Report of the

2017 Water Education Foundation Water Leaders Class

THE FUTURE OF CALIFORNIA WATER STORAGE

WATER EDUCATION FOUNDATION

Water Leaders 2017

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Fellow Californians,

The 2017 William R. Gianelli Water Leaders Class is pleased to present our take on the Future of California Water Storage. This report, and the opinions expressed herein, do not necessarily represent the views of the Water Education Foundation (WEF) or its Board of Directors. The William R. Gianelli Water Leaders Class of 2017 was granted full editorial control of this report. Throughout the development of this report, the Water Leaders gained a valuable understanding of the complicated and sometimes contentious nature of water management issues in California. The sections presented in this report are useful in outlining various positions and perspectives; however, the statements expressed in this report are not necessarily endorsed by all Water Leaders or their employers.

For a prosperous California,

2017 William R. Gianelli Water Leaders Class

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ACRONYMS AND ABBREVIATIONS

ACWA	Association of California Water Agencies
AF	Acre-feet
AFY	Acre-feet per year
ASCE	American Society of Civil Engineers
BARR	Bay Area Regional Reliability
CALFED	CALFED Bay-Delta Program
CEQA	California Environmental Quality Act
CCWD	Contra Costa Water District
CVP	Central Valley Project
CWC	California Water Commission
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
IRWM	Integrated Regional Water Management
JPA	Joint Powers Authority
LAO	California's Legislative Analyst's Office
LVE	Los Vaqueros Reservoir Expansion
MAF	Million Acre-Feet
MWD	Metropolitan Water District of Southern California
NEPA	National Environmental Policy Act
OAL	California Office of Administrative Law

P3	Public-Private Partnership
SAGBI	Soil Agriculture Groundwater Banking Index
SARCCUP	Santa Ana River Conservation and Conjunctive Use Project
SDCWA	San Diego County Water Authority
SGMA	Sustainable Groundwater Management Act
SWP	State Water Project
SWRCB	State Water Resources Control Board
USBR	United States Bureau of Reclamation
WEF	Water Education Foundation
WRD	Water Replenishment District of Southern California
WSIP	Water Storage Investment Program

EXECUTIVE SUMMARY

California's water storage system reflects the state's regional variances in climate, geology, overlying land use, population, water quality and availability. Approximately 1,400 dams and 517 groundwater basins currently have the potential to provide short-term, long-term, seasonal and annual water storage and additional flood control, ecosystem and water quality benefits. Although the current water management system successfully supported the state's rapid population increase throughout the 20th century, the expected future increase in population combined with climatic changes, natural disasters, and degraded ecological conditions provide new challenges. The Water Leaders Class was tasked with developing policy recommendations to provide points of discussion for addressing these challenges. The Water Leaders Class hopes that the five recommendations outlined below can reignite the ongoing conversation about how best to manage water storage in California.

Policy Recommendations

Focus on what you have: Maintain and enhance existing systems and projects prior to considering new storage projects.

Aging infrastructure, increasing demand, sedimentation, subsidence, climate change and environmental needs all necessitate regular maintenance and repairs of existing infrastructure. The average age of California dams is 68 years (California Department of Water Resources [DWR] 2017). A lack of public understanding of maintenance issues and programs, combined with unclear funding sources, has hindered progress of regular maintenance activities. California's Legislative Analyst's Office (LAO) estimates that there is $13.1 billion of deferred maintenance for DWR facilities (LAO 2017). To combat this, promoting water system maintenance and enhancement activities should emphasize the latest details about local water system vulnerability and highlight the consequences of deferred maintenance. Federal, state and local water providers should undertake an extensive review to understand the conditions of their water system infrastructure to effectively plan for maintenance and enhancement activities. Additionally, reservoir expansion projects and opportunities should be prioritized over new sites when possible to limit impacts to the environment.

Put it in the ground: Maximize and capitalize on groundwater storage opportunities.

Groundwater storage will play a major role in the future of water storage in California. DWR studies conducted in 1975 and 1994 estimated California's usable storage to be approximately 143 to 450 million acre-feet (MAF) (California Natural Resources Agency 1975, DWR 1994). Costs to develop new groundwater storage, which are primarily associated with recharge and extraction facilities, are estimated to be $90-$1,100/AF (Water in the West 2014). Moreover, the environmental impacts of groundwater storage development can be minimal, as opposed to the often significant impacts of many types of new surface storage development (Devic 2014). Based on this information, groundwater storage development should be maximized in California. Groundwater storage development could expand long-term storage capabilities, acting as the "afterbay" to existing and future surface water storage projects. To capitalize on future groundwater storage opportunities, there should be a closer examination of the inclusion of groundwater recharge as a beneficial use of water. In addition, to encourage increased groundwater storage development at the state level, the state should develop a new framework specifically designed to award grant funds to groundwater storage projects. Finally, water resources managers should consider developing and offering innovative incentives to maximize groundwater storage and recharge opportunities. Incentives could be in the form of financial or water supply benefits, or modification of legal constraints.

Keep it flexible: Storage systems must be adaptable and have the flexibility to navigate changing conditions.

California's existing infrastructure was planned, designed and built based upon historical patterns: a healthy snowpack in winter months that melts and provides runoff throughout spring and early summer. However, California has experienced an increase of 1.1 to 2 degrees Fahrenheit in mean temperature in the past century, an increase in the percentage of precipitation falling as rain rather than snow, and a shift in the timing of runoff to earlier in the season (DWR 2015). With recent and projected changes in precipitation patterns, it is imperative that future storage solutions incorporate resiliency planning that will allow storage projects to perform to their intended function under threat of variable weather patterns. Conjunctive use is one example of building resiliency in water storage. During wet years, excess surface water that is not utilized to meet preexisting water rights/needs (including environmental needs) could be banked in a groundwater basin that has the available storage capacity. Using existing surface storage as a forebay for groundwater storage by banking excess surface water during wet years affords the flexibility of being able to use this water during dry years, when surface water supplies are lacking. However, for water banking to be an effective storage solution and for continued efficient utilization of the existing storage system, there must be adequate and reliable conveyance with sufficient capacity to move water from the supply source to storage, and to the water supply system. In addition to maximizing conjunctive use practices and strengthening conveyance systems, regional coordination and collaboration can provide additional flexibility to mitigate extreme weather events or emergencies. For example, agencies can build interconnections with neighboring agencies to provide redundancy and reliability into their systems to mitigate these circumstances.

Do it together: Foster coordination and collaboration on water storage across agencies and stakeholders.

California water management is comprised of a complex web of local, regional, state and federal agencies, and non-governmental stakeholders and organizations. There are more than 1,200 water districts in California, often working in close proximity and in the same watersheds and basins. This complexity can reduce efficiency and effectiveness of project implementation due to overlapping authorities, conflicting mandates and contradictory interests. For example, independent reviews of the CALFED Bay-Delta Program (CALFED) structure identified common issues that lead to misguided project management, including a lack of clear authority, priorities, performance measures and a finance framework. Regional partnerships, such as the Bay Area Regional Reliability (BARR), and joint powers authorities (JPAs), such as the Sites Project Authority and Santa Ana Watershed Project Authority, are ideal forms of collaboration because authority is defined and responsibility spread appropriately amongst member agencies. These partnerships can avoid the pitfalls of CALFED's governance issues by remaining regional and project specific. Regional collaboration should be fostered to strengthen regional self-reliance and promote multiple benefit projects that increase trust between entities and divide costs among participants. The regional JPA model should be used when possible to share resources, increase efficiency, and save all participants time and money. Agencies should coordinate and integrate storage operations when possible to provide greater carry-over storage, increase water supply and reliability, and enhance overall resiliency and sustainability.

Show me the money: Develop innovative systems to overcome major barriers that limit the availability of funding for lifecycle water storage costs.

Storage projects in California often are financed at least in part by local government agencies. However, constitutional limitations on the ability of entities to raise revenues have created difficulties in maintaining existing infrastructure and funding new storage projects. Because of these constraints, potential funding options for water storage should include a new tax or public goods charge to create a pool of funding at the state level that can be directed to local and regional water storage needs that would otherwise be unmet. Other options include pooling resources through JPAs or leveraging the use of private financing through public-private partnerships and other innovative financing structures. As California's water future continues to shift, novel financing ideas such as state grants of surplus water rights also should be explored.

1. INTRODUCTION

1.1 2017 Water Leaders Class

The William R. Gianelli Water Leaders Class is a one-year program organized by the Water Education Foundation (WEF) that identifies up-and-coming water industry professionals from diverse backgrounds and educates them about water issues, culminating in the production of a report authored by the class members. The 2017 Water Leaders Class was tasked with exploring the current state of water storage in California and developing policy recommendations for California's water storage future. Twenty early- to mid-career water professionals were selected by WEF to take part in the 2017 Water Leaders Class. Foundation Executive Director Jennifer Bowles paired each member with an experienced water professional for an exchange of ideas around the topic of storage **(Table 1)**.

Table 1 – 2017 Water Leaders Class and their mentors

Water Leader	Mentor
Richard Aragon, Director of Finance/Treasurer Rancho California Water District	Jacklynn Gould, Deputy Regional Director Bureau of Reclamation's Lower Colorado Region
Arturo Barajas Jr., Legislative Aid California State Assembly	Jason Phillips, General Manager Friant Water Authority
Ali Barsamian, Operations & Policy Manager WaterSmart Software	Marguerite Patil, Special Assistant to the General Manager Contra Costa Water District
Lyndsey Bloxom, Communication and Education Services Representative The Water Replenishment District of Southern California	Joe Byrne, Chair California Water Commission; Attorney, Best Best & Krieger LLP
Megan Brooks, Environmental Scientist Delta Stewardship Council	Chris Scheuring, Managing Counsel California Farm Bureau Foundation; Tree Farmer, Yolo County
Ian Buck, Water Resources Engineer Stantec (formerly MWH)	John Laird California Natural Resources Secretary
Heidi Chou, Associate Civil Engineer East Bay Municipal Utility District	Armando Quintero California Water Commissioner; Executive Director of Sierra Nevada Research Institute; Board member, Marin Municipal Water District

Michael Cook, Regional Director River Partners	Dennis O'Connor, Principal Consultant California Senate Committee on Natural Resources and Water
Marcia Ferreira, Associate Resource Specialist Metropolitan Water District of Southern California	Joe Grindstaff, General Manager Inland Empire Utilities Agency; former CALFED Director
Ana Lucia Garcia Briones, Project Manager Environmental Defense Fund	Steve Ritchie, Assistant General Manager of Water Enterprise San Francisco Public Utilities Commission
Andree Johnson, Senior Water Resources Specialist Bay Area Water Supply and Conservation Agency	Juliet Christian-Smith, California Climate Scientist Union of Concerned Scientists
Anusha Kashyap, Water Resources Engineer CDM Smith	Max Gomberg, Climate and Conservation Director State Water Resources Control Board (SWRCB)
Angela Llaban, Senior Environmental Scientist California Department of Fish and Wildlife	Stefanie Morris, General Counsel State Water Contractors
Sara Maatta, Water Operations Analyst Alameda County Water District	John Cain, Conservation Director American Rivers
Sami Nall, Water Resources Engineer California Department of Water Resources	Pablo Arroyave, Acting Regional Director Bureau of Reclamation, Mid-Pacific Region
Gina Nicholls, Associate Attorney Nossaman LLP	Sue Sims, External Affairs Group Manager Metropolitan Water District of Southern California; former Executive Officer of California Water Commission
Donald Portz, Lead Fisheries Biologist US Bureau of Reclamation	David Guy, President Northern California Water Association
Patrick Scott, Environmental Scientist California Department of Water Resources	Oscar Serrano, Principal Engineer Colusa Indian Community Council
Oliver Symonds, Public Information Specialist Contra Costa Water District	Helen Dahlke, Assistant Professor in Physical Hydrology at the Department of Land, Air and Water Resources UC Davis
Bobby Vera, Associate Engineer West Yost Associates	Maurice Hall, Associate Vice President, Ecosystems – Water Environmental Defense Fund

Members of the 2017 Water Leaders Class met at least once with their mentors and conducted interviews using the same agreed-upon questions about California water storage. The intent was to learn about current storage in California from multiple points of view and inform the class during the research phase. Each mentor also provided an in-depth view of their workday by agreeing to be "shadowed" by their mentees for a day. This activity provided invaluable insight into the responsibilities and tasks of experienced water professionals.

In addition, the 2017 Water Leaders Class had the opportunity to hear from a variety of speakers at several Water Education Foundation events and a mandatory, three-day water tour of the Sacramento-San Joaquin Delta (Delta) and San Francisco Bay. Each member of the class also participated in a second Water Education Foundation water tour. Photos from the WEF water tours are shown in **Figure 1**. The field trips provided opportunities for members of the class to discuss their ideas in an informal setting with their peers and with members of the public attending the tours. The Water Education Foundation arranged lectures by speakers from multiple points of view during the tours, adding to the dynamic discussion of the topics and allowing the 2017 Water Leaders Class participants to challenge their own views and expand their knowledge of water issues.

In addition to learning from their mentors and attending tours, all twenty of the 2017 Water Leaders met multiple times in person at the Water Education Foundation offices in Sacramento and participated in several conference calls to share ideas, distribute assignments and check-in on individual work progress.

This report, the result of the year-long research project carried out by the 2017 Water Leaders Class, outlines policy recommendations and implementable actions for the future of water storage in California. The work produced in this report is a compilation of ideas and does not necessarily reflect the point of view of any specific individual, their employer or the Water Education Foundation.

Figure 1 – 2017 Water Leaders Class participants attending the WEF Water Tours

1.2 Is there a Water Storage Problem?

1.2.1 Where are we now?

California's water management system is as diverse and dynamic as the state's widely varied regional water availability conditions and demands. According to the California Department of Water Resources (DWR), approximately 1,400 regulated reservoirs provide seasonal and short-term water storage of about 42 million acre-feet (MAF) for the purposes of flood management, energy storage and production, water quality regulation, ecosystem support and recreation. In addition, the state's 517 groundwater basins have the potential to provide between 143 to 450 MAF of usable annual and long-term water storage capacity, while also providing added benefits of groundwater quality regulation and ecosystem support for overlying wetlands and riparian habitats (DWR 2016b). Additional seasonal water storage is also provided by the Sierra-Nevada snowpack, storing winter precipitation to supply spring and summer runoff.

Relying on demand management actions and expansion of surface storage, the current water management system successfully supported the state's rapid population increase throughout the 20th century, from 1.5 million people in 1900 to nearly 40 million people in 2000. However, more complex challenges lie ahead. Future water storage planning will operate under increasingly erratic climate conditions, including larger floods, more frequent and severe droughts, and reduced snowpack, and will need to provide for an additional 10 million people by 2060 (DWR 2014b). Other challenges will come from aging infrastructure and modern understanding of the ecological impacts of water storage and conveyance practices. Most of California's dams were constructed more than 40 years ago, with some of the oldest reaching over 100 years of age (Lund et. al. 2014). Future water storage planning must address the operational functionality, efficiency and safety of these facilities, while comprehensively examining the positive and negative environmental impacts associated with each part of the system.

For these reasons, proposals to construct, expand and re-operate water storage facilities in the state are not novel, yet have garnered more attention recently due to the prolonged drought of water years 2012 to 2016 and the subsequent wet year of 2017. Proposed storage project concept papers for the Water Storage Investment Program (WSIP), as discussed in Section 1.2.2, included new on-stream and off-stream surface reservoirs, but focused primarily on the expansion or re-operation of existing facilities and the implementation of new local groundwater storage projects and regional banking/ conjunctive use projects. Although groundwater storage potential is much larger than current surface storage capacity, only about 22 groundwater basins (4% of total) in the state are currently implementing passive or active conjunctive use or groundwater banking programs (Gies 2015). The excessive use of groundwater supplies combined with a natural lack of recharge and limited practices of artificial recharge has created significant overdraft and available storage space in groundwater basins typically located near centers of high demand.

1.2.2 The Water Storage Investment Program

In response to the ongoing and increasingly common storage conversations in the state, legislators brought the investment decision to the California voters for action. In November 2014, voters passed Proposition 1: The Water Quality, Supply, and Infrastructure Improvement Act of 2014. The proposition included a dedicated $2.7 billion for investments in water storage projects and designated the California Water Commission (CWC) as the agency responsible for allocating these funds.

In an effort to gather information on potential projects and to allow for refinement of the application review timeline, the CWC solicited concept papers from potential project proponents. This process was also designed to serve as a benefit to project proponents, allowing them to identify potential regional partners or coordinate with other projects. The solicitation for concept papers closed on March 31, 2016 and 43 total papers were received from 30 entities including public agencies and utilities, nonprofit organizations, and local Joint Powers Authorities (JPAs) (see Appendix A).

After review of the submitted Concept Papers, the CWC finalized and released the Code of Regulations governing the investment of public funds for public benefits associated with water storage (OAL 2016). The regulations described the application process and the methods and criteria to be used by the Commission to evaluate proposed projects. On March 14, 2017, the five-month application period opened and by the close date on August 14, 2017, 12 total projects were submitted with the costs to construct all projects totaling $13.1 billion (See Appendix B). A map of the WSIP proposed projects is shown in **Figure 2**. The CWC is currently in the application review process and anticipates releasing early funding decisions in May or June of 2018.

Figure 2 – WSIP Proposed Projects Map

2. CLASS APPROACH

2.1 Research Framework

The research framework employed by the 2017 Water Leaders Class consisted of an initial research and source review period that led to the selection and division of the overall topic into storage-related modules. The group subdivided to perform a focused review of each module, utilizing a set of group-determined evaluation lenses to provide consistency. The entire class then reviewed all modules findings and worked collaboratively to determine the final policy recommendations, as shown in **Figure 3**.

Figure 3 – Research framework used to complete this report

This framework was intended to facilitate collaborative thinking and decision-making, while also allowing each class member to focus on an area of specific interest. The goal was to provide a consistent and congruent methodology during the research and evaluation phase, but also to leverage the diversity of Water Leader educational and professional backgrounds, personal perspectives and unique skill sets. Additionally, due to the wide geographic distribution of class participants, a process favoring individual research and small-group collaboration instead of class-wide coordination was necessary. However, although all research and evaluation was performed in module groups, the final review and policy recommendations were done with all class participants.

2.1.1 Storage Modules

After several months of individually reviewing key sources, attending the Water Education Foundation Executive Briefing, and participating in several WEF tours, the Water Leaders held a general discussion on perceptions of California's current water storage system. During this discussion, several storage-related topics consistently arose as the key points of interest regarding California's current and future water storage capability. After further discussion and a group vote, these points of interest were refined into the following nine module topics:

- Groundwater Storage
- Stormwater Capture and Infiltration
- Floodplain Storage
- On-stream Reservoirs
- Off-stream Reservoirs
- Reservoir Expansion
- Maintenance/Alternative Actions
- Re-Operation/Coordinated Operations
- Financing Options for Storage Projects

The module topics were used as an organizational tool to focus on specific areas of research and to divide into smaller working groups. Module groups spent several additional months finding topic-specific resources and drafting overview documents (including relevant policies, implementable actions, and case studies) to share with the entire group for review.

2.1.2 Evaluation Lenses

During the initial review period, as the module topics were being identified, several common themes arose that were fairly consistent across all storage-related resources, regardless of topic. In order to provide consistency across research conducted within the module sub-groups, seven themes, or lenses were selected to evaluate module topics. The selected lenses are listed below:

1. Environmental – What are the impacts?
2. Financial – Can we afford it? Who pays for it?
3. Technical – Can we physically make it happen?
4. Resiliency – How does the project recover from difficult situations?
5. Regulatory – Are we allowed to do it?

6. Public Benefit – What is the best approach in consideration of all users?

7. Public Perception – Will the public support it?

Prior to completing the review of module topics using the above lenses, each lens was further refined by a 2017 Water Leaders Class sub-group to provide uniform and specific direction.

2.2 What is and what is not in this report?

2.2.1 This report does not endorse any of the WSIP proposals

The Water Leaders group included the WSIP Concept Papers submitted to the CWC in the initial research and review period. However, the deadline for final submission of projects was after the lens evaluation of each module and the group review. For this reason, there is not a an endorsement of any specific WSIP projects in the policy recommendations described below and the focus is instead on broader storage needs and concerns. Additionally, the WSIP regulations were designed to prioritize environmental and ecosystem benefits associated with the Delta, and the goals of this research were to focus on statewide existing and potential storage capability, regardless of geographic location.

2.2.2 This report outlines policy recommendations and implementable actions

Following completion of each sub-group's module evaluation, the entire group met to discuss findings and determine storage-related policy recommendations. Using the lens evaluation of relevant case studies within each module and information taken from mentor interviews, the discussion centered on the underlying issues previously seen or anticipated in constructed and proposed storage projects, and how to overcome these issues. The goal of this process was to develop realistic and achievable recommendations with implementable actions that provide the greatest benefit to California water storage. Specific case studies are used as examples, but the focus is not on specific projects, rather on policy recommendations that are broadly applicable. The policy recommendations and implementable actions presented within are aimed to guide the state in future discussions of storage and development of future funding mechanisms and governing regulations, similar to the current WSIP opportunity.

3. POLICY RECOMMENDATIONS

3.1 Focus on what you have: Maintain and enhance existing systems and projects prior to considering new storage projects.

3.1.1 Importance of Maintenance and Enhancement

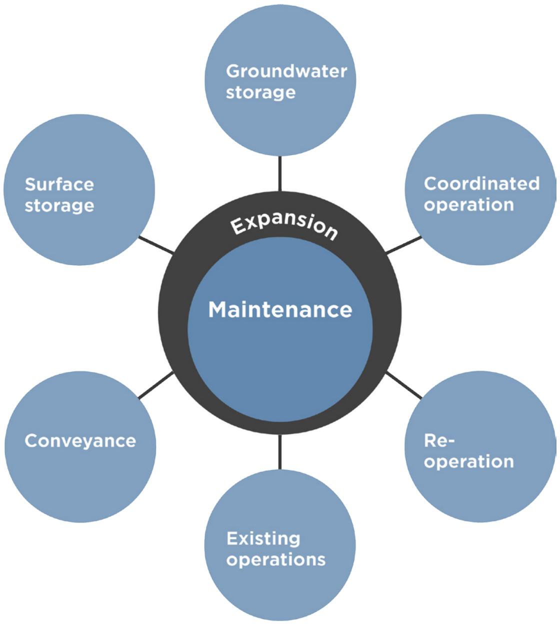
California's interconnected water system serves nearly 40 million people through a complex system of reservoirs and dams, aqueducts and pipelines, pumps and treatment systems. Proper maintenance of each part of this system protects the state's investments and ensures future safety and reliability. Maintenance includes the recurring repairs or replacements needed to preserve and extend the life of facilities. When adequate maintenance is not performed, it can lead to more expensive repair costs, dangerous conditions and less resilience in the future. The California Legislative Analyst's Office (LAO) estimated that there is $13.1 billion of deferred maintenance for DWR facilities (LAO 2017).

As highlighted by the 2016-2017 winter storms, California's water infrastructure is in need of significant maintenance. The Oroville Dam Spillway incident in early 2017 put a spotlight on the current state of the aging facilities that make up California's water infrastructure systems. Many infrastructure components have been weakened over time by land use changes, consumption trends and extreme weather (American Society of Civil Engineers [ASCE] 2017). While there is a need for more water storage in the state, the need to maintain the existing system is even greater, particularly when considering new storage projects that rely on existing infrastructure. Without proper maintenance, investments in system upgrades that rely on existing infrastructure may not provide the desired function and benefit (e.g. upgrades to a water storage facility, but not associated conveyance facilities).

Maintenance relates to most water storage solutions in the state, as illustrated in **Figure 4**. For any existing or future water storage projects to store and deliver water, existing infrastructure, such as conveyance and treatment systems, will be utilized. Reoperations or coordinated operations studies and plans are based on operating existing systems, which can only be relied upon if the systems are properly maintained. Water conservation and increasing water use efficiencies are known strategies to increase water supply without creating additional physical storage, but for those strategies to work as intended, they must also use existing infrastructure to continue delivering water.

Improving maintenance practices alone will not solve the increased need for water supply in the future; enhancing or expanding water storage will also be part of the solution. Since most storage projects rely on existing infrastructure, enhancing or expanding those facilities retains the focus on the existing system, and thus helps to promote the importance of keeping existing infrastructure maintained and in good health.

Figure 4 – Maintenance relation to other water storage solutions



3.1.2 Need for Maintenance and Enhancement

Aging infrastructure, demand, sedimentation, subsidence and climate change all create the need to maintain and enhance water infrastructure. In addition, California faces several water supply challenges into the future such as dramatic growth in population, changing weather patterns and environmental needs.

Aging Infrastructure

Water supply infrastructure such as dams, reservoirs, pumps, pipelines and canals are critical in meeting existing and future demands. **Table 2** lists the 10 largest state reservoirs (excluding federal) and the year they were built. The average age of the approximately 1,400 California dams is 68 years (DWR 2017). While the physical life span of dams is typically greater than 50 years, the physical diminishment of constructed dams and their components results in increased budget needs for maintenance and repair. The inability to adequately fund safety inspections and address dam vulnerabilities results in real societal risks in terms of public safety and potential economic losses. For example, California's Oroville Spillway incident prompted the evacuation of more than 180,000 people. This event may be a precursor of future flood destruction under both a changing climate and aging dam infrastructure (Ho et al. 2017).

Table 2 – Ten Largest California Reservoirs, Non-Federal (DWR 2017)

Dam Name	Owner Name	Year Built	Reservoir Capacity (AF)
Oroville	California Department of Water Resources	1968	3,537,577
Don Pedro	Turlock Irrigation District	1971	2,030,000
Lake Almanor	Pacific Gas and Electric Company	1927	1,308,000
New Exchequer	Merced Irrigation District	1967	1,032,000
New Bullards Bar	Yuba County Water Agency	1970	969,600
Diamond Valley Lake	Metropolitan Water District of Southern California	2000	800,000
Camanche	East Bay Municipal Utility District	1963	417,120
O' Shaughnessy	San Francisco Public Utilities Commission	1923	360,000
Nacimiento	Monterey County Water Resources Agency	1957	350,000
San Antonio	Monterey County Water Resources Agency	1965	350,000

Sedimentation

Sedimentation in reservoirs and conveyance infrastructure reduces the facility capacity. Although natural, sedimentation needs to be regularly addressed in infrastructure maintenance, and project plans should include more resources to inspect and dredge materials.

Climate Change

With global weather pattern changes and associated effects of climate change, incorporating resilience to mitigate the impacts of variable climates is the day-to-day business of water managers (Muller 2007). Resilient infrastructure systems are crucial for minimizing the both the immediate and long-term impacts of extreme events (e.g., earthquakes, storms, floods, or drought). One way to manage the impacts of climate variability on water resources is to capture and control river flows (e.g., dams). It is also necessary to consider the potential impacts of climate change on the management of canals, tunnels and pipelines (Muller 2007). With these challenges, more resources are needed to inspect and maintain the function of current infrastructure (Milman and Short 2008). The converging risks associated with aging water storage infrastructure and uncertainty in climate change result in a pressing need to address the state of infrastructure across California (Ho et al. 2017).

Subsidence

Major facilities in California's Central Valley are suffering negative structural impacts from subsidence, limiting the ability to deliver stored water. The State Water Project (SWP) and Central Valley Project (CVP) were in part developed to combat subsidence, but major conveyance for these projects is suffering reductions in capacity as a result of subsidence. Parts of the California Aqueduct have dropped 20% in capacity and a section of the Friant-Kern Canal in Tulare County is "sinking" so much that capacity has been reduced by 60% (Romero 2017; Fitchett 2017). If these subsidence issues are not addressed, California's water infrastructure will not function effectively.

Water Supply Reliability

California's water supply system is facing reliability challenges with demands exceeding supplies for urban, agricultural and environmental water uses. The California Water Plan Update 2013 concluded that California is facing increases in drought impacts and climate change effects on statewide hydrology (DWR 2014b). Population, land-use changes, regulatory requirements and limitations on storage and conveyance facilities further strain the ability of available water supplies and existing infrastructure to meet demands (United States Bureau of Reclamation [USBR], 2008). Improved water management flexibility is needed to meet current and future challenges associated with increasing population, environmental needs and climate change.

3.1.3 Known Issues Facing Maintenance and Enhancement Efforts

Perception

There is general consensus that infrastructure spending and maintenance are important, but there are unresolved issues regarding who is perceived to be responsible for bearing the costs, how much the public is willing to pay, and what the perceived condition of local infrastructure is.

There are also prevalent perception issues with differentiating between types of maintenance-related activities. Maintenance can be performed as a basic repair or it can be performed as an enhancement or improvement. Both types of maintenance are important, but basic maintenance and repairs often get deferred in lieu of innovative capital projects. This phenomenon is sometimes referred to as the "ribbon-cutting fixation." Basic maintenance and repair is not perceived to be equally exciting when compared to an innovative new capital project, and can be overlooked in situations where repairs might be most appropriate. Policy and spending decisions have reflected this fixation and have historically favored investments in new infrastructure rather than rehabilitation of existing systems (LAO 2011).

CASE STUDY: VALUE OF WATER POLLS

A poll by the Value of Water Campaign in May 2017 found that 82% of voters in the U.S. indicated that water infrastructure is very important for the government to address, and 87% supported increasing federal investment in water infrastructure (Weigel and Metz 2017). A separate poll by the Value of Water Coalition in 2016 found that an overwhelming majority (83%) were willing to consider an increase in at least 5% of monthly water bills to help pay to fix infrastructure (Hart 2016). However, the cost to maintain water infrastructure in the future is expected to be much higher than what people are currently willing or potentially able to pay, resulting in continued uncertainty in funding for future infrastructure projects. It is likely that water bills will continue to increase significantly and there will also be a need for increased federal spending.

The Value of Water Campaign poll also asked respondents to react to a series of messages related to rebuilding water infrastructure and it was found that there is a perception that the nation's overall water infrastructure condition is worse than in an individual's local community. After respondents were provided more information about their local water systems and the potential vulnerabilities, there was a shift in the willingness to pay a higher water bill. It was also found that the level of concern regarding water infrastructure was higher when statements highlighted vulnerabilities of water infrastructure and their potential consequences (Hart 2016).

Deferred Maintenance

Maintenance is defined as the maintenance and repair needed to bring assets back to a minimum-acceptable condition level (The Urban Institute 1994). When maintenance doesn't occur or is delayed, it is considered to be deferred maintenance. Deferred or delayed maintenance can cause minor repair work to evolve into more serious conditions. Routine maintenance is often deferred to meet other fiscal requirements, resulting in a deferred maintenance backlog. The failure to address major repairs and/or restore aging infrastructure systems can result in the need for re-operations or replacement of parts of the system, which is likely to be much more expensive than performing the necessary maintenance throughout the system's lifespan.

Funding

California departments do not often include separate budgets for maintenance, making it difficult for the state to estimate and track how much is spent overall to maintain its facilities. In 2015-2016 and 2016-2017, the state provided almost $1 billion for deferred maintenance, mostly from the General Fund (LAO 2017). California's 2016 Five-Year Infrastructure Plan acknowledges the state's inconsistency in funding maintenance for existing capital investments, identifying more than $77 billion in deferred maintenance, with $13.1 billion just for DWR. The Plan identifies $807 million in deferred maintenance for 2016-2017, including $100 million for DWR) (LAO 2017).

Efforts have begun to address the deferred maintenance issues in California, however there is still much room for improvement. In 2016, the governor's budget proposed $500 million from the general fund to address deferred maintenance backlogs in state facilities to be managed by various departments, but that proposal did not identify what specific projects those departments would take on. In addition, one-time funding proposals such as this, without requirements of specific projects or repairs, do not address the underlying cause of the state's deferred maintenance backlog. LAO identified these points and recommended that there be a required list of proposed projects to be funded and for the individual departments to develop plans to understand the reasons for and to address the underlying cause of their deferred maintenance backlog (LAO 2016).

Maintenance and enhancement projects are often deferred due to fiscal and funding concerns. Funding projects that maintain and repair the system is critical, but there are times when innovative capital projects could enhance and improve the efficiency of the existing system. These projects typically are more expensive than maintenance and can detract funding away from basic maintenance needs. There needs to be adequate planning to achieve a balance between maintenance and enhancement projects, and enhancement projects should include budgets and funding plans for related maintenance work.

Environment

Typically, basic maintenance repair projects have only temporary effects on the environment, such as noise and impacts to air quality and local agricultural resources. However, depending on the type of maintenance, impacts to biological resources could be significant and sometimes costly and difficult (e.g., obtaining permits). Enhancement projects typically will have more environmental concerns compared to maintenance due to changes in water operations, and temporary and permanent construction-related impacts; however, those are typically less-than-significant especially in comparison to new storage. Some of the benefits and effects of reservoir expansion are discussed in Case Study: San Luis Reservoir Expansion.

CASE STUDY: SAN LUIS RESERVOIR EXPANSION

General benefits of expanding reservoirs include increased water storage capacity and associated increased supply for user demands and the environment, recreation opportunities, improved water quality, and emergency storage. Expansion projects make use of an existing reservoir and its infrastructure, which results in incrementally lower costs compared to building a new storage system. Reservoir expansion may present challenges, however, when integrating with existing infrastructure and operations, locating an alternative water supply during construction, acquiring water rights, and obtaining environmental permits.

The San Luis Reservoir, a jointly owned and operated federal and state facility, is an off-stream storage reservoir in Merced County. San Luis Reservoir stores water available from the CVP's Delta-Mendota Canal and SWP's California Aqueduct during summer and fall when demands are higher. San Luis Reservoir expansion would raise Sisk Dam by approximately 10 feet and increase storage capacity at the reservoir by approximately 120,000 AF.

While expanding San Luis Reservoir is expected to have little effect on local fish populations, greater storage and resulting additional yield have the potential to change the coordinated operations of existing CVP and SWP facilities in the Central Valley and Delta. As a result, reservoir expansion has the potential to impact fisheries resources in areas outside of the water storage location and outward to its water source diversion and surrounding area (i.e., Sacramento and San Joaquin rivers and the Delta). Flows in these water bodies are important to maintain water quality and provide proper temperature and passage to enhance the survival of emigrating juvenile Chinook salmon, and pelagic Delta fishes. Seasonal flood flows are also important for floodplain inundation for successful spawning and rearing native California fish species.

These changes in river flows are believed to be insignificant and having no discernable flow-related effects to aquatic species, water quality, or the environment. Increased storage capacity at San Luis Reservoir and other off-stream operating reservoirs could provide more operational flexibility by optimizing export of Delta water when hydrologic and environmental conditions allow.

3.1.4 Provide Maintenance and Enhancement Information

Promoting water system maintenance and enhancement activities should emphasize the latest information on local water system vulnerability and highlight potential consequences of deferred maintenance. There is general consensus that maintenance is important and necessary, but sometimes the local need is not recognized and/or understood by the community. Providing information on the vulnerabilities of local systems and the associated potential consequences has proven successful in creating awareness and an increasing willingness to pay for infrastructure.

3.1.5 Implement Asset Management Programs

Federal, state and local water providers **should implement asset management programs to understand the conditions of water system infrastructure to effectively plan for maintenance and enhancement activities.** Key steps of an asset management program include developing an inventory of infrastructure; evaluations of infrastructure performance and condition; maintenance, repair and replacement plans; and funding plans (ASCE 2017). To properly address and fund water infrastructure maintenance and enhancement projects, there needs to be a clear understanding of the specific issues. As outlined in California State Treasurer John Chiang's 2016 State Treasurer's Biennial Report, detailed infrastructure assessments are needed and should include information on the condition of the infrastructure system, an estimate of when it might wear out, what it would cost to replace it and the cost of deferred maintenance (Chiang 2016). Once these inventory lists have been developed, priorities can be determined and funding should be allocated to specific maintenance activities that have been identified on the inventory lists. Furthermore, groups and departments responsible for the programs and maintenance activities should continually be held accountable for funding received and continue to report on how the maintenance funding is spent.

3.1.6 Prioritize Reservoir Expansion

Maintenance practices alone will not solve the storage need related to increases in water supply demand; enhancing or expanding water storage can be part of the solution. Enhancing or expanding existing storage retains the focus on the existing system, and should therefore be prioritized ahead of new storage projects. Reservoir expansion projects can provide more water storage at a minimal impact to the environment and lower cost relative to other storage projects. **Prioritize reservoir expansion projects and opportunities over new sites when possible to limit impacts to the environment.**

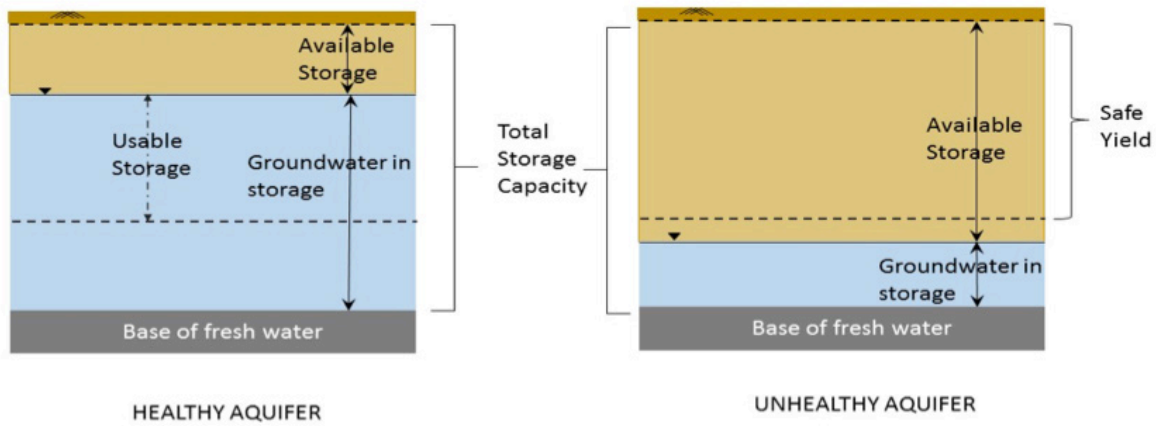
3.2 Put it in the ground: Maximize and capitalize on groundwater storage opportunities

3.2.1 Opportunities and demand for groundwater storage

Groundwater storage is a significant component of the water balance. Up to 30% of earth's freshwater is stored underground in groundwater aquifers and, in California alone, groundwater accounts for approximately 40% of the total water supply during an average hydrologic year (only consumptive use included). This percentage increases during drier years due to reduced surface water flows. Any conversation about water storage in California needs to emphasize the importance of groundwater storage. Groundwater storage, especially conjunctive use projects, will play a major role in the future of water storage in California.

California's 517 alluvial groundwater basins (DWR 2016b) cover 42% of the state's geographical area and have a total storage capacity of up to 1.3 billion acre-feet (AF). However, only a portion of the total storage is usable. Usable storage is defined as the maximum available safe yield that does not cause subsidence, or groundwater quality degradation or groundwater overdraft conditions that would require replacement of existing wells or pumping from a deeper zone. Previous DWR studies conducted in 1975 and 1994 estimated California's usable storage to be approximately 143 to 450 MAF (California Natural Resources Agency 1975, DWR 1994). Available groundwater storage capacity can result from groundwater extraction that exceeds the natural replenishment, resulting in accumulated overdraft of the aquifer and available pore space for replenishment. Available groundwater storage is continually changing in response to recharge and extraction. As shown in **Figure 5**, the available groundwater storage in critically overdrafted and overused groundwater basins could be greater than the usable storage thereby causing severe overdraft conditions. DWR recently estimated 21 of California's 517 groundwater basins are currently in critically overdraft conditions (see **Figure 6** for location of critically overdrafted groundwater basins).

Figure 5 – Schematic of groundwater aquifer storage in healthy and unhealthy (i.e. critically overdrafted and overused) aquifers

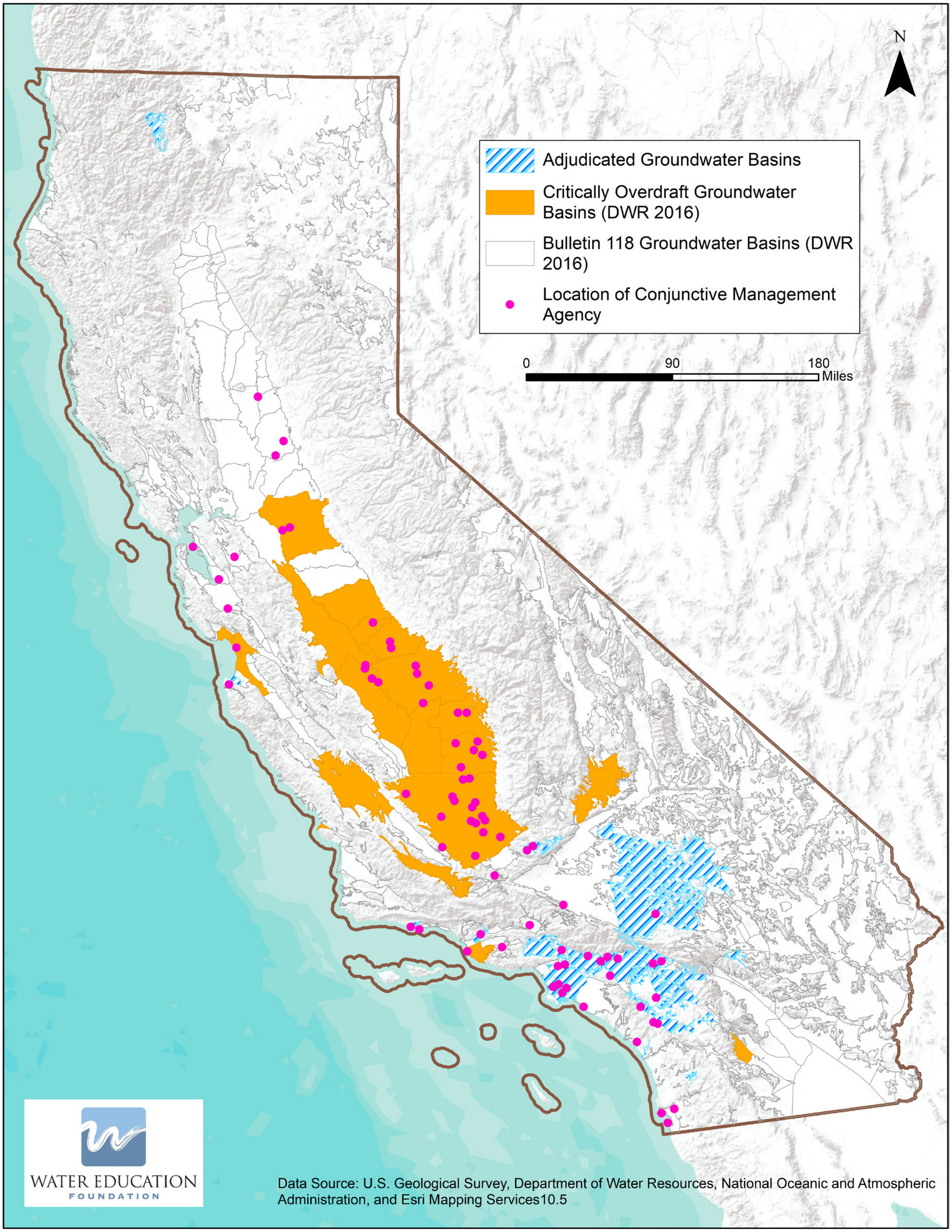


When the groundwater resources do not meet water demands in an area, landowners can turn to the courts to determine how much groundwater can be rightfully extracted by each overlying landowner or appropriator, in a process called adjudication. Courts typically appoint a watermaster to administer the judgment and to periodically report to the court. Groundwater basins that are managed through court directives or a court-appointed watermaster are called adjudicated basins. California currently has approximately 23 adjudicated groundwater basins and one adjudicated stream system (see **Figure 6** for location of adjudicated basins).

In addition to the court-mandated groundwater management system discussed above, California passed the Sustainable Groundwater Management Act (SGMA) in 2014 that requires all groundwater basins to be managed sustainably by 2022. SGMA emphasizes local control, but allows for state intervention if local agencies fail to sustainably manage basins. A sustainably managed groundwater basin is defined as a basin that has balanced levels of pumping and recharge and avoids undesirable results.

Unlike most surface water storage, groundwater storage already exists naturally in the environment; however in agricultural or urban areas usage rates often exceed the rate of natural replenishment from direct precipitation and in-flow from neighboring basins. In order to "develop" groundwater storage, the methods of extraction from the groundwater basin must be built or enhanced and groundwater basin inputs must be supplemented through managed aquifer recharge practices. Artificial groundwater recharge can be achieved through direct injection of fresh water (clean surface water or advanced treated recycled water) into an aquifer using injection wells or through infiltration and percolation using surface spreading basins.

Figure 6 – California groundwater basins, critically overdrafted basins, adjudicated basins and location of conjunctive management agencies



In Los Angeles and Orange Counties, injection wells have historically been multi-purpose, acting as seawater barrier wells while also providing replenishment to coastal basins. However, with recent drought limitations and increases in the production of high-quality advanced treated water, both counties are developing inland injection well projects solely for the purpose of groundwater recharge. Surface spreading projects are typically developed in existing stormwater retention basins where entities can capture stormwater during wet periods and recharge excess imported water or recycled water during dry periods. In surface spreading projects, cheaper, lower quality water such as tertiary recycled water is often permitted (with available stormwater or imported water for blending) due to the additional filtration provided through soil-aquifer treatment during percolation into the aquifer. This provides a lower cost alternative to the high quality water required for direct injection. Surface spreading can also be performed outside of stormwater basins, including flooding of farmland which has gained popularity recently as a groundwater recharge technique when excess surface water is available.

In addition to traditional injection and spreading, several alternative methods for increasing and recharging available groundwater storage capacity have also been utilized throughout the state. With increasing demands and lower costs in treatment technologies, entities have begun to utilize previously unusable contaminated groundwater including naturally occurring colored water, industrial and commercial contamination plumes, and coastal or deep brackish groundwater as both a new water supply and as a method of increasing available groundwater storage capacity for recycled water or excess surface water. Another technique, called in-lieu recharge, involves groundwater users reducing extractions by using alternative water supplies, such as surface water or conservation. The reduced extraction results in a net increase in groundwater storage and is considered a recharge technique. Finally, many local, regional, and statewide entities have begun to promote stormwater capture and infiltration as a method for increasing groundwater storage and also improving local surface water quality. Once captured, stormwater runoff can be treated or naturally filtered by flow through vegetation and soil-aquifer-treatment in the vadose zone. If infiltrated in geologically conducive areas, this water can then percolate into deep primary aquifers and increase local groundwater storage. Known as Green Infrastructure, projects employ small-scale elements such as bioswales, permeable pavements, and green streets and alleyways to capture and infiltrate localized runoff on-site (“What is Green Infrastructure” 2016). These project elements can be retrofits to existing development or incorporated into new construction during the implementation of Low Impact Development standards (“California LID” 2016).

Groundwater storage can be cost-effective, but there can be a wide range of costs to develop new storage. As noted above, developing groundwater storage requires developing methods of recharge and extraction. Water in the West estimated a range of groundwater recharge costs as $90/AF to $1,100/AF, reflecting major differences in project-specific constraints such as access to conveyance, recharge facilities, and water rights. Groundwater extraction costs such as well construction are often minimal in comparison. The range of groundwater storage development costs can be compared to surface water storage costs, but it should be noted that surface storage can provide benefits in addition to water supply storage, such as increased operational flexibility, flood protection, and recreation. For example, water supply-specific costs of two of the WSIP[1] surface storage project applicants are estimated at $580/AF for Sites Reservoir (Sites 2017) and $700/AF for Los Vaqueros Reservoir Expansion[2] (LVE) (Contra Costa Water District [CCWD], 2017 a and b). The water supply costs of these particular proposed surface storage projects fall in the middle of the estimated range to develop groundwater storage. Based on a comparison of these costs, groundwater storage development can be more cost effective than surface storage in some cases, but it is highly dependent on the project specific constraints.

Properly managed groundwater storage projects are generally considered to be relatively environmentally neutral, although in some cases there are groundwater-dependent ecosystems that can be affected. In contrast, there are often significant environmental impacts associated with new surface storage, even when it is managed according to best practices (Devic 2014). Furthermore, due to the specific site requirement necessary to allow for a cost-effective dam, there are significantly more options throughout the state to leverage existing natural groundwater storage than the handful of remaining viable dam sites of sufficient size.

The emphasis on groundwater storage discussed in this section does not suggest or recommend reducing surface storage in California. Many of the most successful groundwater storage programs are conjunctive use programs, which coordinate groundwater and surface water storage. Surface storage can act as a temporary holding bay and release water at optimal times for recharge into groundwater storage, effectively expanding total storage in the system. Existing conjunctive use projects are shown relative

1 WSIP application cost estimates did not require inclusion of some types of costs, such as interest during construction or annual operations and maintenance costs.

2 Reported total water supply costs for LVE annualized over a 95 year project life at 4% interest divided by reported water supply yields, rounded to nearest hundred dollars. Data from WSIP applications.

to groundwater basin delineations in Figure 6. Conjunctive use programs can provide multiple benefits and will play an important role in California's water storage future. Section 3.3, "Keep It Flexible," also discusses the benefits of conjunctive use programs.

Implementing groundwater storage projects often encounters significant legal and political challenges, including complex water right systems and local agency territorial disputes. Regional coordination is necessary because few single agencies have the required financial capacity to cover the source water conveyance, recharge, extraction and necessary distribution facilities. Even if financial capacity were sufficient, local agencies would also need to have legal and physical access to groundwater storage and imported or recycled water conveyance, which can be near to impossible to obtain if not already possessed. A local agency might have one of the key required items necessary for groundwater banking, but it is rare for any single local agency to have all of them and for the facilities required to be cost-efficient at a scale small enough to make sense. The Santa Ana River Conservation and Conjunctive Use Project (SARCCUP) Case Study discussed in Section 3.4.4 is good example of the importance of regional coordination is successfully implementing groundwater storage projects. Given the advantages and despite the challenges, groundwater storage should play a large role in California's future water storage investments. Groundwater storage could effectively act as the "afterbay" to surface water storage. Legal, financial and other innovative tools can be leveraged to incentivize groundwater recharge and therefore, groundwater storage, and are discussed below. In addition, many of the recommendations discussed throughout this report can and should be applied to groundwater storage projects.

CASE STUDY: LOCAL GROUNDWATER STORAGE PROJECTS AND STORMWATER CAPTURE

Southern California's heavily utilized urban groundwater basins with accumulated overdraft provide available storage capacity for percolation or injection. In the Metropolitan Water District of Southern California (MWD) service area approximately half of the 1.5 MAF of annual groundwater production is supported by active recharge through local projects, including about 5,000 acres of spreading basins and seven seawater intrusion barriers (MWD 2007). However, as of June 2006, MWD estimated a remaining 3.2 MAF of available unused groundwater storage capacity. If expanded, local injection and spreading projects could allow entities within the service area to store excess imported water, captured stormwater and urban runoff, and locally generated recycled wastewater. . The Water Replenishment District of Southern California (WRD) has ensured water delivery to the Montebello Forebay Spreading Grounds and the LA County Seawater Barrier injection

CASE STUDY CONTINUED: LOCAL GROUNDWATER STORAGE PROJECTS AND STORMWATER CAPTURE

wells since its formation in 1959 and has utilized recycled water for groundwater replenishment since 1962. Through the District's Water Independence Now program, WRD has steadily increased the usage of recycled water for groundwater recharge. This has increased groundwater storage and reduced imported water demands. However, the LA basin overdraft conditions that existed prior to adjudication have not entirely been overcome through managed aquifer recharge practices and significant available storage capacity exists (estimated 450,000 AF of capacity in the Central and West Coast Basins combined (Johnson and Njiuguna 2002)). With decades of information on the safety of recharge with recycled water, WRD and other area entities have proposed to further increase groundwater storage through the use of recycled water for recharge, beyond the required amounts for adjudication.

The Los Angeles Basin Study assessed the potential for new stormwater capture concepts that would increase the resiliency and improve the quality of local water supplies (USBR 2016). The study identified potential project sites for each type of stormwater capture facility through a GIS assessment of subsurface conditions, soil types, proximity to existing drainage facilities, mitigation of flood risk, and anticipated changes in climate and population. Identified potential projects include 8 new regional spreading grounds and over 6,000 local and regional projects that could capture and infiltrate nearly 220,000 acre-feet per year (AFY) alone. Additionally, over 175,000 acres of currently developed land and transportation corridors were highlighted as suitable for Low Impact Development improvements and the Complete Streets initiative, providing capture of up to 126,000 AFY, and up to 225,800 AFY of stormwater could be conserved simply through changes in regional stormwater policy. To maximize capture, the study suggests an optimized combination of potential projects identified during this study would enable the Los Angeles County Flood Control Department and up to 21 local project partners to nearly double the 200,000 AFY of stormwater capture that currently occurs in the basin.

3.2.2 Groundwater recharge and beneficial use of water

Efforts to increase groundwater recharge are often limited by the legal definition of "beneficial use" in California. The SWRCB treats groundwater storage as it would reservoir storage, meaning that the storage of surface water underground must have a recognized beneficial use beyond storage. In other words, while the SWRCB does not recognize recharge as a beneficial use in and of itself, the SWRCB allows for recharge as a medium through which to put water to beneficial uses within five years. For example, the Kern Water Bank recharges excess surface flows for urban, agricultural and environmental purposes alike. Legislation to recognize recharge itself as a beneficial use has been controversial, as there are concerns that recharged water could be hoarded among some water users to the detriment of surface water users downstream. Further, peak surface water flows generate environmental benefits, requiring a balanced approach between diverting surface water for recharge and leaving it for instream or downstream uses.

Groundwater storage in the Central Valley has significantly declined over the past decades, creating available aquifer space and a significant storage opportunity. However, the ability for water managers to permanently reverse this overdraft condition is limited by the requirement that groundwater recharged by surface water be put to beneficial use within five years. To permanently address this historic overdraft condition, water managers should have the flexibility to leave groundwater in storage for longer than five years - potentially even indefinitely. These considerations should be emphasized in the controversial and complicated discussion of groundwater recharge as a beneficial use.

3.2.3 Emphasize groundwater storage in grant funding frameworks

Although the physical components of groundwater storage projects can be economical, due to the complexities discussed above, these projects can often be difficult to fund and finance. Multiple parties and a lack of obvious demarcations of administrative boundaries complicate and impede groundwater storage funding. State grant funding can help address this impediment. State grant funding for groundwater storage projects is available, but is often a component of a wider grant funding strategy, resulting in groundwater storage projects being evaluated against vastly different projects. This heterogeneity of evaluated projects and the inherent complexity of groundwater storage can result in groundwater projects not performing well in funding decisions relative to other types of projects.

A grant program specifically aimed at boosting groundwater storage similar to DWR's Proposition 13 groundwater storage program could be designed to address the complexity of such projects by acknowledging the constraints and regional coordination efforts encountered by effective groundwater storage projects. Such a tailored grant program could also acknowledge and incorporate existing funding prioritization developed by the state, such as the Proposition 13, Proposition 1 and SGMA.

SWRCB's Proposition 1 has separate groundwater sustainability funding that would administer approximately $800 million to groundwater projects statewide. The framework for funding mainly focuses on cleanup of groundwater contamination sites and remediation projects, not necessarily enhancing storage.

In addition to mitigating groundwater contamination, the state should also consider groundwater storage projects that would rectify other undesirable results: chronic aquifer depletion, reduction of groundwater storage, seawater intrusion, degradation of water quality, land subsidence and depletion of hydrologically connected surface water. SGMA requires local Groundwater Sustainability Agencies (GSAs) to develop and implement Groundwater Sustainability Plans (GSPs) to manage groundwater to avoid such consequences. Any framework to prioritize funding of groundwater storage projects should consider avoidance of these undesirable results as added benefits to projects.

A framework for awarding grant funds to groundwater storage projects should consider at a minimum the following three factors: 1) recharge/extraction locations that can have substantial impacts on the system, 2) interactions with the surface water systems and 3) hydraulic effects which can continue long after pumping/injection has stopped. Failure to fully understand these issues can lead to mismanagement of groundwater storage with long-term implications on surface water/groundwater interactions. Additionally, frameworks for funding and funding for groundwater storage projects, surface water storage projects and maintenance of existing storage projects should be handled separately. This would ensure a healthy mix of storage projects are implemented and thereby diversify California's storage portfolio.

3.2.4 Incentivize groundwater recharge and storage projects for private and public entities

In addition to state-provided grant opportunities, state and local agencies (such as GSAs) should develop incentive structures to foster development of groundwater storage. Some groundwater management tools are designed to provide direct incentives to influence change in water use behavior. Taxes, fees or surcharges as well as energy management practices (i.e. load control) are tools that provide financial incentives for behavior change, and should be considered as important components of an incentive program. There are other, less direct tools that rely on economic valuation of water or underlying land assets, such as land retirement projects, credit-based systems to offset new groundwater development, water transfer systems that allow individuals to move water to where and when it is most needed (for example by trading groundwater storage credits or use permits within a specific geographic area), and landowner-led recharge projects. In addition, overcoming the legal and political challenges with respect to water rights and local agency territorial disputes can make groundwater banking a more viable storage solution. In instances where groundwater managers seek to encourage users to adopt best management practices, cost-sharing programs can also provide financial incentives to participate while also fostering trust between users and managers.

One area for incentivization of groundwater recharge is on-farm flood recharge, which is the practice of flooding agricultural lands with surface water that results in percolation of water to the groundwater table. This practice has been spearheaded by farmers in the Central Valley, and studied extensively by UC Davis researchers (UC Davis 2017). On-farm flooding can be an important tool to increase groundwater storage by increasing groundwater recharge. Water managers should develop strategies to encourage the implementation of on-farm flooding, especially in areas identified as Good and Excellent per the Soil Agriculture Groundwater Banking Index (SAGBI). GSAs should structure their GSP elements to include a financial or water supply incentive for farmers who conduct on-farm flooding. To take full advantage of available surface water, farmers and land managers responsible for agricultural land (especially in areas identified as Good and Excellent per SAGBI) should maintain or develop water delivery systems that could be used to perform on-farm flood recharge. They may need to invest in surface water conveyance and other infrastructure to provide the diversion capacity needed during flood events. Government entities and irrigation districts should support these projects with funding mechanisms and other incentives.

CASE STUDY: ON-FARM RECHARGE

On-farm flood recharge is the practice of flooding agricultural lands with surface water that results in percolation of water into the groundwater system. Flood irrigation practices in the Central Valley, California's major agricultural region, have been in decline in recent years as farmers respond to social and economic pressures to improve water efficiency. However, in many cases, improvements in water efficiency have led to a seemingly paradoxical increase in total water usage as it becomes more profitable for farmers to bring additional acreage into production. In addition, due to the required pressurization and daily application of highly efficient systems and the constraints of the existing surface water delivery systems (which are typically unpressurized and scheduling may only allow weekly deliveries), many farmers who convert to drip irrigation systems also convert to groundwater supply. As a result, a shift away from flood irrigation practices is correlated with accelerating decline in groundwater levels.

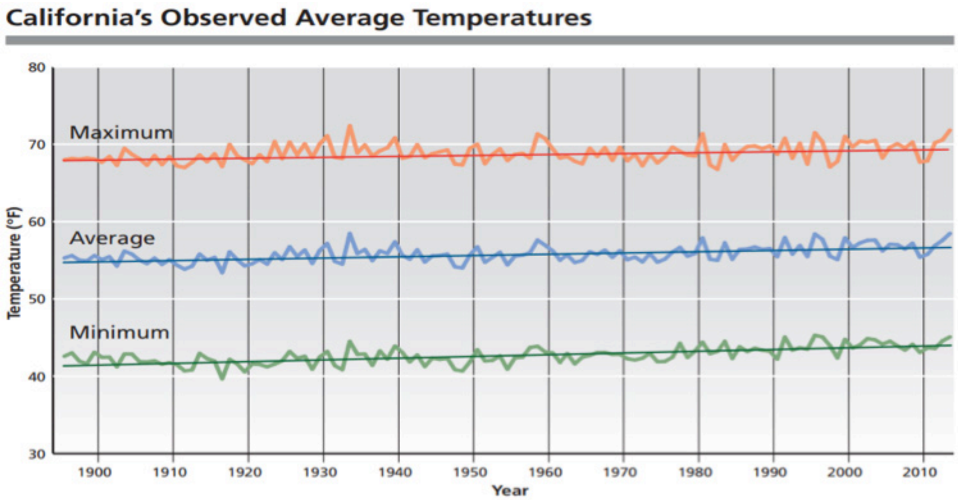
From 2005 through 2010, average annual overdraft in the Central Valley was estimated to be between 1.1 and 2.6 MAF per year (DWR 2015; O'Geen et al. 2015). DWR estimates there to be approximately 0.3 MAF per year to 1.0 MAF per year of water available for recharge in the Central Valley, and on-farm flood recharge appears able to provide the recharge capacity for this volume of water. A 2015 report (SAGBI) investigated soil properties on agricultural lands and identified 5.6 million acres of farmland that could be used for on-farm flood recharge and a preliminary estimate of 1.2 MAF per day of recharge capacity (O'Geen et al. 2015). One implication of this finding is that on-farm recharge could capture at least 1 MAF of excess water in a single storm or flood event, if the required conveyance and water rights were available. Thus, on-farm recharge is a promising practice to increase groundwater recharge and storage in the Central Valley.

3.3 Keep it flexible: Storage systems must be adaptable and have the flexibility to navigate changing conditions

3.3.1 Ever-Changing Conditions

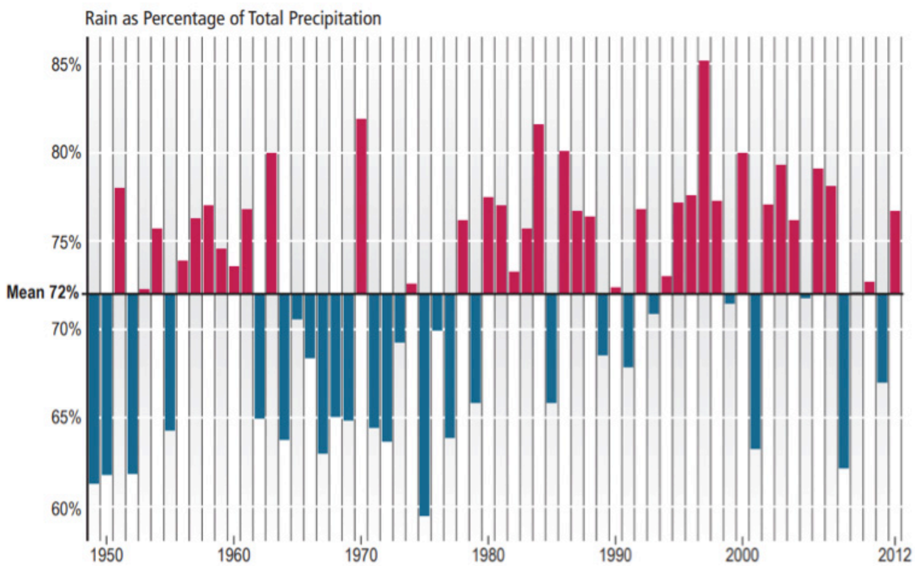
Water managers, farmers and communities have the unique challenge of forecasting and planning for future weather events in order to most efficiently capture and use water. However, climate change has altered California's water cycle and weather patterns. The Western Regional Climate Center data reports that California has experienced an increase of 1.1 to 2 degrees Fahrenheit in mean temperature in the past century (**Figure 7**), which contributes to higher wildfire risk and changing hydrology.

Figure 7 – Temperature trends in California over the last century (DWR 2015)



As a result of increased temperatures, there has been an increase in the percentage of precipitation falling as rain rather than snow (**Figure 8**). As snowpack historically represented up to one-third of the state's annual water supply, the recent change in precipitation patterns has significant water management implications. In addition, California's water infrastructure was largely designed to capture runoff from snowmelt throughout the spring and deliver it to water users during the summer months.

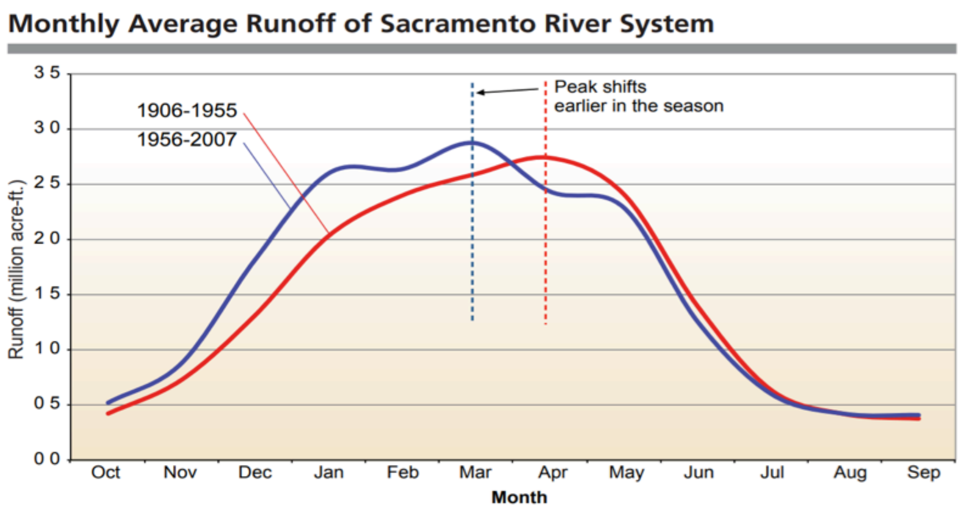
Figure 8 – Trend of the Percentage of Rain Falling as Precipitation (DWR 2015)



In California's largest water supply watershed, the Sacramento River watershed, the timing of runoff has shifted to earlier in the water year (**Figure 9**). The timing of peak monthly runoff has shifted nearly a month sooner between 1906 to 1955 and 1956 to 2007. This change in the timing of peak monthly runoff is understood to also be a result of climate change and increasing temperatures and is projected to continue to move earlier in the year, with the peaks continuing to increase.

In addition to the changes in the water cycle due to climate change, natural disasters and extreme events also pose an extreme threat to the California water supply system. A primary concern is the reliability of the Delta and the ability of the existing complex levy system to perform in the event of an extreme flood or earthquake.

Figure 9 – Comparison of monthly average runoff from recent 50 years versus the previous 50 years (DWR 2015)



Climate change, looming natural disasters, and the ever-changing landscape of California's water are a fact; and as historical data has shown, past performance/patterns are not always an accurate indicator of future patterns. California's existing infrastructure was planned, designed, and built upon historical patterns. These historical patterns (e.g., a large percentage of precipitation falling as snow, and released later in the season) have been superseded with new ones (e.g., more precipitation falling in the form of rain earlier in the season). Therefore, it is important that future storage solutions build in resiliency so projects can still perform to their intended functions, even under threat of variable weather patterns. It is also critical to maintain the systems already in place to allow these systems to be reoperated as needed to maximize their current use, in light of the changing conditions, as previously discussed. The following are recommendations that can be implemented to build in flexibility into the system.

3.3.2 Encourage and Employ Conjunction Use Practices

Conjunctive use practices, assuming that surface water effectively acts as a “forebay” for groundwater storage, are one example of resiliency. Under this type of approach, during wet years, excess surface water that is not used to meet pre-existing water rights/needs (including environmental needs) should be banked in a groundwater basin that has the capacity to accept this excess. **Banking excess surface water during wet years affords the flexibility of being able to use this water during dry years, when surface water supplies are lacking.** In addition, with the implementation of SGMA, the management of groundwater recharge will be of increasing importance; and groundwater banking and/or Aquifer Storage and Recovery programs will be essential in overcoming accumulated overdraft.

It is worth noting that excess surface water does not necessarily need to be directed to existing or new groundwater storage banks. The banking of the excess water can also be accomplished by encouraging on-farm flooding (see Section 3.2.4, Case Study: On-Farm Recharge). This is particularly attractive, as this could be done with reasonably low up-front capital costs. However, to accomplish this, farmers, communities, and water managers need to work together and address the various issues and/or historical institutional barriers associated with on-farm flooding (e.g., identification of farmlands, conveyance of water to the farmland, financially incentivizing farmers to take excess water and/or plant crops that are capable of handling flooding, etc.) These types of programs can also be enhanced by deliberately banking water in areas/basins that have groundwater- dependent ecosystems.

While commonly discussed in demand management, the development of other water sources, such as reclaimed water and stormwater, is important to add resiliency to a system. These new water sources improve diversification of water supplies in existing surface storage reservoirs or groundwater basins. With regard to natural disasters or other unforeseen events, storing water in the ground has an inherent benefit that is not susceptible to potential failure as a result of a massive earthquake or a large flood.

3.3.3 Reliable Conveyance

The concept of banking excess surface water during wet years for use during dry years is only feasible if there is capacity to move this water from the supply source to the "bank" and from the "bank" back into the water supply system. This highlights the importance of conveyance. Although this topic is not specifically addressed in this report, adequate and reliable conveyance is key to the efficiency and utilization of existing and new storage projects moving forward. As a result, it is important that existing conveyance systems be evaluated and potentially improved or upsized to maintain their current function and reliability. Redundancy should also be considered when feasible to strengthen the conveyance system.

Expanding conveyance to connect surface water storage and groundwater basins is also beneficial to maximize storage when supplies are plenty. With changes in precipitation pattern from a snow-driven system to a rain-driven system, conveyance is fundamental for an effective interconnected storage system. Economically speaking, it is not feasible to build enough surface storage capacity to capture all of the precipitation models are predicting will fall as rain.

3.3.4 Build Interconnections

Due to the ever-changing patterns of California's water cycle, it will be important for agencies to continue to leverage and maximize all available resources. In extreme circumstances or emergencies, agencies could work together to share the precious resource of water by building interconnections with neighboring agencies, thereby building in redundancy and reliability into their systems.

One particular example is highlighted by the Case Study: Bay Area Regional Reliability (BARR) in Section 3.4.3. Agencies in the San Francisco Bay area have been developing agreements and building infrastructure to help better connect agencies and combat extreme circumstances or emergencies. These interconnections will establish the ability to share, leverage and maximize the use of all available resources – in BARR's case, the Los Vaqueros Reservoir. However, for programs of this nature to work, agencies must work together to establish agreements and trust.

3.4 Do it together: Foster coordination and collaboration on water storage across agencies and stakeholders.

3.4.1 Introduction

California has a complex web of federal, state and local agencies. This complex web, coupled with the numerous stakeholders and non-governmental organizations, can impact project implementation as a result of overlapping authorities, conflicting mandates and contradictory interests. These obstacles can be overcome through effective communication and working together. Joint implementation and partnerships can develop solutions and overcome issues such as troublesome permitting and funding. Through coordination and collaboration at the federal, state, and local level, investments in water storage solutions can be more effectively and efficiently developed and implemented.

3.4.2 The Need

The future of water storage in California relies on successful regional collaboration, the implementation of the JPA model and integrated water resource management. In the 21st century, a limited water supply has become a constraining factor to California's agriculture, industry, municipality expansion and ecosystem health. Addressing the current and projected deficiencies within the state's water storage system requires innovative solutions and tremendous coordination from local to statewide levels.

The integrated water resource management approach, proposed by the Association of California Water Agencies (ACWA), states that, "Integrating the operation of new storage projects with the state's existing infrastructure would add much-needed flexibility to the system, particularly enhanced timing and coordination of storage releases to meet the coequal goals of improving water supply reliability and ecosystem health" (ACWA 2017). Additional storage projects have increased benefits when operated in conjunction with existing infrastructure. Coordinated storage operations lead to greater carry-over storage by capturing additional water during times of abundance, enhanced groundwater management, higher water availability for water users and the environment, and more overall resiliency within the system. Many of the new storage projects analyzed within the ACWA study were included in the CALFED Bay-Delta Program (CALFED) Record of Decision and 10-year implementation plan.

CASE STUDY: CALFED

CALFED was created as a consortium of state and federal agencies that have regulatory authority over water and resource management in the Bay-Delta Region (LAO 2007). The program was created in 1994 in response to the signing of the Bay-Delta Accord. The program consisted of 13 state agencies and 12 federal agencies working together to implement the program's objectives:

- To ensure reliability of water supplies within the Delta
- To improve and safeguard the Delta's water quality.
- To restore the Delta's ecosystem by protecting native species and eradicating invasive species.
- To improve levee protection along the Delta's rivers.

The program was conceived with the goal of bringing together state and federal agencies to address major issues within California's water conveyance hub, the Delta. The scope of CALFED quickly expanded beyond the Delta as the causes for issues in the Delta were identified statewide. The program was large, ambitious and directed large amounts of funding to projects throughout the state. Ultimately, systemic issues within the program led to legislative and congressional scrutiny. In 2005, CALFED was independently reviewed by four separate entities: The Little Hoover Commission, the office of State Audits, the Performance Review Unit within the California Department of Finance, and KPMG, a private consultancy firm (LAO 2007). The reviews found common issues with the governance structure of the program. The common issues were:

- **Structural:** The organizational structure was deemed convoluted. There was a lack of clear assignment of authority among participating agencies. The California Bay-Delta Authority board, created to oversee project implementation, had no authority for implementation.
- **Priorities:** The program was not guided by clear, specific goals. Bay-Delta goals quickly evolved into a complete makeover of the state's entire water system.
- **Lack of accountability for performance:** No performance measures were specified. After $4 billion in spending, the program had trouble articulating outcomes achieved.
- **Funding:** Financing was loosely divided between state, federal and water users. No framework was completed to ensure funding was guaranteed and uniform amongst the three. Funding amongst all involved parties became uneven and unreliable. (LHC 2005).

CASE STUDY CONTINUED: CALFED

Almost all of the state's major water issues were addressed by CALFED and rolled into a 10-year plan (CALFED 2006). Project management became misguided and lacked the development of a critical path. The recommended remedies provided by the analyses included: discarding the diffused leadership structure and focusing authority and responsibility, establishing performance measures tied to the budget process, setting expenditure priorities to align the program's expenditures with available resources, and approving a finance framework. CALFED had an extensive amount of projects identified within its Record of Decision and 10-year implementation plan. Many of the major storage projects applying for Proposition 1 funding under WSIP were identified by CALFED as worthy to pursue. The lesson learned from CALFED is that those projects may have a higher chance of success when approached individually by partnerships formed by local or regional interests or by using the JPA model.

Regional partnerships and JPAs are a more ideal form of collaboration because authority is defined and responsibility spread appropriately amongst member agencies. These partnerships can avoid the pitfalls of CALFED's governance issues by remaining regional and project specific. The goals, priorities and performance measures of a project are agreed upon by the involved parties. The focus on a single project makes effective project management much more likely. The funding and financial framework is handled by member agencies and more closely tied to stakeholders. The details of these partnerships and current examples of successful regional collaboration are presented below.

3.4.3 Foster Regional Collaboration

To maximize the success of future water storage projects, agencies should foster regional collaboration. In California, there are more than 1,200 water purveyors operating in close proximity, and often in the same watersheds and basins. Increasingly, these water agencies must work with one another and their stakeholders to manage limited water supplies, share costs and increase regional self-reliance.

CASE STUDY: COLORADO RIVER BASIN

Benefits of regional collaboration are evident in places like the Colorado River basin, where states in the upper basin worked cooperatively to address supply concerns in drought years. The 1922 Colorado River Compact guaranteed the upper and lower Colorado River basin 7.5 MAF each per year (Mulroy 2008). Under the compact, states in each basin were to work out each state's allocation of deliveries. Unlike states in the lower basin, the upper basin states worked together toward settlement, avoiding litigation or federal intrusion.

Facing uncertain flows and concerns about supply in drought years, upper basin states in 1956 came to agreement with the Colorado River Storage Project Act. The Act ensured states in the upper Colorado River basin could make good on their obligation to deliver 7.5 MAF to the lower basin during drought years while meeting the needs of upper basin water users. The Act authorized four projects that created a network of surface storage projects benefitting numerous agencies spanning multiple states (USBR 1956). The result is a collaborative effort that stores water for beneficial consumptive use, provides for reclamation of arid and semi-arid lands, provides flood control and generates hydropower. States in the upper Colorado River basin utilized relationships and a shared goal, rather than litigation, to drive the success of the Colorado River Storage Project and secure water supply reliability for the people they serve.

Collaboration among water agencies requires relationships, trust and empathy. Many mentors of the 2017 Water Leaders class suggested water agencies should find common ground with other stakeholders as a coalition has more sway than an individual entity. These collaborative efforts can be particularly effective with multiple-benefit projects, such as those that address surface water, groundwater, recreation and the environment, among others. Interagency collaboration can be aided by better information systems, the sharing of data and the assistance of neutral parties, like academia to provide unbiased information to drive decisions.

CASE STUDY: BAY AREA REGIONAL RELIABILITY

Water is a shared resource with finite volumes. Collaboration among stakeholders is important to build regional self-reliance and tackle tomorrow's water problems. In the San Francisco Bay Area, urban water providers are beginning to work together to develop a regional solution to improve water supply reliability. The joint effort, called BARR,

CASE STUDY CONTINUED: BAY AREA REGIONAL RELIABILITY

comprises eight water districts that have agreed to work cooperatively to address water supply reliability concerns on a mutually beneficial and regionally focused basis. In recent years, the agencies have independently invested approximately $1.4 billion in their own projects (BARR 2014). By leveraging these existing facilities and building new ones as needed, BARR aims to collaboratively enhance water supply reliability, bolster emergency preparedness, address climate resiliency needs and facilitate the transfer of water supplies during drought or disaster.

Necessity can be a driver for collaboration. Motivated by challenges during the recent drought emergency and the possibility of state funding via 2014's Proposition 1, seven of the eight participating BARR agencies are collaborating with as many as five outside agencies to pursue the Phase 2 expansion of Los Vaqueros Reservoir (CCWD 2017). The Phase 2 expansion would increase the reservoir capacity from 160,000 AF to 275,000 AF and add new conveyance systems to facilitate the movement of water to regional partners to provide water supply to wildlife refuges and municipalities. The collaborative project raised more than $1 million to complete environmental documents and its Proposition 1 funding application. Interest in Los Vaqueros as a regional resource wasn't always as strong. The original 100,000 acre-foot Los Vaqueros Reservoir, owned and operated by the CCWD, was built in 1997 to address seasonal water quality issues in that district. In 2004, CCWD began exploring an expansion of the reservoir up to 275,000 AF with partners. At the time, potential partner agencies were in pursuit of other projects, or none at all. The reservoir eventually was expanded in 2012 by CCWD with no partners to a lesser capacity of 160,000 AF.

3.4.4 Regional Joint Powers Authority

To focus coordination and collaboration towards specific goals regarding water storage projects, the regional JPA model should be used with an all-in attitude. The term "joint powers" is used to describe government agencies that have agreed to combine their powers and resources to work on their common problems (Cypher and Grinnell 2007). The California Government Code sections 6500-6536 provide the authority for public agencies to enter into JPAs, which may form between local entities in order to acquire land, construct regional infrastructure, share maintenance or operate shared facilities.

Some JPAs are cooperative arrangements among existing agencies, while others create new, separate institutions. A JPA is a new government organization created by two or more public agencies that is legally independent from them. A JPA allows member agencies to exercise their powers as a single agency to work on a common problem, fund a project, accomplish shared goals and cooperate on regional issues and solutions.

There are several advantages to implementing a regional JPA. By sharing resources and combining services, the member agencies and their stakeholders save time and money. Costs can be cut through joint purchases and land acquisition, redundancy is reduced and efficiency is increased with a JPA model. Member agencies of a JPA can join forces and tackle issues together as well as consolidate personnel, expertise and resources. Lastly, partnerships utilizing a JPA model can have more influence than an individual entity. See Section 3.5.3 for further discussion.

While the advantages to the JPA model are clear, there remain challenges that must be overcome in order for the partnership and collaboration to be successful. JPAs require establishing mutual trust among its partners. Getting separate public agencies to cooperate can be difficult, as each organization has its own powers, purposes and politics. Another challenge is maintaining solidarity for the long-term. Since JPAs are voluntary, changes in local public support, new political leaders or financial pressures may cause a member agency to reconsider their participation in the JPA. To facilitate collaboration in a JPA setting to overcome institutional barriers, an all-in, collaborative attitude and approach is needed from the start. Mentors of the 2017 Water Leaders class said they observed real progress with a “get it done” attitude, emphasis towards win-win situations, and by keeping a local focus to allow projects to move forward.

CASE STUDY: SANTA ANA RIVER CONSERVATION AND CONJUNCTIVE USE PROJECT

The members of Santa Ana Watershed Project Authority, representing an area of 2,800 square miles and 15% of the state’s population, have embarked on an effort to overcome the traditional political and legal hurdles to develop a regional water bank covering an entire watershed through the SARCCUP initiative. These members consist of Eastern Municipal Water District, Inland Empire Utilities Agency, Orange County Water District, San Bernardino Valley Municipal Water District, and Western Municipal Water District. The SARCCUP is a collaborative regional and watershed wide program that seeks to improve water resiliency primarily through development of a regional bank via regional infrastructure, as well as reduced water use, and improved habitat for native threatened

CASE STUDY CONTINUED: SANTA ANA RIVER CONSERVATION AND CONJUNCTIVE USE PROJECT

species. Specifically, SARCCUP leverages the existing facilities, groundwater rights, and access to imported water of the individual five member agencies for the collective benefit of all the members through a series of legal agreements, a joint governance structure via a JPA, and additional facilities purchased by the collective financial resources of the group and grant funding. The project framework has been developed and is in the first leg of implementation involving the negotiating and executing of the necessary operational and financial legal agreements between the agencies, and the design and environmental review stage of the physical facilities construction. SARCCUP is designed to produce a water bank with a total storage capacity of 180,000 AF over four separate groundwater basins, with equal recharge and extraction capacity of 60,000 AF per year (Barr 2017). The intent is to provide sufficient additional yield during dry years to negate the impacts of reduced imported and local sources to effectively become drought insurance that mitigates the impact of requiring extreme actions on local users.

The foundation of SARCCUP is built around seeking the lowest overall cost collectively as a region by each agency willing to contribute use of its strategic assets, including groundwater capacity. This is done in such a way that each local agency may not be the "winner" in every specific element of operations and legal agreements, but that when done collectively each member receives an overall benefit in the way of lower cost than if they had done so alone. Concurrently, the operational framework of the plan prioritizes the lowest cost options first for storage, extraction, and distribution to target agency. Each groundwater basin is filled in order of lowest cost and the extractions are based on which basin produces the lowest cost to the entity needing the water, typically based on proximity. However, if delivery of called water can be accomplished with the least cost through an in-lieu delivery through an existing system such as with the MWD, than the delivery is made through in-lieu rather than pumping water from one section of the region to another. Additionally, the JPA will purchase water collectively to leverage negotiating power and looks at the lowest cost source water, possibly through water transfers on the SWP through MWD available water. All of the operational and legal framework of SARCCUP is pre-negotiated in its formation, inclusive of the necessary agreements with outside agencies such as MWD. These pre-negotiated agreements allow for rapid response to changing water supply situations both to store water and to distribute it, rather than trying to negotiate such deals during the "storm."

CASE STUDY CONTINUED:SANTA ANA RIVER CONSERVATION AND CONJUNCTIVE USE PROJECT

The additional capital facilities to be constructed have a total cost of $84 million, or $466 per AF of storage capacity (Barr 2017). Santa Ana Watershed Project Authority has already been successful in obtaining a grant through the Integrated Regional Water Management (IRWM) portion of Proposition 84 funds for 56% of the capital costs, leaving $37 million as a remaining cost to the local agencies at a per unit cost of $205 per AF (Barr 2017). The project is projected to also go for additional grant funds via Proposition 1 IRWM for additional stages of the project its regional and watershed wide scale of benefits. Each of the five member agencies is required to contribute an equal share of the remaining $34 million and is entitled to an equal 36,000 AF share of the storage capacity and 12,000 AFY annual extraction capacity (Barr 2017). Based on the operational framework noted above, SARCCUP uses a single postage stamp rate applicable to all its members to distribute the costs. Currently, these costs are estimated to be in the $800-$950 per AF range which is in line with the cost of treated water from MWD (Barr 2017).

CASE STUDY: SITES PROJECT AUTHORITY

An example of a JPA is the Sites Project Authority. Sites is a proposed offstream reservoir in Colusa County near the town of Maxwell, California, northwest of Sacramento. The Sites Reservoir Project was previously known as North of the Delta Offstream Storage and was identified in CALFED Bay-Delta Program in 2000 (DWR 2014a). The proposed Sites Reservoir is approximately 12,000 to 14,000 acres in size with a storage capacity of 1.8 MAF (WEF 2016). It will be created by inundating the unincorporated community of Sites, California, also referred as Antelope Valley. Water would be conveyed from the Sacramento River to Sites Reservoir using two existing points of diversion, and a newly established point of diversion. The proposed project claims to provide benefits to instream flows, the Delta ecosystem and water supply.

The Sites Reservoir proposal first emerged as part of the second stage of the SWP in the 1980s. Renewed interest in the Sites Reservoir Project has been triggered by drought conditions and a diminished water supply, Delta pumping restrictions, population growth and climate change. In October 2001, DWR and the United States Bureau of Reclamation (USBR) initiated the environmental review process to prepare a joint Environmental Impact Report (EIR)/Environmental Impact Statement (EIS) to fulfill requirements of both the

CASE STUDY CONTINUED: SITES PROJECT AUTHORITY

California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA). Continuing forward, the Sites Project Authority was formed as a JPA on August 26, 2010 when seven regional entities, including several local water agencies and counties executed a joint powers agreement. The primary purpose of the Sites Project Authority and shared goal of its member agencies was to pursue the development and construction of the Sites Reservoir Project. The Sites Project Authority includes public entities located and operating in the Sacramento Valley such as the City of Roseville, Colusa County Water District, County of Colusa, County of Glenn, Glenn Colusa Irrigation District, Maxwell Irrigation District, Orland-Artois Water District, Placer County Water Agency, Poberta Water District, Reclamation District 108, Tehama-Colusa Canal Authority, Western Canal District and Westside Water District (Schoonover 2007; Sites Project Authority 2017).

While facilitating regional collaboration on a specific water storage project, the Sites Project Authority has spent the last several years working towards their shared project by engaging the public, various stakeholders, state and federal agencies and landowners, initiating the required environmental planning process and conducting feasibility studies. To further the review and development of the proposed Sites Reservoir, the Authority is now acting as the CEQA lead agency for the proposed Sites Reservoir in partnership with DWR as a responsible agency. On January 31, 2017, the Sites Project Authority released a notice indicating its intent to prepare an EIR. The USBR published a notice of intent to prepare an EIS under NEPA on November 9, 2001. A couple mentors of the 2017 Water Leaders class believe that the Sites JPA and local action has become the driving force of the project, which has helped move the project forward much more steadily. The Sites JPA is working smoothly because time was spent in getting all the involved agencies and stakeholders up-to-speed and on the same page.

3.4.5 Coordinated Storage Operations

To maximize performance of water storage facilities, agencies should coordinate storage operations and integrate operations of new and existing storage projects for increased benefits. Successful coordinated operations have been observed with existing water storage partnerships. The San Luis Reservoir is a joint use project between the state of California and federal government that stores water for the SWP and the federal CVP. San Luis Dam is owned by the USBR, but the reservoir storage space is allotted 47.6% federal and the remaining 52.4% to the state (DWR). California's DWR operates the state portion of the reservoir and water supply infrastructure while the San Luis Delta-Mendota Water Authority operates the federal portion on behalf of 29 federal water contractors.

Barriers to project funding and initiation were overcome when the state and federal agency created a partnership. In December 1955, the USBR submitted a feasibility report for the San Luis Unit to the state of California, however the state of California intended to build its own water project, the Feather Project at Oroville. The state's design also needed an off-stream water storage reservoir and the size of the project was too large for the state to accomplish on its own. As a result, the state approached the federal government with an offer to design a joint-use facility, but the federal government was reluctant to consider the partnership and took four years before USBR entered into an agreement on May 16, 1960. The state and the USBR signed a "coordinated operation' agreement that laid out plans for the construction of joint-use facilities, including the San Luis Dam and Power Plant. The state government was to cover 55% of the cost with the federal government providing the rest (USBR n.d.).

In addition to interagency coordination on an individual project, integrating operations of several storage projects on a statewide level aids in maximizing benefits and efficient use of water. Individual storage projects each have their own unique role and connections to California's water system and operational opportunities. By integrating and coordinating operations of water storage projects, each project can contribute to the state's water system in a manner that expands benefits beyond the sum of the individual projects. Coordinated storage operations lead to greater carry-over storage, increase water supply and reliability for water users and the environment, enhance groundwater sustainability and provide overall resiliency within the system (MBK 2017)

3.5 Show me the money: Develop innovative systems to overcome major barriers that limit the availability of funding for lifecycle water storage costs.

3.5.1 Introduction

In California many water storage projects are financed at least in part through local government. However, over the past several decades local government agencies have faced tightening constraints on their ability to raise revenues needed to finance new projects, or even maintain existing infrastructure. This transition has occurred over the same period that the willingness of federal and state government to supply upfront capital for massive water projects has decreased.

In the past, the state and federal government, respectively, took the lead in building and financing the SWP and the CVP. The federal and state governments have largely transitioned away from this model toward providing loan options such as the Water Infrastructure Finance and Innovation Act, or relatively small regional grants such as the IRWM grant. It is increasingly rare for more substantive grants to be available such as with the current $2.7 billion Proposition 1 Water Storage Investment Program. Although Senate Bill 5 recently was passed by the Legislature to put a $4 billion parks and water bond on the 2018 ballot, none of the $1.55 billion water-related portion of the bond is for water storage programs. Furthermore, it is uncertain when the next major influx of cash will be available to assist with water storage needs, and trends from recent history would suggest it may be well over a decade or more. Consequently, with much-needed projects and estimated costs ranging from hundreds of millions of dollars to several billion dollars each, local agencies have no choice but to pool their resources to try to advance only the most cost effective major storage projects that are necessary for California's future.

However, the ability of local government to raise revenue is sharply constrained in a number of ways by the California Constitution. For example, in 1978 voters approved Proposition 13, which added Article III A to the Constitution, thereby capping property taxes at a maximum of 1 percent of property value and placing restrictions on how property value is calculated. As a result of Proposition 13 and subsequent laws, property taxes have come to play a relatively minor role in the budgets of most water agencies, even as property values have skyrocketed in many areas of the state.

Perhaps more importantly, in 1996 voters approved Proposition 218, which added Articles XIII C and XIII D to the California Constitution, as amended in 2010 by Proposition 26.

Under these constitutional provisions, almost all local government levies must observe what is commonly referred to as a "cost causation" or "nexus" principle. In general terms, this principle requires that a government utility cannot charge a customer more for water service than a proportional share of the agency's actual cost to serve the customer. More specifically, the Constitution imposes a high burden on every local government agency to prove, first, that its revenue from fees and charges does not exceed its actual cost of service, and second, that costs are assigned to each individual customer, or in some cases to reasonably constructed customer classes, in a manner such that no one pays more than their proportional cost of service. This cost nexus principle poses significant challenges to large, multi-benefit storage projects because the costs associated with each specific benefit type such as recreation, environmental or water storage are often difficult to differentiate and quantify in a defensible manner. As such, Proposition 218 can be a significant barrier to large, multi-benefit water storage projects. Where some of the benefits of a project cannot be passed on to customers because of cost nexus challenges, local agencies must rely on scarce funding from other sources such as state or federal government.

Another consequence of the Proposition 218 cost nexus principle is that local agencies cannot ameliorate the effects of rate increases on disadvantaged communities by shifting financial burdens away from their low-income customers toward those with greater ability to pay. Furthermore, even when rates are fully justified under the Proposition 218 cost nexus principle, some local agencies may have difficulty satisfying the procedural requirements. Majority protest procedures and other constitutional provisions that allow for rates to be repealed or reduced by voter initiative mean that rate increases cannot be imposed in areas where there is strong local opposition.

Proposition 218 and Proposition 13 have many defenders who believe that they help prevent excessive taxation and wasteful government spending. On the other hand, almost every year bills are introduced in the Legislature to try to limit the effects of Proposition 218, and efforts are underway to try to roll back aspects of Proposition 13. However, these laws cannot be altered in any significant respect without one or more constitutional amendments, and currently there are no proposed ballot measures that would make it easier for local government to generate revenue. For the foreseeable future, Proposition 218 and Proposition 13 will continue to limit the ability of local agencies to maintain existing water infrastructure and fund new storage projects, absent funding from external sources.

3.5.2 Consider creating a new pool of state funding for unmet water storage needs through the imposition of statewide taxes or a surcharge on water consumption or related activities.

The state government is not subject to the same constraints faced by local government agencies under Proposition 218. Although there are similar constitutional limitations on the ability of the Legislature to enact statutes that result in higher fees or charges, these limitations function somewhat differently from Proposition 218.

Taxes

Importantly, state taxes can be enacted by a two-thirds vote of the Legislature without the need for any popular vote or protest procedure. As a result, especially for areas that historically have been resistant to any increase in taxes and other charges, it may be more politically feasible to enact new levies at the statewide level. There are other advantages to accumulating funding in this manner. First, the cost nexus principle does not apply. Accordingly, tax revenues can be directed more easily toward the most beneficial projects, and greater consideration can be given to the needs of disadvantaged communities and other hard-to-fund activities such as environmental protection, remediation, research and education. Finally, the accumulation of a larger pool of funding means greater potential access to financing opportunities.

Public Goods Charge

Charges that are not considered taxes can be enacted with a simple majority vote of the Legislature, without the need for a two-thirds vote, if the charge is structured properly under Article XIII A of the California Constitution. Proposals for a statewide public goods charge or surcharge, as opposed to a tax, have been circulating for years. Generally speaking, the concept is that a surcharge would be applied to utility bills to fund public programs related to that utility service. This type of charge potentially could be enacted for the specific purpose of creating funding at the state level for local or regional water storage projects. A drawback of this approach is that fees and charges are subject to cost nexus principles similar to those under Proposition 218. Accordingly, this type of charge is less flexible than a tax and potentially cannot be used to subsidize projects intended to benefit disadvantaged communities.

3.5.3 Consider providing statewide education and tools to encourage the formation of local or regional joint powers authorities and the use of public-private partnerships (P3s) for appropriate projects.

Undoubtedly there would be political resistance to imposing a new statewide tax or charge to create funding for local and regional water storage projects. Accordingly, it is important to consider alternatives with the potential to generate revenue without imposing new taxes or charges on the public.

Joint Powers Authorities

As discussed in more detail in Section 3.4.4 above, California law allows multiple public agencies and certain other kinds of entities to pool their individual resources and jointly exercise common powers through a JPA. The JPA may, but need not, be formed as separate and distinct legal entity from its individual members. Each JPA can form with a governance and financial sharing structure that best accommodates addressing the regional and interagency concerns specific to its members. Although forming the JPA may take a considerable amount of time and negotiation between agencies to reach agreement, once formed it provides the opportunity for the group of agencies to act as a single entity applying for grants, traditional bond financing, and private sector financing through P3s and other innovative financing tools.

Public-Private Partnerships

P3 is a long-term contractual relationship between public and private entities to finance, develop, construct, operate and/or maintain government assets. A P3 contract allows the private sector to earn an appropriate risk-adjusted return on their investment. The contract is structured to meet public needs by optimizing the skills and resources of the public and private parties, and to allocate risks to the parties best able to manage them. P3s can be used for new or significantly rehabilitated projects, and are best suited to projects that are large in size and complexity.

In some cases, P3 arrangements are not necessary or desirable in order to finance storage projects. Some local agencies have access to tax-exempt debt, which costs significantly less in terms of interest rates than what is available through private markets. However, major California water storage projects may be ideal candidates for the P3 model. For example, the Carlsbad Desalination Project is considered a successful P3 water project that was completed on-time and on-budget at a cost of roughly $1 billion (Fikes 2015). In theory, similarly large-scale projects such as the proposed Temperance Flat Dam and Sites Reservoir could be completed more quickly and less expensively under a P3 model than could be accomplished exclusively by the public sector. P3 projects often cite implementation savings of about 10% through project procurement and delivery efficiencies in design and construction, which would translate to a $580 million potential savings on the Sites Reservoir project alone.

Another major benefit of P3 for major water storage projects is that the contract can be designed to guarantee specific maintenance, price and water quality levels. The Carlsbad Desalination Project, the private entity, Poseidon Water, guaranteed to make available the project water to the San Diego County Water Authority (SDCWA) at certain quantities, price and water quality. These contractual provisions not only effectively require Poseidon Water to maintain the infrastructure appropriately, but it also guarantees a funding stream from SDCWA to cover the project's capital maintenance needs (SDWCA 2017). Although this removes budgeting flexibility on the part of the local agency, maintaining critical water storage infrastructure may be one of few areas where this is warranted. After all, water infrastructure is the backbone of health, welfare and economy of the state, and it poses significant threats to health and safety when structural problems arise such as with the recent Oroville spillway emergency.

Many of the biggest drawbacks to P3s, such as the loss of government control or higher financing costs associated with equity or taxable financing, can be adequately addressed. Using new methods, JPAs or not-for-profit entities can be used as legal intermediaries that allow access to tax-exempt financing as well as private entity administration of the design, build, procurement and maintenance elements of project. The P3 structure can be adapted to retain government control of the specific sections of the project of most concern to the sponsor agencies. In the case of the Carlsbad Desalination Project, SDCWA issued bonds for $734 million of the $1 billion project cost with tax-exempt financing and had Poseidon finance the remainder (SDCWA 2017). Additionally, SDCWA chose to be heavily involved in the entire process of project design and implementation to ensure that its standards were upheld.

Pooling resources to form a JPA or to utilize P3 contracting requires technical, financial and legal expertise as well as inter-agency trust and cooperation. Presumably some opportunities that could be pursued by utilizing these structures are missed or overlooked because not all of the requisite factors are present. The state could help overcome institutional barriers and lack of in-house expertise by providing services and tools to encourage or facilitate the use of JPAs, P3s and/or other innovative financing for appropriate large storage projects. For example, in the context of the implementation of SGMA, statewide organizations have provided education, outreach and various tools to help facilitate the formation of multi-agency groundwater sustainability agencies. A similar approach could be offered to groups pursuing local and regional water storage projects in order to encourage JPA formation as well as P3 and other innovative financing.

3.5.4 Consider establishing a program to award available rights to surplus water from large storm events for regional projects that would provide the best projects to store and put the water to beneficial use.

This novel concept assumes that the state can, or does, have rights to some of the surplus water that occurs during very wet years or from large storm events. For example, in 2017, numerous flood control releases were made around the state primarily to protect infrastructure and not to supply water to any rights holder. Presumably some of that water was not put to any reasonable and beneficial use because existing water systems do not have capacity to take advantage of it and environmental needs are already being met. A portion of this flood water undoubtedly is not subject to any water rights permit or license and may constitute surplus water that could be used or diverted.

Assuming that rights to flood flows can be firmly established on the part of the state, offering interests in these rights would provide an incredible incentive to agencies and others to overcome institutional barriers, to collaborate with the private sector to provide innovative solutions, and to make funding commitments. Such a program could encourage new investment in water infrastructure or re-operation methods intended to put large quantities of surplus water to beneficial use without having to burden the state's finances.

4. DISCUSSION & CONCLUSIONS

The California water storage conversation has been ongoing since the turn of the 20th century. Large dams were first constructed in the Owens Valley in 1913 and Hetch Hetchy Valley of the Tuolumne River in 1923 to store large volumes of water and allow for diversion of that water to the population centers of Los Angeles and San Francisco. Since then, the CVP was constructed, which includes 20 dams, 400 miles of conveyance and 9 MAF of capacity, as well as the SWP, which consists of 33 reservoirs, 29 pumping/generating plants, 700 miles of aqueducts and 5.8 MAF of capacity (Lund et al. 2014). With a total surface storage capacity of 42 MAF and active groundwater recharge operations since the 1930s, California is not inexperienced in water storage planning.

However, the expected challenges in the coming century are not the same challenges seen in the past. Climate is changing, population continues to increase, and the accumulated impacts of human actions on surrounding ecosystems can no longer be ignored. Future water storage projects will be evaluated by more than costs and capacity, but by their overall impact to the system and the resiliency they can provide both locally and statewide.

For these reasons, it is time for innovation that digs deeper than the obvious simple solution. Existing projects must be routinely re-evaluated and investments should be made in maintenance and improvements that will maximize the resource and minimize costs and impacts. The state water system needs to be managed as a whole and the natural storage facilities beneath the earth's surface should be better utilized. In all projects, at all levels, entities must work together and be flexible. Water does not stop flowing when it reaches a political or jurisdictional boundary and neither should the water storage conversations. It is time to encourage creativity in governance structures and financing plans. Traditional approaches have brought California successfully into 2017, but resources are scarce and water infrastructure is forced to compete with other demands of modern growing society.

Most importantly of all, the discussions and conversions must continue. The recommendations provided above are only a piece of the future of water storage discussion. These ideas can serve as a starting point for the next century of water management innovations, a guide for solutions to the foreseeable challenges ahead, and a direction of thought for those challenges that cannot be predicted. Regardless of the projects constructed in the near future, California's water storage future is reliant upon continued re-evaluation of current practices and continued collaboration moving forward. One state, one water, one water future.

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APPENDICES

Appendix A: WSIP Concept Papers

Organization	Project Name	Agency Type	Project Type	Estimated Project Cost	Estimated Program Request	Ecosystem?	Water Quality?	Delta?
Alameda County Water District and Zone 7 Water Agency	Lake Del Valle Reservoir Water Supply Storage Expansion	Public Agency	Reservoir Reoperation, Local/Regional Surface Storage	$150,000,000	$75,000,000	Y	Y	Y
Antelope Valley - East Kern Water Agency	Westside Enterprise Water Bank Project	Public Agency	Groundwater Storage	$130,000,000	$65,000,000	Y	Y	Y
Calaveras County Water District	Wilson Lake Rehabilitation and Meadow Restoration Plan	Public Utility	Conjunctive Use, Local/Regional Surface Storage	$300,000	$150,000	Y	Y	Y
Calaveras County Water District	Historic Blagen Mill Pond Restoration Project	Public Utility	Local/Regional Surface Storage	$1,200,000	$600,000	N	Y	Y
California Land Stewardship Institute	Reoperation of Lake Curry to Benefit Steelhead Trout in Suisun Creek	Nonprofit Organization	Reservoir Reoperation	TBD	TBD	Y	Y	Y
Citizens Water Plan	Delta Tulare Plan	Nonprofit Organization	CALFED, Groundwater Storage, Conjunctive Use, Local/Regional Surface Storage	$5,000,000,000	$2,500,000,000	Y	Y	Y
City of San Diego	Pure Water San Diego	Public Utility	Local/Regional Surface Storage, Other	$3,200,000,000	TBD	Y	Y	Y
Contra Costa Water District	Los Vaqueros Reservoir Expansion Project	Public Agency	CALFED	$800,000,000	$400,000,000	Y	Y	Y
Deckhands Marine Supplies	Delta Legacy Project	Other	Conjunctive Use	$4,500,000	$4,500,500	Y	Y	Y
El Dorado Irrigation District and El Dorado County Water Agency	Alder Reservoir	Public Agency	Local/Regional Surface Storage	$909,000,000	$450,000,000	Y	Y	Y
Foresthill Public Utility District	Sugar Pine Dam Raise	Public Agency	Local/Regional Surface Storage	$5,000,000	$5,000,000	Y	Y	Y
Fresno Irrigation District	Fresno Eastside Stream Facilities Conjunctive Use Improvement Project	Public Agency	Groundwater Storage, Conjunctive Use, Reservoir Reoperation, Local/Regional Surface Storage	$40,000,000	$20,000,000	Y	N	Y
Inland Empire Utilities Agency	Chico Basin Groundwater Storage and Recovery Program	Public Agency	Groundwater Storage, Groundwater Contamination Prevention or Remediation, Conjunctive Use	$294,600,000	$147,300,000	Y	Y	Y
Natural Desalination	Benicia Salinity Managed Delta Restore	Nonprofit Organization	CALFED, Conjunctive Use, Local/Regional Surface Storage, Other	$400,000,000	$400,000,000	Y	Y	Y

Organization	Project Name	Agency Type	Project Type	Estimated Project Cost	Estimated Program Request	Ecosystem?	Water Quality?	Delta?
Natural Desalination	Connect Folsom South Canal to SWP	Nonprofit Organization	CALFED, Conjunctive Use, Local/Regional Surface Storage, Other	$500,000,000	$500,000,000	Y	Y	Y
Nevada Irrigation District	Centennial Reservoir Project	Public Agency	Local/Regional Surface Storage	$300,000,000	$100,000,000	Y	N	Y
North Kern Water Storage District, California Resources Corporation, and Lawrence Berkeley National Laboratory	Sustainable Groundwater Banking Demonstration Project	Public Agency, Other	Groundwater Storage, Conjunctive Use	$1,500,000	$750,000	Y	Y	Y
Orange County Water District	Santa Ana River Conservation and Conjunctive Use Program Phase 2	Public Agency	Groundwater Storage, Conjunctive Use	$200,000,000	$100,000,000	N	Y	Y
Palmdale Water District	Littlerock Sediment Removal Project	Other	Local/Regional Surface Storage	$15,000,000	$7,500,000	Y	Y	Y
Regional Water Authority	American River Basin Regional Conjunctive Use Project	Local JPA	Conjunctive Use	$1,400,000,000	$150,000,000	Y	Y	Y
River Recycler Systems, LLC	Coastal Aquifer Recharge - Drill and Fill	Other	Groundwater Storage, Groundwater Contamination Prevention or Remediation, Other	$1,700,000,000	$500,000,000	Y	Y	Y
River Recycler Systems, LLC	Klamath Forest Protection with Irrigation and Recharge	Other	Groundwater Storage, Other	$3,000,000,000	$1,500,000,000	Y	Y	Y
River Recycler Systems, LLC	New Freshwater for San Luis Reservoir	Other	Other	$2,000,000,000	$2,000,000,000	Y	Y	Y
River Recycler Systems, LLC	Ocean Chilled Freshwater to Shasta	Other	CALFED, Groundwater Storage, Other	$2,300,000,000	$1,700,000,000	Y	Y	Y
River Recycler Systems, LLC	Thomas Didymus Waterline	Other	Groundwater Storage, Other	$12,000,000,000	$2,000,000,000	N	N	Y
Sacramento Regional County Sanitation District and The Nature Conservancy	South Sacramento County Agriculture and Habitat Lands Recycled Water Program	Other	Groundwater Storage, Conjunctive Use	$250,000,000	$125,000,000	Y	N	Y
San Joaquin Valley Water Infrastructure Authority	Temperance Flat Reservoir	Local JPA	CALFED	$2,800,000,000	$1,400,000,000	Y	Y	Y
Semitropic Water Storage District	Tulare Lake Storage and Floodwater Protection Project	Public Agency	Groundwater Storage, Conjunctive Use, Local/Regional Surface Storage	$500,000,000	$250,000,000	Y	Y	Y
Sites Project Authority	Sites Reservoir	Local JPA	CALFED	$4,400,000,000	$2,200,000,000	Y	Y	Y

Organization	Project Name	Agency Type	Project Type	Estimated Project Cost	Estimated Program Request	Ecosystem?	Water Quality?	Delta?
South Sutter Water District	Camp Far West Reservoir	Public Agency	Conjunctive Use, Local/Regional Surface Storage	$16,000,000	$7,000,000	Y	Y	Y
Stanislaus Regional Water Authority	Regional Surface Water Supply Project	Local JPA	Groundwater Storage, Conjunctive Use	$200,000,000	$100,000,000	Y	Y	Y
Tuolumne Utilities District	Herring Creek Reservoir Expansion	Public Agency	Local/Regional Surface Storage	$150,000,000	$75,000,000	Y	Y	Y
Tuolumne Utilities District	Tuolumne County Water Supply Reliability Project	Public Agency	Other	$48,000,000	$24,000,000	Y	Y	Y
Tuolumne Utilities District	Sierra Pines Reservoir	Public Agency	Local/Regional Surface Storage	$40,000,000	$20,000,000	Y	Y	Y
Tuolumne Utilities District	Upper Strawberry Reservoir	Public Agency	Local/Regional Surface Storage	$120,000,000	$60,000,000	Y	Y	Y
Valley Mutual Water Company	Willow Springs Water Bank	Other	Conjunctive Use, Reservoir Reoperation	$200,000,000	$100,000,000	Y	Y	Y
Valley Water Management Company	Treatment and Banking of Oil Field Produced Water	Nonprofit Organization	Groundwater Storage, Groundwater Contamination Prevention or Remediation	$3,250,000	$750,000	N	Y	Y
Water Replenishment District of Southern California	Safe Drinking Water Program	Public Agency	Groundwater Storage, Groundwater Contamination Prevention or Remediation	$9,000,000	$4,500,000	Y	Y	Y
Water Replenishment District of Southern California	Perchlorate Remediation	Public Agency	Groundwater Storage, Groundwater Contamination Prevention or Remediation	$13,500,000	$6,750,000	Y	Y	Y
Water Replenishment District of Southern California	West Coast Basin Brackish Water Reclamation Project	Public Agency	Groundwater Storage, Groundwater Contamination Prevention or Remediation, Conjunctive Use	$82,000,000	$41,000,000	Y	Y	Y
Water Replenishment District of Southern California	Groundwater Basin Optimization Pipeline	Public Agency	Groundwater Storage, Conjunctive Use, Other	$253,000,000	$126,500,000	Y	Y	Y
Water Replenishment District of Southern California	Montebello Forebay Injection Wells	Public Agency	Groundwater Storage, Conjunctive Use	$452,000,000	$226,000,000	Y	Y	Y
Water Replenishment District of Southern California	West Coast Basin Inland Injection Well System	Public Agency	Groundwater Storage, Conjunctive Use, Other	$339,000,000	$169,500,000	Y	Y	Y

Appendix B: WSIP Application Summary, August 15, 2017

WSIP Application Summary, August 15, 2017

Project	Project Type	Requested WSIP Funding	Cost to Construct	Applicant	Applicant Type	Claimed Public Benefit Types	Early Funding Requested
Sites Project	Surface Storage CALFED ROD	$1,662,000,000	$5,176,000,000	Sites Project Authority	Joint powers authority	Ecosystem, Water Quality, Flood Control, Emergency Response, Recreation	Yes
Los Vaqueros Reservoir Expansion Project	Surface Storage CALFED ROD	$434,000,000	$795,000,000	Contra Costa Water District	Public Agency	Ecosystem, Emergency Response, Recreation	Yes
Willow Springs Water Bank Conjunctive Use Project	Conjunctive Use	$305,793,000	$343,143,000	Southern California Water Bank Authority	Joint powers authority	Ecosystem, Emergency Response	No
Temperance Flat Reservoir Project	Surface Storage CALFED ROD	$1,330,350,000	$2,660,700,000	San Joaquin Valley Water Infrastructure Authority	Joint powers authority	Ecosystem, Flood Control, Emergency Response, Recreation	Yes
Centennial Water Supply Project	Local Surface Storage	$11,950,000	$324,000,000	Nevada Irrigation District	Public Agency	Ecosystem, Recreation	No
Pacheco Reservoir Expansion Project	Regional Surface Storage	$484,500,000	$969,000,000	Santa Clara Valley Water District	Public Agency	Ecosystem, Flood Control, Emergency Response	Yes
Chino Basin Conjunctive Use Environmental Water Storage/Exchange Program	Conjunctive Use	$480,000,000	$480,000,000	Inland Empire Utilities Agency	Public Agency	Ecosystem, Water Quality, Emergency Response	No
San Joaquin River & Tributaries Conjunctive Use	Conjunctive Use	$22,085,000	$22,085,000	River Partners	Non-profit Organization	Ecosystem, Water Quality	No
The Tulare Lake Storage and Floodwater Protection Project	Conjunctive Use	$452,159,000	$602,887,000	Semitropic Water Storage District	Public Agency	Ecosystem, Flood Control, Emergency Response, Recreation	No
Kern Fan Groundwater Storage Project	Groundwater Storage	$85,660,930	$171,321,860	Irvine Ranch Water District	Public Agency	Ecosystem, Emergency Response	No
Pure Water San Diego Program North City Phase 1	Local Surface Storage	$219,310,000	$1,209,780,300	City of San Diego - Public Utilities Department	Public Agency	Ecosystem, Water Quality, Emergency Response, Recreation	No
South Sacramento County Agriculture & Habitat Lands Recycled Water, Groundwater Storage, and Conjunctive Use Program (South County Ag Program)	Conjunctive Use	$304,024,500	$373,119,102	Sacramento Regional County Sanitation District (Regional San)	Public Agency	Ecosystem, Water Quality, Emergency Response, Recreation	No
Total		**$5,791,832,430**	**$13,127,036,262**				