

Water Sector Plan



AGRICULTURAL SECTOR PLAN



BIODIVERSITY AND HABITAT SECTOR PLAN



EMERGENCY MANAGEMENT SECTOR PLAN



ENERGY SECTOR PLAN



FORESTRY SECTOR PLAN



LAND USE AND COMMUNITY
DEVELOPMENT SECTOR PLAN



OCEANS AND COASTAL RESOURCES
AND ECOSYSTEMS SECTOR PLAN



PUBLIC HEALTH SECTOR PLAN



TRANSPORTATION SECTOR PLAN



WATER SECTOR PLAN



Water Sector Plan



Introduction

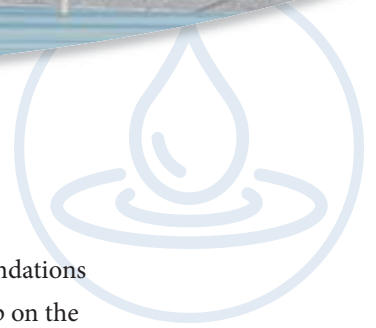
Climate change creates critical challenges for California water resources management. The vulnerability of the water sector to climate change stems from a modified hydrology that affects the frequency, magnitude, and duration of extreme events, which, in turn, affect water quantity, quality, and infrastructure. Warmer temperatures drive the snow line higher and reduce snowpack, resulting in less water for the environment, and urban and agricultural users. Warmer temperatures increase the risk of forest fire, which further affects water supply and temperature. Intense rainfall events will continue to affect the state, possibly leading to more frequent and/or more extensive flooding. The acceleration of sea-level rise will produce higher storm surges during coastal storms. Droughts are likely to become more frequent and persistent during this century. In addition, climate change may make preservation and restoration of habitat more difficult. For example, climate change is expected to warm rivers and streams. Already, summer temperatures often approach the upper tolerance limits for salmon and trout; higher air and water temperatures will exacerbate that problem.

Because California contains multiple climate zones, each region of the State will experience a combination of impacts from climate change unique to that area. Key climate change vulnerabilities for the various hydrologic regions of the State are shown in Figure #WS1. For more in-depth descriptions of regional vulnerabilities see *California Climate Science and Data for Water Management* (DWR, 2015). While significant uncertainties still remain for local precipitation and temperature changes, projections at the regional and statewide levels are already available.

Federal, State, and local water resource managers have multiple tools and institutional capabilities that can be used to adapt water management and limit vulnerability to changing conditions. Nonetheless, meeting the challenges of a rapidly

changing climate will require coordinated and integrated efforts that use a watershed-based approach to design, plan, and manage our water resources and water resource infrastructure to provide multiple benefits while considering natural, social, and built systems.

This plan will outline the specific vulnerabilities associated with ongoing and inevitable climate impacts, the current actions that California State government is undertaking to reduce those vulnerabilities, and a set of next steps that are needed to continue progress in adapting to threats from climate change. The State's climate adaptation strategy, which was updated in July 2014 by the Natural Resources Agency with the report *Safeguarding California: Reducing Climate*



Risk (Safeguarding California), guides ongoing and planned initiatives, and the plan concludes by outlining ways that progress has been made so far. While climate change presents serious challenges for water resource managers in California, this

plan to fully implement the recommendations in *Safeguarding California* is a key step on the road to protect California’s people, economy, and environment.

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Vulnerability Assessment

Major statewide climate change threats to California’s water sector summarized above are described in more detail in numerous State reports, plans, non-governmental reports, and peer-reviewed literature (e.g., California Department of Water Resources 2008, California Natural Resources Agency 2009, California Natural Resources Agency 2014). Climate change vulnerability assessments for the water sector provide the most useful information when they are focused on specific systems or regions of the State. Figure WS-2 shows how each region is expected to warm by the middle of the 21st century. It is clear that each region of the State is likely to experience climate change differently; some portions of the State may get wetter while other areas get drier; warming is expected to be much more severe in the Sierra Nevada than along the coast. Additionally, water resources are, for the most part, managed locally by thousands of different local water management agencies. Local agencies within similar foothill, inland valley, or coastal parts of the State may experience impacts unique to common topography and landscapes throughout large portions of the State. Additionally, each local water agency will have to contend with impacts to their local watershed, as well as the upstream and downstream watersheds that influence local water supply or water quality constraints. Local communities will also have to deal with impacts to any distant watersheds that may provide imported water supplies.

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Specific types of impacts will pose much greater risk for some local resource managers than others (even within the same or adjacent watersheds). For example, sewage collection and wastewater

treatment infrastructure is vulnerable to multiple impacts of climate change. Sea level rise will challenge existing gravity-flow sewer systems and treatment facilities located along the coastline,



and increased storm surges will demand higher hydraulic capacity in treatment systems to sustain existing treatment levels, resulting in increased energy requirements and expensive capital improvements needed to adapt to these changes. The impact of increased drought conditions and the warming environment will lead to less in-stream flow dilution and inflow ambient conditions that require enhanced treatment to address higher levels of toxicity in warmer surface waters. Lastly, increased extreme precipitation events will increase the need to immediately upgrade and expand the capacity of existing sewage collection, wastewater treatment, storm water, flood management, and drinking water infrastructure for resiliency against flooding and spill-related vulnerabilities.

As State government continues implementation of Safeguarding California, the process to iteratively

update this comprehensive adaptation strategy can explore drawing from this combined statewide, regional, and local approach to address identified vulnerabilities. Implementation plans for other sectors of Safeguarding California explore threats at a sector-wide level, but the particularly disparate geographic climate impacts in the water sector set ideal circumstances for prioritizing and establishing case studies for utilizing regional vulnerability assessments. The following pages illustrate continued and new work from the California Department of Water Resources (DWR), and the State Water Resources Control Board (State Water Board) and the nine Regional Water Quality Control Boards (Regional Water Boards), working closely with other federal, State, regional, and local partners, to address the State response to climate vulnerabilities across California.



Figure #WS-1. California's Water Sector Climate Change Vulnerabilities



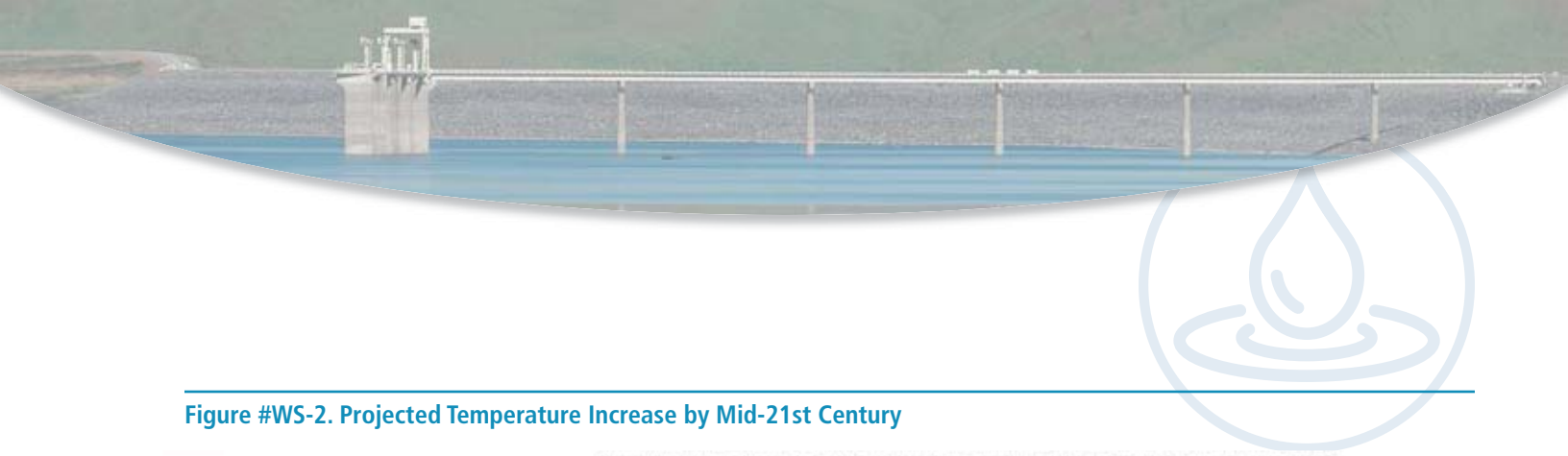


Figure #WS-2. Projected Temperature Increase by Mid-21st Century



For a detailed description of the Western Region Climate Center zones used for temperature projections, and how they differ from California's hydrologic zones, please see California Climate Science and Data for Water Resources Management, page 11, http://www.water.ca.gov/climatechange/docs/CA_Climate_Science_and_Data_Final_Release_June_2015.pdf, DWR, 2015).



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Current Actions to Prepare for Climate Impacts

The State of California has dozens of actions underway to prepare for climate change impacts on the water sector. These actions span the different areas of the water sector including: (1) surface water and groundwater, (2) drinking and environmental water supplies, (3) wastewater, (4) flood flows and storm water, and (5) recycled water.

The actions focus on safeguarding State- and locally-managed infrastructure and resources by supporting current actions, and incentivizing local water managers to plan for future actions to address climate change impacts on local and regional water resources.

I. SAFEGUARDING CALIFORNIA: PRIORITY STRATEGIES FOR REDUCING CLIMATE RISK

A. Vigorously prepare California for flooding

DWR continues to work with other State, federal, and local agencies to improve California’s resiliency and preparedness for the various types of extreme precipitation and high stream flow levels experienced in the past, with expectation of even more extreme events in the future.

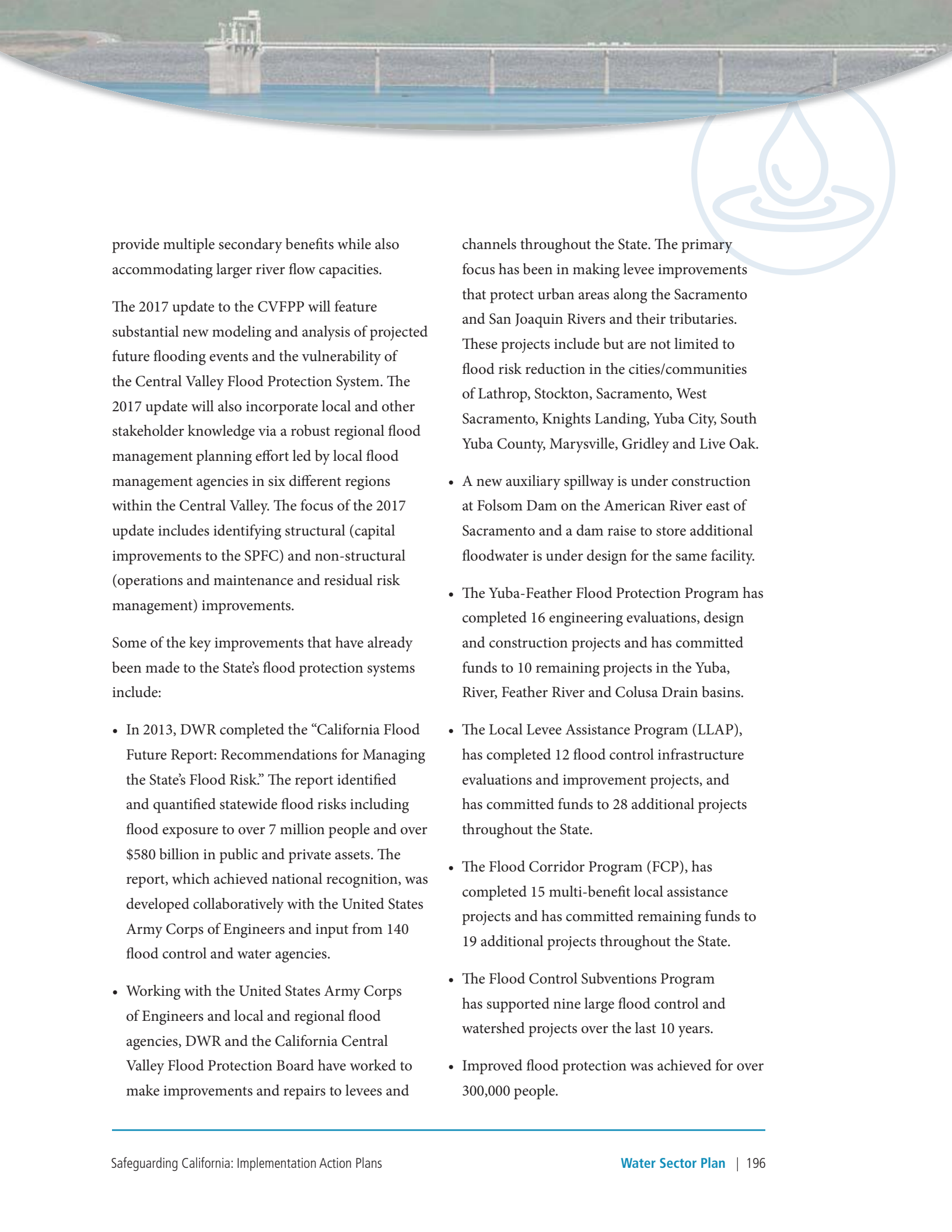
The *2012 Central Valley Flood Protection Plan* (CVFPP) is guiding California’s participation (and influencing federal and local participation) in managing flood risk along the Sacramento River and San Joaquin River that feed into, and are part of the Sacramento-San Joaquin Bay-Delta. The CVFPP is updated every five years. The primary focus of the CVFPP is to address deficiencies in the State Plan of Flood Control (SPFC), which is the name of the State-owned and -maintained flood management system in the Central Valley. The CVFPP will help prioritize Central Valley flood risk reduction and ecosystem restoration investments, including preparing feasibility

level studies for the Sacramento River and San Joaquin River basins. The CVFPP will support State investments and regulatory actions that enhance flood system resiliency, address low-



frequency riverine flooding, integrate programs and resources, and preserve management flexibility for future generations. Despite effective investments in flood management programs and infrastructure, flood risk remains high and is expected to increase over time due to projected population growth and development, California’s existing extreme hydrologic variability, and climate change. Actions such as the expansion of existing river and bypass channels through levee setbacks, creation of new flood bypass channels, and development of wildlife and fisheries habitats in the bypass system, all creating open space and integrating with recreation activities, could

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provide multiple secondary benefits while also accommodating larger river flow capacities.

The 2017 update to the CVFPP will feature substantial new modeling and analysis of projected future flooding events and the vulnerability of the Central Valley Flood Protection System. The 2017 update will also incorporate local and other stakeholder knowledge via a robust regional flood management planning effort led by local flood management agencies in six different regions within the Central Valley. The focus of the 2017 update includes identifying structural (capital improvements to the SPFC) and non-structural (operations and maintenance and residual risk management) improvements.

Some of the key improvements that have already been made to the State's flood protection systems include:

- In 2013, DWR completed the "California Flood Future Report: Recommendations for Managing the State's Flood Risk." The report identified and quantified statewide flood risks including flood exposure to over 7 million people and over \$580 billion in public and private assets. The report, which achieved national recognition, was developed collaboratively with the United States Army Corps of Engineers and input from 140 flood control and water agencies.
- Working with the United States Army Corps of Engineers and local and regional flood agencies, DWR and the California Central Valley Flood Protection Board have worked to make improvements and repairs to levees and

channels throughout the State. The primary focus has been in making levee improvements that protect urban areas along the Sacramento and San Joaquin Rivers and their tributaries. These projects include but are not limited to flood risk reduction in the cities/communities of Lathrop, Stockton, Sacramento, West Sacramento, Knights Landing, Yuba City, South Yuba County, Marysville, Gridley and Live Oak.

- A new auxiliary spillway is under construction at Folsom Dam on the American River east of Sacramento and a dam raise to store additional floodwater is under design for the same facility.
- The Yuba-Feather Flood Protection Program has completed 16 engineering evaluations, design and construction projects and has committed funds to 10 remaining projects in the Yuba, River, Feather River and Colusa Drain basins.
- The Local Levee Assistance Program (LLAP), has completed 12 flood control infrastructure evaluations and improvement projects, and has committed funds to 28 additional projects throughout the State.
- The Flood Corridor Program (FCP), has completed 15 multi-benefit local assistance projects and has committed remaining funds to 19 additional projects throughout the State.
- The Flood Control Subventions Program has supported nine large flood control and watershed projects over the last 10 years.
- Improved flood protection was achieved for over 300,000 people.



- Over 10,000 acres of agricultural land and 5,000 acres of wildlife habitat have been preserved.
- Over 225 miles of levees have been evaluated or improved.
- Approximately 5,000 acre-feet of floodplain transitory storage have been added.

Through research partnerships, DWR is also working with State, local, and federal partners to improve our scientific understanding of the climate system and use that knowledge to reduce flood risk. DWR is working with the National Oceanic and Atmospheric Administration and the research community to:

- Improve the State’s forecasting capability for seasonal precipitation and climate to provide reservoir managers with better information about future seasonal outlooks.
- Develop atmospheric river-based methods for water supply and flood management planning and operations to improve prediction of, and management of, storm waters that serve as the core of California’s water supply while concurrently posing the greatest risk of flooding.
- Improve forecast-based operations that will allow reservoir operators to manage reservoir storage levels according to actual detailed upstream watershed conditions and forecasted storms.
- Preserve existing reservoir storage for improved flood protection, proper management of surface drinking water supplies, and appropriate

reservoir releases to maintain minimum in-stream flows.

DWR is also supporting the development of regional flood management plans (RFMPs) developed to increase institutional relationships within the Central Valley that lead to

greater regional self-reliance and a broader focus on capital improvements that provide greater resiliency toward managing flood waters in a highly uncertain future. The RFMPs identified more than

580 actions that could be implemented to reduce existing and future flood risk, including calls to reform the National Flood Insurance Program to allow agricultural activities in floodplains, and the need for increased funding of annual flood system maintenance and operations activities at the local, State, and federal levels.

The State Water Board and the Regional Water Boards hold regulatory responsibility for controlling storm water pollutant discharges into surface and ground waters. The Water Boards implement federal and State regulatory requirements through permits for large communities, small communities, Caltrans, and industrial and construction activities. The Water Boards update these permits every five years to

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incorporate modified requirements which can address further impacts to the State's water quality and water supply from climate change. Water Board permits include provisions that allow for the necessary adaptation to impacts from extreme precipitation, extreme low and high stream flow conditions (due to both drought and flooding), and erosion and sediment control.

In 2016, the State Water Board adopted a Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy; for more details see section I.H), a high-level planning effort that incorporates the recently-established storm water watershed planning and funding programs and future projects needed for the State to use storm water as a resource (no longer viewing storm water as a polluted nuisance). In addition to capturing and treating storm water, the Storm Water Strategy results in local storm water management that produces multiple benefits, including reduced or attenuated flooding of downstream utilities, facilities, and water bodies, and increased coordination and cooperation among wastewater, storm water, flood management, transportation, and drinking water agencies.

All of California's continuing investments in flood control systems will reduce, but will never completely eliminate, the risk of floods. Public awareness, education, and involvement are important strategies for alerting the public to residual risks. Each year, DWR notifies more than 350,000 property owners whose properties receive protection from SPFC facilities. Each notice alerts the property owner to the source of potential

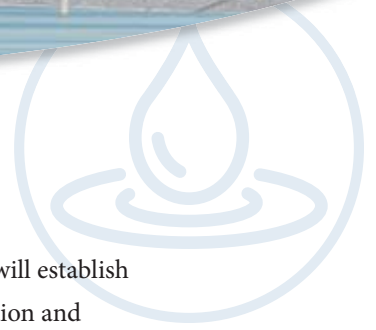
flooding and focuses on flood risk preparedness, prevention, and protection. A program website provides enhanced flood risk information, and an interactive viewer that allows property owners to enter a property address and view related levee flood protection zone maps.

Emergency preparedness, response, and recovery are also important components of managing residual flood risks. DWR, in cooperation with the Office of Emergency Services (OES) and other State, federal, and local agencies, continues to invest in, and prepare for, emergency responses to flooding, including:

- Development of flood safety plans at all levels of emergency response.
- Establishment of command and control structures at the local and county level for flood emergency response.
- Establishment of regional stockpiles of resources.
- Development of mutual aid agreements and response protocols specific to flooding, sewage spills, and drinking water system contamination and failures.
- Development of training and practice programs for emergency response agencies and personnel.

B. Support regional groundwater management for drought resiliency

The Governor signed the Sustainable Groundwater Management Act (SGMA) into law on September



16, 2014. This legislation defines sustainable groundwater management as the “management and use of groundwater in a manner that can be maintained during the planning and implementation horizon without causing undesirable results (Water Code Section 10721 [u]).”

The legislation requires the formation of groundwater sustainability agencies (GSAs) in all high- and medium-priority groundwater basins under the California Statewide Groundwater Elevation Monitoring (CASGEM) program by June 30, 2017 (Water Code Section 10735.2 [a]). GSAs in basins subject to critical conditions of overdraft are required to be managed under a groundwater sustainability plan (GSP) by January 31, 2020 (Water Code Section 10720.7 [a] [1]), while all other high- and medium-priority groundwater basins are to be managed under a GSP by January 31, 2022 (Water Code Section 10720.7 [a] [2]). Each GSA is required to establish a sustainability goal and achieve that goal within 20 years of implementing its GSP. The sustainability goal requires achieving groundwater sustainability without causing significant and unreasonable “undesirable results.”

SGMA provides GSAs with incentives, tools, authority, and guidance to achieve local sustainable groundwater management. The development and implementation of SGMA plans will help achieve improved water supply reliability, resiliency, public health and safety, ecosystem services, and a stable California economy.

DWR’s responsibilities under SGMA will establish a new framework for the implementation and assessment of GSPs in California. A key outcome of this framework will be established standard methods and assumptions for baseline conditions concerning hydrology, water demand, and regulatory restrictions affecting surface water availability and surface water supplies. DWR will adopt a common set of methods, assumptions, and standardized approach for evaluating the effects of climate change on future water supply reliability and groundwater management practices. Providing GSAs with a standard approach for evaluating potential climate change impacts will help GSAs more accurately develop and implement the appropriate adaptive management options needed to maintain local groundwater sustainability.

SGMA authorizes the State Water Board, under a limited set of circumstances, to intervene in local groundwater management in order to protect groundwater resources in areas where local and regional agencies are unable or unwilling to sustainably manage the groundwater. State intervention requirements remain in place until local efforts are able to sustainably manage groundwater resources. In some circumstances, the State Water Board may, in consultation with

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DWR and through a public process, identify groundwater basins as probationary and develop interim sustainability plans for those basins. The interim plan remains in effect until the State Water Board finds that local efforts will likely achieve groundwater sustainability.

C. Diversify local supplies and increase water use efficiency

Increasing regional self-reliance and diversification of local water supplies, and maximizing water conservation and water use efficiency will enable Californians to better respond to changing economic and climatic conditions while ensuring a reliable water supply for the diversity of the State's water needs. These strategies must ultimately be implemented by local and regional water management agencies throughout the State, but DWR, the State and Regional Water Boards, and other State agencies are promoting local water supply development projects, and local conservation and efficiency projects, through State policies that allow, and multiple financial and technical assistance programs that incentivize, the following:

- Water appliance and fixture rebate programs.
- Agricultural water use efficiency grants.
- Desalination grants.
- Turf replacement grants.
- High-efficiency toilet retrofit program.
- Agricultural water management plan assistance.
- Water-Energy Technology (WET) Grant Program.

- Water-Energy Grant Program.
- Water Recycling Grant Program.
- Clean Water State Revolving Loan Fund Program.
- Drinking Water State Revolving Loan Fund Program.
- Update of State Model Water Efficient Landscape Ordinance.
- Local Assistance Program.
- Emergency Drinking Water Assistance Program.
- Storm Water Management Grant Funding Program.
- Conservation Rates Program.
- Groundwater Management Grant Funding Program.
- Integrated Regional Water Management (IRWM) climate change technical assistance.
- Statewide campaign to promote drought-tolerant landscapes.



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The State Water Board adopted the Recycled Water Policy in 2009 to encourage use of recycled water as a water supply, and streamline permitting of recycled water projects, which in most regions will diversify the local water supply options. A State mandate was established to increase the



use of recycled water in California by 200,000 acre-feet per year by 2020 and by an additional 300,000 acre-feet per year by 2030. Regulations for groundwater replenishment using recycled water became effective in 2014, and are incorporated into Recycled Water-related regulations. The State Water Board, through its Division of Drinking Water, has been mandated by the Legislature to adopt regulations for augmenting surface water supplies with recycled water by December 31, 2016, and to submit a report to the Legislature by December 31, 2016 the feasibility of promulgating regulations for direct potable reuse of recycled water. An expert panel has been working since mid-2014 to determine if the proposed regulations for surface water augmentation of recycled water are sufficiently protective of public health and to give the State Water Board their assessment of the feasibility of adopting regulations allowing for the direct potable use of recycled water. This panel will complete its work by mid-2016. It is anticipated that recycled water surface water augmentation regulations will be adopted by the end of 2016, and a report on the feasibility of using recycled water for direct potable reuse will also be completed. Both of these milestones will make significant progress toward making recycled water a viable alternative potable water supply source.

The State Water Board's Storm Water Strategy (for more details see section I.H) to incentivize statewide use and redefine storm water as a resource will contribute to diversification of local supplies through, but not limited to, replenishment of depleted groundwater aquifers, increased storm

water use for local irrigation and non-potable water demands, increased flows in local streams and rivers, incentives for regionalization of local utilities, increased regional and local community partnering, and joint-involvement in regional and local water resource management.

The State Water Board has adopted Storm Water Grant Funding Guidelines to establish the process and criteria that the State Water Board will use to administer grants for multi-benefit storm water management projects funded by the Proposition

1 Storm Water Grant Program Funding. Proposition 1 is a water bond measure that, among other funds, authorized \$200 million in grants for multi-benefit storm water management projects to assist in adapting water infrastructure systems to climate change and

to provide incentives for water agencies throughout each watershed to collaborate in managing the region's water resources. The State Water Board has also adopted Storm Water Resource Plan Guidelines to provide guidance for development of storm water resource plans or functionally equivalent plan(s) required by the recent amendments to the California Water Code prior to receiving State grant funding for storm water projects.

The State Water Board provides grant and loan funding for the planning, design, and construction of water recycling projects that offset or augment State fresh water supplies.



The State Water Board provides grant and loan funding for the planning, design, and construction of water recycling projects that offset or augment State fresh water supplies. The purpose of the Water Recycling Funding Program is to promote the beneficial use of treated municipal wastewater by providing technical and financial assistance to agencies and other stakeholders in support of water recycling projects and research. Increase in treatment and cost of municipal wastewater discharges to surface waters impacted by climate provides additional recycling incentives for recycling of municipal wastewater. Higher levels of treatment for inland surface water dischargers to respond to lower flows and higher temperatures in receiving waters move those sanitation agencies closer to attaining the level of treatment required for recycled municipal wastewater per Title 22 reuse requirements.

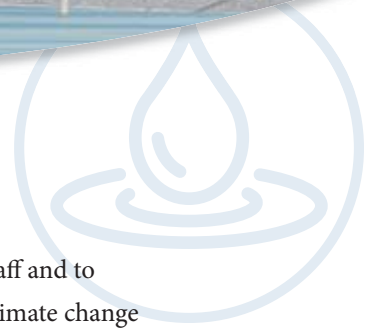
In addition to providing financial assistance for storm water and recycling water actions, the State Water Board has been promoting water conservation measures through implementation of statewide water conservation requirements and establishment of required local water agency conservation levels, which has both climate adaptation and mitigation benefits. Additionally, water conservation principles are incorporated in State and Regional Water Board resolutions, actions and permits, either directly through conservations measures and indirectly through permitting and incentives for increased use of recycled municipal wastewater, storm water, and grey water for agriculture and municipal irrigation.

Specifically addressing mandated water conservation, in May 2015, the State Water Board adopted an emergency regulation requiring an immediate 25 percent reduction in overall potable urban water use, in accordance with the Governor's Executive Order B-29-15. The regulation uses a sliding scale for setting conservation standards so that communities that have already reduced their consumption through past conservation have lower mandates than those that have not made such gains since the last major drought.

The State Water Board continues to work closely with water suppliers to implement the regulation and to support improved local efforts where conservation savings are falling short. In November 2015, the Governor issued an additional Executive Order directing the State Water Board to extend and revise the emergency water conservation regulations based on conditions through January 2016. The Board will consider the proposed emergency regulation extension in February 2016.

DWR is also continuing to implement its flagship local assistance program, the IRWM Program by awarding the remaining Proposition 84 grant funding and launching the Proposition 1 IRWM

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grant program. In total, California approved \$23.2 billion in water bonds between 2000 and 2013 (California Department of Water Resources 2013), a significant portion of that investment has gone to local agencies through financial and technical assistance programs.

In addition to providing funding through grant and assistance programs, DWR has undertaken a number of studies to determine how local water management agencies are addressing climate change in their planning processes.¹ These studies are designed to learn more about the challenges of conducting local level climate analysis and adaptation planning and to identify opportunities to simplify and streamline the process. DWR is also using the information gathered in the studies to develop new tools and resources to support climate change planning at the local and regional level. To date, DWR has completed studies looking at how urban water suppliers (urban water management plans), regional water management groups (integrated regional water management plans), and regional flood planning agencies (regional integrated flood plans) have addressed climate change in their planning processes. DWR also recently completed an evaluation of its 2011 *Climate Change Handbook for Regional Water Planning*, which is the key resource used by most regional water management groups.² Regional climate change specialists continue to be stationed by DWR in each of its four regional offices to work

directly with local and State agency staff and to provide direct technical support for climate change planning.

Water-use efficiency and conservation also provide adaptation for the energy sector by reducing the amount of energy needed to extract, convey, treat, deliver, and use water and wastewater. DWR, CPUC, and other State agencies are actively involved in efforts to better understand the water-energy nexus and to leverage resources for water efficiency improvements that provide energy benefits and energy efficiency improvements that provide water benefits. Additional water-energy-GHG work is also being done by the California Air Resources Board, DWR and others to promote GHG emissions reductions and climate change mitigation through the Climate Change Scoping Plan and AB32.



More than
25
million
Californians get their
drinking water from
the Delta.

D. Reduce Sacramento-San Joaquin River Delta climate change vulnerability

The Sacramento-San Joaquin River Delta (Delta) is the largest estuary on the West Coast, and is home to many threatened and endangered species, as well as a historic agricultural community. The Delta is also an important part of California's water supply system. Approximately 50 percent of all

¹ http://www.water.ca.gov/climatechange/docs/IRWM_CCReport_Final_June2012_EConrad_UCBerkeley.pdf
http://www.water.ca.gov/climatechange/docs/UWMPClimateChangeReport_Final_June2013.pdf
http://www.water.ca.gov/climatechange/docs/IRWM_RFMP_FinalReport_May2014.pdf

² <http://www.water.ca.gov/climatechange/CCHandbook.cfm>



runoff in the State flows through the Delta. More than 25 million Californians get their drinking water from the Delta; agriculture relies on water from the Delta to irrigate thousands of acres. But the Delta is severely threatened by climate change. Larger, more severe, storms will send larger flood flows through the Delta. At the same time, sea level rise will increase the amount of sea water intruding into coastal groundwater aquifers and the estuary from the Pacific Ocean. Both of those impacts will place additional stress on the groundwater drinking water and irrigation water supply, the Delta's already fragile levee system, and the deeply subsided Delta islands. As climate change reduces water supplies and increases water demands (as a result of higher temperatures), additional stresses are being placed on the Delta and other estuaries along the California coastline.

As discussed in the Forestry Sector, much can be done in the upper watersheds and source areas that feed the rivers that flow into the Delta to buffer the effects of climate change. In addition, DWR has several ongoing programs aimed at addressing climate impacts within the Delta itself.

- The largest investment aimed at reducing Delta vulnerability to climate change is the proposed California WaterFix project. This project will use water system upgrades to protect the State's water supplies from climate change. The upgrades will protect against water supply disruption from failure of aging levees resulting from sea-level rise, earthquakes, and flood events. The proposed new facilities will provide

greater operational flexibility so that statewide water supplies can be better managed during all hydrologic conditions. In July 2015, a partially recirculated draft environmental impact report/supplemental draft environmental impact statement

(EIR/EIS) was released for the Bay Delta Conservation Plan/California WaterFix. A final EIR/EIS is anticipated in spring 2016. More information about the California WaterFix is available at: <http://www.californiawaterfix.com/>

- Since the late 1990s, DWR's West Delta Program has been investigating subsidence on Delta peatlands. In 2008, large-scale pilot projects were implemented to investigate wetland crops (rice and tule) impacts on subsidence, water quality, and air quality. Monitoring air quality impacts since 2008 has shown that growing wetlands has a net greenhouse gas (GHG) benefit of 7 to 15 tons of CO₂ equivalent per acre per year. As a result, DWR is currently implementing a strategy to convert significant acreages of marginal farmland on Sherman and Twitchell islands into wetlands. To date, approximately 2,400 acres have been converted and another 1,100 acres will be converted to wetland crops by 2017.

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- Additionally, the West Delta Program is working with a few other agencies to develop a GHG protocol for wetlands in the Delta and coastal regions. The protocol was submitted to the American Carbon Registry in June 2015, and will ultimately be submitted to the California Air Resources Board for its review and approval in early 2016. Expanding upon this effort, DWR and local reclamation districts recently received a \$10.5 million grant from the California Department of Fish and Wildlife’s GHG Grant Program to construct additional wetland projects on Sherman Island, and to investigate GHG sequestration Delta-wide. Partnering with University of California, Berkeley, DWR will quantify GHG emissions from common agricultural practices, as well as continue to quantify GHG sequestration rates from wetland treatments, ultimately yielding mathematical models that will predict the net GHG flux based on easily acquired field information.
- In 2010, the State Water Board prepared a report that included the volume, timing, and quality of flow for fishery protection under existing conditions. In order for any flow objective to be established, the State Water Board must consider and balance all competing uses of water in its decision-making. Recognizing that changes in existing conditions may alter the need for flow, and as our understanding of the Delta improves, the State Water Board intends to develop and establish the framework for adaptive management to review and modify flow criteria in the Delta that is responsive to scientific

advances, changing environmental conditions including climate change, and changes in conveyance and water operations.

E. Prepare California for hotter and drier conditions and improve water storage capacity

In November 2014, California voters passed Proposition 1: the Water Quality, Supply, and Infrastructure Improvement Act of 2014. The Act allocated \$2.7 billion to the California Water Commission (CWC) to fund the public benefits associated with water storage projects, which include ecosystem improvements, water quality improvements, flood control, emergency response, and recreation. The CWC is implementing the requirements of the Act through the Water Storage Investment Program (WSIP). The projects funded through the WSIP must improve operations of the State water system, be cost effective, provide a net improvement in ecosystem and water quality conditions, and provide measurable benefits to the Delta ecosystem or its tributaries. WSIP will be developed and implemented in accordance with Executive Order B-30-15 and special consideration will be given to actions that build climate preparedness and reduce GHG emissions, take flexible and adaptive approaches for uncertain climate impacts, protect the State’s most vulnerable populations, and consider natural infrastructure solutions. Box WS-1 provides an example of a storage project that could be partially funded through WSIP and how the project’s benefits change as the climate changes.



Water quality standards adopted by the State and Regional Water Boards are the foundation of municipal and industrial permits that protect and restore the chemical, physical, and biological integrity of the State’s surface and ground waters. Hotter and drier conditions with climate change are expected to affect water quality in many ways, and the Water Boards will continue implementing

adaptive strategies to ensure continued efficacy of regulatory programs to achieve and maintain compliance with water quality objectives for continued protection of beneficial uses. For example, critically low stream flows are noted more often in the State’s inland surface waters due to drought conditions; in the past, the Water Board regulatory permits may have allowed for dilution

Box #WS-1 North of Delta Offstream Storage Project

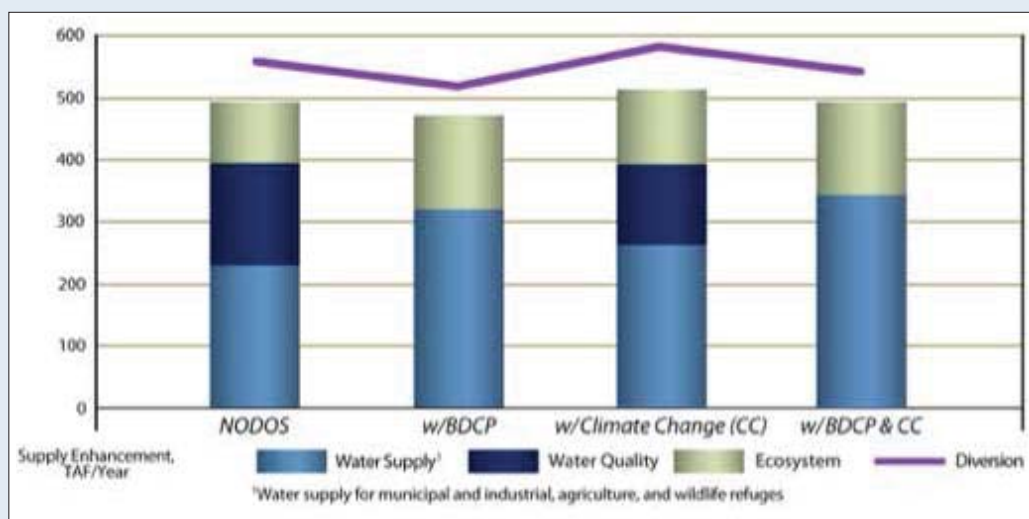
The North of Delta Offstream Storage (NODOS) investigation evaluated the performance of a surface storage reservoir located in Sites, California, about 10 miles west of the Sacramento River. Water would be pumped into the reservoir from various sources when excess flows are available and would be released from storage when additional water is needed. The project was evaluated with potential alternative futures, including four climate change scenarios and three Bay Delta Conservation Plan (BDCP) conveyance and operations scenarios. In 2015, the BDCP was transitioned and reconfigured and is now known as the California WaterFix. While the operations of NODOS were modified to

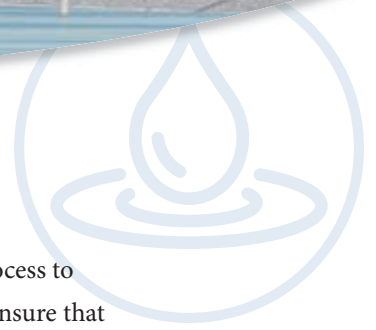
accommodate alternative futures, sensitivity studies indicate that NODOS performance would be resilient.

Figure #WC-3 shows a comparison of NODOS performance with alternative futures. For example, water diversion to fill NODOS would be reduced by 7 percent with BDCP, increased

by 4 percent with climate change and sea level rise, and decreased by 3 percent with both climate change and BDCP. NODOS water quality actions would not be needed with the BDCP scenarios because BDCP would provide significant water quality improvements with its north Delta diversion location. With BDCP, NODOS water would be shifted for uses supporting restoration and increasing water supply reliability. Both water supply reliability and restoration benefits would be increased with each alternative future as compared to the No Action future. Total benefits would be decreased by 4 percent with BDCP, increased by 4 percent with climate change, and unchanged with both.

Figure #WS-3. NODOS Climate Change Resilience Analysis





credits, reducing the level of treatment needed by municipalities discharging community wastewater. To maintain existing water quality objectives in the same streams experiencing lower stream flows, the dilution credits may no longer be granted to inland wastewater effluent-dominated water bodies. Similarly, the water temperatures of our inland streams and rivers is increasing; warmer ambient water temperatures, with accompanying changes in pH, creates a more toxic condition for aquatic life with the same level of ammonia in the municipal wastewater discharge. Maintaining water quality objectives incentivizes communities to proceed with other compliance options to meet water quality requirements in these circumstances, such as recycling the treated wastewater, thus augmenting local water supplies.

Additionally, in 2013, the State Water Board adopted a statewide Aquifer Storage and Recovery permit. This permit allows water purveyors to store water of drinking water quality in a local aquifer (as allowed by a water rights permit). Examples of communities that have proceeded with aquifer storage and recovery projects to add another layer of resilience to local water supply include the cities of Roseville, Woodland, and Davis.

F. Address water-related impacts of climate change on vulnerable and disadvantaged populations and cultural resources

Vulnerable and disadvantaged populations and cultural resources face significant water-related impacts of climate change, as the 2012-2015 drought has shown (e.g., poor water quality, increased costs). DWR has taken a lead role

through the California Water Plan process to identify the key actions necessary to ensure that disadvantaged communities receive an equitable distribution of benefits from State processes and programs. Objective 13 of *California Water Plan Update 2013* includes multiple key actions necessary to ensure these communities receive equitable distribution of State resources.

In 2014, DWR published *Californians without Safe Drinking Water and Sanitation*, which looks more deeply into where Californians lacked safe drinking water and sanitation, the challenges those communities face, and the progress that has been made in the

10 years since the previous investigation of these conditions was conducted.

In 2015, the State awarded \$28 million, funded by the Greenhouse Gas Revolving Fund (proceeds from cap and trade allowance auctions), for water-energy-GHG grants.

More than \$22 million (80 percent) was given to disadvantaged communities.

The California Conservation Corps (CCC), which enrolls young men and women to complete public service conservation projects throughout the State, is a partner in providing “boots on the ground” to

DWR has taken a lead role through the the California Water Plan process to identify the key actions necessary to ensure that disadvantaged communities receive an equitable distribution of benefits from State processes and programs.



address water-related impacts of climate change on vulnerable and disadvantaged populations. CCC crews have engaged in climate-related projects including turf removal, irrigation retrofits, plumbing retrofits, erosion control on riverbanks, flood preparedness, and flood fighting.

The California Department of Public Health, Drinking Water Program was transferred to the State Water Board in July 2014, resulting in immediate benefits as the drought emergency has unfolded, especially for disadvantaged communities. For example, the transfer has enabled the State Water Board, through the coordinated efforts of its Division of Water Rights and Division of Drinking Water, to get more accurate assessments of actual disadvantaged community water supply conditions. This enabled its Division of Financial Assistance to more effectively fund new wells, interties, and emergency drinking water supplies for dozens of communities with failing water systems during the drought. Within the State Water Board, the new Division of Drinking Water has instituted many programs that are designed to improve the drinking water systems that serve disadvantaged communities. Its small water system plan has targeted 183 small public water systems, many of which are disadvantaged, that are in violation of one or more drinking water maximum contaminant levels for aggressive enforcement action to bring them into compliance. These efforts also include directing these systems to the State Water Board's funding programs to get the funding they need to correct the system deficiencies that prevent them from providing

water to their customers that meets current water quality standards. Proposition 1, as well as the State Revolving Fund Program, provides both low interest loan and grant agreements for planning and infrastructure improvement projects for these water systems. Legislation was signed by the Governor in 2015 to enable the State Water Board's Division of Drinking Water to encourage, as well as to legally mandate, consolidation of failing drinking water systems with larger public water systems with the capacity to absorb them. Funding is also provided from the State Water Board to enable these consolidations to be completed.

In 2015, the Division of Drinking Water issued a report to the Legislature titled *Safe Drinking Water Plan for California*, which addressed small and disadvantaged communities with a focus on water quality issues in drinking water supplies. Many of these drinking water quality issues may be resolved by development of new supplies or consolidation with larger water agencies.

Many of the management and funding efforts being made in the Division of Drinking Water are also being made for wastewater, water recycling, and storm water programs serving disadvantaged communities. In order to better serve the drinking water and wastewater needs of disadvantaged communities, the Office of Sustainable Water Solutions was established within the State Water Board's Division of Financial Assistance in March 2015 by Assembly Bill 92. Some of the key functions are to promote permanent and sustainable solutions to ensure effective and efficient provision of safe, clean, affordable, and



reliable drinking water and wastewater treatment services, focusing on addressing financial and technical assistance needs, fostering partnerships, and capacity-building in disadvantaged communities.

Through their primary mission, numerous Water Boards’ programs will help address water-related adaptation to climate change. For example, the general mission of the Water Boards’ Storm Water Program is to ensure that pollutants present in storm water are minimized through the use of effective best management practices at municipal, industrial, and construction sites. Also, many storm water best management practices result in enhanced percolation of storm water into groundwater aquifers that can serve as water supply sources. A permitting process under the National Pollutant Discharge Elimination System is used to regulate these activities and promote clean storm water discharges. Ensuring that the quality of storm water discharges meets appropriate water quality objectives, including those for the protection of human health, results in the protection of beneficial uses of the water supply including for municipal and domestic supply. Higher water quality in surface and groundwater supplies means reduced cost to treat water supplies prior to human use. Good implementation of the Storm Water Program will help address water-related impacts of climate change on vulnerable and disadvantaged communities.

G. Continue to mainstream climate considerations into water management

In addition to the actions described in this Safeguarding California plan that are already being implemented by DWR

to mainstream climate considerations into water management, DWR completed a three-year collaboration with the Climate Change Technical Advisory Group (CCTAG) as part of its Climate Action Plan: Phase II. The DWR Climate Action Plan: Phase II will provide DWR and the broader water sector with consistent, scalable, high quality technical climate change analysis

tools and resources based on the best available science. DWR empaneled the CCTAG, an external advisory group comprised of 14 experts in hydrology, climatology, engineering, local water resource management, groundwater, and law to discuss scientific tools and analytical methods for water resource assessments, and the practical constraints of climate change analysis faced by a State agency. This collaborative effort resulted in a report that provides CCTAG’s perspectives and guidance for several elements of climate change

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analysis including: model selection, downscaling, and extreme event and stress test evaluations. This guidance will provide a detailed decision framework and analysis tools for use by DWR program and project managers as well as inform the State's Fourth Climate Change Assessment. These tools will streamline and improve the quality and consistency of climate change analysis across State-level water resource analyses. DWR will also work with the science community, and local and regional water managers, to develop similar guidance and tools that can be applied across the wide range of needs for local and regional water management and planning.

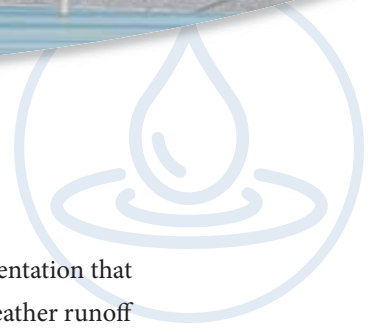
Several other State agencies have plans to use the information developed by DWR and CCTAG to improve, streamline, and standardize climate change analysis for their own purposes. The State Water Board, for example, is increasing climate change staff within the water quality and financial assistance divisions, and is working with Regional Water Boards to develop and implement a regional/State plan to address climate change. Streamlined permitting, and considerations for encouraging and supporting water conservation, groundwater replenishment (including storage and recovery), storm water capture, regionalization of water and wastewater treatment, and water recycling are included in State Water Board actions, increasing the water sector resilience and continued preparedness for adaptation to climate change.

The State Water Board is investing millions of dollars annually towards statewide water quality

data and information (via the Surface Water Ambient Monitoring Program – SWAMP – and the Groundwater Ambient Monitoring and Assessment – GAMA). Much of these data serve as the foundation and framework that is anticipated to be critical for adaptive management planning and implementation needed to adapt and respond to climate change stressors. Critical water management decisions are being informed by data collected through these programs, along with data from other, real-time sources now. One example is the use of integrated information on the www.baydeltalive.com website to inform water management decisions affecting millions of Californians. The investment in and use of systems like this is preparing us better for future water management decisions driven more and more by climate change-related stresses.

H. Utilize low-impact development and other methods in State and regional stormwater permits to restore the natural hydrograph

Low Impact Development (LID) is a sustainable practice that benefits water supply and contributes to water quality protection. Unlike traditional storm water management, which collects and conveys storm water runoff through storm drains, pipes, or other conveyances to a centralized storm water facility, LID takes a different approach by using site design and storm water management to maintain the site's pre-development runoff rates and volumes. The goal of LID is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall.



The State and Regional Water Boards recognize LID and green infrastructure as critical tools for climate adaptation at varying scales, from low-impact development in urban streetscapes to natural and living buffers against flooding and sea level rise. The State and Regional Water Boards incorporate requirements for LID and green infrastructure in their statewide and regional storm water permits, and dischargers have begun planning and implementing storm water projects that provide multiple benefits to the landscape and surrounding community.

In January 2016, the State Water Board adopted a Strategy to Optimize Resource Management of Storm Water (Storm Water Strategy) that identifies high priority statewide projects to promote storm water as a water resource, and address barriers such as lack of local funding and technical support. Through the newly-adopted Storm Water Strategy, the State and Regional Water Boards are continuing with a comprehensive funding and regulatory approach for storm water management that directly incorporates the ongoing adaptation needed to jointly address storm water management, water supply management, and flood management. The Storm Water Strategy works hand-in-hand with State and Regional Water Board-issued storm water permits implementing water quality requirements on local municipalities and industries.

All but one of the Water Boards' municipal separate storm sewer systems (MS4s) permits include requirements for LID and/or green infrastructure. More recently adopted permits

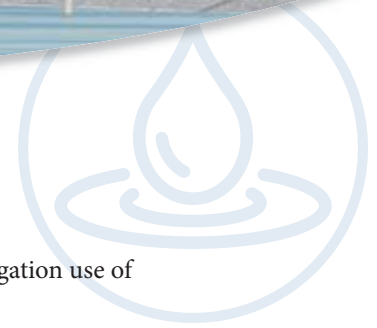
also include watershed-based implementation that contributes to storm water and dry weather runoff capture and infiltration within developed and undeveloped portions of the watershed. Regional Water Boards are incorporating a watershed storm water management approach and green infrastructure master planning that provides strong incentives for storm water and dry weather runoff capture across the jurisdictional watersheds.

The watershed-based regulatory approaches to storm water management is a comprehensive approach to municipal, commercial, and industrial storm water that incorporates requirements for LID and green infrastructure, and protects/restores the natural hydrograph, through local planning efforts. Examples

of local planning efforts include: (1) Green Infrastructure Plans in the San Francisco Bay region, (2) Watershed (and Enhanced Watershed) Management Plans in the Los Angeles region, (3) Water Quality Improvement Plans in the San Diego region, and (4) Total Maximum Daily Load (TMDL) Implementation Plans in the North Coast and Lahontan (Lake Tahoe) regions.

Municipalities statewide are leading the charge in addressing storm water quality issues using green

Municipalities statewide are leading the charge in addressing storm water quality issues using green infrastructure approaches that capture, treat, and infiltrate storm water runoff into local aquifers, and/or use storm water as a non-potable water supply.



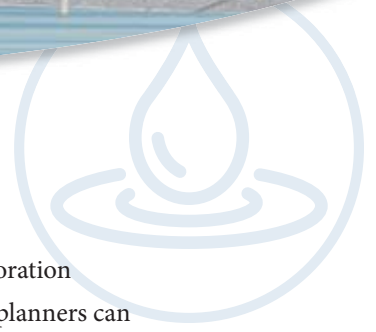
infrastructure approaches that capture, treat, and infiltrate storm water runoff into local aquifers, and/or use storm water as a non-potable water supply. Regional and local watershed planning efforts are incorporating drinking water, storm water, wastewater, and flood management seek to replicate natural hydrology and watershed processes by managing storm water and dry weather runoff onsite or within the watershed where rainfall occurs. In addition to flood control, these watershed-based approaches are a critical tool for climate adaptation, providing multiple tangible and intangible benefits to the water quality, landscape, and surrounding community, including:

- Supply of fresh water to local creeks and streams, enhancing stream flows to sustain aquatic life and wildlife habitat, and establishing a healthy hydrological-connection to local groundwater aquifers;
- Reduced pollutant loads discharged to surface waters;
- Attenuated flood waters and overall flood management;
- Recharge of groundwater aquifers through pervious urban or agricultural areas to support sustainable groundwater levels and increase local drinking and irrigation water supplies;
- Supply of fresh water to increase parks and recreational landscapes including walking, hiking, bird-watching, hunting, swimming, fishing, and boating;

- Harvesting and local landscape irrigation use of rainwater;
- Minimization of erosion, landslides, and/or destabilized land; and
- Reduction of unnatural alteration of natural drainage features of streams, rivers, wetlands, and lakes (also known as hydromodification).

The State Water Board has developed Proposition 1 Storm Water Grant Funding guidelines (See section I.C) with the goal of initiating grant awards for storm water projects in 2016 that best advance the goals of improving water quality and realizing multi-benefit storm water management projects, which may include green infrastructure, rainwater and storm water capture projects, and storm water treatment facilities. The State Water Board also established guidance for municipalities on how to fulfill the Water Code requirements, and accompanying State Water Board recommendations, for incorporating quantifiable metrics to properly evaluate and implement projects resulting in multiple benefits.

Lastly, through its issuance of a statewide storm water permit for the California Department of Transportation (Caltrans), the State Water Board allows Caltrans to comply with its water quality requirements through cooperative agreements with municipalities located adjacent to its right of way, and a Caltrans grants program that provides funds for the State Water Board to administer to municipalities for storm water management. The Caltrans has developed and is implementing



its Storm Water Program, which includes implementation of 10 years of planned projects that prioritize treatment and management of storm water entering the most pollutant-impaired surface water bodies

I. Require closer collaboration and coordination of land use and water planning activities to ensure that each reinforces sustainable development that is resilient to climate changes

State law requires demonstration of “adequate water supplies” for development, and there are extensive requirements for land use and water resource planning. Existing law also requires local government to work at a collaborative regional scale for reducing GHG emissions, and that such planning will benefit water management. Nonetheless, individual land use decisions may or may not result in sustainable development resilient to climate change. In keeping with their longstanding primary responsibility for land use planning and regulations, land use decisions at the city and county levels provide additional opportunities to reduce water consumption and GHG emissions through implementation of more sustainable land use policies, siting, and design techniques.

Cities and counties, with their existing land use authority, have primary responsibility for land use planning and regulation in California. Land use planners consider water throughout the local land use planning process, and water is a critical element in adopting sustainable land

use planning policies. Stronger collaboration between land use planners and water planners can promote more sustainable land use patterns and greater integration of water and wastewater management into local land use plans. When planned and implemented correctly, integrated regional and local water management aligns flood and storm water management, drinking and irrigation water supply, water quality protection, and groundwater management, and contributes to successful adaptation that robustly supports local government land use and growth policies, while focusing to minimize increased greenhouse gas emissions due to increased pumping and treatment facilities.

State agencies are working to align land use and water planning through multiple programs. For example:

- Objective 15 of California Water Plan Update 2013 is to “Strengthen Alignment of Land Use Planning and Integrated Water Management.” Objective 15 identifies multiple actions to be taken by the State Legislature, State agencies, local governments, and regional planning agencies that will improve integration between: water managers and planners and land use planners and decision makers.

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- DWR and Sonoma State University’s Center for Sustainable Communities have developed an integrated water and land management tool capable of specifying different residential land cover and infrastructure choices, and comparing development outcomes. The tool examines the costs and benefits associated with land use projects using compact, integrated water management, and low-impact development technologies. For climate change analyses, the tool can be used to calculate the GHG intensity of water supplies and to help identify land use strategies that reduce water use.
- The State and Regional Water Boards continue to integrate statewide and regional policies, plans, and permits to incentivize: (1) the unification of planning efforts for drinking water, storm water, and wastewater with local land-use and climate change planning efforts, and (2) regionalization of local utilities to address regional water and land-use objectives and goals.
- The Governor’s Office of Planning and Research (OPR) is currently updating and overhauling the General Plan Guidelines. A General Plan is the local government’s long-term blueprint for the community’s vision of future growth. OPR is responsible for updating the General Plan Guidelines – the “how to” resource for drafting a general plan. OPR also monitors general plan implementation with annual progress reports from cities and counties, and grants general plan extensions for qualified cities and counties. The new General Plan Guidelines will include

resources, data, tools, and model policies to help cities and counties update their general plans, and has been informed by extensive outreach and collaboration. Information on integrating water resource planning and land use planning will be one of the major additions to this update of the General Plan Guidelines.



J. Protect and restore water resources for important ecosystems

Following Governor Brown’s announcement on April 30, 2015, regarding modifying the permit strategy for the Bay-Delta Conservation Plan, and creating two new programs known as the California WaterFix and California EcoRestore, the DWR EcoRestore Program was established. California EcoRestore is a California Natural Resources Agency initiative to help coordinate and advance at least 30,000 acres of critical habitat restoration in the Delta during the next four years. Driven by world-class science and guided by adaptive management, California EcoRestore, working through new and existing programs, will pursue habitat restoration projects to address aquatic and terrestrial ecosystem needs in order to improve the overall health of the Delta.

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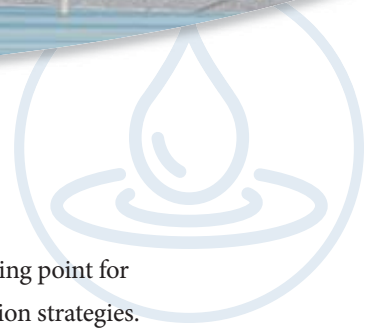


California EcoRestore aims to address legacy impacts, such as invasive species in the Delta and the effects from the ongoing operation of the State and federal water projects, and strengthen and protect ecosystems in the face of climate change. More than 10 percent of the 30,000-acre goal will be focused on creating managed wetlands for subsidence reversal, and on carbon management to address impacts of climate change. Many of the individual projects implemented under California EcoRestore will include aspects to improve the Delta's resilience to changing climate impacts. For example, tidal habitat restoration makes up nearly one-third of the habitat restoration goal. That includes creating a wide upland transition area to provide refuge for wetland animals during high tides, which are predicted to increase with climate change, and opportunities for wetland migration upslope in response to sea level rise. The enhancement of floodplains and improved floodplain connections to rivers will restore the ability of floodplains to absorb flood flows and provide a reservoir of water to help aquatic species withstand droughts. The DWR EcoRestore program, which will be the department's primary connection to California EcoRestore, was established to provide the department with a centralized location for coordination, communication, and integration of all habitat restoration planning and implementation efforts. Many of the department's programs have landscape overlap, especially those within the Delta, which offers the opportunity for increased alignment in order to maximize the value of the monetary investment and the environmental

benefit. This new program is focused on improving efficiency and streamlining the process for utilizing resources, approving land acquisition, resolving issues and developing policy, coordinating unified communication and outreach efforts, and tracking the progress of habitat restoration projects.

The State Water Board is in the process of developing and implementing updates to the Bay-Delta Plan and flow objectives for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed through the following phases:

- Phase 1 involves updating San Joaquin River flow and southern Delta water quality requirements included in the Bay-Delta Plan. The State Water Board hearing to consider adoption of changes to the Bay-Delta Plan and certification of Final Substitute Environmental Document is anticipated for summer 2016.
- Phase 2 involves other comprehensive changes to the Bay-Delta Plan to protect beneficial uses not addressed in Phase 1 (Delta outflows, Sacramento River inflows, Suisun Marsh salinity, Delta Cross Channel Gate closure, export limits, reverse flows). This phase is scheduled to be completed by early 2018.
- Phase 3 involves changes to water rights and other measures to implement changes to the Bay-Delta Plan from Phases 1 and 2.
- Phase 4 involves developing and implementing flow objectives for priority Delta tributaries outside of the Bay-Delta Plan updates. This phase will be ongoing.



K. Better understand climate risks to California water and develop tools to support efforts to prepare for climate risks

California is a national and international leader in improving scientific understanding of the causes, impacts, and risks of climate change on water resources. The State also leads in developing tools and resources for managers and planners to prepare for climate risks and their impacts. California State agencies and commissions have independently, and in partnership with the research community, local agencies, and federal agencies, developed a wide range of tools and resources that support climate preparedness and reduce GHG emissions from new supply, treatment, and conveyance system infrastructure.

At the highest level, *California Water Plan Update 2013* provides an in-depth analysis of the climate change risks in the Central Valley (Sacramento, San Joaquin, and Tulare Lake basins³). More than 200 scenarios of land use, population, and climate change were evaluated to explore the range of uncertainty in future conditions. For each scenario, a range of system performance metrics (e.g., urban supply reliability, agricultural supply reliability, unmet environmental demand) was calculated. Those performance metrics provide a range of potential impacts to different water uses resulting from expected changes in land use, population, and climate. Implementation of a range of resource management strategy packages was also evaluated to identify which strategies would be most robust for addressing impacts across the range of future

scenarios—providing a high-level starting point for more detailed investigations of adaptation strategies.

California also continues to invest in tools that support efforts by planners, professionals, and the public to prepare for climate risks in the water sector. Cal-Adapt.org is undergoing updates that integrate new modeling and science to show more accurate projections for precipitation and snowpack. Innovative new tools such as DataBasin are being integrated into resource planning processes for information sharing and decision-making allowing increased transparency and public participation in areas such as watershed policy.

The California Public Utilities Commission is developing a tool to identify the cost effectiveness of water energy projects. In 2015, the CPUC adopted the Water-Energy Calculator and the Avoided Water Capacity Cost Model that will allow better quantifying of the benefits from reduced water use.

California is a national and international leader in improving scientific understanding of the causes, impacts, and risks of climate change on water resources.

The following studies, carried out since the publication of *Safeguarding California*, show the continued broad-based effort to better understand climate impacts:

California Climate Science and Data for Water Resources Management Brochure (2015). This brochure, developed by DWR, is a concise

³ <http://www.waterplan.water.ca.gov/cwpu2013/index.cfm>



and comprehensive overview of observed and projected impacts of climate change on the State's water sector, regionally-specific impacts and strategies, and water-energy information.

Paleohydrology Study: Klamath/San Joaquin/Sacramento Hydroclimatic Reconstructions from Tree Rings (2014). DWR commissioned the University of Arizona to provide hydroclimate reconstructions, using updated tree-ring chronologies from the Klamath, San Joaquin and Sacramento River basins. The report allows assessment of hydrologic variability over centuries to millennia, gives historical context for assessing recent droughts, and can be used in climate change research, analysis, and planning.

Through the actions of DWR, the State Water Board, and others, the State of California has made significant progress toward safeguarding the

water sector; however, substantial additional steps remain. Indeed, because California's water sector is exposed to some of the most difficult challenges of climate change, improvements and innovations to implement state of the art technologies with reduced GHG emissions will need to be continuously made. Many actions are already being planned and developed.

The State makes every effort to publicly post all new research and studies so that local agencies may benefit from the information they contain. For example, DWR maintains webpages that highlight climate change publications⁴ and resources specific to local and regional resources.⁵ Cal-Adapt.org also has a page that features a number of resources and publications on climate change impacts and adaptation.⁶

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Next Steps and Future Actions

The California Water Action Plan (CWAP) is a roadmap for water management during the Brown administration, and the Safeguarding Water Implementation Plan will guide the State in its climate adaptation management actions, as identified in the CWAP.

Improving Statewide Flood Management:

DWR's Statewide Flood Management Planning Program is developing a flood investment strategy. The investment strategy will address flood risk management in the context of integrated water

management. It will include an inventory of planned projects statewide, and recommendations for State investments using an outcome based framework for effectiveness. The recommendations consider existing and changed conditions including identifying:

⁴ http://www.water.ca.gov/climatechange/pub_video.cfm

⁵ <http://www.water.ca.gov/climatechange/resources.cfm>.

⁶ <http://cal-adapt.org/resources/>



- Local, State, and federal agency proposed flood management project needs.
- Potential management actions to address flood risk and climate change to balance risk and reward on floodplains.
- How climate change and sea-level rise affect flood risk, and how flood risk is understood by the public.

Incentivizing Integrated Regional and Multiple-Benefit Projects: The State Water Board highly encourages projects that provide regionalized utilities and provide multiple benefit – tangible quantifiable water treatment/supply and flood management benefits, economy-of-scale benefits, and intangible, at-times unmeasurable community benefits – that utilize storm water as a resource. (See section I.H for further information on the State Water Board’s Storm Water Strategy). The Storm Water Strategy is intended to guide the Storm Water Program for at least the next ten years, and climate change adaptation is one of the key principles throughout the Strategy.

Improvements to Economic Analysis to Consider a Broader Accounting of Costs and Benefits: The DWR Economic Analysis Section is planning to update its Economic Analysis Guidebook. Updates will include recent developments in theory and practice, State and federal regulations and directives, new methods of economic modeling and analyses, valuation of ecosystem services, and sustainability indicators and metrics. These changes are intended to improve economic analysis within DWR in light of recent developments in methodologies and State

directives, including the Governor’s recent Executive Order B-30-15 that mandates State agencies take climate change into account and employ the Full Life Cycle Cost Accounting method in planning and investment decisions. As a result, the updates will incorporate a full life cycle accounting of costs in economic analysis in consideration of climate change impacts.

Improved Reporting of Current Hydroclimate Conditions and Trends: Starting in 2016 and annually thereafter, the State Climatologist’s Office will publish a hydroclimate bulletin that presents a broad range of climate-related metrics, focusing on indicators important to the water sector. The indicators will be

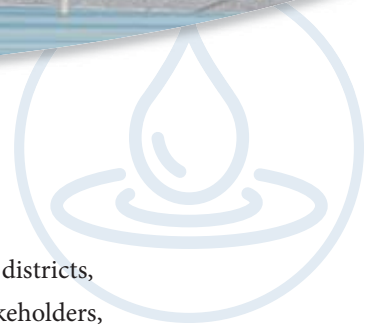
presented and discussed in relation to the historical record. The bulletin will discuss and analyze the recent water year in detail, calling out significant events and characteristics of the year in relation to the historical record. The bulletin will also discuss climate signal detection, data sources and gaps, and potential for future sampling networks to improve knowledge of the climate.

DWR Climate Action Plan–Phase III

Vulnerability Assessment and Adaptation Plan:

DWR is currently working on a detailed climate change vulnerability assessment and adaptation

Starting in 2016 and annually thereafter, the State Climatologist’s Office will publish a hydroclimate bulletin that presents a broad range of climate-related metrics, focusing on indicators important to the water sector.



plan for state owned and operated assets. Using several new quantitative tools that draw on the latest research and science, DWR will identify the activities and assets it controls that face the greatest climate change threats and the adaptation strategies that can be employed to minimize or mitigate those threats. As part of the vulnerability assessment and adaptation plan, DWR worked with researchers at the University of Massachusetts to employ a new approach to climate change analysis called “decision scaling” that allows DWR to explore a very wide range of future conditions and the specific risks posed by California’s uncertain future. DWR will publish the results of this cutting edge climate change analysis in 2016. <http://www.water.ca.gov/climatechange/CAP.cfm>

Decision Scaling Analysis of Climate Change

Impacts on California: DWR Vulnerability Assessment and Adaptation Plan. In 2014, DWR began working with researchers at the University of Massachusetts who were pioneering a new approach to climate change analysis. The approach focuses on system evaluation to identify key thresholds of vulnerability and then uses information from global climate models to evaluate the likelihood of future conditions that would exceed those vulnerability thresholds. DWR will publish the results of this cutting edge climate change analysis procedure as part of its vulnerability assessment in 2016.

Improve Operation of Integrated Water Supply and Flood Protection Systems to Provide

Increased Benefits: DWR is conducting a system reoperation study (SRS) in cooperation with other

State and federal agencies, local water districts, groundwater managers, and other stakeholders, to identify potential strategies for reoperation of the statewide flood protection and water supply systems. DWR is developing the SRS to identify viable reoperation strategies and understand how integrated management can:

- Improve the reliability of municipal and irrigation water supply.
- Reduce flood hazards.
- Restore and protect ecosystem function and habitat conditions.
- Buffer the hydrologic variations expected from climate change.
- Improve water quality.

In 2014, DWR began working with researchers at the University of Massachusetts who were pioneering a new approach to climate change analysis.

California’s water supply and flood management infrastructure, including Federal, State, and locally owned systems, is physically interconnected to the extent that it is technically feasible to move water around the system from Trinity County in the north to Imperial County in the south. But, the management of the water system may not be as well integrated as it could be. The underlying logic of the SRS is that California can do more with its existing water infrastructure by taking advantage of the physical interconnections (and enhancing them) while also operating the system in a coordinated manner to optimize the benefits.



The SRS will evaluate how potential reoperation strategies perform across potential future climate scenarios ranging from warmer and wetter, to much hotter and dryer. The information from this climate change sensitivity analysis will be used to provide an analytical indicator of the potential resiliency of system reoperation strategies to the effects of climate change.

Improve Quantitative Vulnerability Assessments of State Owned/Operated Infrastructure: For water related infrastructure such as the State Water Project, climate change impact analysis can provide local water agencies with important information that they can use to help plan for their water supplies. A number of improved methodologies and tools exist for improved impact and vulnerability analysis. The State will move forward with advanced vulnerability assessments for priority water related infrastructure.

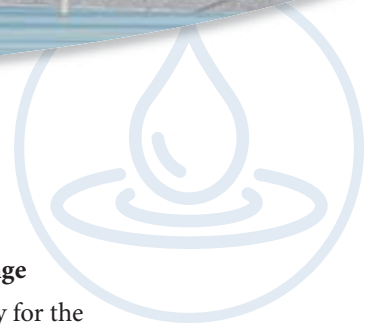
Urban Water System Resilience Model. The California Public Utilities Commission (CPUC) will encourage the development of a new urban water resiliency modeling tool that assess water system capabilities resiliency metrics such as the ability to respond to, adapt to, or recover from a disturbance. Leveraging work done in the electric and gas sector, the CPUC will work with partners such as the National Association of Regulatory Utilities Commissioners, the U.S. Department of Energy’s Office of Electricity Delivery and Energy Reliability, and academic institutions to expand, transform, and integrate existing climate, energy, and water models. A new water resiliency modeling platform will allow utilities

and stakeholders to evaluate the performance of proposed system changes to a variety of climate scenarios.

Some of the key features in a resiliency modeling platform include:

- Incorporation of water system vulnerabilities to climate risks.
- Incorporation of probability distributions of climate events.
- Real time infrastructure status updates—approaching full-system awareness
- Evaluation of the interaction of event uncertainties.
- Capability to assess the conditional impact of events.
- Capability to assess the conditional cost of events.
- Comparison of proposed adaptation portfolios.

State Water Resources Control Board Staff. The State Water Board has been provided California Air Resources Board (CARB) funding for two staff positions to work on greenhouse gas emissions reductions; to date one staff has been hired and works at the State Water Board. The second staff position was loaned to CPUC to develop a tool for evaluating the cost effectiveness of water energy projects. The staff position has been filled and the staff will be moved to a permanent position at the CPUC. With the additional staff position, the State Water Board will focus on incorporating



climate considerations into State and Regional Water Board policies, plans and permits while concurrently addressing water supply and water quality protection needs. The Water Boards will also continue its re will be increased capacity to work with academics, other State agencies, and other stakeholders to expand Water-Energy technologies, and incorporate climate change considerations (including reduction of GHG emissions) into water management regulatory and funding actions. Ultimately, the CARB-funded position for greenhouse gas emissions reductions will be moved to the State Water Board, Division of Financial Assistance to ensure State funding investments contribute to California's need to address climate change.

The State and Regional Water Boards will continue to focus on water conservation, water use efficiency, recycled water, storm water capture and use, water recycling, and gray water use, all of which are climate resiliency tools to adapt to California's uncertain hydrologic future.

Strategy to incorporate climate change

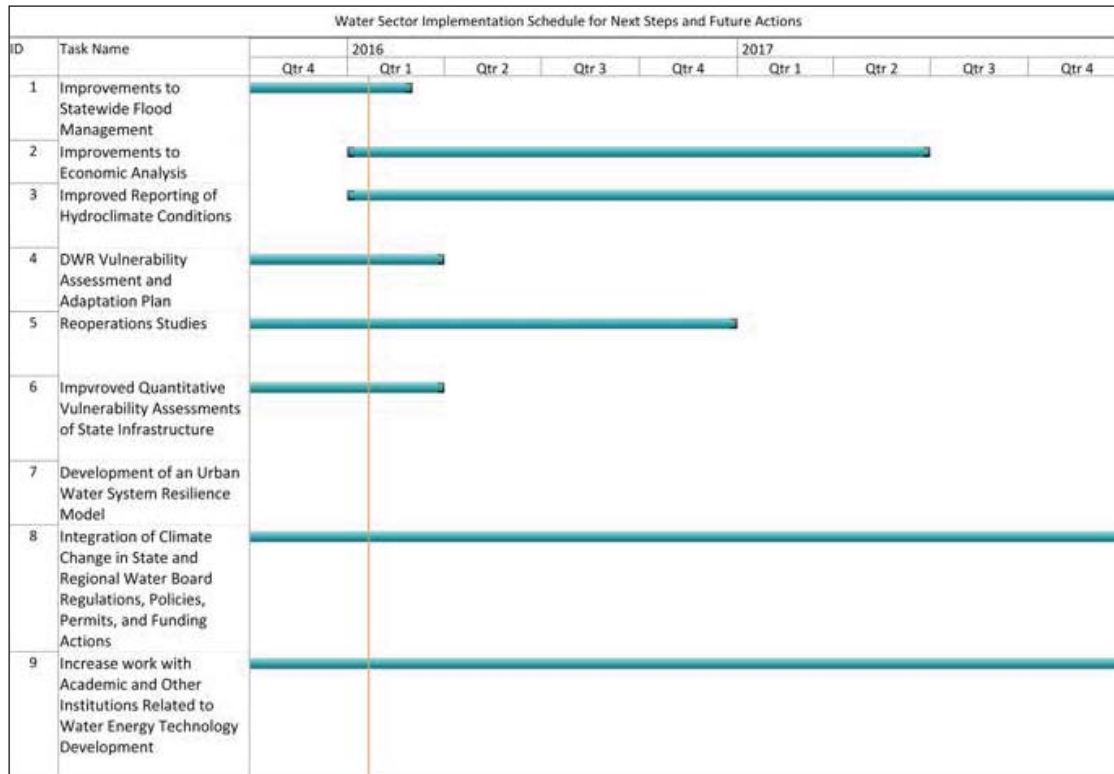
considerations: An effort is underway for the State Water Board to incorporate climate change considerations consistently throughout the organization, each division, office, and the nine Regional Boards. In 2016, the State Water Board will consider the adoption of a resolution outlining its actions and priorities to address climate change over the next few years.

Bay-Delta Water Quality Control Plan. The State Water Board will complete its update of the Water Quality Control Plan for the Delta and its upstream watersheds. New resources were allocated to this effort in the FY 2015-16 budget. The Board will complete planning activities in the San Joaquin Basin and the southern Delta in 2016. Delta outflow and other flow-related Delta standards will be updated by spring 2018. The Water Board's action will balance competing uses of water including municipal and agricultural supply, hydropower, fishery protection, recreation, and other uses



A. TIMELINE FOR IMPLEMENTATION OF EXPANDED AND NEW INITIATIVES

Figure #WC-4 Water Sector Implementation Schedule for Next Steps and Future Actions





Monitoring and Evaluation

A **METRICS FOR EVALUATION** Measuring climate resilience in the water sector, like in other sectors, is complex. Resilience will take on different characteristics for different aspects of the water sector (e.g., wastewater, urban water supply, environmental streamflows) and in different areas of the State impacts and therefore resilience characteristics will differ.

Work has begun on developing sustainability indicators for water resources (California Water Sustainability Indicators Framework, 2011). These sustainability indicators could be used as a starting point for development of monitoring and evaluation metrics for climate change resilience. Work on these sustainability indicators highlighted that there was no shortage of potential indicators of sustainability. More than 100 indicators were suggested and explored as part of the California Water Plan Water Sustainability Indicators Project (<http://indicators.ucdavis.edu/water/indicators>). Indicators included such metrics as:

- **Water Scarcity Index:** Water scarcity is a function of water availability and water use.
- **Abundance of Key Non-Native Species:** Relative abundance of key non-native species, for example Brazilian waterweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), and harmful invasive species such as *Microcystis aeruginosa* and other harmful algal blooms.
- **Managed Geomorphic Flows:** Magnitude and timing of managed system flows suitable

for native riparian habitats and geomorphic processes.

- **Water Footprint:** the sum of the water used directly or indirectly to produce goods and services consumed by humanity. Agricultural production accounts for most of global water use, but drinking, manufacturing, cooking, recreation, washing, cleaning, landscaping, cooling, and processing all contribute to water use.
- **Levee Stability:** Frequency of levee breaks in the region.

The abundance of indicators notwithstanding, data upon which to measure historical and/or current conditions is often lacking, of low quality, or inconsistent. Thus, developing evaluation metrics for the water sector may involve a significant new monitoring and baselining effort before progress can begin to be measured. To this end the Water Board SWAMP program (http://www.waterboards.ca.gov/water_issues/programs/swamp/) is working with the Office of Environmental Health Hazard Assessment (OEHHA) to not only build up baseline and trend datasets but to optimize the indicators needed to inform decisions



anticipated on the five, ten and twenty year planning horizon: <http://oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html>

B. IDENTIFY OTHER NEEDED TECHNICAL ADVICE

DWR, CPUC, the State and Regional Water Boards, and other State agencies have done a tremendous amount of work to investigate, analyze, and describe potential impacts of climate change on the water sector. But, much work remains to be done to prepare California for the future impacts of a changing climate. The State has limited authority and finite resources for analyzing, planning, and implementing adaptation and resiliency strategies for the water sector—most water resources are managed by local governments and agencies. Many local water managers have yet

to begin analyzing and planning for impacts of climate change on their specific watersheds and water systems. Additional tools, resources, and incentives for local agencies are needed to increase the level of planning, facility design and facility operation for climate change and greenhouse gas impacts by local resource managers. While many resources already exist such as those described in Section I-K, as well as in other section of this implementation plan, there remains a tremendous need at the local and regional level for technical assistance to conduct analysis and adaptation planning that considers the specific impacts, constraints, and opportunities of the local region and the specific resource management agency