generation during peak power needs. Photo by Andrew Innerarity/DWR.

Water Code section 165 requires the California Water Commission (Commission) to conduct an annual review of the progress of the construction and operation of the SWP. This review highlights SWP planning and operations in 2021 and includes findings and specific recommendations for DWR to keep the Commission apprised of operations and construction activities in 2022. The Commission reports its findings and recommendations to DWR and the Legislature.

In 2021, DWR made 15 presentations to the Commission on various SWP topics centered around the theme of **Creating a Resilient State Water Project: addressing climate change and aging infrastructure to provide multiple benefits for Californians**. These presentations are a continuum of the public transparency that the Commission has provided since 1967: They utilize the Commission's public forum to help the public stay informed of DWR's efforts, and they provide the basis of the recommendations that the Commission makes to DWR and the Legislature regarding operation of the SWP.


State Water Project Facilities
DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA
Shasta Lake
Sacramento River
Antelope Lake
Lake Davis
Frenchman Lake
Grizzly Valley Pipeline
Thermalito Diversion Dam Powerplant
Thermalito Forebay
Thermalito Pumping-Generating Plant
Thermalito Afterbay
Lake Oroville
Hyatt Powerplant
Feather R.
Barker Slough Pumping Plant
North Bay Aqueduct
Cordelia Pumping Plant
Clifton Court Forebay
Skinner Fish Facility
Banks Pumping Plant
South Bay Pumping Plant
Del Valle Pumping Plant
South Bay Aqueduct
Lake Del Valle
Gianelli Pumping-Generating Plant
O'Neill Forebay
Dos Amigos Pumping Plant
San Luis Reservoir
Los Banos Reservoir
Little Panoche Reservoir
San Joaquin River
California Aqueduct
Badger Hill Pumping Plant
Devil's Den Pumping Plant
Bluestone Pumping Plant
Polonio Pass Pumping Plant
Las Perillas Pumping Plant
Coastal Branch Aqueduct
Teerink Pumping Plant
Chrisman Pumping Plant
Edmonston Pumping Plant
Tehachapi East Afterbay
Alamo Powerplant
Buena Vista Pumping Plant
Oso Pumping Plant
West Branch
Quail Lake
Warne Powerplant
Pyramid Lake
Castaic Powerplant (LADWP)
Castaic Lake
East Branch
Pearblossom Pumping Plant
Mojave Siphon Powerplant
Devil Canyon Powerplant
Silverwood Lake
Lake Perris
East Branch Extension
Greenspot Pumping Station
Crafton Hills Pumping Station
Crafton Hills Reservoir
Cherry Valley Pumping Station
Citrus Reservoir
Citrus Pumping Station
N
Miles 0 25 50 100 200
Public Affairs Office 11/7/2018

Governor Gavin Newsom and California Department of Water Resources Director Karla Nemeth examine the cracked Lake Mendocino lakebed after a press conference held April 21, 2021, in Mendocino County. The conference centered on the fact much of the West is experiencing drought conditions, and with California squarely in a second consecutive dry year, Gov. Newsom announced he was directing state agencies to take immediate action to bolster drought resilience and prepare for impacts on communities, businesses, and ecosystems if dry conditions extend to a third year. Photo by Andrew Innerarity/DWR.

2021 HIGHLIGHTS

Drought Contingency Planning

In 2021, California experienced its second year of drought – and, with it, never-before-seen climate change impacts related to snowmelt.

On August 1, 2021, Lake Oroville, one of the largest SWP facilities, reached a historic low water elevation of just over 642 feet, which is an equivalent volume of 788,000 acre-feet of stored water. The previous lowest elevation of just under 645 feet occurred in September 1977. Lake Oroville had started the water year on October 1, 2020 with approximately 1.6 million acre-feet in storage. This initial Lake Oroville storage benefitted from a DWR decision the year prior to formally increase the targeted minimum amount of water carried over to the following year by approximately 300,000 acre-feet. This decision was made to better position the SWP in case of future drought conditions.

On April 1, 2021, snowpack in the Feather River watershed was nearly 70 percent of average. While below average, these conditions did not indicate an immediate need for drought actions. However, in April, May, and June, California saw extraordinary conditions, experiencing the lowest precipitation totals for these three months in recorded history. The lack of precipitation in combination with the heat, low humidity, high winds, and dry soils greatly reduced runoff from

the Feather River Watershed into Lake Oroville. As the snowpack melted, only 20 percent of the water content in the snowpack ended up as inflow into Lake Oroville. In contrast, in typical years California sees 60 to 80 percent of the snowpack end up as inflow. A defining characteristic of 2021 drought conditions is how runoff from snowmelt did not materialize as anticipated. This greatly diminished runoff efficiency was unprecedented and is a notable facet of a changing climate related to much higher temperatures than normal, which lead to higher than normal evaporation and drier than normal soils. In the 21st century, there has been a clear trend toward above-average temperatures, which is being factored into water management planning for the coming year.

The unexpected diminishment of runoff in April and May prompted a quick change in focus from planning for potential drought conditions in 2022 to taking immediate actions to manage supplies through 2021. In 2021, DWR coordinated closely with the U.S. Bureau of Reclamation (USBR) – whose Central Valley Project (CVP) shares some Delta water quality requirements – to take a wide variety of drought actions with the primary objective of retaining as much cold-water storage as possible in storage reservoirs, particularly Lake Oroville for the SWP. In 2021, DWR and USBR worked together to:

- seek and obtain modified Delta salinity standards through a Temporary Urgency Change Order issued by the State Water Resources Control Board, allowing more water to be retained in upstream reservoirs;
- install an Emergency Drought Salinity Barrier in the Delta to help protect freshwater supplies from seawater intrusion;
- delay delivery of CVP and SWP south-of-Delta water transfers to the fall to bolster Shasta, Oroville, and Folsom reservoir storage to help reserve cold-water flows for fishery releases;
- release additional water from New Melones Reservoir storage to preserve water in other reservoirs;
- implement a groundwater substitution program on the Sacramento River to bolster Shasta Reservoir storage;
- reduce CVP municipal and industrial water allocations to primarily public health and safety levels to conserve as much water as possible;
- create a Shasta Reservoir warm-water bypass intended to conserve cold-water storage;
- limit fall 2021 rice-decomposition deliveries to preserve storage in upstream reservoirs; and
- support a Sacramento Valley groundwater substitution program to protect Pacific flyway habitat and preserve water storage in reservoirs.

In 2021, DWR was able to provide a water allocation of five percent to its customer agencies, SWP water contractors. Deliveries to senior water right holders on the Feather River were reduced by half, in accordance with the

contracts between DWR and those water right holders. The large majority of deliveries to customer agencies south of the Delta were made with water stored in San Luis Reservoir from the previous winter, while water stored in Lake Oroville was used to make local deliveries to the senior water right holders on the Feather River and, in conjunction with releases from CVP facilities, to meet modified Delta outflow standards.

For the coming water year, SWP and CVP are faced with extremely low end-of-2021 water storage levels and the potential for continued hot and dry conditions throughout the state, putting the state at higher risk of a very low water supply in 2022. DWR is aggressively preparing for 2022 by:

- starting multi-agency coordination earlier than has occurred historically;
- refining forecasting tools to reduce uncertainty;
- together with the USBR, petitioning the State Water Resources Control Board for additional relief on Bay-Delta standards, should continued dry hydrology make that necessary; and
- delaying the removal of the Emergency Drought Salinity Barrier on the West False River and considering installation of additional barriers.

Next year, if extreme drought conditions continue, there may be a need for additional salinity barriers and conservation measures, or a need to seek further modifications of Delta water quality standards.

DWR is working with the SWP water contractors to understand what their unmet human health and safety needs will be for 2022. Guided by its Human Right to Water policy, DWR is prioritizing meeting these unmet human health and safety needs in 2022. Additional priorities include salinity management, protection of endangered species, conserving storage in case of a dry 2023, and meeting other critical water supply needs where possible.

Climate Change Vulnerability Assessment and Adaptation Plan

DWR performs a wide range of activities to support climate change analysis and adaptation planning by local and regional water managers. DWR is also leading by example in developing its own comprehensive Climate Action Plan to guide how DWR is addressing and will continue to address climate change for programs, projects, and activities over which it has authority, including its operations of the SWP. The goal of the Climate Action Plan is to:

1. Reduce greenhouse gas emissions;
2. Conduct consistent and rigorous climate change analysis within DWR programs and projects; and
3. Conduct a climate change vulnerability assessment and implement adaptation actions to protect staff, business operations, and assets.

DWR's Climate Action Plan is divided into three phases:

- Phase I is DWR's Greenhouse Gas Emissions Reduction Plan (GGERP), which covers how DWR will help mitigate the future impacts of climate change by reducing the greenhouse gas (GHG) emissions from its activities. Phase I was completed in June 2012 and updated in 2020. DWR has reduced annual GHG emissions by more than one million metric tons below 1990 levels and achieved its 2020 emissions reduction target five years ahead of schedule.
- Phase II is DWR's framework and guidance for consistent incorporation and alignment of analysis for climate change impacts in its project and program planning activities. In 2018, DWR released its Climate Change Analysis Guidance to guide decision making and assist DWR managers as they incorporate climate change analyses into their planning for DWR activities, including strategic planning, investment decisions, risk assessments, and infrastructure development. This phase ensures that all DWR planning activities meet standards for quality, scientific rigor, and consistency.
- Phase III is DWR's Climate Change Vulnerability Assessment and Adaptation Plan. This phase of the Climate Action Plan evaluates, describes, and, where possible, quantifies the vulnerabilities of DWR's assets and business activities to projected changes in temperature, wildfire, sea level rise, long-term and persistent hydrologic changes (including precipitation, snowpack runoff, and flooding), and habitat and ecosystem services degradation. The Vulnerability Assessment served as a foundation for the development of an Adaptation Plan to help prioritize DWR resiliency efforts such as infrastructure improvements, enhanced maintenance and operation procedures, revised health and safety procedures, and improved habitat management.

Climate Change Vulnerability Assessment

The Vulnerability Assessment, released in February of 2019, examines the vulnerability of DWR staff, facilities, and managed lands to wildfire, extreme heat, sea level rise, long-term persistent hydrologic changes (these are changes that take place over the timespan of years or decades, such as droughts or sea level rise), short-term extreme hydrologic changes (these are changes that take place over days or weeks, such as peak flooding events), and habitat and ecosystem services impacts within the mid-century timeframe of 2030-2070. Vulnerability was determined by looking at each DWR asset's exposure and sensitivity to each of the stressors noted above, and then considering the adaptive capacity for moderately or highly exposed facilities and operations. The Vulnerability Assessment is a key step in identifying how the SWP will be affected by the impacts of climate change noted in the introduction.

The Vulnerability Assessment made the following findings:

- Wildfire: Most facilities are not vulnerable to wildfire because existing practices are considered adequate for protection. However, SWP operations are vulnerable to increased wildfire risk, particularly in the Upper Feather River Watershed, above Oroville Dam.
- Extreme Heat: Some areas have high risk to extreme heat, but most places also have adequate adaptive capacity, meaning existing DWR safety plans and programs could keep the vulnerability of staff at current levels.
- Sea-Level Rise: Although DWR facilities may have high exposure to sea level rise, they have low sensitivity to it, therefore, vulnerability is considered low. However, SWP operations were found to be vulnerable to rising sea levels in the Delta.
- Long-Term Persistent Hydrologic Changes: There is a high likelihood of significant reductions in SWP delivery and storage performance due to long-term persistent hydrologic changes.
- Short-Term Extreme Hydrologic Events: Maximum one-day to three-day flows are projected to increase for all watersheds evaluated, leading to high risks throughout the Central Valley, especially the San Joaquin Valley.
- Ecosystems: Climate change will exacerbate stresses on listed species and habitat types. DWR may need to act beyond what was originally intended to manage or restore lands for mitigation or other purposes.

Climate Change Adaptation Plan

The Climate Change Adaptation Plan helps prioritize resiliency efforts such as infrastructure improvements, enhanced maintenance and operation procedures, revised health and safety procedures, and improved habitat management. Used as more of a dynamic process than a static plan, the Adaptation Plan identifies and develops plans for vulnerable assets; these plans are then implemented and monitored and evaluated. The Adaptation Plan priority focus areas are staff safety, the SWP, Upper Feather River Watershed, and landscapes (ecosystems and habitats) – all of which are related, but considered separately below.

Vulnerabilities associated with the safety of staff responsible for the operations and maintenance of the SWP include delays in work completion, increased costs, and injury and illness associated with extreme heat events. These vulnerabilities can be addressed through the use of the Heat Illness Prevention Plan and specific strategies (e.g., shifting schedules to cooler parts of the day).

The SWP is at risk of reduction in delivery and storage performance due to long-term hydrologic changes. DWR is exploring adaptation strategies, including the effect of monthly reservoir inflow forecasting on system operation, improved multi-objective upper watershed management, and conjunctive management and groundwater recharge, which includes managed aquifer recharge.

The Upper Feather River Watershed is important to the Lake Oroville reservoir. It is critical green infrastructure that supports the operation of the SWP and helps sustain its climate and ecosystem resilience. One of its primary vulnerabilities is exposure to wildfire. Wildfire risk is expected to increase to moderate to high risk by mid-century. Currently, DWR is conducting outreach about its Climate Action Plan, engaging local watershed groups and the Upper Feather River Integrated Regional Management group, holding stakeholder interviews, and inventorying stakeholder priorities for water-related projects in the region. DWR's goal is to collaborate with the local water management groups on mutually beneficial projects, particularly those that build resilience and increase the knowledge of adapting to wildfire. From here, DWR will align stakeholder priorities with DWR priorities, vet the aligned priorities with stakeholder groups, and synthesize priorities in the DWR Adaptation Plan as a pathway for approval of resource investment.

DWR manages thousands of acres of land in California for the sake of mitigating ecosystem impacts caused by the operation of the SWP. These mitigation lands represent a substantial investment. Climate change is projected to negatively impact the quality of ecosystems on DWR-owned and managed lands, creating a risk to DWR's restoration investments and environmental regulatory requirements. The Vulnerability Assessment indicated that climate change will exacerbate existing stressors on listed species and habitats, that degradation may result in additional regulation, and that disruptions to key ecosystem services are more likely. Many of DWR's existing policies, plans, and procedures provide adaptive capacity. As its next steps, DWR will create a comprehensive database of DWR-owned and managed lands, conduct land use scenario modeling, and collaborate with the Delta Stewardship Council on Adaptation Planning in Suisun Marsh.

With its Climate Change Adaptation Plan, DWR is advancing the goal of the Climate Action Plan to implement adaptation actions to protect staff, business operations, and assets, and taking steps to ensure it can continue to meet its mission, including reliably operating the SWP, in the years to come.

Aging Infrastructure

Primarily constructed in the 1960s and 1970s, a large part of SWP infrastructure has been in service for almost 60 years. As with all aging infrastructure, refurbishment, replacement, maintenance, and modifications are needed to secure reliable operation of the system and to ensure public and infrastructure safety. California's increasing population continues to rely on SWP infrastructure to provide water supply, clean energy, and flood protection, which makes addressing issues related to aging infrastructure central to the SWP's operation and to California's water resilience. Given the state's changing climate, there is a need to make sure that the system is maintained holistically so that this statewide infrastructure can continue to deliver its benefits. To do so, DWR is strengthening the SWP's asset management (described further in the Asset Management section

An inside view during motor refurbishment work for one of the units in William R. Gianelli Pumping-Generating Plant which pumps water from O'Neill Forebay into the San Luis Reservoir. Water is released through the plant in generating mode when service area demands are in excess of direct Delta diversions. The San Luis Complex is a joint-use facility between U.S. Bureau of Reclamation and California Department of Water Resources. Photo by Kelly M. Grow/DWR.

.

below), maintenance management, and project delivery programs, policies, and strategies.

The SWP is comprised of civil, mechanical, and electrical infrastructure, each with a unique set of challenges which are amplified by their age, obsolescence, additional demand, regulatory requirements, and additional skilled workforce required to maintain reliability and resiliency of the overall SWP. While DWR has continued to perform maintenance of SWP facilities since the system's inception, as infrastructure ages, the risk of failures and incidents will increase, which will negatively impact reliable operation of the SWP. If DWR does not proactively address the challenges of aging infrastructure, there is a higher risk for events that result in interrupted water deliveries, threaten public safety, and damage private and state property. Aging infrastructure may lead to the system's inability to support the electric grid, leading to increased costs of water and unstable water rates. Timely and efficient delivery of capital improvement projects, in addition to improvements to maintenance practices, are required to ensure the risk associated with aging infrastructure is mitigated.

DWR is taking several steps to respond to the risks associated with aging infrastructure and provide quality and affordable water to SWP water users. DWR is planning aging infrastructure projects based on the implementation of risk-

informed asset management plans for critical SWP infrastructure, and increasing maintenance, refurbishment, repair, and replacement of aging infrastructure to continue meeting demands and to support increased flexibility and water resiliency. DWR utilizes an asset and maintenance management approach to promote long-term reliability and affordability of SWP benefits.

DWR performs condition assessments of its infrastructure by teams of engineers from the Division of Operations and Maintenance (O&M) and Division of Engineering who inspect and evaluate the condition of the assets, develop asset management plans, and create maintenance procedures to be deployed. DWR is enhancing the maintenance tracking system, which helps schedule, perform, and document maintenance. This is overlaid with an analysis of asset performance and risks, in addition to the development of risk-prioritized long-term capital investment plans. Maintenance activities are also evaluated for climate risks using a two-step process. All projects are screened to identify any climate vulnerabilities and a more detailed analysis and design review is completed on those projects that are deemed to have greater sensitivity or exposure to climate change.

DWR is committed to improved project delivery for refurbishment, repair, and replacement projects, ensuring that projects are delivered on time, within scope, and on budget. To deliver projects efficiently and effectively, DWR needs two important tools: 1) applicable contracting methods, such as a design/build approach that positions the construction manager as general contractor; and 2) enhanced project and program management, which DWR is ensuring through dedicated project managers and offices, as well as setting and meeting project management standards.

DWR recognizes that improved maintenance practices, additional skilled technical resources, and improved project delivery processes are required to secure SWP facilities for future generations. In order to execute these programs, policies, and strategies, DWR is increasing the SWP resources allocated to aging infrastructure.

Findings

The Commission finds that, in 2021:

• DWR operated the SWP to safely supply quality water for the benefit of Californians and the environment; provided renewable energy resources and advanced statewide emissions reduction goals; and continued to adapt its business practices to nimbly respond to the ongoing COVID-19 pandemic.

• DWR apprised the Commission of its financial goals, SWP budget, and cost projections, indicating that its 2021 approved SWP budget was $969 million, including operations and capital costs.

• DWR continued to maintain SWP facilities and to provide timely and efficient delivery of capital improvement projects and maintenance practices to ensure that the risks associated with aging infrastructure are mitigated.

• To address the challenges of aging SWP infrastructure, DWR employed its Asset Management Program to use a risk-informed process to prioritize capital and extraordinary operations and maintenance projects for the repair, refurbishment, and replacement of SWP infrastructure.

• DWR advanced dam safety assessments, design and construction projects, and risk management at its dams throughout the state to address aging dam infrastructure and new understandings in seismic and flood hazards.

• DWR gathered data and conducted early design for projects that will address the California Aqueduct's capacity and conveyance loss due to subsidence in the San Joaquin Valley, and moved forward with a long-term planning process to address this issue.

• DWR kept the Commission and the public informed of its plans for a single-tunnel Delta conveyance system, and engaged stakeholders in the consideration of a community benefits program that would create economic and social benefit to the residents, businesses, and organizations facing project impacts.

• DWR is using its 2020 Climate Change Adaptation Plan to explore adaptation strategies for the SWP to improve the system's resilience to climate change.

• In acknowledgement of the fact that the Upper Feather River Watershed and the Sacramento-San Joaquin Delta are critical green infrastructure components that support the operation of the SWP, DWR supported and led projects to enhance the climate and ecosystem resiliency of these areas.

• In partnership with local agencies, DWR furthered Forecast Informed Reservoir Operations (FIRO) in northern California with the intent of operating Lake Oroville more optimally to mitigate the impacts of climate change and create flood management and water supply benefits.

• DWR completed a draft Flexible Resources Study that examines the opportunities and constraints for potential operational and structural upgrades to the SWP to aid California in achieving its climate and energy goals.

• DWR took actions to mitigate the impacts from the 2021 drought and is

involved in early drought planning for 2022 and 2023.

• DWR informed the Commission about key construction activities undertaken in the past year to manage and maintain the SWP, including the installation of an emergency drought barrier to prevent Delta saltwater intrusion.

Recommendations

The Commission recommends that:

• DWR provide the Commission with information about how it is adapting its planning and operations to address the challenges of a changing climate. Specifically:

  • how modelling is integrating 21st century data, and novel weather forecasting is being used to improve water management;

  • how natural and green infrastructure are being managed to strengthen the SWP's climate and ecosystem resilience, particularly in the Upper Feather River Watershed and Sacramento-San Joaquin Delta;

  • how DWR is holistically preparing for long-term drought, large-scale flooding, and massive wildfires;

  • how staff and public safety is being accounted for; and

  • how DWR is working across silos with other state or federal agencies.

• DWR continue to provide the Commission with financial and capacity updates and projections that reflect future resource needs to address the anticipated challenges of climate change. Specifically:

  • how DWR organizes and staffs its teams to address challenges related to aging infrastructure, ongoing operations and maintenance, and new stressors associated with climate change;

  • how DWR will finance climate-resilient infrastructure; and

  • how DWR will align multiple beneficiaries and funding sources to continue to deliver the benefits provided by the SWP over the coming decades.

• DWR keep the Commission apprised of its efforts to advance large-scale infrastructure construction and maintenance in a manner that is inclusive of diverse stakeholders and accounts for the challenges of a changing climate. Specifically:

  • how planning for the new Delta Conveyance Project is progressing, and how DWR is considering impacts to the Delta as place; and

  • how projects to address the near-term impacts of subsidence on the California Aqueduct are being coupled with efforts to stem the underlying causes of subsidence.

• DWR inform the Commission of how it balances the needs of its multiple beneficiaries – including the environment and smaller water districts and communities – over the long term and particularly in years of extreme drought.

Table 1: SWP Water and Power Statistics[1]

Year	Water Delivered (acre-feet)	Power Generated (GWh/year)	Power Used (GWh/year)
2000	3,584,667	6,832	8,518
2001	2,042,118	4,588	6,358
2002	2,850,215	5,631	8,191
2003	3,167,604	6,117	8,862
2004	3,119,578	6,887	9,661
2005	3,627,004	5,661	8,282
2006	3,691,568	7,515	9,109
2007	2,996,629	6,410	9,276
2008	1,950,968	4,100	5,701
2009	1,933,735	4,255	5,438
2010	2,660,960	4,368	7,184
2011	3,596,749	5,258	8,583
2012	2,848,082	4,810	7,404
2013	2,107,572	3,679	5,721
2014	1,079,839	1,426	2,780
2015	1,375,536	1,699	3,483
2016	2,299,679	3,535	6,598
2017	3,732,527	5,011	9,652
2018	1,984,723	2,933	5,723
2019	3,049,485	4,842	7,662
2020	1,457,500	2,484	3,877
2021[2]	1,092,341	1,363	2,659

[1] Source: Department of Water Resources' State Water Project Analysis Office. (In addition to Table A, reported deliveries include Carryover, Article 21, other SWP deliveries such as Settlement, Permit and Flexible Storage, and other non-SWP deliveries such as Dry Purchase, Temporary Transfer and Water Bank Recoveries.)
[2] Through October 31, 2021.

Figure 1: SWP Water Deliveries and Power

SWP Water Deliveries, Power Generation, and Use

The SWP delivered 1,092,341 acre-feet of water in 2021. The SWP water contractors received an initial allocation of 10 percent which decreased to 5 percent on March 3, 2021. During 2021, the SWP facilities generated 1,363 gigawatt hours (GWh) of energy. During the same period, the SWP used 2,659 GWh of energy. The contractors' allocations were based on their maximum Table A amount, which equals 4,172,786 acre-feet for all 29 contractors combined.

Table 1 displays recent years' water deliveries and energy generation and usage. In general, SWP power usage increases with SWP water deliveries. Figure 1 shows that 2021 power generation and power use were the lowest since 2000, and that water deliveries were the second lowest since 2000, with 2014 deliveries being slightly lower. These numbers were driven by the limited precipitation and diminished runoff in 2021.

Flexible Resources Study

In addition to delivering water, the SWP is both a major producer and consumer of electricity. The SWP uses five hydroelectric generating plants and four hybrid pumping/generating plants to generate clean power – a critical multi-benefit function of the system that can be used to help mitigate climate change. The function of the SWP must also adapt to the impacts that climate change will have on its aging infrastructure. DWR sells the power it generates from the SWP to the California Independent System Operator (CAISO) market, mostly during peak

From left, Tony Meyers, Executive Director of DWR's Delta Conveyance Office, and Behzad Soltanzadeh, SWP Operations and Maintenance Assistant Division Chief, in Roseville, Calif., one of two sites where DWR has deployed four temporary power generator units for connection to power plants like the one seen in the rear. Two generators will also be installed in Yuba City. With a potential to place 120 Megawatts to the grid in minutes, potentially avoiding rolling outages, these units are part of a broader effort to safeguard California's energy grid in the face of climate-induced drought, wildfires, and extreme heatwaves. This collaborative project includes DWR, the California Energy Commission, the California Public Utilities Commission, and the California Independent System Operator. Photo by Andrew Innerarity/DWR.

demand hours to help displace fossil generation and lower overall grid greenhouse gas (GHG) emissions. The SWP is also the largest single consumer of electricity in California. Electricity is used to operate the SWP pumping plants, which help deliver water throughout the state. SWP operations are optimized along the following parameters: first, the SWP meets its water delivery obligations; second, it operates within CAISO power market design constraints by consuming more energy during solar hours, which reduces greenhouse gas emissions, and by generating power during super peak hours, which helps displace fossil generation, again reducing greenhouse gas emissions. Because of the SWP's large power demand and its power production for CAISO, which provides electricity to approximately 80 percent of California, there is great potential to utilize the SWP to advance statewide clean energy goals. DWR is continuously engaged with CAISO to better position the SWP to help alleviate some of the challenges that CAISO operators are and will be facing.

There has been an evolution in the state's power market because of California's ambitious greenhouse gas emission reduction targets relative to the rest of the country. SWP must adopt new operational strategies, make physical changes

to DWR-owned facilities, and deploy new technologies to sustain reliable water deliveries and to meet future power market opportunities, challenges, and obligations. On October 9, 2019, Governor Newsom signed Senate Bill 49, Energy: appliance standards and State Water Project assessment (SB 49). The bill requires the California Natural Resources Agency (CNRA), the California Energy Commission, and DWR to collaborate on assessing the opportunities and constraints for potential operational and structural upgrades to the SWP to aid California in achieving its climate and energy goals, and to provide associated recommendations. The implementation of the recommended actions will be a staged process, ultimately driven by SWP reliability needs, economic viability, and the strategic timing and portfolio fit of each action.

The SWP's Flexible Resources Study is an ongoing power planning study that started in 2017 to develop a roadmap for the SWP's future participation in CAISO's evolving market. With the passage of SB 49, the study will be used to investigate how the SWP could provide varying ranges of electrical grid reliability services that could help reduce reliance on fossil fuel energy resources and better integrate renewable resources in California. The goal of the study is to increase the ability to provide grid reliability support and services, enable the integration of renewable resources, reduce overall greenhouse gas emissions, support clean energy policy implementation, and provide recommendations for state and federal funding for specific elements. The nine-track study was broken down by grid reliability benefits, clean energy benefits, and challenges. The study will look at the viability of implementation and needed capital investments. The Flexible Resources Study is a dynamic approach to meeting the state's clean energy goals. The study's scope and recommendations will change over time, evolving as state mandates addressing climate change, technology developments, CAISO's market design, reliability needs, and price trends continue to evolve.

DWR has completed Phase 1 of the Flexible Resources Study, which identified possible improvements to SWP operations to meet statewide energy goals. These improvements include shaping SWP load and generation, reoperation and retrofit of select pumping plants, pumped storage, integrating battery storage with renewable resources, hydraulic and transient modeling and aqueduct stability, real-time market load bidding, adding pockets of energy storage such as battery banks at strategic locations, and the integration of on-site solar generation at pumping plants. The challenges to implementing these improvements include evolution of the power market, escalation in transmission access charges, changing regulatory policies and the CAISO market design, aging infrastructure and inherent constraints, California Aqueduct subsidence, climate change impacts, competing SWP priorities, financial impacts to the SWP water contractors, water demand flexibility, safety and security compliance, and workforce retention.

Short-term (one to three years) opportunities for the SWP to aid California in achieving its climate and energy goals are to continue to align and shape SWP load and generation to respond to grid needs; procure renewables to achieve

DWR's Climate Action Plan goals; offer excess generating capacity to the CAISO market to help other utilities meet their load obligations; actively participate in CAISO stakeholder processes to influence market design changes; maintain industry outreach and develop partnerships on initiatives and projects; monitor power market dynamics and adjust SWP operations and procurement strategies; continue working with the SWP water contractors to develop a vision document for the SWP Energy Roadmap power portfolio; maintain active participation in investor-owned utilities transmission rate case filings at the Federal Energy Regulatory Commission (FERC); and develop the Flexible Resources Study Plan: Phase 2, which will move the proposed opportunities closer to implementation, seek external funding and partnerships, and investigate new planning tracks and concepts.

Mid-term (three to seven years) opportunities are to investigate and implement integration of solar and battery storage at main SWP pumping plants; work with CAISO to enable the SWP to have more latitude in offering more grid reliability services such as frequency regulations and flexible ramping products; implement physical improvements to reduce subsidence impacts on SWP operational flexibility; integrate new technologies at SWP pumping plants to reduce wear and tear on equipment; collaborate with the SWP water contractors on developing a program that coordinates water demand side flexibility; revitalize pump-back operations at the Hyatt-Thermalito complex to provide long duration energy storage services to the grid; and update the SWP Integrated Resources Plan, which is a periodic assessment of the SWP power portfolio that assesses changes in markets and the regulatory space, and adjusts strategies accordingly.

Long-term (seven-plus years) opportunities are to develop plans to achieve a zero emissions power portfolio by 2035; develop plans to neutralize greenhouse gas emissions from the fossil-fuel generating Lodi Energy Center; develop broad plans to integrate energy storage in SWP operations and elsewhere; develop plans to fully resource the SWP portfolio with clean energy; develop bidding strategies to fully hedge SWP positions in the power market; neutralize power costs through deploying supply and demand side flexibilities; collaborate with CAISO and others to develop bi-lateral agreements that can utilize SWP capabilities to support grid reliability; secure right-of-way needed for future power resources developments; and inform energy policy and initiatives to achieve resilient and efficient power market design.

Looking at the short- and mid-term opportunities, DWR has developed an interim action plan which covers actions from 2021 to 2025. The interim action plan includes continuing planning work for Phase 2 of the Flexible Resources Study's nine assessment tracks and additional new tracks; continuing to align SWP load and generation with CAISO's grid needs; monitoring power market dynamics and influencing needed market design changes; continuing outreach to CAISO and other state agencies highlighting the SWP's plans for supporting the grid and the need for partnerships and outside funding; collaborating with CAISO

The Department of Water Resources, along with independent contractors, continue work on restoration measures at Bethany Reservoir. These measures include excavating and backfilling each downstream dam face to repair rodent holes and erosion areas. Bethany Reservoir is part of the State Water Project and is located 10 miles northwest of Tracy, Calif. Photo by Kelly M. Grow/DWR.

to enable the SWP to offer real-time load bidding and frequency regulation; partnering with the SWP water contractors to investigate and deploy demand side flexibility; investigating state and federal funding opportunities; continuing to add renewables to the SWP power portfolio; selling excess SWP resource adequacy capacity to support CAISO's grid reliability needs; continuing to maintain active participation in Participating Transmission Owners rate case filings at FERC; and advocating for more control over escalating transmission access charge cost.

DWR circulated a draft of Phase 1 of the Flexible Resources Study to industry partners for review, consulted with CAISO, and finalized the Phase 1 report in preparation to submit it to the Legislature in early 2022.

Budget and Planning

The SWP annual budget maps out projected expenses for O&M, environmental compliance, debt service, capital projects, and planning programs. The budget addresses aging infrastructure needs central to SWP operation, as well as the anticipated effects that climate change could have on its ability to deliver a reliable water supply. The five-year planning process involves reviewing annual reoccurring programs and extraordinary activities, and projection of the capital project resources needed to secure reliable operation of the system. SWP financial management goals are to ensure transparency and accountability, promote affordability through financial management, develop strategies for funding recreation and fish and wildlife enhancement, standardize processes for planning, address cash flow requirements, and maximize cost-share opportunities.

The SWP has an annual operating revenue of just over $1 billion, which includes planned capital financing of around $300 million, on average. Funding sources include payments from the 29 SWP water contractors, cost-share partners such as the USBR, revenue from power generation, and the Davis-Dolwig fund, annually appropriated under a 60-year-old state law that specifies that the cost of fish and wildlife enhancements and recreation components of the SWP be paid for by an annual appropriation from the state General Fund.

The 2021 approved SWP Budget for annual and capitalized costs was $969 million, with $340 million in planned capital costs and $629 million for programs, projects, and annual O&M costs. SWP plans its annual budget through the Bulletin 132 cost-planning process, aligns the calendar year planning with the fiscal year budget for the Governor's budgeting process, and bills the SWP water contractors on a calendar year basis through an annual statement of charges. Cost projections include personnel costs, operating expenses, and equipment costs. The Bulletin 132 cost planning includes costs for water supply and other purposes such as recreation, fish and wildlife enhancements, and flood control. Cost share for joint-use facilities is also included in the projection.

Power costs are handled separately from the budget for annual and capitalized costs. The power portfolio includes a mix of purchases that mitigate financial risk and manage the project within risk limits for near-, middle- and long-term, working closely with CAISO.

Portfolio/Project Management and Resource Management is a component of DWR's financial management enhancement program, an all-in-one system designed to improve the planning, selection and execution of SWP-funded and resourced programs, as well as staffing and work activities. It allows project and program managers to identify, prioritize, plan, and allocate resources, and is integrated with the state budget process and with DWR's asset management process, described in the following section. Chosen through this process, the top capital O&M projects and their costs from 2021-2023 include:

• Perris Dam Emergency Release Facility	$46 million
• Sisk Dam Seismic Remediation	$37 million
• San Joaquin Field Division Fire and Life Safety	$29 million
• San Luis Field Division Fire and Life Safety	$28 million
• Oroville River Valve Outlet Retrofit	$21 million
• Delta Dam Rodent Burrow Remediation	$20 million
• Bethany Dam Restoration and Rodent Burrow Prevention	$19 million
• Perris Dam Outlet Tower Seismic Improvements	$19 million
• Perris Dam Seepage Recovery	$18 million
• Protective Relay Replacement - Phase 3	$15 million

Asset Management

The SWP Division of O&M Asset Management Program is responsible for developing and implementing asset management policies, strategies, and objectives for operations, maintenance, repair, refurbishment, and replacement of SWP equipment and infrastructure. DWR has been developing its Asset Management Program over the past five years, modeling it after international standards to create a risk-informed process for prioritizing capital projects. Asset management is the primary way in which the SWP ensures that it is repairing, refurbishing, and replacing aging infrastructure so it can continue to supply water and other benefits to California.

Project prioritization is one component of DWR's approach to asset management, and it is used to determine how to do the right work, at the right time, with the right resources. Project prioritization consists of risk identification through inspections, condition assessments, and studies; a risk assessment for each proposed project using a common matrix; and financial management and resource planning. This approach considers mandatory requirements, benefits, risk, and resources to find the right balance between performance, cost, and risk.

DWR has developed a structured and repeatable process based on best practice. A risk assessment is completed for every proposed project using the O&M risk matrix, allowing every project to be objectively compared against another in terms of risk to the organizational goals and the amount of risk reduced if the project is selected. This allows climate change-driven projects to be evaluated against other regulatory and aging infrastructure projects during the project prioritization process. Several climate change vulnerabilities identified in the Climate Action Plan – particularly related to wildfire hazards – have triggered projects that have completed a risk assessment and been approved and executed.

DWR's risk matrix uses criteria based on the SWP Strategic Plan:

- Public safety
- Personnel safety
- Compliance
- Water delivery
- Other SWP purposes
- Reputation
- Financial impact

This assessment also informs management of the risks accepted or carried forward if a project is deferred or not selected. DWR recognizes that risk often cannot be eliminated completely, but can be reduced to acceptable levels. Projects are not the only means of reducing risk. Operational changes, monitoring, response plans, changes in maintenance, and further evaluation are all options that DWR considers.

A drone view of the work being conducted by DWR and their contractors as part of a scheduled subterranean evaluation by drilling through the concrete surface on the State Water Project's Castaic Dam emergency spillway in Los Angeles County. Castaic Lagoon can be seen at the bottom of the spillway. Photo by Kelly M. Grow/DWR.

Project prioritization is performed because there is more work than resources and capacity to do it. DWR's long-term forecast estimates more than $8 billion in capital investment needs over the next 20 years. Each year, approximately 300 projects are identified, with a total cost of $300 million to $400 million. In an average year, DWR has resources for approximately 200 projects. Some projects selected are mandatory, others are chosen based on risk, and others are values-based projects, selected to improve business processes. The results of the annual project prioritization process are a two-year Prioritized Project Plan and a five-year Specialized O&M Project Plan. The annual planning process includes presentations to stakeholders about the projects that DWR will be undertaking in the coming year.

Dam Safety

The SWP system includes 26 dams, designed and constructed in the 1960s and 1970s, that range from the 770-foot-tall Oroville Dam, capable of storing more than 3.5 million acre-feet of water, to the 35-foot-tall Patterson Dam with a 100-acre-foot capacity. Hazard profiles vary, with some having large populations immediately downstream, while others are quite far from population centers.

Some have a flood control component, others are strictly off-line storage with no nearby watershed. Through the SWP Dam Safety Program, DWR commits resources to ensure public safety and minimize risk associated with SWP dams and their appurtenant structures. Risk management prioritizes dam safety issues and aligns decision making with DWR's Asset Management Program.

The Dam Safety Program relies upon commitment and engagement from all levels of DWR. In recent years, DWR has been working to enhance the Dam Safety Program through a series of 16 initiatives to further the resilience and safety of SWP dams. The 16 initiatives were identified in late 2017 and 2018 through a series of program reviews and include the incorporation of risk-informed decision making, increased stakeholder and industry engagement, enhanced training, and formalization of program reviews and progress reporting.

Surveillance is a cornerstone of the Dam Safety Program, and includes early detection, inspections, instrumentation monitoring, and testing with robust data collection and analyses. Many of the instruments in the field, such as piezometers, slope inclinometers, and settlement monuments, were installed following construction of the dams to monitor them during the initial filling and allow the designers to evaluate the dams' early performance. Today, many instruments are installed to monitor potential failure modes or to inform ongoing analyses.

Dam safety assessments are an important component of the Dam Safety Program. They evaluate a facility's performance and design considering modern standards, analysis methodologies, and modeling technologies. Many assessments are driven by changes in the seismic loading or changes in hydrology that dams and watersheds can experience. Detailed inspections and condition assessment of spillways include geologic investigation of the spillway foundations, integrating that data into structural, hydraulic, and erodibility studies.

Design and construction is another critical element of the program, and involves employing conservative design and construction practices in accordance with regulatory requirements and modern industry standards. Identified and prioritized through the Portfolio/Project Management and Resource Management process and currently in design phase, the Perris Dam Outlet Tower Seismic Improvements and Perris Dam Emergency Release Facility projects will create a berm along a major boulevard and convey any emergency release to a channel that leads to the Perris Valley Drain, bypassing a residential community and greatly reducing the inundation area.

Wildfires are recognized as a hazard to dam safety because they can lead to woody debris on lakes, damaged instrumentation, and damage to concrete structures from intense heat. Additional staff was pulled from other field divisions to hold post-fire inspections at the Oroville Dam complex after the Potter Fire of 2020 and at the Frenchman Dam after the Beckwourth Complex Fire of 2021. Both dams were unaffected by the fires, in part due to vegetation maintenance in the surrounding area, which kept heat that would have caused damage away from

In this photo from March 9, 2021, Bosco Constructors personnel lay concrete as subsidence repair work takes place on the California Aqueduct near Lost Hills in Kern County. Photo by Andrew Innerarity/DWR.

key infrastructure. The removal of large woody debris on Lake Oroville has been a routine maintenance activity for Oroville Field Division since its inception. Much of the Upper Feather River Watershed, critical green infrastructure that helps support the SWP's climate and ecosystem resilience, has experienced fires. The SWP Dam Safety Program is working with partners to enhance documentation of debris removal efforts and gain a better understanding of changes in sedimentation, reservoir capacity, and inflows that result in increases in woody debris on the lake. In this manner, the Dam Safety Program is adapting its purview given the emergent threats caused by a changing climate.

The Dam Safety Program's emergency preparedness centers around Emergency Action Plans (EAPs) and is facilitated through tabletop and functional exercises as well as annual EAP seminars with downstream partners and emergency management agencies to build a common understanding of roles and responsibilities and communication channels during an emergency. The SWP has been working on an Emergency Preparedness Initiative that considers not just dams but all other SWP assets and works toward a common alignment on how to approach an emergency.

California Aqueduct Subsidence Program

Central to the 700-mile-long SWP system is the California Aqueduct (Aqueduct), a portion of which is a 220-mile-long canal running along the west side of the San Joaquin Valley. This portion of the Aqueduct is subdivided into two field divisions

for operational purposes. The southerly segment is owned by DWR and operated and maintained by DWR's San Joaquin Field Division. The northerly segment, also known as the San Luis Canal, is a joint-use facility owned by USBR and operated and maintained by DWR's San Luis Field Division. The Aqueduct, along with other key features of USBR's CVP – the Delta-Mendota Canal and the Friant-Kern Canal – operate as a water conveyance system serving the environment, millions of acres of agriculture, and millions of people, including disadvantaged communities (DACs) in southern and central California. The Aqueduct is a linchpin of the state's water security, serves as a key component of the flood management and water conveyance facilities of the Central Valley, and is relied on for groundwater recharge and water transfer and exchange projects.

Groundwater overdraft is causing subsidence across the San Joaquin Valley, with adverse impacts extending throughout the state. Subsidence along the Aqueduct has damaged numerous structures including canal liners, embankments, bridges, turnouts, utility crossings, recorder stations, and gate structures. By making interim repairs and modifying Aqueduct operations, DWR has managed to maintain water deliveries; however, these measures are becoming less effective as subsidence increases. Subsidence has reduced the designed hydraulic conveyance capacity, and continuing overdraft will increasingly disrupt water supplies for vulnerable communities and others. Additionally, subsidence leads to decreased operational flexibility, which reduces an operator's ability to take advantage of lower energy costs while moving water, leading to higher energy costs to deliver the water. Restoring the original design intent of the Aqueduct will reduce the load on the electrical grid during the times of day when the grid is most stressed, resulting in a slower increase in the costs to deliver water through the SWP. These adverse subsidence impacts increase the need and demand for local, state, and federal funding of water supply and flood projects in the Central Valley.

The California Aqueduct Subsidence Program (CASP) addresses the impacts of subsidence on the Aqueduct while also ensuring continued deliveries to water users. The CASP comprises near-term and long-term projects to mitigate the risks posed by the impacts of subsidence and to proactively preserve the Aqueduct's ability to deliver water for the next 75 years. Early implementation projects include ongoing geotechnical investigations; cultural and environmental surveys; and engineering, environmental, economic and social studies to support the evaluation and determination of rehabilitation/replacement projects that will provide the greatest net public benefit resulting from modernization of the Aqueduct. Over the next three years, the projects determined to best remediate the consequences of long-term subsidence will emerge through this alternative evaluation process. Long-term plan development involves considerable outreach to and coordination with communities of interest in the San Joaquin Valley, and close cooperation with the USBR. While attempting to reduce subsidence along the Aqueduct as quickly as possible, DWR will work to avoid redirecting impacts elsewhere, as 87 percent of the community water systems in the San Joaquin Valley rely on groundwater.

In November of 2021, DWR initiated a $100 million funding program to restore capacity to portions of the California Aqueduct, San Luis Canal, Delta-Mendota Canal, and Friant-Kern Canal lost to land subsidence. This state-funded program is part of a cooperative approach to fixing California's water conveyance infrastructure being pursued by local, state, and federal agencies, all of whom will financially support the projects. The program will provide up to $37 million to the State Water Project's California Aqueduct and San Luis Canal, $39.2 million to Friant Water Authority for the Friant-Kern Canal, and $23.8 million to San Luis Delta-Mendota Water Authority for the Delta-Mendota Canal. Recipients will use program funds to pay for planning, permitting, design, and construction of subsidence-related rehabilitation projects. Agencies with funded projects will need to investigate the risk of subsidence and how to prevent continued subsidence. The completed projects will restore up to 50 percent of the capacity of the canals over the next 10 years.

Delta Conveyance Project

Three of five Californians depend on water that flows through the Delta. A major disruption to water moving through the Delta would result in a catastrophic health crisis. Primary risks to existing Delta conveyance are seismic activity and risk of a major earthquake, climate change and sea level rise, and subsidence of Delta islands that puts increased pressure on levees. According to the United States Geological Survey, there is a 72 percent chance of a 6.7 or greater magnitude earthquake occurring in the Bay Area by 2043. Such an event could cause levees in the Delta to fail, crippling the state's ability to deliver clean water. Additionally, as sea levels continue to rise, the inner Delta will be faced with increased saltwater intrusion, which threatens clean water supplies conveyed by the single water diversion point in the south Delta. The proposed Delta Conveyance Project would help protect the reliability of SWP deliveries into the future by modernizing the infrastructure in the Delta to restore and protect the reliability of water deliveries in a cost-effective manner.

The Delta Conveyance Project would create two new water intakes in the north Delta on the Sacramento River, each with 3,000 cubic-feet-per-second capacity, and connect them via an underground tunnel to SWP conveyance facilities in the south Delta. The new facilities would be operated jointly with the existing south Delta facilities and provide flexibility to respond to a changing climate by increasing DWR's ability to capture water during high flow events that come from concentrated periods of rainfall.

DWR is developing an Environmental Impact Report (EIR) to describe the proposed project and alternatives, assess potential environmental effects, and identify mitigation measures to avoid or reduce significant effects. The draft EIR is scheduled to be released for public review and comment in mid-2022. DWR will then respond to comments, finalize the EIR, and make a decision about if and how to move forward. DWR is collaborating with regulatory agencies to develop

operational criteria that comply with the Endangered Species Act, setting capacity limits on how much water could be diverted based on conditions in the Delta. These findings will be incorporated into the Biological Assessment and Incidental Take Permit applications that get filed with the U.S. Fish and Wildlife Service. DWR is also coordinating with the Delta Stewardship Council and will submit a Certification of Consistency with the Delta Plan. To support understanding of Delta geology and Delta conveyance planning, DWR conducted soil boring and cone penetration tests to determine the composition, location, and geotechnical properties of soil materials in the Delta. These investigations will continue in 2022.

DWR conducted four technical workshops during summer 2021 to help prepare members of the public to review the upcoming draft EIR. The workshops provided technical background and information on the CEQA analysis assumptions and methods and provided an opportunity for members of the public to ask questions of technical experts. The workshops focused on SWP operations, fisheries, climate change, and environmental justice.

In conjunction with local communities that could be affected by the project, DWR is developing a Community Benefits Program to create lasting, tangible, and potentially significant economic and social benefits to the residents, businesses, and organizations facing project impacts. The program acknowledges that the direct project benefits, such as SWP reliability, are not located inside the Delta, and the project, if approved, could have potential adverse effects that Delta communities may endure through construction. With that in mind, the Community Benefits Program would offer a defined set of commitments made by DWR that would provide benefits in addition to traditional California Environmental Quality Act (CEQA) environmental mitigation included in the EIR. Based on input from the community, including interviews and several public workshops, the framework for the Community Benefits Program will include two components: The Delta Community Fund would fund projects and programs that empower the local community based on a framework developed through grassroots involvement, and the Project Implementation Commitments are requirements that would be embedded in the project, such as local hiring targets, jobs training and education, local business utilization, and development of local infrastructure and facilities.

DWR has also been working to engage a diverse array of stakeholders in the Sacramento-San Joaquin Delta to ensure that the public outreach and information efforts are conducted in a culturally and community-responsive manner. A survey titled “Your Delta, Your Voice” gathered direct input from communities in the region that may be disproportionately affected by the proposed project. It focused on communities that are historically burdened or underrepresented, people of color, and low-income communities of interest, as well as Tribal entities. The survey had robust participation, with 2,117 total respondents, 540 of whom were Delta region DAC members. The survey results indicated that respondents place

The Lookout Slough Tidal Restoration Project, located in the Cache Slough complex within the southern part of the Yolo Bypass in Solano County. Approximately 3,000 acres of tidal wetlands will be restored through California EcoRestore, an initiative to help coordinate and advance at least 30,000 acres of critical habitat restoration in the Sacramento-San Joaquin Delta over the next four years. Photo by Florence Low/DWR.

high priority on clean air and drinking water, the natural environment, habitat for fish, migrating birds, and wildlife; that there is strong anti-project sentiment; and that people do not understand the potential impacts and benefits of the project. Ongoing public engagement will continue in 2022 to facilitate DAC participation in CEQA public review opportunities.

Green Infrastructure and Multi-Benefit Watershed Management

The SWP is an integral part of California's water system and relies on a complex network of green and traditional infrastructure, much of which needs improved management or modernization to meet current and future challenges. The SWP's central role requires the state, through DWR, to be a key driver of system improvements to adapt to ongoing changes as well as to recover threatened ecosystems. Given the integrated nature of the state's water resources and the imperative to maximize public investments, embracing a multi-benefit approach to developing solutions from the headwaters to the Delta can support the breadth of societal values necessary for a thriving California. For example, vulnerabilities to the Upper Feather River Watershed were outlined in the Climate Change Adaptation Plan. Current meadow restoration efforts there contribute

both to improved water resources and habitat for fish and wildlife. In the mid-elevations, forest management has been shown to reduce the risk of catastrophic wildfires, improve water quality, and provide habitat. And in the Delta, California EcoRestore (EcoRestore), a multi-agency initiative launched in 2015, is advancing complex multi-benefit habitat restoration projects.

The Governor's Water Resilience Portfolio calls on DWR to improve the management and upgrade the infrastructure of the SWP. It also includes actions that call on the SWP to play a role in habitat and species conservation and ecosystem viability, such as expanding wetlands, including mountain meadows, encouraging investment in upper watersheds to promote water quality and supply, and protecting the economic and ecological vitality of the Delta. DWR, through its Integrated Regional Watershed Management Program, has invested in mountain meadow restoration in the Upper Feather River Watershed to promote groundwater capture and infiltration, and to provide habitat. Nonprofit organizations and local water agencies have conducted forest management in the Sierra Nevada mountains to protect the upper watershed and, resultingly, water supplies, and there is an imperative for DWR to do more in this space. Fires burned much of the Upper Feather River Watershed over the past three years, devastating hundreds of thousands of acres of forests, in addition to several communities. DWR will play a partner role with local agencies and communities to help the watershed recover and actively manage the forests to reduce the risk of catastrophic fires in the future, managing the watershed as the key piece of SWP infrastructure that it is.

DWR's EcoRestore program has been working to promote the ecological vitality of the Delta through projects such as the Tule Red Project, a mitigation project for the impacts of the SWP, which offers 300 acres of tidal wetlands for Delta smelt, longfin smelt, and salmon; and the Lower Elkhorn Basin Levee Setback, a multi-benefit project designed to improve flood protection, restore 900 acres of floodplain habitat, improve agricultural sustainability, and improve recreation. The Lookout Slough Project will restore more than 3,000 acres of tidal wetlands, floodplains, and riparian habitat, while reducing flood levels in the Yolo Bypass. This project, funded mostly by the SWP, is a key component of improving the Sacramento River flood system, which protects hundreds of thousands of residents, businesses, and farms in the greater Sacramento region. Altogether, DWR restoration projects in the Delta through the EcoRestore program will total 30,000 acres. This is an important investment in multi-benefit habitat management, but only a fraction of the habitat that once existed in the Delta and of what is needed to meet the challenges of climate change.

To increase the pace and scale of green infrastructure and multi-benefit water management projects currently being conducted, DWR needs to identify and implement best practices in project and program development and delivery mechanisms. Increased investment in green infrastructure is critical and will require developing and maintaining extensive partnerships, streamlining permitting efforts, and integrating communities into projects.

Nick Ellis, Electrical Engineer with DWR's Statewide Monitoring Network Section, services a weather station near Meadow Lake in Nevada County, Calif. Photo by Kelly M. Grow/DWR.

Forecast Informed Reservoir Operations

Hydrology in California is episodic: Just a few storms each year are the core of the state's water supplies. Climate change is exacerbating this variability. Current reservoir management and flood risk analyses depend on historical estimates and statistics of hydrology. Water management infrastructure and policy decisions will likely be tested against climate variability and change not experienced in the past 100-year period of record. Better utilization of advances in forecasting can help abate this situation by allowing for more nuanced reservoir management. If a forecast shows a large storm event approaching, reservoir releases can be made gradually in advance of peak inflow to attenuate peak outflow downstream, yielding greater flood control benefits. Conversely, in the spring, if no storms are forecasted, water can be stored, yielding water supply reliability benefits.

DWR's Forecast Informed Reservoir Operations (FIRO) initiative is a key component of adapting the management of the SWP to climate change. The FIRO initiative aims to provide the information necessary to update flood operations rules in the United States Army Corps of Engineers (USACE) Water Control Manual, and to provide continuous investments in improving forecasting capabilities. DWR is currently focused on weather forecasting in northern California and how improvements could be used to operate Yuba Water Agency's New Bullards Bar facility and DWR's Oroville facility more optimally, and to help mitigate the anticipated increases in extreme hydrologic events associated with climate change. The Yuba-Feather FIRO effort is a partnership between DWR, Yuba Water Agency, USACE, the Center for Western Weather and Water

Extremes at the Scripps institute for Oceanography, National Weather Service, National Marine Fishery Service, and the Sonoma Water Agency, which was an early leader by employing FIRO at Lake Mendocino. The goal of the Yuba-Feather FIRO work is to improve precipitation and reservoir inflow forecasting capability and then translate those improvements into information that can be used to improve reservoir operations on the Yuba-Feather system that provide broad flood management and water supply benefits.

The Yuba-Feather FIRO initiative builds upon the existing Forecast Coordinated Operations Program, initiates research investigations to improve forecasting, and develops and conducts viability assessments for formal operations rule changes, with the intention of informing development of updates to the USACE Water Control Manuals, which are currently dated to the early 1970s. Phase I of the Oroville and New Bullards Bar Water Control Manual Update was completed in September 2021. In mid-2022, the Yuba-Feather FIRO team plans to complete a preliminary viability assessment of FIRO alternatives and transmit those candidate alternatives to the USACE for consideration in the development of new Water Control Manuals for Lake Oroville and New Bullards Bar. The final updates are expected by 2024.

Understanding atmospheric rivers is key to water management for both floods and droughts in California. For FIRO to be successful, it is important to understand when and where these events will occur, and, importantly, when they will not occur – particularly toward the end of the wet season. For this reason, DWR is investing in ocean- and land-based monitoring and meteorological and hydrological modeling improvements to identify oncoming atmospheric rivers and rain and snow levels and soil moisture, which together should produce better estimates of resulting runoff.

Status of SWP Construction Projects

DWR manages the SWP to ensure adequate water supplies are available under various hydrologic and legal conditions while maintaining operational flexibility. The Division of O&M Asset Management Program is responsible for the prioritization of projects for the repair, refurbishment, and replacement of SWP infrastructure. Key construction activities undertaken in the past year to manage and maintain the SWP are occurring across the entire length of the SWP and include all major facility types – dams, canals, pipelines, and pumping and generating plants. These projects represent DWR's efforts to modernize fire and life safety programs, to identify and implement needed repairs, and to refurbish aging infrastructure.

Fire and life safety modernization at Oroville, San Luis, and San Joaquin Field Division facilities
This program was implemented in response to the 2012 Thanksgiving Day fire at Thermalito (Robie) Pump-Generating Plant and covers fire detection and

SWP Construction Projects

alarms, fire suppression systems, protected egress routes, HVAC modifications, new domestic and water lines, and emergency responder communications. In the Oroville Field Division, Thermalito was completed and Hyatt had its final Office of the State Fire Marshal (OSFM) inspection in December 2021. In the San Luis Field Division, OSFM approved 19 design packages, with construction estimated to start May 2022. In the San Joaquin Field Division, full design began December 2021, with construction estimated to start November 2023.

Construction crews working on the temporary emergency drought barrier for the West False River in the Sacramento-San Joaquin Delta in Contra Costa County. The 750-foot-wide rock barrier will help deter the tidal push of saltwater from San Francisco Bay into the central Delta. Photo by Andrew Innerarity/DWR.

Oroville Dam river valve outlet system rehabilitation project
This project will install two 72-inch spherical valves over a 12-month construction schedule, and will include demolition and reconstruction of thrust block, pressure relief wall, and existing hydraulic and electrical equipment; and installation of a new hydraulic system, electrical system, ventilation system, and seat water system. This is a drought- and safety-critical project as it allows DWR to safely meet water delivery requirements during periods of low water elevations at Lake Oroville. This multi-year planning effort requires approval from DWR's Division of the Safety of Dams and, because the Oroville Complex is a power generating facility, the FERC. A construction contract is expected to be advertised and awarded in 2022, with start of construction dependent upon a favorable water year.

Emergency drought salinity barrier to prevent Delta saltwater intrusion in West False River
During extreme drought conditions, the West False River barrier mitigates negative impacts of drought by slowing salinity intrusion into the central and south Delta to prevent contamination of water supplies. The barrier construction was completed in June 2021. Construction of a notch to facilitate fish and boat passage will begin January 2022 and will be refilled in April 2022 to once again protect water quality. The barrier will be fully removed by December 2022.

South Bay Aqueduct reliability improvement program
DWR performed inspection and preventative maintenance and designed repairs along the South Bay Aqueduct pipelines and terminal tank to maintain and improve the reliability of water delivery for South Bay water contractors impacted by the drawdown of Anderson Reservoir for seismic remediation purposes.

An inside view during motor refurbishment work for one of the units in William R. Gianelli Pumping-Generating Plant, which pumps water from O'Neill Forebay into the San Luis Reservoir. Photo by Kelly M. Grow/DWR.

Bethany Dam restoration and rodent burrow prevention project
Rodent burrowing endangers the structural integrity of a dam by weakening the embankment and increasing the risk of seepage. This project ensures dam safety by refacing the dam with wire mesh and armoring it with rip-rap to prevent rodent burrowing. The majority of construction, specifically the armoring, was completed in 2021. Other small components of the project will continue into 2022. The project required a lengthy environmental permitting process due to its proximity to multiple endangered species habitats.

Gianelli Pumping-Generating Plant unit refurbishment project
This project includes redesign, replacement, and refurbishment of rotating and embedded components to Original Equipment Manufacturer (OEM) design. Components are at the end of their service life. Six out of eight units have been refurbished to date; the rest will be completed by 2024.

Dos Amigos Pumping Plant unit refurbishment project
This project includes the redesign, replacement, and refurbishment of rotating and embedded components to OEM design. Components are at the end of their service life. This multi-year effort to complete the six units replaces one unit approximately every two years.

California Aqueduct liner and embankment repair projects
Repair sites along the Aqueduct were identified through SWP Condition

Scaffolding surrounds a partially completed column during this portion of a Castaic Dam Modernization Project whose goal is to allow the facility to better withstand earthquakes' effects by, among other things, wrapping piers with sections of Fiber Reinforced Polymer for the first time. The column in white is a completely wrapped section. Photo by Andrew Innerarity/DWR.

Assessment Teams (explained in the Aging Infrastructure highlight) and were prioritized based upon risk, with repairs scheduled based on operational constraints. Twenty-eight sites were repaired in 2021, with 60 to 80 more sites planned for repair in 2022. Emergency repair work to fix a 1,000-gallon-per-minute leak at milepost 54.95 began in August 2021 and was completed in October 2021; this repair stopped the leak and remediated the embankment and canal liner in that area. The canal liner was raised from milepost 173-213 in response to subsidence, part of the CASP portfolio of projects.

California Aqueduct radial gate maintenance and repairs
DWR conducts ongoing assessment, maintenance, refurbishment, and replacement of the radial gates along the Aqueduct. Beginning in 2021, DWR will be replacing 10 gates within the Delta Field Division, with a completion date of 2025.

Castaic Dam outlet tower seismic retrofit project
One of the first design and construction projects under the Castaic Dam Modernization Program, this project retrofits tower piers with carbon-fiber wrapping and modifies bridge hinges. The project required a reservoir drawdown to the elevation of 1,380 feet above sea level (135 feet lower than the maximum operating water elevation) to allow access to the piers for the installation of the carbon fiber wrapping. Work is on or ahead of schedule due in part to contractor incentives.

Infrastructure controls, communications, and protection assets
This system-wide project includes replacing end-of-life electrical protection and control equipment to stay compliant with increasing regulatory requirements. Equipment has a life cycle of 15 to 20 years. The equipment being replaced includes:

- Automatic voltage regulators that maintain unit voltage within specified limits.
- Protective relays that protect electrical equipment from faults or system disturbances that could severely damage equipment.
- Programmable logic controllers that interface with equipment and instrumentation for local and remote monitoring and control for facilities.

Projects are independent of one another. Completing replacements for the entirety of SWP facilities is a multi-year effort.

Senate Bill 626 – New SWP construction delivery authorization
Senate Bill 626, Department of Water Resources: Procurement Methods (SB-626), signed by the Governor in September 2021, includes two additional public works construction procurement methods effective January 2022, with authorization ending in January 2033. The bill allows contractors to be selected on qualifications and not solely on cost, and to become partners in the development of the project. Risks are reduced or transferred to the contractor, and the construction phase can commence prior to completion of design. Authorization is limited to projects necessary for the construction, maintenance, or operation of elements of SWP facilities, and limited to seven projects under each procurement method. New procurement methods are not authorized for Delta conveyance.

Conclusion

This document fulfills the Commission's requirement to review the progress of the construction and operation of the SWP. The Commission has determined that DWR is working to maintain the operations of the SWP, addressing issues of aging infrastructure, and preparing for and responding to climate change so that the SWP continues to provide multiple benefits to the people, the environment, and the economy of California. The Commission requests that DWR continue to keep the Commission apprised of operations and construction activities in 2022. These findings and recommendations will be presented to DWR and the Legislature.

California
WATER COMMISSION

California Water Commission
P.O. Box 942836
Sacramento, CA 94236-0001

www.cwc.ca.gov