Climate Action Plan Phase III:

Climate Change Adaptation Plan

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California Department of Water Resources

Climate Change Program

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SUMMARY

As part of a three-phase process known as the Climate Action Plan (CAP), the California Department of Water Resources (DWR) seeks to reduce greenhouse gas emissions (CAP – Phase I), conduct consistent and rigorous climate change analyses within its programs and projects (CAP – Phase II), and complete a climate change vulnerability assessment and develop and implement an adaptation process to protect staff, business operations and assets (CAP – Phase III).

This document presents the first iteration of the DWR Climate Change Adaptation Plan, which is the last step of CAP – Phase III. This Adaptation Plan creates a foundation from which DWR can adapt to climate change and improve its resilience. The first section introduces concepts, framing, and principles of adaptation and how to use these to support adaptation monitoring, evaluation, and reflection as the Adaptation Plan progresses. The second section describes actions to reduce the vulnerability of four assets identified in the DWR Climate Change Vulnerability Assessment. The third section presents other efforts by DWR that promote climate adaptation at local and regional levels throughout California. And the fourth section concludes with additional efforts required to meet DWR's climate change challenges.

The activities presented in this document vary in terms of timelines, participation of DWR divisions and outside agencies, and approaches to adaptation: (1) Staff safety vulnerabilities to heat and flooding risk will be addressed primarily by working internally to update the DWR Safety Program's existing protocols; (2) a series of analyses will be used to explore and develop a suite of adaptation strategies to improve State Water Project performance; (3) Upper Feather River Watershed vulnerabilities to wildfire risk (jeopardizing the State Water Project headwaters) are being addressed through a collaborative process with stakeholders in that region; and (4) moving forward with DWR's managed lands, which are vulnerable to sea level rise, heat, and shifting flows, begins with inventorying those landscapes and assessing their specific vulnerability to climate change. Together these approaches create a diverse portfolio of adaptation planning tactics to meet DWR's needs under a changing climate.

The scope of the Adaptation Plan is based directly on the findings of the Vulnerability Assessment. While climate-change-driven hazards were assessed for DWR's facilities, lands, operations, and staff activities, there are threats outside the scope of the Vulnerability Assessment for which DWR does not have sole authority, the ability to address, or could not be assessed because of data gaps. Initially, limiting the vulnerable assets addressed in the Adaptation Plan will enable DWR managers and staff to focus attention on adapting to vulnerabilities that DWR holds the greatest capacity to address.

Section 1. Introduction, Concepts and Definitions

The Intergovernmental Panel on Climate Change (IPCC) defines climate adaptation as "the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities," (IPCC, 2014). DWR recognizes and endorses this definition's emphasis on adaptation as a *process* by initiating its own Climate Change Adaptation Plan as a series of ongoing and planned processes. The processes presented in this first iteration of the Adaptation Plan focus on reducing vulnerabilities identified in the DWR Climate Change Vulnerability Assessment. Focusing adaptation activities to reduce a specific set of vulnerabilities results in a narrower scope, but purposefully so to help launch a tractable process to be expanded upon in future versions. Ultimately, "the process of adaptation should be designed to make society more resilient to a range of influences - including, but not limited to climate change" (Nelson, 2009). Therefore, understanding the drivers behind these vulnerabilities can reveal the much deeper societal changes that are needed (Dilling et al., 2015), beyond the authority and jurisdictional reach of DWR. Given the important role of social values and norms in influencing how adaptation proceeds and how water resources are managed (O'Brien, 2009), neither DWR nor even the State (or any) government will be able to fully direct the process of adaptation. This document offers a first proposition to accounting for projected impacts and reducing the identified vulnerabilities.

1.1 Structure and Timing

The DWR Climate Change Adaptation Plan completes the third and final part of its three-phase Climate Action Plan (CAP). CAP - Phase I is the strategy to reduce greenhouse gas (GHG) emissions (DWR, 2012). CAP - Phase II supports DWR project managers in conducting consistent and rigorous climate change analyses within their programs and projects (DWR, 2018). CAP - Phase III involves conducting a climate change vulnerability assessment (DWR, 2019a) and developing and implementing an adaptation plan to protect staff, business operations and assets (this document).

The first section of this document introduces concepts, tools and framing of adaptation and how these are intended to be used to support adaptation monitoring, evaluation, and reflection as climate adaptation progresses within DWR (Figure 1). Section 2 presents synopses of each vulnerability identified as a priority in the DWR Vulnerability Assessment: (1) Staff Safety; (2) State Water Project; (3) Upper Feather River Watershed; and (4) DWR Landscapes (Ecosystems and Habitats). Section 3 presents a snapshot of other efforts that also support adaptation within DWR and for California water management generally. Section 4 concludes with next steps for implementing and updating both the Vulnerability Assessment and this Adaptation Plan.

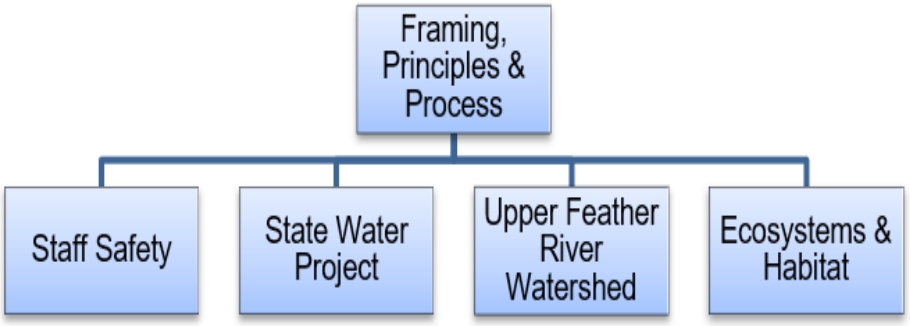


Figure 1. Structure of the DWR Adaptation Plan

1.2 Tools to Track Progress and Direction

Tracking tools are important for climate adaptation to support effective and regular evaluation of progress, communicate adaptation activities to the public and internally, and to justify funding needs (Ford et al., 2013). Outcome-based measures of adaptation are typically specific to the adaptation strategy (such as reduction in vulnerability for a given asset). More broadly, DWR can track and report on adaptation progress for its adaptation activities as a whole using generalizable indicators and principles.

The following presents a set of three tools to help track, evaluate, and reflect upon DWR's adaptation activities and goals over the long term. These tools include: (1) a typology or types of adaptation-supporting activities; (2) principles to guide adaptation planning; and (3) adaptation process stages. We use these tools to frame and reflect our plans of action for each of DWR's four vulnerable assets. They are used to help document *whether* we are advancing in climate adaptation and *how* we are advancing. This process involves tracking internal progress in climate adaptation, documenting barriers encountered, identifying potential strengths or weaknesses, while serving to prioritize and guide the progress of adaptation efforts. The tools can help determine whether one or more types of activity receive most of the emphasis or if there is one that is left out entirely, whether some principles are applied more rigorously than others, the progression DWR is making towards its goals, and then how adaptation-supporting activities are evaluated as part of the full adaptation process.

Together these tools should be used to examine the full suite of adaptation activities in DWR at least every five years and can be reported as part of *Safeguarding California*, the State's climate adaptation plan, and the Climate Change Adaptation chapter in the Department's Sustainability Roadmap.

Typology

The first tool offers a typology for documenting the nature of adaptation strategies pursued and implemented. There is a set of common types of activities pursued for adapting to climate change (Patt, 2013). These can be associated with one of the three dimensions of adaptation

capacity (Azhoni et al., 2018), each of which is critical to supporting adaptation processes and advancement. These activities include the following:

- Construct or modify infrastructure
- Modify patterns of production and consumption
- Develop and deploy new technologies
- Invest in adaptive capacity and social learning

The first three of these types of activities depend on acknowledging and understanding to some extent the climate risks posed. The fourth does not necessarily rely on knowledge of climate risks, but it is fundamental to supporting the other activities, especially where low or absent adaptive capacity impedes progress.

In addition to the general typology offered above, DWR has developed a "toolkit" of water resources management-specific strategies that it has published as part of the California Water Plan. These Resource Management Strategies (RMSs) are a diverse set of approaches that may help local water managers, of which many are also adaptation strategies. A subset of RMSs is included as potential adaptation approaches to address the Department's vulnerable assets, based upon DWR's authority and capacity to implement RMSs, their applicability to DWR's vulnerabilities, and their technical feasibility. As practical experience is gained with the use of these RMSs for climate adaptation, they should be revisited to ensure DWR is incorporating the full breadth of available options to support water resilience given the changing climate.

Principles

A set of well-established principles offers a foundation from which climate adaptation can be monitored and evaluated as it progresses. DWR and any agency, person, community, or other entity actively involved in climate adaptation seeks to achieve some level of success in reducing or avoiding the risk of harm from climate change. Such success is often difficult to define and differs based on societal or sectoral values, both of which may change over time. Recognizing the underlying assumptions of what is "successful adaptation" is part of creating a transparent and trackable process (Moser and Boykoff, 2013). The following principles have shown to be useful for tracking and implementing successful adaptation within California, in the greater United States, and internationally:

- Application of adaptive management;
    - Test, monitor and evaluate - set up to test and track effectiveness; maintain the willingness to observe failure and be flexible to changing knowledge and social values.
- Use of best available science;
- Development of robust decisions and planning to a wide range of futures (Dilling et al., 2013; Lempert et al., 2006);
- Exploration of all system levers of change (Meadows, 1999; O'Brien, 2011), including the deepest paradigms upon which we base decisions and hold values;

    - Periodically revisit the question of "Are we trying to maintain a potentially futile endeavor and calling it adaptation? Would deeper transformation be more effective to support long-term resilience?"
- Transparency of process: make paradigms, assumptions, and value-driven decisions explicit and allow for transparent decisions and actions;
- Consideration of equity to avoid unintended consequences of adaptation options selected that could create inequitable conditions;
- Collaboration, including multiple sectors, and meeting multiple values:
    - Recognize the dynamics of vulnerability within the connected system.
    - Recognize and explore tradeoffs across sectors and water use types, regions, populations, and value systems.
    - So-called no/low regrets measures may not always lead to successful adaptation (Dilling et al., 2015).

Process Stages

A heuristic is commonly used to describe the set of decision-making stages common to most adaptation processes (Figure 2, Moser and Ekstrom, 2010). Some stages are given more attention, time, and resources than others (some may be skipped entirely). The stages include: (1) understanding, (2) planning, and (3) managing. Understanding the problem of climate change to the system entails defining the problem, gathering information to assess the problem, and then refining what the problem or threat is. The planning stage involves developing options to reduce the threats of climate change, assessing those options, and selecting the options to implement. The management stage involves implementing, monitoring, and evaluating actions of adaptation.

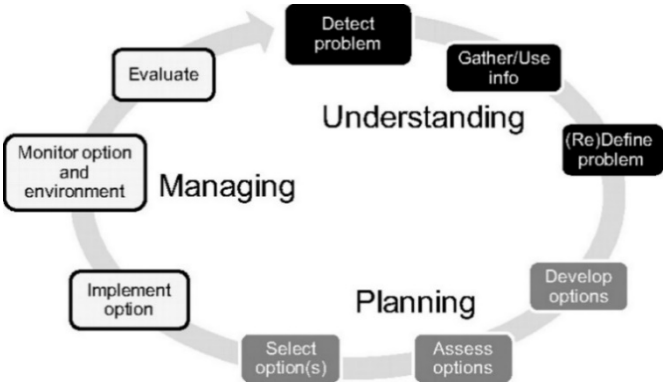


Figure 2. Common stages within a climate adaptation process (Moser and Ekstrom, 2010)

These stages can be used to map - and track - where an activity, or a plan for a specific vulnerable asset, is currently in its process and whether it is progressing. Using this method to track plans and activities can help staff to reflect on all stages of adaptation. Monitoring and evaluation - post-implementation - often are left out but are critical to achieve the adaptive management principle (Ford et al., 2013; Lee, 1993).

1.3 Application of Tools in DWR Adaptation Plan

These tools together establish a process for helping to maintain adaptation progress at DWR, in addition to the ongoing project-based screening developed for the CAP – Phase II (see Section 3.2). These tools will be applied to review the progress of adaptation initiatives and the reduction of vulnerabilities.

Section 2. Priorities for DWR's Adaptation

DWR's Vulnerability Assessment identified and prioritized four key assets vulnerable to climate change impacts, all of which are critical to DWR's core function: (1) staff safety; (2) State Water Project (SWP); (3) Upper Feather River Watershed; and (4) landscapes (ecosystems and habitats). Vulnerabilities identified and initial adaptation plans for each vulnerable asset are described below. Beyond these four priorities, there are other issues outlined in the Vulnerability Assessment that will not be considered in this initial Adaptation Plan, for specific reasons. For example, adaptation measures for vulnerable flood protection infrastructure is not included, as the Central Valley Flood Protection Board and DWR are already evaluating and planning for short-term extreme hydrological events in the Central Valley Flood Protection Plan. Rather than conducting potentially duplicative efforts, these very thorough, cross-jurisdictional research and planning efforts will be relied upon to adapt DWR facilities and flood protection infrastructure to increased risk of flooding.

2.1 Staff Safety

Climate models project that, by mid-century, DWR staff will be at increased exposure to high heat days and flooding, potentially resulting in dangerous conditions, emergency reassignments, overtime pay, and damage to facilities or equipment. These impacts can cause loss of life and property, and at the very least can cause illness (physical and mental), affect labor productivity, and disrupt business operations. Described below are the vulnerabilities along with recommended next steps for safeguarding DWR staff.

Vulnerability to Increased Extreme Heat Events

- The increase in frequency of extreme heat days may prevent employees from completing field surveys, conducting regular maintenance and construction activities, and sampling and monitoring, which could be problematic for real-time compliance monitoring and could also impact emergency response.
- Maintenance and construction activities, including emergency repairs, could take longer or be more expensive to complete due to work interruptions during extreme heat events including: heat-related disruptions to the power grid that impact DWR's ability to operate; increased workloads as scheduled activities get moved into shorter work windows; increased costs associated with higher staffing levels to offset the need for more on-site rest periods; and increases in staff sick days for existing or new health conditions exacerbated by heat and heat illness.

DWR has existing protocols to address the risk of high temperature to staff. As part of the Vulnerability Assessment, a DWR-wide survey of supervisors indicated some ability to shift work schedules to the cooler portions of the day, and nearly half indicated that they can reschedule certain work activities. In addition, DWR has protective measures for staff in place via the existing DWR Heat Illness Prevention Plan (HIPP).

Adaptation Approach to Safeguard Staff as Extreme Heat Events Increase

The Vulnerability Assessment indicated that the regions in which DWR operates have historically experienced and are projected to experience different levels of high temperatures, which creates different levels of vulnerability. Some strategies to strengthen high heat protection of staff include the following.

- Quantify potential budget impacts of heat-related project delays and increased staffing costs, especially in areas where staff have numerous fieldwork days during summer.
- Collaborate with DWR's HIPP managers to explore how to incorporate increasing extreme heat in the HIPP.
- Establish protocols that ensure managers are aware of impending high heat days and establish plans to ensure the least amount of disruption to work progress.
- Ensure staff have high heat health and safety equipment in advance of work start date; including shade/cooling structures, water coolers, access to ice machines, and working air conditioners in vehicles.
- Continue educating staff in coordination with the DWR Safety Office about DWR's HIPP, signs of heat illness, and prevention of heat illness.
- Coordinate with the DWR Safety Office on high heat planning and to establish a timeline to co-develop adaptation strategies.

Next Steps

- Coordinate with the DWR Safety Office to identify needed updates to existing protocols or planning for projected changes in temperature and extreme heat events.
- Leverage the expertise of the California Department of Public Health with respect to heat illness prevention in a changing climate.

Vulnerability to Floods

Climate change analyses indicate more frequent and longer flood events driven by projected intensification of extreme precipitation and the increase of temperature. The floods of 2017 demonstrate what the future might hold with the Flood Emergency Center open more often and for longer periods. Without adequate adaptation, projected increases in severity and frequency of flood events could lead to longer engagement and deployment of staff for event response, which could create physical and mental stress.

Adaptation Approach for Flood Exposure

DWR's Flood Emergency Response Program is responsible for preparing for floods, responding effectively to flood events and supporting quick recovery when flooding occurs. Already anticipating this need from experiences during the 2017 events, the Flood Emergency Response Program recently developed new protocols and organizational charts for the flood operation center and field response. The updated protocols and flood emergency response and

preparedness structure will be tested as DWR experiences new flood events. These should continue to be revisited and amended as needed.

2.2 State Water Project Hydrologic Risk

Vulnerability

The DWR Vulnerability Assessment indicates that mid-century projections of increased temperature (which leads to less snowpack storage) and sea-level rise (which leads to increased flows needed to maintain Delta water quality) result in a high likelihood of reduced contractor deliveries and reduced carryover storage (DWR, 2019a and Schwarz et al. 2018).
Scientific studies indicate that the performance of the SWP will likely diminish over the coming decades if nothing is done to adapt.

Adaptation Approach

The proposed approach is composed of five steps outlined in the *Climate Risk Informed Decision Analysis* (CRIDA), published by the United Nations Educational, Scientific and Cultural Organization (UNESCO) (Mendoza et al. 2018). The five steps are described below in the context of the SWP, all of which align with the adaptation process shown in Section 1 (Figure 2):

Step 1.	Structuring a Process for Vulnerability Assessment
Step 2.	Implementing a Bottom-up Vulnerability Assessment
Step 3.	Formulating Alternative Plans
Step 4.	Comparing and Recommending Plans
Step 5.	Institutionalizing the Decisions

Steps 1 and 2 align with the Understanding stage (Figure 2) and have largely already been implemented by the Vulnerability Assessment. Steps 3 and 4 follow the Planning stage and Step 5 follows the Managing stage, where all these stages represent a process toward adaptation. The steps are further described below.

Step 1. Structuring a Concerted Process for Vulnerability Assessment

The SWP is studied, operated and maintained by multiple divisions in DWR, which all have specifics goals and objectives to meet water and energy supply requirements on behalf of the state and DWR. Divisions responsible for the SWP will help define key metrics and critical thresholds of performance of the SWP which will guide the next steps.

Step 2. Implementing a Bottom-up Vulnerability Assessment

DWR staff completed an assessment of the SWP hydrologic vulnerability in Schwarz et al. (2018) and *Decision Scaling Evaluation of Climate Change Driven Hydrologic Risk to the State Water Project – Final Report* (DWR, 2019b). This assessment involved an innovative method called "decision-scaling" (Brown et al, 2012), which allows planners to quantify the risks and costs associated with both the status quo and those of various adaptation strategies. Planners can then use this information to make informed decisions about which adaptation strategies will be most likely to improve conditions for various performance metrics identified in Step 1.

Figures 3 and 4 show the findings for SWP exports presented in the DWR Vulnerability Assessment. Figure 3 represents a "response surface" of the SWP exports with the change in

temperature and precipitation while overlaying the conditional probability distribution informed by General Circulation Models (GCMs). Figure 4 presents the probability density function and cumulative density function for SWP exports.

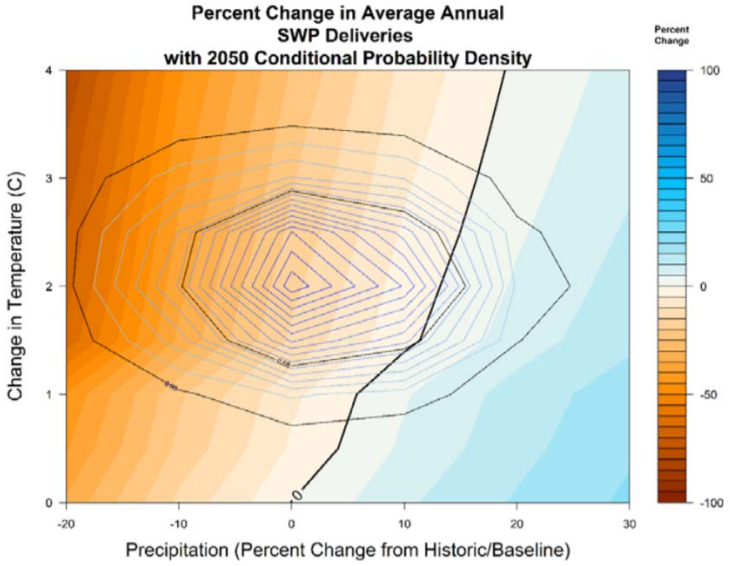
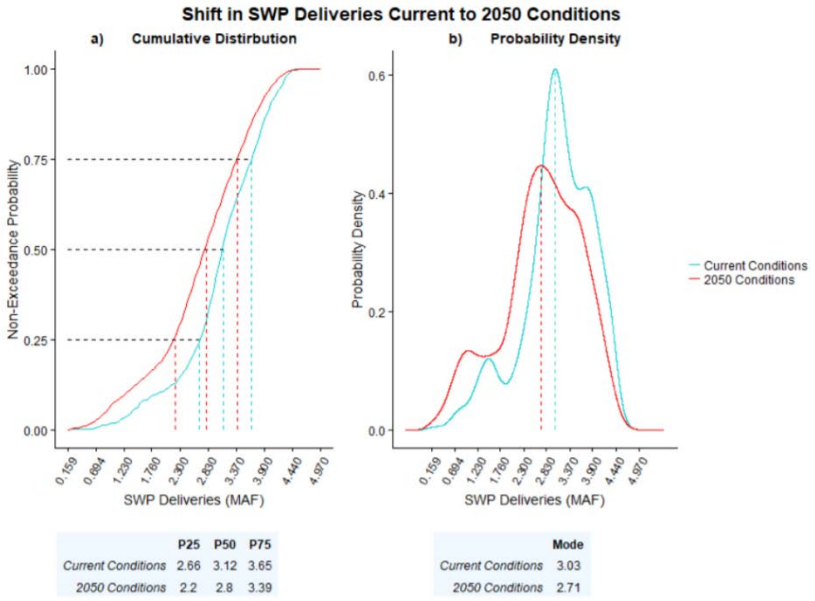


Figure 3. Average Annual SWP Deliveries with General Circulation Model-informed probability distribution function at 2050



	P25	P50	P75
Current Conditions	2.66	3.12	3.65
2050 Conditions	2.2	2.8	3.39

	Mode
Current Conditions	3.03
2050 Conditions	2.71

Figure 4. Cumulative Distribution and Probability Density Functions for Annual SWP Deliveries

According to these figures and based on the model scenarios considered in this assessment, it is *very likely* that by 2050 SWP deliveries performance would be less than current performance. In other words, performance of the SWP would diminish over the coming decades if nothing is done to adapt to climate change. The approach taken here provides opportunities to improve

planning for climate change, seeking to lessen the impacts of climate change on the SWP performance.

Based on the metrics and critical thresholds determined in Step 1, DWR will use the SWP vulnerability assessment findings and add any other relevant information important to decisionmakers. Once the quantitative assessments of future risk are established, quantitative adaptation objectives that address this uncertainty can be developed. An example of a quantitative climate adaptation objective might be:

> *For mid-century conditions, decision scaling analysis indicates that there is a 22 percent probability that long-term average annual SWP deliveries will fall below 2 million-acre feet. Implement adaptation strategies that reduce the probability of this condition to no more than 5 percent.*

Step 3. Formulating Alternative Plans

This step includes the formulation of actions to reduce the vulnerabilities identified in Step 2. All proposed risk-reducing actions are then stress-tested to identify options that improve the robustness of the SWP to perform above critical thresholds. A group of consecutive actions called "decision pathways" (Haasnoot et al. 2013) can be elaborated to determine long-term strategies required to build flexible and robust plans. Adaptation pathways provide an analytical approach for exploring and sequencing a set of possible actions based on alternative external developments over time. This method acknowledges that some decisions concerning so-called "known unknowns," such as future climate or socioeconomic uncertainties, can be addressed through a process of targeted monitoring and incremental decision making.

The *Decision Scaling Evaluation of Climate Change Driven Hydrologic Risk to the State Water Project – Final Report* (DWR, 2019b) established a sample of proposed climate change adaptation strategies, drawn from the 37 Resource Management Strategies in the California Water Plan Update2013. Those include, but are not limited to:

- The effect of monthly reservoir inflow forecasting ability on system operation;
- Weather modification or cloud-seeding;
- Incorporation of improved multi-objective upper watershed management; and
- Conjunctive management and groundwater recharge.

Step 4. Comparing and Recommending Plans

This step involves first the assessment of the robustness and flexibility of the formulated decision pathways or plans. These plans are compared against a baseline measure of performance and across different future scenarios. The plans' benefits and costs are also compared. A flexible plan would allow decision makers to select a course of action to adjust to shifting or emerging conditions while ensuring a near-term action does not rule out potential future actions. The final plan would articulate how it copes with uncertainty by adapting to changing conditions.

Step 5. Institutionalizing the Decisions

The fifth step consists of institutionalizing the plan that was developed in the preceding steps and providing general guidance on organizational, financing, and monitoring requirements. As the processes, guidance or other strategies are adopted organizationally and/or legally, they then must be tracked and then periodically evaluated for effectiveness and adapted to new conditions and new science.

Next Steps

- Coordinate the implementation of the five steps listed above with the SWP.
- Explore the adaptation potential of the four RMSs noted above, as well as Delta Conveyance.
- Incorporate consideration of climate change into SWP's Asset Management Program (e.g. the impact of increased heat on equipment efficiency and lifespan).
- Potentially partner with academic researchers to further explore the vulnerability, adaptive capacity, and adaptation options for the SWP.

2.3 Upper Feather River Watershed

Vulnerability

According to analysis conducted in the DWR Vulnerability Assessment, wildfire exposure to the watershed of Lake Oroville, and the Upper Feather River Watershed, is expected to change from a currently low and moderate wildfire exposure risk, to moderate and high by mid-century. Indeed, the 2018 Camp Fire affected lower areas of the Upper Feather River Watershed, demonstrating the catastrophic impacts of wildfire in this region. Watershed scale vulnerability to projected increases of wildfire and watershed health were identified as a top priority to be addressed in the DWR Adaptation Plan. Moreover, Assembly Bill (AB) 2480 (2016) formally defines watersheds as part of the state's water infrastructure.

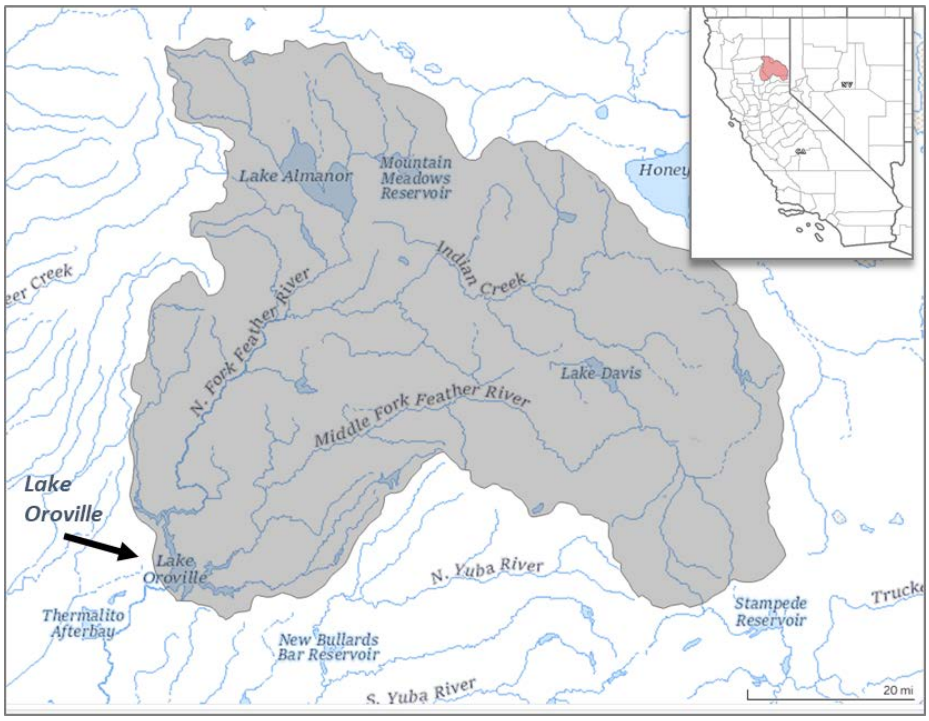


Figure 5. Location of the Upper Feather River Watershed, noting the location of Lake Oroville. Inset map shows the location of the Upper Feather River Watershed within California.

Adaptation Approach

Given that approximately 99 percent of land in the Upper Feather River Watershed is owned by federal or private entities, DWR does not have direct jurisdiction to reduce wildfire risk in the region. Therefore, DWR seeks to serve as a collaborator and active supporter of meeting mutual climate resilience goals for the region with other stakeholders. DWR staff began efforts to collaborate with regional stakeholders by participating in meetings and conducting a survey to gather stakeholder current interests in 2019. Stakeholder priorities were identified and will be examined to determine how DWR can support ongoing efforts of the Upper Feather River Watershed Integrated Regional Water Management (IRWM) program and its stakeholders. In particular, DWR will need to work collaboratively with specific stakeholders in the watershed, such as tribal entities, other State agencies (e.g. Sierra Nevada Conservancy), the federal government (e.g. the U.S. Forest Service), and the private sector (e.g. Pacific Gas & Electric).

Initial Outreach Findings

Discussions and surveys with stakeholders between July and December 2019 in the Upper Feather River Watershed garnered several priority areas related to adaptation to climate change:

- Agriculture
- Forest Management
- Hydrology
- Wildfire
- Meadows
- Climate, Weather Data, and Forecasting

Next Steps

Next steps will involve gathering and prioritizing specific strategies and barriers to adaptation that stakeholders are pursuing (or seeking to pursue). DWR staff then will examine which of these strategies align with DWR activities and/or priorities. These mutual priorities will be presented to the IRWM stakeholder group for further feedback and input.

External Collaboration

- Continue to attend quarterly IRWM meetings and coordinate with the Upper Feather River IRWM and stakeholders.
- Provide presentations of initial findings of stakeholder input and propose a ranking strategy for focus areas.
- Prioritize adaptation focus areas by IRWM members of initial outreach efforts by hosting a workshop session at an upcoming Upper Feather River Watershed IRWM meeting.
- Learn from other, similar watershed collaborative studies and efforts, such as those in the Yuba and Mokelumne watersheds, as well as in the Tahoe Basin.
- With the IRWM, actively seek grant and other financing opportunities that may be available in the non-governmental and private sectors.

Internal Collaboration

- Stakeholder priorities will be compared with and then linked to the Adaptation Plan, draft Water Resilience Portfolio, and other DWR goals.
- IRWM group input will be considered for further investment in research, technical assistance, and specific projects in the watershed.

Continued involvement with the Upper Feather River Watershed IRWM and other stakeholders in the region will be key for DWR to help address climate adaptation needs in the watershed. Working through the Upper Feather River Watershed group also demonstrates DWR's support generally for the IRWM process.

2.4 Landscapes (Ecosystems and Habitats)

The quality of ecosystems and habitats that DWR owns and manages—either solely or with others—is projected to decline under a changing climate. This decline poses a risk to achieving environmental regulatory requirements, which in turn can affect DWR's ability to achieve water supply reliability targets. DWR manages thousands of acres of land throughout California to support ecological habitat and protected species populations, much of which is in the Delta. Habitat types on managed lands statewide include wetland, riparian, grassland, tidal marsh, oak woodland, saltbush scrub, and others. Among other landholdings, DWR owns and/or manages mitigation properties and restoration projects. This Adaptation Plan focuses mainly on these two types of landholdings given the high investment involved and current opportunities for incorporating adaptation into operations and management planning.

Vulnerability

Impacts on lands owned or managed by DWR were examined for the Sacramento Valley, San Joaquin Valley, and Southwestern ecoregions — all of which have habitats that are already negatively impacted by non-climate related factors, making them particularly vulnerable to climate change impacts. The DWR Vulnerability Assessment indicated the following issues.

- Climate change will exacerbate stresses on listed species and habitat types.
- Degradation of species and habitat types may result in additional regulations affecting DWR and SWP operations.
- The Suisun Marsh, which is part of the EcoRestore initiative, is recognized as being at high risk of potential impacts from climate change.

Adaptation Approach

In this first iteration of the Adaptation Plan, two steps are proposed to advance adaptation for supporting vulnerable ecosystems and habitats under DWR's auspices.

1. Inventory all DWR owned and managed lands and analyze whether any of these properties are exposed to projected climate change hazards.

2. Conduct an analysis to identify EcoRestore projects that may need additional adaptation support as sea level and temperature conditions shift under climate change.

The first step entails completing an inventory of DWR-owned or managed lands that would allow for a more inclusive analysis of projected climate change impacts than could be conducted in the DWR Vulnerability Assessment. This analysis could be incorporated into future updates of the Vulnerability Assessment.

The second step would focus on the EcoRestore initiative specifically, the larger umbrella project of which Suisun Marsh habitats are a part. Sustaining and advancing habitat restoration projects is the mission of the California Natural Resources Agency EcoRestore initiative, which, through multiple partnerships, seeks to restore 30,000-acres in the Delta. EcoRestore projects

consider climate change and associated impacts during planning, design and permitting. However, the climate change standards, criteria and projections considered on a project-by-project basis vary depending on the level of environmental documentation and permitting required and when permitting was completed. Post-construction habitat restoration sites become part of DWR's land management portfolio, creating an opportunity to study the ability of restored sites to adapt to climate change.

For EcoRestore, the climate change vulnerability analysis would focus on the following activities.

- Inventory standards used for addressing sea-level rise in CEQA analysis for each of EcoRestore's projects.
- Determine which DWR managed sites are in areas that could benefit from a more thorough analysis regarding the impacts of sea-level rise than would be conducted for planning based on the standards applied under CEQA review documents.
- Estimate the ability of the project to maintain its desired habitat and the economic costs of updating and maintaining each project's habitat under higher salinity and inundation levels and increased temperatures for several points in time.
- Coordinate with the Delta Stewardship Council's Vulnerability Assessment and Adaptation Plan process ("Delta Adapts"), which also includes the Suisun Marsh.

Knowing how climate change may impact properties could allow land management decisions and investments to be made in advance of climate change impacts or habitat changes. Using this analysis, DWR managers with other collaborating agencies could collectively determine approaches that reduce the impacts of climate change on these restoration sites.

Next Steps

The two proposed steps described above are on different timelines and will advance independently of one another. First, the inventory of managed lands from the Real Estate Branch needs to be analyzed to determine if it can be used for an exposure assessment of projected climate change hazards. Second, the next steps for implementing the EcoRestore program is to identify the staff or external party who would develop and analyze the inventory of the CEQA analyses and work with EcoRestore staff to develop economic estimates for adaptation. This EcoRestore-focused activity may benefit from an advisory group committee to ensure the work is conducted consistently with other ongoing efforts to plan for and manage the region's ecosystems.

Additionally, DWR's ongoing research studies related to carbon sequestration, land subsidence reversal, and wetlands creation, enhancement, and restoration, in areas such as Twitchell and Sherman Islands, highlight the potential for achieving multiple benefits, prompting further investigations and a focus on multi-benefit initiatives as a climate change adaptation strategy.

Section 3. Other DWR Activities Supporting Climate Adaptation

Beyond the assets evaluated in the Vulnerability Assessment, DWR also engages in a wide variety of activities, internally and externally, that support climate adaptation in California's water sector. Recognition of these efforts as part of the Adaptation Plan is important because they will likely change the context for the elements in DWR's Adaptation Plan as they continue to progress. Several of these efforts are briefly described below; many more adaptation strategies are included in the State's *Safeguarding California Plan*.

3.1 Climate Action Plan, Phase II

Nearly a decade ago, DWR identified a need for consistent departmental analysis of climate change impacts on the wide array of project and program planning activities it conducts (Khan and Schwarz, 2010). Climate change analysis can be complex, as it must account for large uncertainties about future climate conditions and their impacts. Phase II of the Climate Action Plan seeks to ensure that all DWR planning activities meet standards for quality, scientific rigor, and consistency. The intent of the guidance is to provide the following benefits to DWR.

- Assist DWR managers in conducting required climate change analyses.
- Improve the consistency and scientific rigor of DWR's approaches for analyzing climate change and its potential impacts on DWR projects and operations, while preserving both flexibility and efficiency.
- Improve compatibility and comparison of data from different studies.
- Promote the use of the best available science.
- Eliminate duplication of efforts.
- Improve clarity and consistency of messaging across DWR documents.
- Streamline decision-making and document review.

3.2 Inventory and Alignment Analysis of DWR Climate Change Efforts

To better understand potential areas to improve alignment on climate change efforts, DWR Climate Change Program staff examined efforts by DWR that include or consider climate change projections in decision making and planning. This includes efforts geared towards external parties (e.g., Groundwater Sustainability Agencies, Regional Water Management Groups), internal programs, and data produced internally that are used by DWR or other parties.

3.3 External Grant & Planning Programs

DWR oversees and provides assistance to local entities through several programs, many of which help promote climate adaptation planning at the local level. These programs are supportive broadly of the goals of the CAP – Phase III, given the importance of alignment at the local and state levels in adaptation planning.

Integrated Regional Water Management

The Integrated Regional Water Management (IRWM) grant program is a collaborative water management effort that brings together regional stakeholders to plan and develop mutually

beneficial projects. As part of an IRWM plan, Regional Water Management Groups (RWMGs) complete a climate change vulnerability assessment to prioritize climate change vulnerabilities and consider project alternatives that provide adaptation and mitigation benefits. In addition, IRWM plans must provide a process that determines a project's ability to help the IRWM region reduce GHG emissions as new projects are implemented over a 20-year planning horizon and consider energy efficiency and reduction of GHG emissions when choosing between project alternatives. RWMGs share information and leverage resources to build regional water sustainability and climate change resilience.

Flood-Managed Aquifer Recharge (Flood-MAR)

Flood-MAR is an integrated resource management strategy that uses floodwater for managed aquifer recharge (MAR) on agricultural lands, other working landscapes, and managed natural landscapes, including refuges, floodplains, and flood bypasses. DWR is currently working on a reconnaissance-level study in the Merced River Watershed. This study is exploring the effectiveness of Flood-MAR concepts, testing theories, and assessing strategies in overcoming barriers and challenges to project planning and implementation. One of the primary objectives of this study is to evaluate Flood-MAR's potential to adapt to climate change.

Central Valley Flood Protection Plan and California Water Plan Update

Water management in California is challenged by droughts and floods which may increase in magnitude and frequency under a changing climate. The Central Valley Flood Protection Plan and California Water Plan Update are two of the State's major planning documents. DWR is aligning these planning efforts to help develop cohesive adaptation strategies. One of the primary opportunities of this alignment is to conduct planning and analysis with the same foundational technical information and tools at the watershed and regional scale.

Water Storage Investment Program

Approved by voters in 2014, Proposition 1, Chapter 8, allocated $2.7 billion to the California Water Commission to fund public benefits associated with water storage projects throughout California. To support the Commission in that effort, DWR created detailed climate projection datasets for the entire state to estimate how water resources are expected to change in the future due to climate change impacts. Applicants for water storage funds were required to quantitatively analyze future climate conditions to compete for funding.

Groundwater Sustainability Planning

To facilitate implementation of the Sustainable Groundwater Management Act (SGMA), DWR provided modeled projections of climate change impacts on hydrology that could affect groundwater sustainability planning, and technical guidance for how to use this information. It is DWR's best available downscaled GCM-based dataset that includes statewide coverage of all climate, hydrology, and water supply variables necessary for conducting water resources planning and analysis under projected climate change conditions.

Water Use & Efficiency

Climate change is projected to impact not only water supplies but also water demands, including how much and when people use water. DWR supports implementation of water conservation laws by developing standards and guidance, providing grants and loans, and conducting research and data analysis.

3.4 Engaging and Supporting Vulnerable Communities

Since 2012, California law (AB 685) has declared that every person in the state has a right to clean, safe, and affordable drinking water. The State Water Project helps provide clean, safe, and affordable drinking water to approximately 27 million people, including six million people in disadvantaged communities. In addition, DWR endeavors to provide vulnerable communities with technical, financial, and policy assistance that responds to local challenges and opportunities. This goal is accomplished through an array of outreach, collaboration, and grant making within programs such as IRWM and SGMA. Since 2002, IRWM has provided over $1.5 billion in state funding to support and advance integrated, multi-benefit regional projects, with priority funding for projects in vulnerable communities. Through SGMA, DWR will be offering over $85 million in grants for groundwater sustainability projects that directly benefit vulnerable and disadvantaged communities.

These programs not only provide financial assistance, they offer technical and facilitative support through regionally dedicated staff and partners. DWR actively seeks new and innovative ways of engaging with disadvantaged and vulnerable communities such as providing multilingual workshops and educational materials and through partnerships with non-governmental organizations working within the community. Tools such as Disadvantaged Communities Mapping and CalEnviroScreen enable the Department to identify areas most in need of support service and to target funding. DWR will continue to seek relationships with disadvantaged and vulnerable communities and ensure they are involved in planning and implementation efforts. It is collectively through these efforts that DWR identifies and prioritizes actions to address the climate change related needs of vulnerable and disadvantaged communities.

3.5 Engaging and Supporting Tribes

DWR continues to engage with tribes to better understand their perspectives and concerns about water and natural resources, especially regarding climate change. DWR assists tribal governments and communities to: 1) determine or assess how climate change impacts tribal communities; 2) seek information from tribes on their conceptual framework for adapting and mitigating for climate change on a local and region (or wider) scale; 3) discover how Traditional Ecological Knowledge is incorporated; and 4) identify data gaps and opportunities for technical assistance which DWR could provide.

DWR has also partnered with tribes in developing tools and outreach materials that identify potential climate change vulnerabilities and adaptation strategies for tribal communities. With a dedicated Tribal Policy Advisor, DWR is committed to open, inclusive, and regular communication with tribal governments and communities to identify and understand their

needs and interests, recognizing that climate change deeply and directly affects tribes because they depend on water and natural resources for their livelihoods and ways of life.

Section 4. Next Steps for the Climate Action Plan – Phase III

This Adaptation Plan provides the next steps for CAP – Phase III by presenting recommended actions for each vulnerable asset identified in the Vulnerability Assessment. CAP – Phase III will require further efforts to meet climate change challenges to which DWR assets are exposed. Three additional efforts serve the larger purpose of CAP – Phase III and should be advanced as part of implementing this Adaptation Plan:

1. Climate change science and analysis evolve, continually advancing with new data, models and methods to evaluate projected impacts and uncertainties. New information should be applied to DWR vulnerabilities at least every five years and with the issuance of each California Climate Change Assessment. Updates could include: (1) an expanded range of projections; (2) sensitivity of water indexing methods and potential of changing water-year typing; (3) warming across seasons and elevations; and (4) staff exposure to increased wildfire smoke. The vulnerability of DWR assets to compounding and cascading extreme events should also be investigated.

2. One significant gap in the decision scaling modelling framework is the representation of groundwater in the Central Valley and potential conjunctive operations of the SWP. The *Decision Scaling Evaluation of Climate Change Driven Hydrologic Risk to the State Water Project Final Report* (DWR, 2019b) identified two possible methods to incorporate integrated groundwater-surface water modelling into the modelling framework. The improvements would provide a more detailed understanding of risk that climate change poses to the SWP and will help explore potential adaptation strategies and benefits of enhanced groundwater storage and recovery north and/or south of the Delta.

3. The DWR Climate Change Program will monitor, track, evaluate, and document the progress of each step of this plan. This will ensure transparency and demonstrate the application of the other principles outlined in section 1, which are critical for successful climate adaptation.

Finally, this Adaptation Plan can help meet multiple recommendations of the draft Water Resilience Portfolio in response to the Executive Order N-10-19. These recommendations fall under several themes including: (15) Encourage investment in upper watersheds to protect water quality and supply; (18) Help protect the economic and ecological vitality of the Sacramento-San Joaquin Delta; (19) Modernize inter-regional conveyance to help regions capture, store, and move water; (26) Help regions prepare for drought; and (27) Sharpen the ability of regions to anticipate weather and climate changes.

Adapting to climate change is one of the most difficult challenges society has ever encountered. As the first Adaptation Plan for DWR, this document offers a foundation for DWR to build upon and helps facilitate dialogue about climate resilience. Beyond DWR it serves a model for other agencies and sectors to articulate their efforts and diversify their approaches to adaptation. Ultimately, success in adaptation relies on coordinated alignment of adaptation efforts across sectors, within State government and at all levels of society.

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