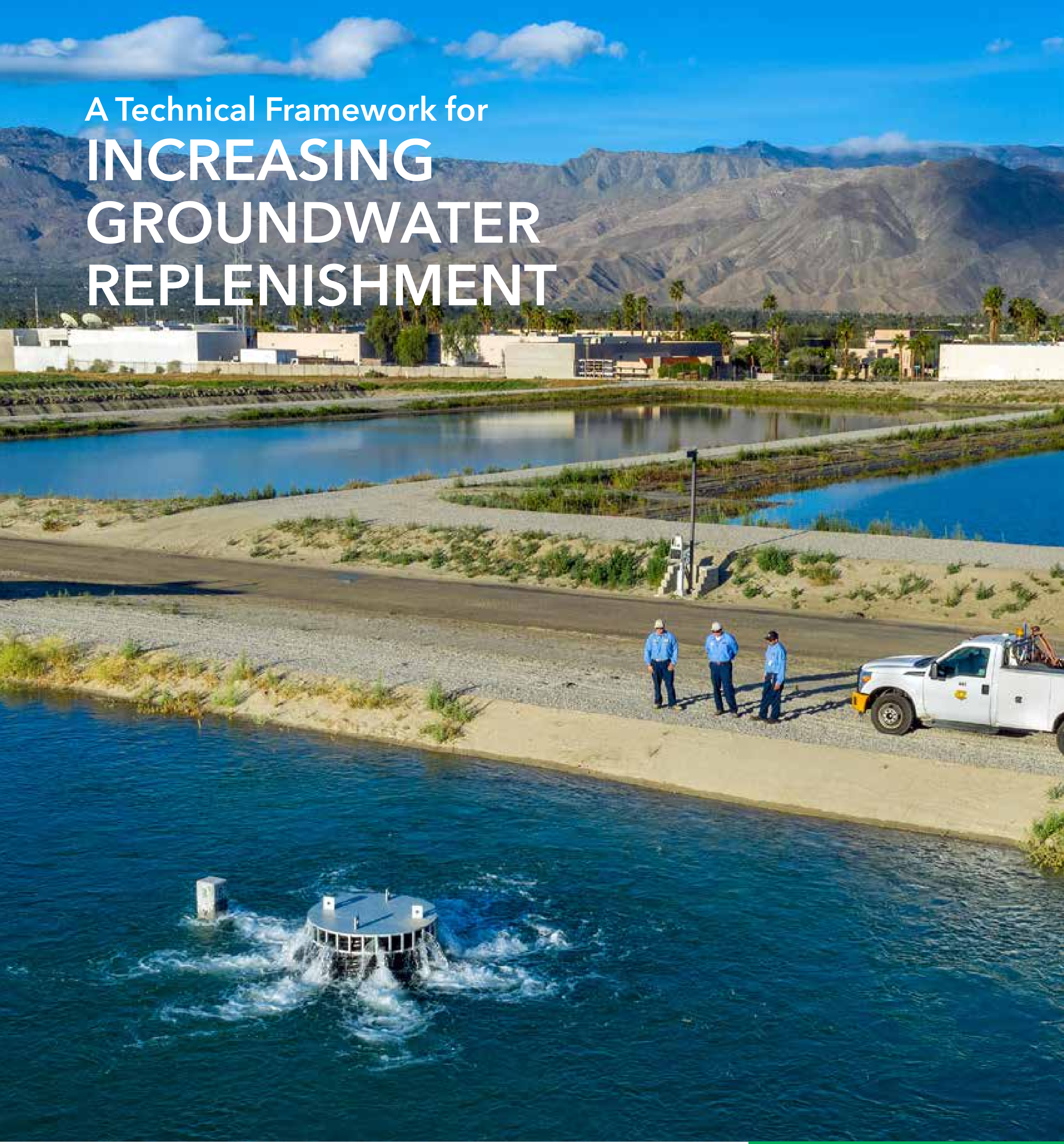
A Technical Framework for

INCREASING GROUNDWATER REPLENISHMENT



NOVEMBER 2019

ACWA
Association of California Water Agencies

Association of California Water Agencies

CONTACTS AND LOCATION

Sacramento Office
980 9th Street, Suite 1000
Sacramento, CA 95814
916.441.4545

Brent Hastey
ACWA President

Steve LaMar
ACWA Vice President

Dave Eggerton
Executive Director

CONTENTS

ACKNOWLEDGMENT

The development of this technical framework was requested by ACWA members and supported by former Executive Director Tim Quinn, ACWA President Brent Hastey and led by ACWA's Groundwater Committee Vice Chair Eric Averett. ACWA would like to recognize Montgomery and Associates for their early work in surveying ACWA members as part of this initiative. Lastly, ACWA would like to recognize the many members that contributed time in developing the content and editing the document.

EXECUTIVE SUMMARY

A Technical Framework for Increasing Groundwater Replenishment is a roadmap document for local agencies or groundwater sustainability agencies (GSAs) to utilize when navigating how to develop groundwater replenishment projects. This document walks readers through the current landscape of the Sustainable Groundwater Management Act (SGMA) and provides the context that, as part of SGMA implementation, groundwater replenishment will be an important component to how sustainability is achieved under SGMA. The technical framework provides the following considerations for how to develop groundwater replenishment projects.

- **Financial** – scoping the capital costs, operating costs, and water supply yield and cost
- **Technical** – identifying the source water, infrastructure needs and constraints, method of recharge, and specific locations for direct recharge
- **Institutional** – developing partnerships and agreements, and navigating water rights
- **Administrative** – contracting, applying for permits, and securing funding

The document includes additional resources that support the development of groundwater replenishment projects, as well as case studies of entities that are piloting their own replenishment projects.

INTRODUCTION

The Association of California Water Agencies (ACWA) has prepared this technical framework in response to a growing need to promote groundwater replenishment activities as a strategy to maintain or improve groundwater levels statewide. California's 515 groundwater basins are classified into one of four categories based on components identified in the California Water Code Section 10933(b): high-, medium-, low-, or very low-priority. Groundwater basins throughout California are also designated as critically overdrafted condition when a continuation of water management practices would likely result in significant, adverse overdraft-related environmental, social, or economic impacts. Such undesirable results, as defined under SGMA, include lowering groundwater levels, reduced groundwater storage, land subsidence, surface water depletion, sea water intrusion, or degraded groundwater quality. There is widespread recognition that further action will be required to promote and achieve groundwater sustainability statewide, basin by basin. This framework summarizes the tools and resources, as well as provides a narrative framework and checklist for water managers to consider as they pursue groundwater recharge projects and activities.

This technical framework document builds on the Association's Board-adopted Groundwater Management Policy Principles (March 2009), ACWA's landmark document, "Sustainability from the Ground Up: A Framework for Groundwater Management in California" (April 2011), and ACWA's "Recommendations for Achieving Groundwater Sustainability" (April 2014). Each of these documents provide an in-depth look at groundwater management in California with recommended proactive steps to overall advance groundwater sustainability. This technical framework is intended to support local water managers in their efforts to identify the potential for new or enhance current groundwater recharge activities, significantly improve groundwater management capabilities where they are deficient, and accelerate the achievement of sustainability by local and regional entities.

LEGISLATIVE BACKGROUND

In 2014, then-Governor Jerry Brown signed into law a three-bill legislative package, composed of AB 1739 (Dickinson), SB 1168 (Pavley), and SB 1319 (Pavley), collectively known as the Sustainable Groundwater Management Act (SGMA).

With the enactment of SGMA, for the first time in California water history, a statewide regulatory framework incorporating deference to local control was set forth for the sustainable management of groundwater basins over a 20-year planning and implementation horizon. SGMA requires local governments and water agencies of high- and medium-priority basins to form groundwater sustainability agencies (GSAs) to develop groundwater sustainability plans (GSPs). The GSPs will describe how GSAs will prevent, halt and/or reverse overdraft and undesirable results and sustainably manage groundwater basins with balanced levels of pumping and recharge.

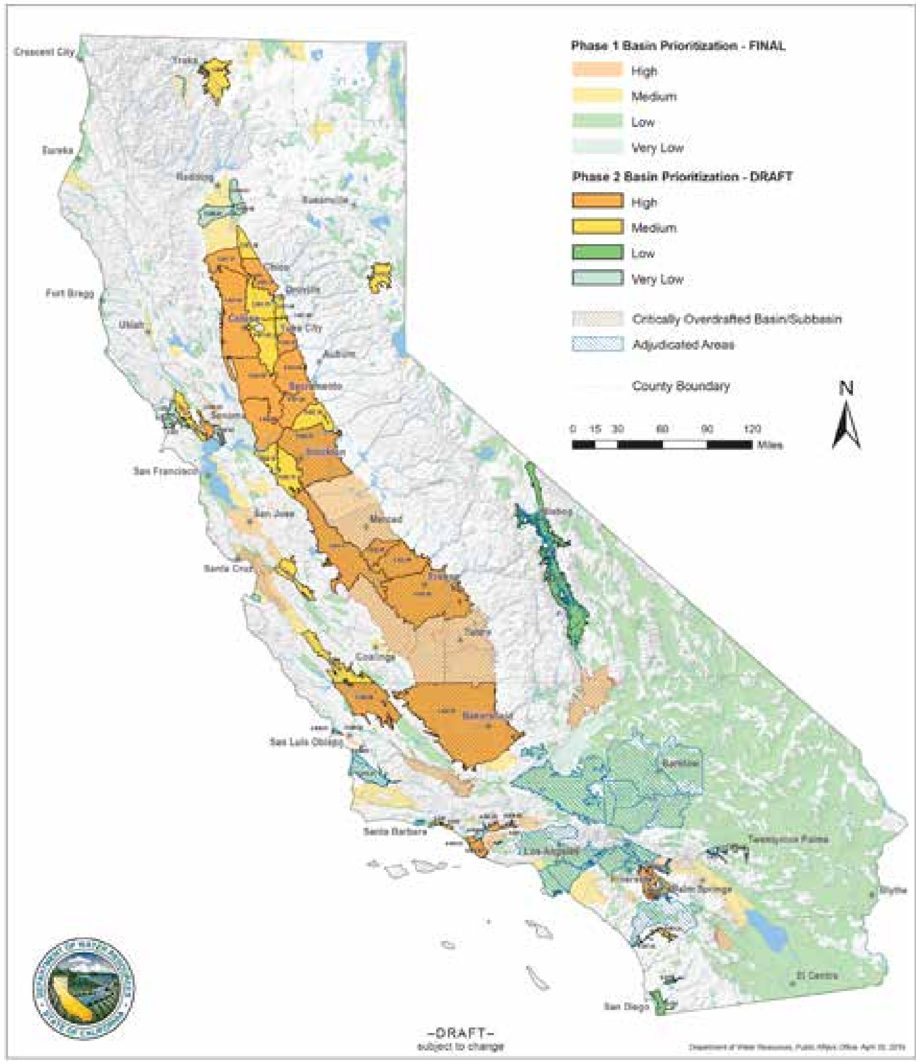
POLICY CONTEXT FOR GROUNDWATER REPLENISHMENT

The following policy context is derived from ACWA's "Recommendations for Achieving Groundwater Sustainability" (April 2014) Report. These fundamental components to groundwater management must be further advanced by local GSAs statewide to ensure an increase in groundwater replenishment, effective SGMA implementation, and achieve groundwater sustainability throughout California.

- **Promote Local Management:** Continue groundwater basins management by local and regional agencies with input from local stakeholders through GSAs and development of GSPs.
- **Increase Groundwater Storage:** Increase surface water in underground storage basins and develop significant new groundwater storage and conjunctive use projects to optimize use of the state's limited and highly variable water supplies.
- **Remove Impediments to Recharge:** Coordinate and plan to use surface water, recycled water, stormwater and groundwater resources to maximize the availability and reliability of water supplies.
- **Avoid or Minimize Subsidence:** Identify areas where groundwater pumping is resulting in subsidence at levels causing damage or risk of damage to overlying infrastructure and increase additional land use planning, engineering, and capital improvements, monitoring and reporting requirements.
- **Improve Data Availability:** Collect appropriate data and make it publicly available both locally and at the state level.
- **Assess Groundwater Connection to Surface Waters:** Evaluate the relationship of surface water sources and groundwater levels and quality in basins and identify the impacts, if any, on surface water sources and its related public benefits.
- **Provide State Financial and Technical Assistance.** Encourage the state, through DWR, to continue to provide significant new financial assistance and technical support to local and regional agencies for improving or developing GSPs and implementing replenishment projects. Developing management capacity in currently critically overdrafted basins should be the first priority.

GROUNDWATER – THE CURRENT LANDSCAPE

SGMA requires GSAs to develop, adopt, and implement GSPs in high- and medium-priority basins to halt overdraft and bring groundwater basins into balanced levels of pumping and recharge. Under SGMA, these basins should reach sustainability within 20 years of implementing their sustainability plans. For critically over-drafted basins, the deadline is 2040. For the remaining high- and medium-priority basins, 2042 is the deadline. In his signing statement, then-Governor Brown emphasized that “groundwater management in California is best accomplished locally.” Currently, local GSAs are preparing their GSPs which are due in either 2020 (for critically overdrafted basins) or 2022. The GSPs will include critical information related to undertaking enhanced groundwater replenishment activities based on groundwater conditions, monitoring activities, projects and management actions, while reducing uncertainty and data gaps.



BASIN PRIORITIZATION

California’s 515 groundwater basins are classified into one of four categories: high-, medium-, low- or very-low-priority based on components identified in the California Water Code Section 10933(b):

1. Population
2. Rate of population growth
3. Number of public supply wells
4. Total number of wells
5. Total irrigated acreage
6. Degree to which persons overlying the basin rely on groundwater as their primary source of water
7. Documented impacts on the groundwater within the basin, including overdraft, subsidence, saline intrusion, and other water quality degradation
8. Any other information determined to be relevant by the department, including adverse impacts on local habitat and local streamflows

During the prioritization process, the best available datasets and information were applied in a consistent, statewide manner. Basin prioritization is critical in determining which provisions under SGMA apply to specific basins. The current basin prioritization map is shown above and can be found on DWR’s website.

CRITICALLY OVERDRAFTED BASINS

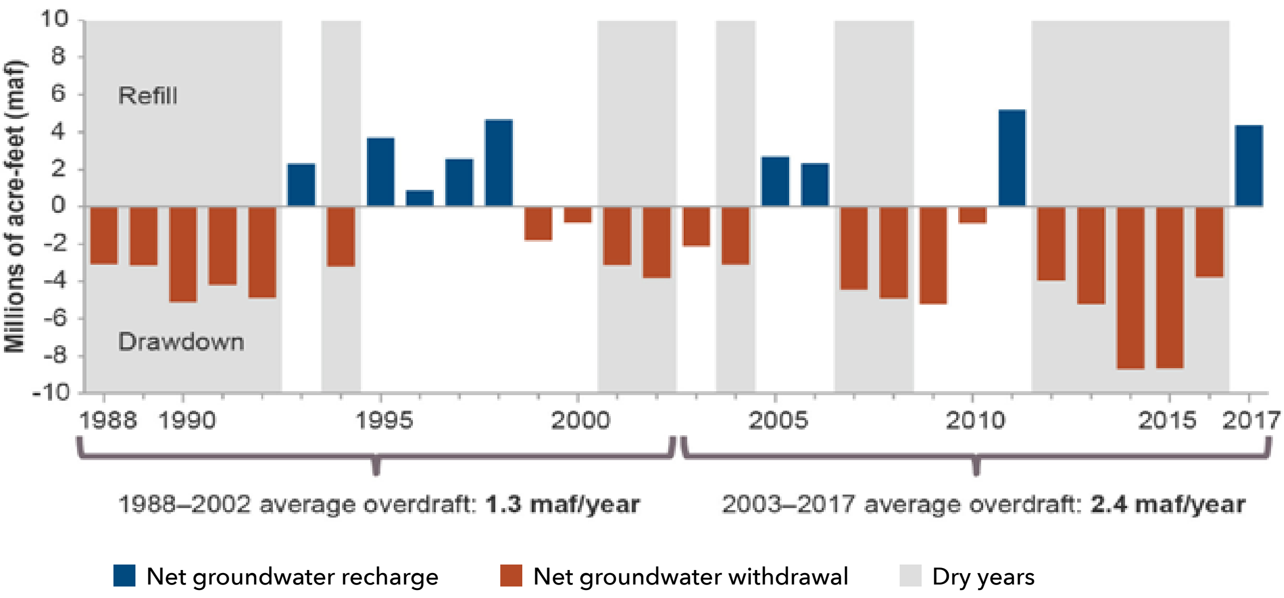
As defined in California Water Code Section 10735(a) "Condition of long-term overdraft" means the condition of a groundwater basin where the average annual amount of water extracted for a long-term period, generally 10 years or more, exceeds the long-term average annual supply of water to the basin, plus any temporary surplus.

Overdraft during a period of drought is not sufficient to establish a condition of long-term overdraft if extractions and recharge are managed as necessary to ensure that reductions in groundwater levels or storage during a period of drought are offset by increases in groundwater levels or storage during other periods.

As reported in several recent Public Policy Institute of California (PPIC) studies, the San Joaquin Valley is "ground zero" for implementing SGMA, where since the mid-1980s the valley's average annual overdraft is nearly 2 million acre-feet per year (or 13% of net water use).

However, in many areas of California, and particularly in the San Joaquin Valley, overdraft has been and continues to be exacerbated by a significant reduction in available surface water supplies over the past two decades. As PPIC notes, the inability of the State Water Project (SWP) and the federal Central Valley Project (CVP) to reliably deliver contracted surface water supplies has eliminated a substantial amount of surface water that once played a key role in recharging groundwater basins. In many cases, demand for groundwater is directly related to the reliability and availability of surface water supplies. The loss of reliable surface water supplies means that past investments in local and regional water systems — and the agricultural, urban and environmental water uses long supported by conjunctive management of surface water and groundwater resources — are now at risk and face ongoing devaluation and reduced effectiveness.

GROUNDWATER OVERDRAFT IN THE SAN JOAQUIN VALLEY



PPIC Report – Note: "Dry years" are those classified as dry or critically dry for the San Joaquin Valley.

RECENT PPIC STUDIES RELATED TO GROUNDWATER MANAGEMENT

"Water and the Future of the San Joaquin Valley" – February 2019

"Managing Drought in a Changing Climate: Four Essential Reforms" – September 2018

"Replenishing Groundwater in the San Joaquin Valley" – April 2018

In the 2013 Update of the California Water Plan, an inventory and assessment was completed by the California Department of Water Resources (DWR) and the Association of California Water Agencies (ACWA), which identified 89 active conjunctive management agencies or programs statewide. The statewide conjunctive management inventory and assessment consisted of literature research, an online survey, personal communication with local agencies, and a documented summary of the conjunctive management programs in California.

In 2019, ACWA conducted a follow-up survey with local agencies to evaluate measurable progress on conjunctive management use and recharge activities since the 2013 inventory and assessment. Of significant relevance between the 2013 and 2019 timeframe was the historic passage of the Sustainable Groundwater Management Act (SGMA) in 2014.

Full results from the 2019 ACWA survey can be found in Appendix A of this report. Below are the key takeaways, comparing the 2013 inventory and assessment results and the 2019 survey.

Conjunctive management or groundwater recharge projects or programs identified statewide:

- 2013: 89 agencies/programs
- 2019: 105 projects/programs

The most reported types of conjunctive management or recharge projects:

- 2013 and 2019: Spreading basins/percolation ponds and in-lieu recharge

The most identified source of water for active or planning conjunctive management or groundwater recharge projects or programs:

- 2013: State Water Project water and local surface water
- 2019: local surface water and recycled water

Two of the most reported goals or objectives for these projects/programs:

- 2013: part of a conjunctive management program and correcting overdraft conditions
- 2019: increasing groundwater storage and correcting overdraft conditions

The top identified constraint to doing these projects:

- 2013 and 2019: cost

A TECHNICAL FRAMEWORK FOR GROUNDWATER REPLENISHMENT

This technical framework describes the financial, technical, institutional, and administrative context that GSAs and other local entities should consider when planning and developing groundwater replenishment activities. The following technical framework outlines a comprehensive approach for the development of groundwater recharge projects as GSAs integrate them into their GSPs and implement groundwater management projects.

Financial Considerations to Evaluate

Where there are non-monetary values associated with project development and implementation, cost considerations are a critical component in evaluating the viability of any groundwater replenishment project. Most GSA's will likely evaluate the cost of a project, for comparison to other potential water supply projects, on a dollar per acre-foot basis ($/AF). The viability of any proposed groundwater replenishment project is generally evaluated by dividing the total capital and annual operating cost of the project by the anticipated water supply benefit or yield.

While capital costs for a potential project can be projected and developed, the more difficult challenge is quantifying the water supply benefit or yield available for replenishment. Recharge projects rely upon low cost/high flow water, which can be highly variable on a year-to-year basis. Evaluating and scoping a project's viability requires a method of evaluation as well as developing metrics, such as the projected average water yield and the frequency or volume to calculate the dollar per acre-foot cost. The evaluation needs to include a comparison of different alternatives to the scoped project to determine the scaled cost of that particular investment.

Technical Considerations to Identify

There are various technical considerations when developing groundwater replenishment activities, including the identification of a water supply source, infrastructure needs and constraints, recharge methods, and appropriate recharge locations. To be able to increase groundwater recharge, a water source is required. This will require both local and state entities to be flexible in managing existing water supply sources in new ways. As an example, this could include utilizing stormwater or recycled water for recharge purposes as innovative approaches to reusing runoff or wastewater. Further, when California experiences high flow or peak flow years, a process should be established for capturing high or excess flows in riverine systems for recharge that would not impact instream flows or beneficial uses and continues to protect downstream water rights holders. Additionally, local as well as the SWP and CVP operations could be adapted to leverage existing surface water supply sources for purposes of recharging groundwater basins though enhanced conjunctive management. Finally, collaboration and partnerships with other water rights holders may allow the mutual leveraging of assets to provide access to available water for replenishment. For example, a partnership to bank and reregulate water on behalf of an out-of-basin or out-of-region interest may provide in-basin access to available water through a transfer or exchange agreement.

Conveyance and Recharge Infrastructure. Other technical aspects to consider when developing groundwater recharge projects include determining what infrastructure is needed to capture and convey available water. Such infrastructure could include ensuring maintenance and capacity of the SWP and CVP facilities that would be utilized to move surface water statewide for replenishment, as well as enhancement of locally operated infrastructure such as interties to help facilitate water trading, injection wells, recharge ponds, and additional conveyance capacity for moving high or excess flows diverted from riverine systems. It is also important to identify and secure appropriate recharge locations for percolation and aquifer storage capacity when developing recharge activities. This requires an understanding of the physical conditions of the surface and subsurface environment, soils and geology, as well as land acquisition or land use planning decisions and constraints. An emerging strategy for integrating agricultural water use with additional recharge benefits is to use flood managed aquifer recharge (Flood-MAR) techniques on existing agricultural lands or croplands.

In-Lieu Recharge. In-lieu recharge is a method for allowing recharge to occur naturally, over time by leaving water in a groundwater basin. Groundwater-dependent communities and agriculture acquire and use surface water supplies to offset the need to use limited or stressed groundwater sources. In many locations, this type of conjunctive water management will be integral to achieving long-term sustainable yields.

Institutional Considerations to Navigate

To be able to successfully and efficiently implement the technical aspects of groundwater recharge, the ability to navigate institutional relationships and obstacles is essential. Such institutional considerations include determining, with whom to develop partnerships and how the water rights system may affect recharge activities in a basin.

There is much more that can be done in regards to local conveyance systems, such as interties between systems or basins for water transfers and the development of local groundwater markets. Similarly, there are institutional barriers related to the SWP and the CVP. Below is a general overview and understanding of the SWP and CVP operations and constraints, which is critical in identifying how to access, use or transfer project water supplies differently for optimal groundwater recharge purposes.

Article 21 Water. The California Department of Water Resources (DWR) manages the long-term contracts with 29 local water supply entities who receive surface water supplies from the SWP. Table A amounts are the maximum annual SWP amounts in acre-feet of water delivered to the contractors. Water available for delivery that is non-Table A is called Article 21 water and is identified in the water supply contracts as water that becomes available on an intermittent basis. Article 21 water is considered excess water in the system. Delivery of Article 21 water cannot impact the Table A allocation of any of the contractor's water, nor can it negatively impact SWP operations. A contractor cannot defer their Table A allocation because they are getting Article 21 water. The process for determining Article 21 water availability and allocation begins with DWR's SWP Operations Office determining how much water will become available based on forecasted and existing hydrology and then contracts are put in place. Once allocated, DWR then monitors demands on a weekly basis. There are additional considerations for using Article 21 water, such as geography, location, timing, and cost.

Section 215 Water. Similarly, the U.S. Bureau of Reclamation (Bureau) manages the agreements related to the CVP. The Reclamation Reform Act of 1982 includes Section 215, which authorizes the Bureau to provide temporary water service contracts. Section 215 water becomes available because San Luis Reservoir is full and the Jones Pumping Plant's export capacity exceeds south of Delta service area demands. As an example, in 2018 the Bureau proposed to execute 215 water service contracts with CVP and non-CVP contractors within Friant's CVP Place of Use (a determined service area). The contract amounts were based on the availability of Section 215 water and managed at the Bureau's discretion, depending on reservoir capacity and operations, and hydrologic conditions. There were several conditions placed on the 2018 Section 215 water contracts, such as the water could be used for irrigation, municipal and industrial purposes and must be used within the contractor's water service boundary and Friant's Place of Use. No banking, transferring, or exchanging of Section 215 water was allowed unless otherwise approved by the Bureau. These contractual limitations are important in understanding the timing, yield, frequency and cost of available water coming from the SWP and the CVP.

Partnerships. Relationships between water agencies, irrigation districts, GSAs and community members is a key factor to developing successful recharge projects. As on-farm recharge and other flood-MAR techniques become more widely practiced, individual landowners will be an increasingly important stakeholder to engage with in obtaining, managing, and delivering water. Landowners should be considered integral partners who can help address groundwater recharge based on coordinating their land uses with water agencies or GSAs who have the expertise, water rights and infrastructure to support groundwater replenishment activities.

SGMA requires coordination between basins and/or sub-basins to prevent adverse impact between neighboring basins or specific areas where there is interconnected surface water and groundwater. For example, relationships between surface water and groundwater users will be central to many future agreements targeted at increasing recharge capabilities. Coordination with local entities and state agencies will be important for acquiring permits, water rights approval, environmental planning, and related agreements for managing critical habitat and biological species (i.e., safe harbor agreements, habitat conservation plans (HCPs), or natural community conservation plans (NCCPs)).

Administrative Considerations to Advance

There are other administrative aspects GSAs and local entities should consider when moving forward with planning for groundwater recharge projects. The State Water Board's new streamlined permitting process to capture and divert high or excess flows can be a tool for local entities to utilize (see page 15 for details). DWR provides grant funding, technical and facilitation support services that could be used to support GSAs working to develop recharge projects. The GSAs have statutory fee authority to generate funding to support recharge efforts.

Checklist for Groundwater Replenishment

The checklist below reflects the financial, technical, institutional, and administrative considerations. This checklist does not outline all possible actions to undertake, but provides an initial list water managers can use to start evaluating locally relevant considerations, and develop basin-specific groundwater recharge proposals and activities to include in the *Projects and Management Actions* section of their GSPs.

Financial Considerations

- [ ] **Scoping the funding for project development, including capital costs, operating costs and water supply cost & yield**

Technical Considerations

- [ ] **Sources of water supply**
    - Contractual limitations
- [ ] **Infrastructure needs and constraints**
    - Conveyance accountability and timing of releases
    - New local infrastructure, if needed
- [ ] **Various recharge methods**
    - Direct recharge or in lieu recharge
    - Direct recharge methods includes various methods such as injection wells, recharge ponds, and flood-MAR techniques
- [ ] **Appropriate direct recharge locations**
    - Land use acquisition or land use planning decisions and constraints
    - Physical conditions of the surface and subsurface environment, soils and geology
    - Place of use and water quality considerations of source water supply

Institutional Considerations

- [ ] **How the water rights system affects recharge projects**
    - Current water rights holders and consideration of individual landowners obtaining water rights (balance water rights to ensure groundwater availability for beneficial uses/users)
- [ ] **Navigating partnerships**
    - Coordination between basins
    - Communication between surface water districts and groundwater users
    - Potential agreements between individual landowners and water agencies (beneficiaries)
    - Coordination with state agencies related to permits, water rights, and environmental planning purposes
- [ ] **Other regulatory barriers to developing such recharge projects**
    - Legal or procedural operation agreement constraints

Administrative Considerations

- [ ] **Contractual aspects, such as the necessary water rights**
    - State Water Board's streamlined permit to capture excess flows
- [ ] **Funding mechanism to successfully implement recharge projects**
    - Grant funding, technical assistance, facilitation services, GSA fee authority, etc.
    - Funding for local staffing to manage recharge activities, and monitoring and reporting

COMPREHENSIVE TOOLBOX APPROACH

To increase groundwater replenishment activities in groundwater basins, water managers need to use a comprehensive toolbox approach. It will take most, if not all, of the tools in a water manager's toolbox to achieve sustainability. GSAs across California have different undesirable results impacting their basins and sub-basins. Local water agencies will need to continue to manage their water supplies creatively and conjunctively to meet supply demands, reduce stress on groundwater sources, and achieve sustainability. Described below are various tools and resources water managers may utilize when scoping and developing groundwater recharge projects and activities.

Recently Enacted AB 658 (2019): Provides for Urgency and Temporary Permits

On October 9, 2019, Governor Newsom signed into law Assembly Bill (AB) 658, authored by Assemblymember Arambula. The law provides legislative intent to encourage groundwater recharge projects during times of high-flow events by codifying an urgency 180-day permit, a temporary five-year permit and a temporary five-year change order administered by the State Water Board. The urgency 180-day permit provides an opportunity to divert water, when needed, under an urgent situation, without impact to any lawful user of water and without unreasonable effect on fish, wildlife or other instream beneficial uses. The urgency permit automatically expires after 180 days from authorization.

SETTING THE STAGE: TEMPORARY WATER RIGHTS PERMIT TO CAPTURE HIGH RUNOFF

On April 6, 2017, then-Governor Jerry Brown signed Executive Order B-39-17, which directed the State Water Board to prioritize temporary water right permits for projects that enhance the ability of a local or state agency to capture high runoff events for local storage or recharge. The Executive Order also suspended the provisions of the California Environmental Quality Act (CEQA) for State Water Board actions on these types of temporary permits. Prior to Executive order B-39-17, the former Governor issued Executive Order B-36-15 in November 2015, which contained a similar directive. These Executive Orders set the stage for legislation in this arena.

The law also provides that a GSA or a local agency may apply for and the State Water Board may issue a conditional five-year temporary permit for diversion of high or excess surface water to underground storage for beneficial use that advances the sustainability goal of a groundwater basin. Applicants are required to include evidence that they have completed environmental review under the California Environmental Quality Act (CEQA) for the project and received a notification that the applicant has consulted with the Department of Fish and Wildlife (DFW) at least 30 days before the submission of the application not to exceed 60 days for any conditions proposed by DFW. Applicants are also required to provide a water availability analysis that quantifies a range of foreseeable hydrologic conditions, the amount of unappropriated water available considering all known legal users who divert water hydrologically connected to the proposed point of diversion, effects on beneficial uses, including instream beneficial uses, and the ability to meet water quality objectives.

STATE WATER BOARD FACT SHEETS

As helpful resources prior to the release of the streamlined permit guidance, the State Water Board developed several fact sheets related to groundwater recharge:

"Purposes of Use for Underground Storage Projects"

"Flood Control, Groundwater Recharge, and Water Rights"

New Streamlined Permitting Process for Groundwater Recharge

In November 2019, the State Water Board released a new streamlined permitting process for diversion of water from high flow events for groundwater recharge purposes. The State Water Board recognizes that capturing surface water to recharging groundwater aquifers generally requires an appropriative water right. This new streamlined permitting process allows GSAs or local agencies to obtain a new water right or change their existing water rights to authorize a diversion of excess or high flows for groundwater recharge. On the State Water Board's website, they walk through the step-by-step of who is eligible for this streamlined permit, the permit process, a fact sheet on beneficial uses, guidance on developing a water availability analysis, water accounting, and the fees and forms. The new streamlined permitting process does not change any existing water rights, laws, or regulations.

This permitting concept recognizes that our water system receives varied flows throughout each season, including intense atmospheric rivers, and there are times when excess flows can be captured and diverted for groundwater recharge purposes, without impact to any lawful user of water and without unreasonable effect on fish, wildlife or other instream beneficial uses. More information and detailed 'Frequently Asked Questions' can be found at the State Water Board's Water Rights for Groundwater Recharge webpage.

PERMITTING TOOLS FOR GROUNDWATER RECHARGE

180-Day Urgency Permit

5-year Temporary Permit

Administrative Streamlined Permit

Berkeley Law Issue Brief

The University of California, Berkeley Center for Law, Energy & the Environment published an issue brief in August 2018 titled, "When Is Groundwater Recharge a Beneficial Use of Surface Water in California?" The issue brief helps define the conditions under which recharge for non-extractive purposes is a beneficial use and encourages the State Water Board to develop such guidance as they are pursuing now. The following chart is a helpful summary identifying the extractive and non-extractive uses.

Differences between Water Rights for Recharge to Support a Non-Extractive Use vs. Water Rights to Support Recharge for Storage and Recovery

	RE CHARGE FOR NON – EXTRACTIVE USE	RECHARGE FOR STORAGE AND RECOVERY (Extractive Use)
Beneficial Use	Non-extractive use(s) identified in the water right permit, e.g.: • Protecting or enhancing water quality • Preventing or reversing land subsidence • Protecting or enhancing groundwater dependent ecosystems • Protecting or enhancing groundwater levels to ensure that basin residents using private domestic wells and those that depend on small community water systems have access to water. • Other non-extractive uses which provide basin-wide benefits	End use(s) identified in the water right permit, e.g.: • Agricultural irrigation • Aquaculture • Domestic use • Fish and wildlife preservation • Frost protection • Heat control • Mining • Municipal / industrial use • Power generation • Recreation • Stock watering • Other beneficial extractive uses
Place of Use	Within the aquifer system, or at locations where water flows passively from the aquifer system	Location(s) of identified end use(s)
Status of Recharged Water	Left in the aquifer system (factored into the basin's sustainable yield)	Considered stored surface water (not factored into the basin's sustainable yield)
Right to Subsequent Extraction	None (under this water right)	Includes the right to recover stored water for the identified end use(s) under this water right
Distribution of Benefits	Water is recharged to achieve one or more broad public benefits, not for the specific extractive benefit of the water right holder.38	Water is recharged for the future extractive benefit of the water right holder, but may provide broader incidental benefits.

Diagram provided by the University of California, Berkeley Center for Law, Energy & the Environment.

FLOOD MANAGED AQUIFER RECHARGE (FLOOD-MAR)

"Flood-MAR" is an integrated and voluntary resource management strategy that uses flood water resulting from, or in anticipation of, rainfall or snow melt for managed aquifer recharge (MAR) on agricultural lands and working landscapes, including but not limited to refuges, floodplains, and flood bypasses. Flood-MAR can be implemented at multiple scales, from individual landowners diverting flood water with existing infrastructure, to using extensive detention/recharge areas and modernizing flood management infrastructure/operations.

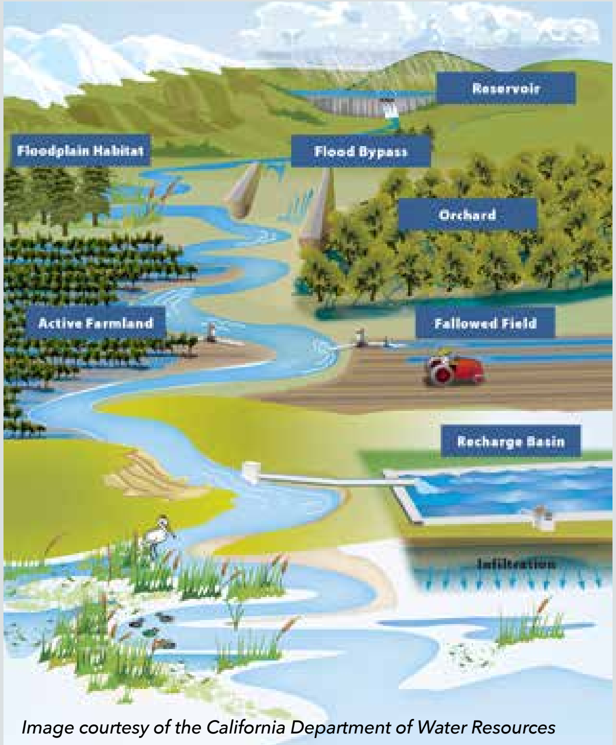


Image courtesy of the California Department of Water Resources

Flood-MAR projects can provide broad benefits for Californians and the ecosystems of the state, including:

- Water supply reliability
- Flood risk reduction
- Drought Preparedness
- Aquifer Replenishment
- Ecosystem Enhancement
- Subsidence Mitigation
- Water Quality Improvement
- Working Landscape Preservation and Stewardship
- Climate Change Adaptation
- Recreation and Aesthetics

There is strong, and growing, interest across the state in understanding the benefits, limitations, concerns, costs, and funding opportunities for Flood-MAR projects. DWR is working with other state, federal, Tribal, and local entities, academia, and landowners. Their white paper can be found online. More information can be found on DWR's website. Flood-MAR is a multi-benefit technique that can be used by GSAs when identifying ways to replenish basins.

Managed Aquifer Recharge Guidelines

In 2001, the American Society of Engineer's (ASCE) published Standard Guidelines for Artificial Recharge of Ground Water, EWRI/ASCE 34-01 (ASCE 2001). These guidelines are a valuable reference document when developing a new recharge project or already running a MAR system. It can be purchased and downloaded from the ASCE website. Over the past several years, a team of experts have been developing a new, updated comprehensive set of guidelines that describe the numerous activities required to implement a MAR project. The updated guidelines will build upon and supersede ASCE 2001. The updated guidelines, *"Standard Guidelines for Managed Aquifer Recharge,"* are expected to be released in late 2019 or 2020.

MAR projects are inherently interdisciplinary in their design, construction, implementation, and maintenance. The Standard Guidelines provide a general understanding how to plan, design, construct, operate and maintain MAR facilities.

RECHARGE ROUNDTABLE CALL TO ACTION REPORT

The Groundwater Resources Association of California and the University of California Water Security and Sustainability Research Initiative, collaborated on a *"Recharge Roundtable Call to Action"* report that aims to motivate focused actions resulting in large quantities of recharge to produce regional benefits.

ON-FARM RECHARGE OF ANNUAL CROPS & WATERBIRD HABITAT QUICK REFERENCE GUIDE

The Migratory Bird Conservation Partnership developed an on-farm recharge of annual crops and water bird habitat reference guide. More information can be found online at www.camigratorybirds.org.

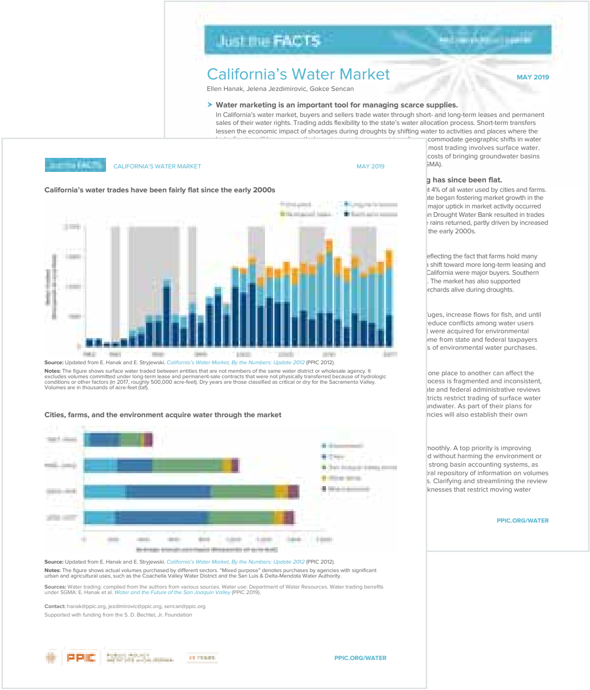
Groundwater Recharge Assessment Tool (GRAT)

The GRAT is a decision support tool that enables irrigation districts, water agencies, and GSAs to easily create and assess recharge scenarios. The tool evaluates where (active cropland, fallow land, and dedicated recharge basins), when (which weeks across multiple water year types, across a 20 year planning horizon) and how much water may be recharged based on best available data and hydrologic, agronomic and geologic science. The GRAT informs GSA's regarding their most cost effective options and incorporates considerations of the unintended environmental and social impacts in their basins. The organization, Sustainable Conservation, has developed a fact sheet and instruction manual for the GRAT.

Groundwater Markets

The Nature Conservancy and Fox Canyon Groundwater Management Agency, have instituted the first groundwater market to emerge under SGMA, called the Fox Canyon Groundwater Market. The following report outlines the experiences of the local partners, steps taken, and lessons learned in developing a unique, algorithmic groundwater market within the basin to match voluntary sellers who have available water supplies with those buyers who are in need of water for groundwater replenishment.

PPIC also recently published a fact sheet on California's water market in May of 2019, which concluded that increased access to information regarding water availability would enhance efficiencies and the effectiveness of California's overall water market.



Groundwater Dependent Ecosystem (GDE) Tool

Identifying groundwater dependent ecosystems and freshwater species located within a given groundwater basins can be used by GSAs to better evaluate the impacts in determining where and when to replenish groundwater basins, as well as identifying critical groundwater level thresholds to maintain to promote ecosystem health. The Nature Conservancy has also developed a Groundwater Dependent Ecosystems (GDE) Pulse Tool that provides data and information on how GDEs have changed over the last 30 years, trends in groundwater levels and rainfall, and includes an interactive map and charting interface.

Water Quality Impacts

Stanford's Water in the West Program developed a report in Spring of 2019 titled, "*A Guide to Water Quality Requirements under the Sustainable Groundwater Management Act*." The report discusses water quality considerations as they relate to SGMA and provides some helpful context related to groundwater recharge. The report recognizes that groundwater recharge and other forms of active aquifer management are important tools for sustainable groundwater management, with potential to improve both groundwater supplies and groundwater quality. However, the report also references research that indicates groundwater recharge via recharge ponds and/or direct injection could have negative potential to mobilize naturally occurring constituents or mobilize or expand contaminant plumes. These are considerations that GSAs should keep in mind when exploring recharge activities.

CASE STUDIES

The following case studies show examples of multi-benefit groundwater replenishment projects throughout California.

Colusa County, Managed Aquifer Recharge: Benefitting Aquifers, Farmers and Migratory Birds

In partnership with growers and the Colusa Groundwater Authority (CGA), The Nature Conservancy (TNC) is implementing a pilot multiple-benefit managed aquifer recharge program on farmland in California's Central Valley, Colusa County. This program will benefit local groundwater users by replenishing critical domestic and agricultural groundwater supplies in a Severely Disadvantaged Community (SDAC). Participating farmers will benefit economically through incentive payments, and migratory shorebirds will benefit through the creation of critical winter habitat on farms in accordance with field and water depth specifications unique to the particular acreage.

Modesto Irrigation District: Groundwater Replenishment Plan

The Modesto Irrigation District (MID) Board of Directors finalized their 2019 Groundwater Replenishment Plan. The GRP is a voluntary in-lieu recharge plan that allows MID to deliver surplus surface water to any farmer with already-developed agricultural land who is solely reliant upon groundwater within the Modesto Sub-basin and within MID's existing sphere of influence. This surface water is for agricultural use only and the participants must demonstrate that the surface water received is put to beneficial uses at all times. The GRP was constructed following an abundance of precipitation in 2019.

Sacramento County, Making Room for Recharge: Consumnes River Levee Removal and Floodplain Restoration

Reconnecting rivers to floodplains can facilitate groundwater recharge. A recent project along the Cosumnes River is one of the first to demonstrate this intentional recharge benefit. While this project was expensive and more complex than many forms of recharge, public funding paid for the project and a partnership with UC Davis is improving the understanding of groundwater-surface water interactions and basin groundwater conditions. In 2014, The Nature Conservancy piloted this concept by selectively removing portions of a private levee system along the Cosumnes River to enhance floodplain processes and restore approximately 500 acres of riparian habitat. The levee removal project offers multiple environmental benefits, including increased groundwater recharge in the floodplain.

Arvin-Edison Water Storage District, In-Lieu Program

Arvin-Edison Water Storage District (District) has developed an in-lieu groundwater recharge program. When the District has available water supplies in excess of the current needs within their surface water service area, the available water supplies can be delivered to an 'in-lieu water user' or other landowners interested in in-lieu supplies. This program allows the District to reduce groundwater pumping and apply surface water supplies to help recharge their groundwater basin. Overtime, the In-Lieu Program is an opportunity to improve and stabilize the groundwater conditions within the District.

Ventura County, Treated Wastewater as a Multi-Benefit Groundwater Sustainability Project

The Arroyo Las Posas Creek in Ventura County has connected their wastewater treatment plant (WWTP) to discharge into their stream as a multi-benefit project. These flows are a significant factor in the basin's water balance and support important Groundwater Dependent Ecosystems (GDE). The use of recycled water is an important water supply source and will continue to play a significant role in planning for the basin's groundwater sustainability. Before proposing expensive water recycling projects, water managers should consider multiple benefits of discharging treated water to streams or rivers like the Arroyo Las Posas Creek Project. As pressures increase to augment supplies, GSAs should consider the potential opportunities of utilizing WWTP discharges to streams to support recharge and improve GDEs.

ANTICIPATED CHALLENGES

Even with helpful tools, technical support, and financial resources for GSAs, replenishing California's groundwater basins will still present significant challenges. The following are several critical challenges that must continue to be addressed in future discussions related to groundwater recharge:

- **Time is Essential.** As defined under SGMA, GSAs have a 20-year planning and implementation horizon to bring basins into sustainable yield. However, time is of the essence when it comes to determining the appropriate extraction and recharge balance, particularly for basins already in critically-overdrafted conditions.
- **Changes in Groundwater Use and Land Use.** To achieve SGMA compliance, a number of GSAs may need to mandate and manage a reduction in groundwater pumping. This could impact domestic water supplies for communities that are groundwater-dependent and agricultural lands that use groundwater as their primary water source. This could lead to a reduced amount of water available for agricultural use and eventual changes in land use. This, in turn, will impact California's agricultural industry and economy at-large.
- **State and Local Coordination.** Close coordination between state and local agencies will be essential to ensure surface water supplies can be flexibly managed to maximize the amount of water that can be applied towards recharging groundwater basins. Similarly, coordination between GSAs will need to occur to be able to ensure basin management activities between neighboring basins do not conflict with one another.
- **Additional Funding.** Some GSAs are already starting to begin processes to set rates under the GSA's fee authority. However, future funding at the federal, state and local level needs to become available to incentivize and increase groundwater replenishment activities, which will be necessary for successful SGMA implementation in many areas of California.

STATEMENT OF COMMITMENT

ACWA and its member agencies have a demonstrated history of strong leadership in confronting challenges and embracing needed changes to better manage groundwater resources in California. ACWA continues to be committed to working with the state and with urban and agricultural water users, growers and landowners, environmental and disadvantaged community interests, and other stakeholders to promote and effectuate increased groundwater replenishment to contribute to sustainable groundwater management throughout California.

APPENDIX

Introduction

In the 2013 Update of the California Water Plan, an inventory and assessment was completed by the California Department of Water Resources (DWR) and the Association of California Water Agencies (ACWA). The statewide conjunctive management inventory and assessment consisted of literature research, an online survey, personal communication with local agencies, and a documented summary of the conjunctive management programs in California.

In 2019, ACWA conducted a follow-up survey with local agencies to evaluate measurable progress on conjunctive management use and recharge activities since the 2013 inventory and assessment. Of significant relevance between the 2013 and 2019 timeframe was the historic passage of the Sustainable Groundwater Management Act (SGMA) in 2014.

The online survey administered by ACWA specifically requested for active or planned conjunctive management or groundwater recharge projects or programs from its member agencies and groundwater sustainability agencies (GSAs).

The following information was requested for active or planned projects/programs:

1. The location of projects/programs
2. The number of projects/programs pursued per decade
3. The type of projects/programs
4. The source water identified for projects/programs
5. The reported goals and objectives of the projects/programs
6. The administrator/operator of the projects/programs
7. The capital cost to develop the projects/programs
8. The annual operating cost of the projects/programs
9. The capacity of the projects/programs in units of acre-feet per year
10. How the projects/programs are included in the local groundwater sustainability plan (GSPs)

The results of the 2019 ACWA survey are below. Several items should be noted. Data reflected in the survey results may not represent all conjunctive management or groundwater recharge projects or programs in California. Due to the confidentiality concerns expressed by some local agencies, all questions were optional and survey participants are kept anonymous.

Results

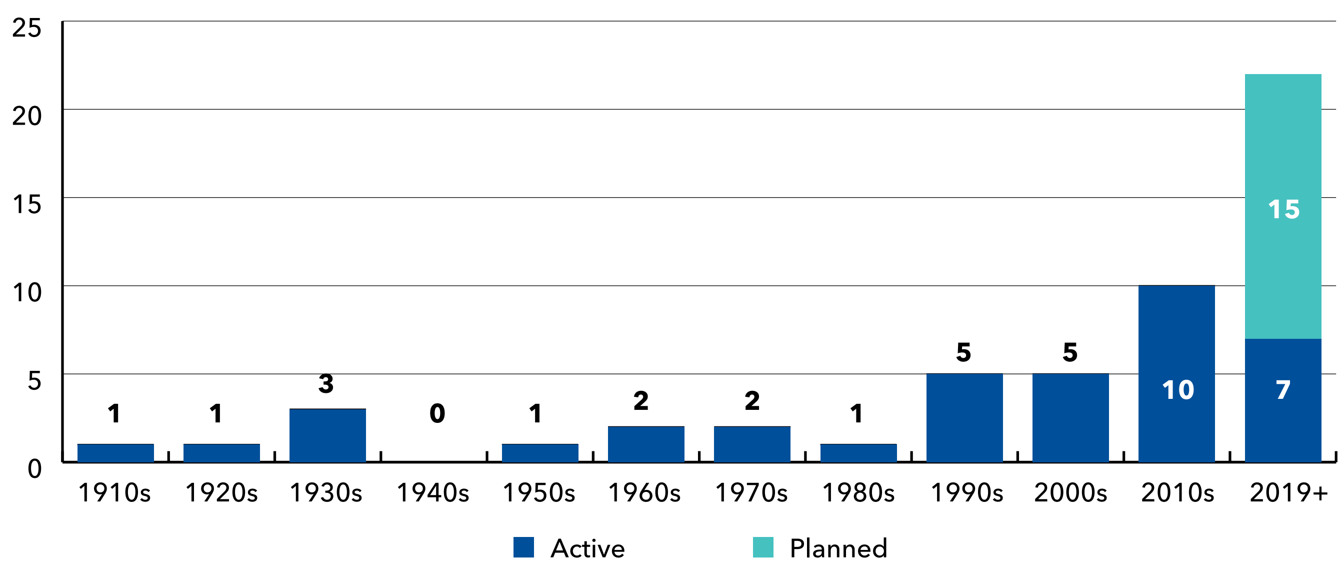
The 2019 survey data identified 105 active or planned conjunctive management or groundwater recharge projects/programs. From this dataset, the four hydrologic regions where the most active or planned projects/programs are being pursued include Tulare Lake, San Joaquin River, South Coast, and Central Coast. Project/program locations, if identified by survey participants, can be found in the list on page 29. Approximately 96 percent of survey participants responded to this question.

Table 1: 2019 survey results of number of active or planned conjunctive management or groundwater recharge projects/programs by hydrologic region.

Hydrologic Region	Number of Projects
North Coast	0
San Francisco Bay	5
Central Coast	16
South Coast	19
Sacramento River	3
San Joaquin River	22
Tulare Lake	32
North Lahontan	0
South Lahontan	8
Colorado River	0
TOTAL	**105**

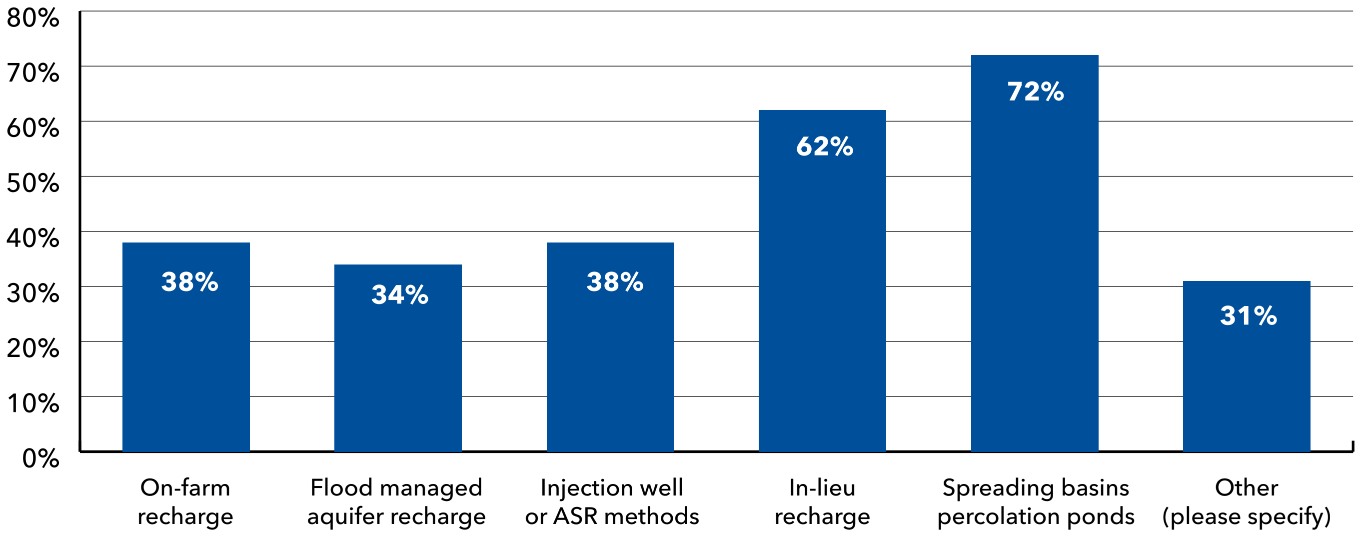
Based on the survey results, 53 projects or programs were identified as active or planned in a specific decade. The earliest project or program was reported as developed in 1912. Of the 22 projects or programs reported in 2019+ decade, seven are considered active and 15 are considered planned projects or programs, with survey participants clearly identifying projects that are still being planned in 2019 or have a project completion date between 2020 and 2035.

Figure 1: Number of active or planned conjunctive management or groundwater recharge projects/programs per decade in California



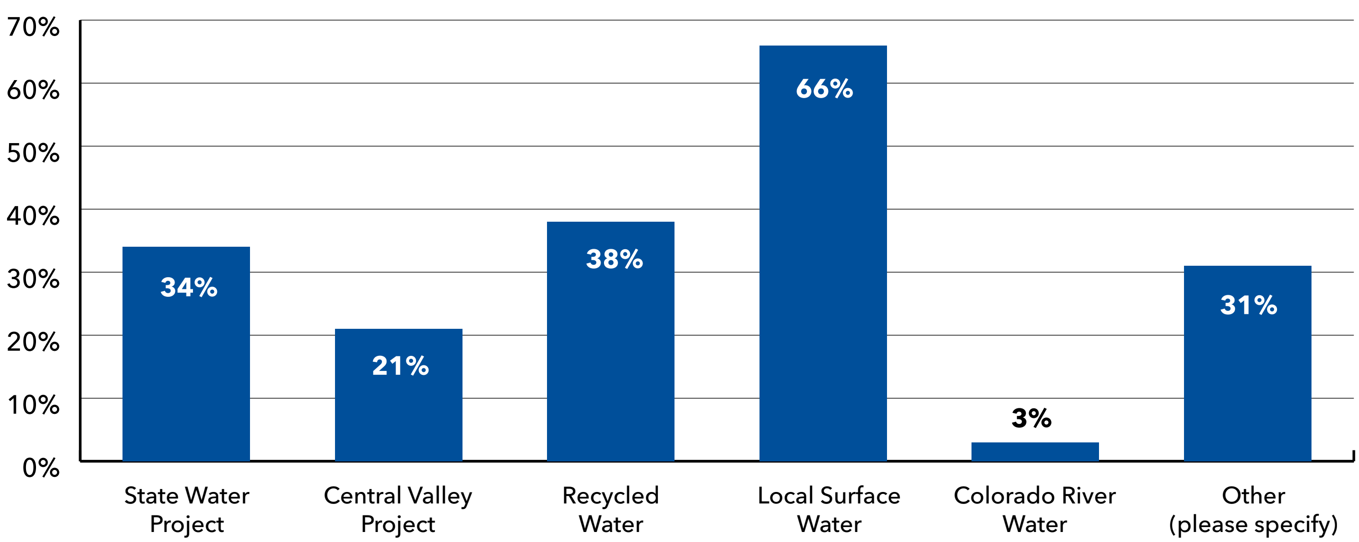
Survey participants were asked to identify all types of active or planning conjunctive management or groundwater recharge projects and programs that they are pursuing. The two most commonly identified methods of conjunctive use or recharge were spreading basins/percolating ponds (72%) and in-lieu recharge (62%). Some of the other types of projects/programs included green streets, water conservation programs, and enhanced in-channel recharge. It should be noted that survey participants could select more than one type of project or program.

Figure 2: Types of active or planned conjunctive management or groundwater recharge projects/programs



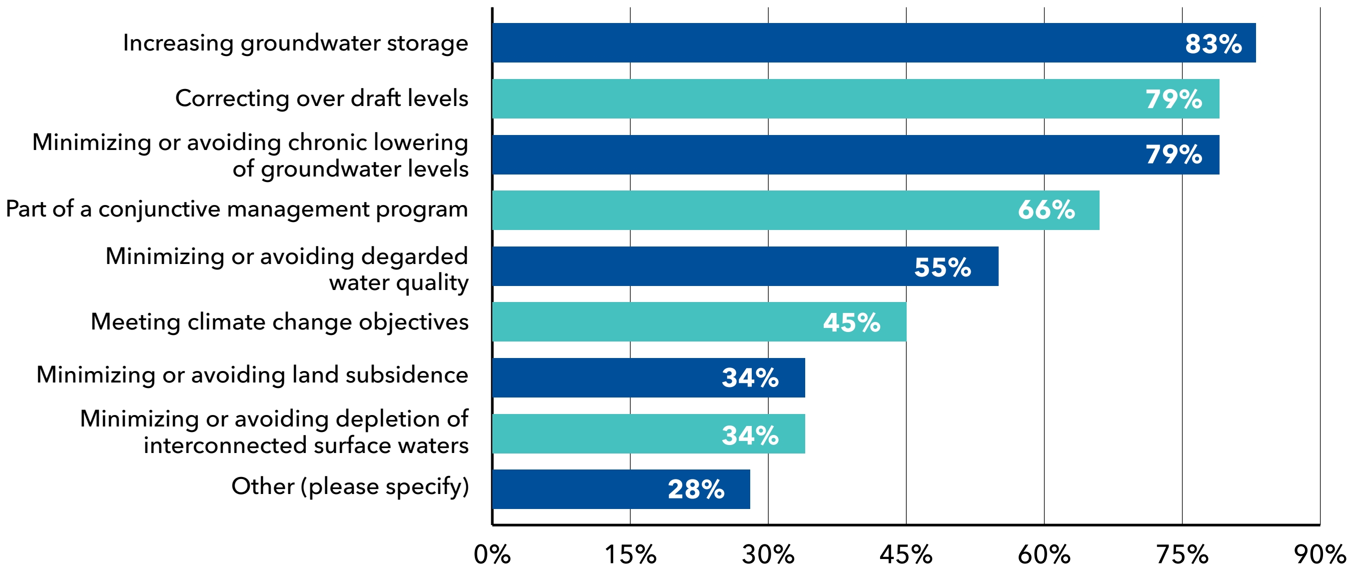
Survey respondents provided the identified source water for use in their active or planned active conjunctive management or groundwater management projects/programs. Local surface water (66%) was the most common identified, followed by recycled water (38%) and then State Water Project water (34%). When other was identified, it included Excess Los Angeles Aqueduct water, water from water transfers, stormwater, and flood flows. It should be noted that survey participants could select more than one source water.

Figure 3: Source water identified for active or planned conjunctive management or groundwater recharge projects/programs



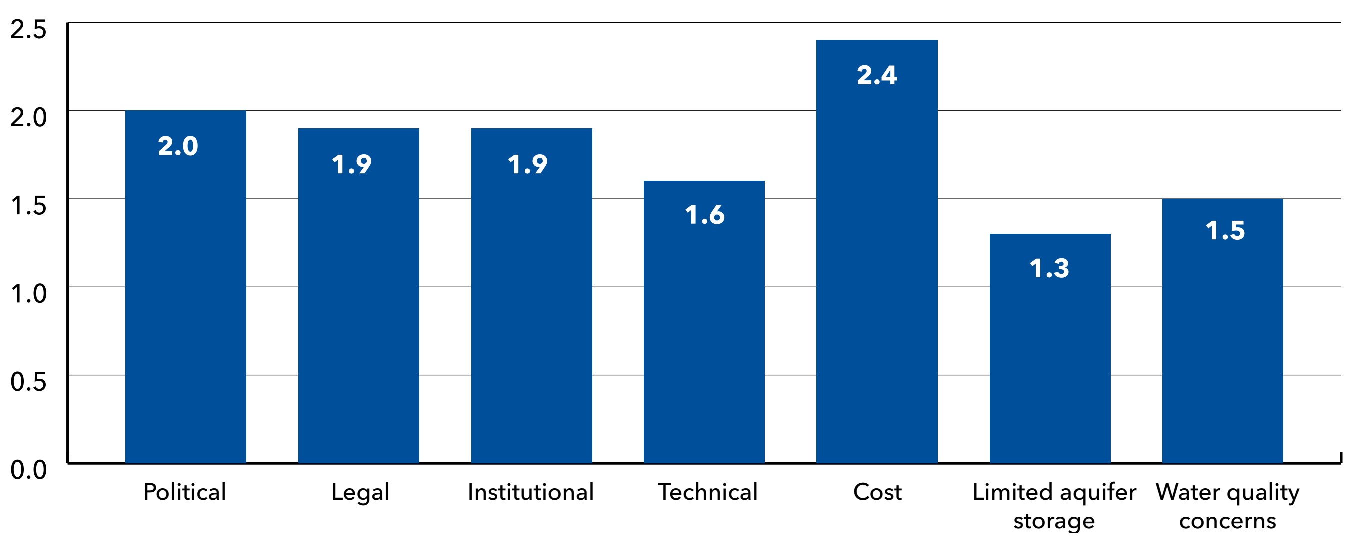
Based on the survey results, survey participants identified the top three goals and objectives of their active or planned conjunctive management or groundwater recharge projects/programs including increasing groundwater storage (83%), correcting overdraft conditions (79%) and minimizing or avoiding chronic lowering of groundwater levels (79%). The survey participants that identified other goals and objectives specified integrated water resource management between local agriculture and Tribal communities, increasing summer flows for fish habitat, drought-proofing the region, and preserving agriculture. It should be noted that survey respondents could select multiple goals and objectives for their projects/programs.

Figure 4: Reported goals and objectives of active or planned conjunctive management or groundwater recharge projects/programs



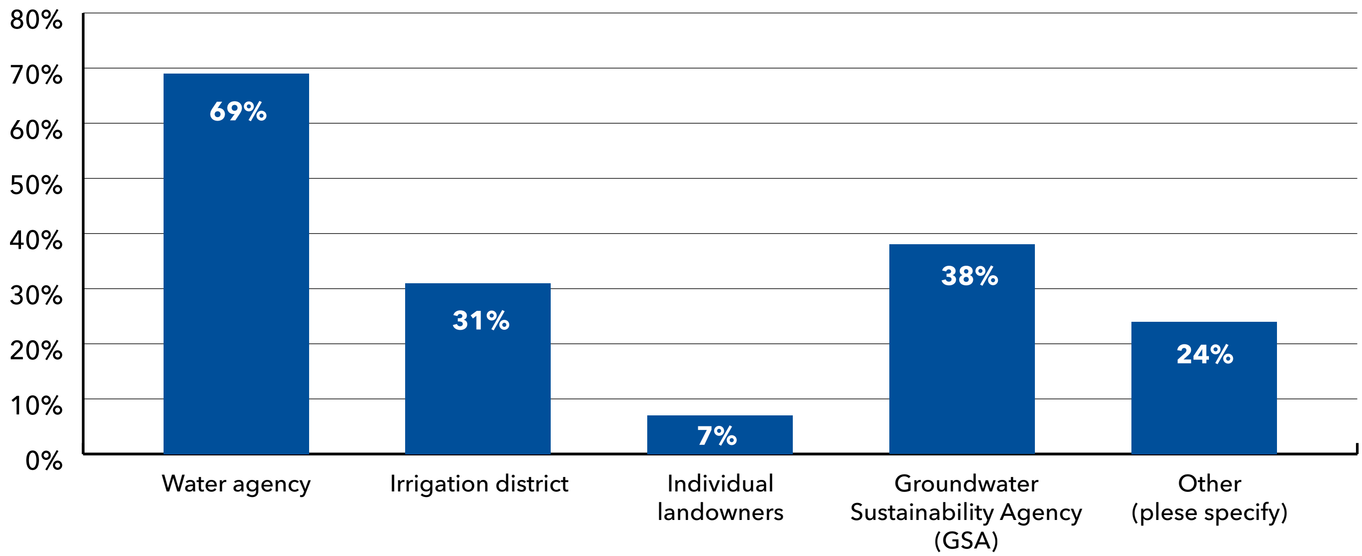
Survey participants were asked to rank all of the applicable constraints to develop conjunctive management or groundwater recharge projects/programs. Rankings were labeled as minimal constraint, moderate constraint or significant constraint. A weighted average was used to calculate the rankings below, which show cost and political as the top two reported constraints. Survey participants could list other constraints, and many reported environmental permitting or environmental approvals.

Figure 5: Reported constraints to develop conjunctive management or groundwater recharge projects/programs



Based on the survey results, most administrators/operators of these types of projects/programs are water agencies, groundwater sustainability agencies (GSAs), and irrigation districts. When asked if there are other entities, respondents shared they have a committee of pumpers, Tribes, cooperative council of water producers, watermaster, and cities.

Figure 6: Entity who administers the active conjunctive management or groundwater recharge projects/ programs



Cost

When survey participants were asked what the capital costs are to develop a conjunctive management or groundwater recharge project/program, many responded that it varies greatly by project type. Capital costs shared by respondents ranged from as little as $100,000 to multi-million dollar estimates based on the type of conjunctive use project, such as infrastructure, conjunctive use operations, stormwater capture, or advanced treatment facilities. Some survey respondents shared they have spent $142 million in capital costs for construction of recharge facilities since 1988.

Similarly, when looking at annual operating costs of conjunctive management or groundwater recharge projects/programs, survey respondents shared that it varies greatly by project type. Survey respondents provided a wide range between $15,000 to $25 million per year.

Capacity

When survey participants were asked the approximate capacity in acre-feet per year (afy) of their active or planned conjunctive management or groundwater recharge projects/programs, a wide range was provided. The smallest approximation was 3,000 afy and the largest was 500,00 afy. The total capacity from the survey respondents in active or planned conjunctive use or groundwater recharge projects or programs was approximately 2.1 mafy.

Connection to SGMA

Survey participants responded that the active and planned conjunctive use and groundwater recharge projects/ programs were incorporated or being developed as projects, management actions, and implementation activities in the groundwater sustainability plans under SGMA. Several respondents acknowledged that they are managing groundwater pursuant to an adjudication.

Identified locations of active or planned conjunctive management or groundwater recharge projects/programs

Ames Valley Groundwater Basin

Antelope Valley Groundwater Basin

Beaumont Basin

Central Basin

Chowchilla Basin

Delta-Mendota Basin

East Bay Plain Groundwater Basin

East San Joaquin Groundwater Basin

Indians Wells Valley Groundwater Basin

Joshua Tree Groundwater Basin

Kaweah Subbasin

Kern County Basin

Kings Basin

Livermore Valley Groundwater Basin

Lower Mojave River Valley Groundwater Basin

Lucerne Valley Groundwater Basin

Madera Basin

Madera Subbasin

Main San Gabriel Basin

Middle Mojave River Valley Groundwater Basin

Modesto Subbasin

Niles Cone Subbasin

Orange County Groundwater Basin

Owens Valley Basin

Pajaro Valley Groundwater Basin

Pleasant Valley Basin

Raymond Basin

Sacramento Region's North Basin

San Bernardino Bunkerhill Basin

San Fernando Valley Groundwater Basin

Santa Cruz Mid-County Groundwater Basin

Santa Margarita Groundwater Basin

Tulare Basin

Turlock Subbasin

Upper Mojave River Valley Groundwater Basin

Upper San Luis Rey Groundwater Basin

Warren Valley Groundwater Basin

West Coast Basin

Westside Subbasin

ACWA'S GROUNDWATER REPLENISHMENT INITIATIVE TASK FORCE

Chair: Eric Averett, General Manager, Rosedale Rio Bravo Water Storage District

ACWA Staff Liaisons: Melissa Sparks-Kranz, Regulatory Advocate
Dave Bolland, Director of State Regulatory Relations

Task Force Members: Brent Hastey, ACWA President, Ex Officio Member

San Joaquin Valley

Chad Wegley, General Manager of Alta Irrigation District
Steven Collup, General Manager of Arvin Edison Water Storage District
Jeevan Muhar, Engineer-Manager of Arvin Edison Water Storage District
Chris White, General Manager of Central California Irrigation District
Alan Hofmann, General Manager, Fresno Metropolitan Flood Control District
Jason Phillips, General Manager, Friant Water Authority
Palmer McCoy, Executive Assistant at Henry Miller Reclamation District #2131
Curtis Creel, General Manager, Kern County Water Agency
Jon Parker, General Manager, Kern Water Bank
Paul Peschel, General Manager, Kings River Conservation District
Dan Vink, General Manager of Lower Tule River Irrigation District
Thomas Greci, General Manager of Madera Irrigation District
Matt Hurley, General Manager at McMullin Area Groundwater Sustainability Agency
John Sweigard, General Manager, Merced Irrigation District
Paul Hendrix, Manager, Mid-Kaweah Groundwater Sustainability Agency
Jake Wenger, former Board Member, Modesto Irrigation District
John Davids, Assistant General Manager of Water Operations, Modesto Irrigation District
Dave Orth, General Manager, North Friant Authority
Richard Diamond, General Manager, North Kern Water Storage District
Steve Chedister, Executive Director of San Joaquin River Exchange Contractors
Jason Peltier, former General Manager, San Luis & Delta-Mendota Water Authority
Jason Gianquinto, General Manager, Semitropic Water Storage District
Tou Her, Assistant General Manager of Turlock Irrigation District
Bill Taube, Consultant, Wheeler-Ridge-Maricopa Water Storage District
Melissa Poole, Wonderful Company

Sacramento Valley

Thad Bettner, General Manager, Glenn-Colusa Irrigation District
David Guy, President, Northern California Water Association
Lewis Bair, General Manager, Reclamation District 108
John Woodling, former General Manager, Executive Director, Sacramento Groundwater Authority
Greg Zlotnick, Water Resources Manager, San Juan Water District
Jim Watson, Executive Director, Sites Joint Power Authority

Southern California

Peter Kavounas, General Manager, Chino Basin Watermaster
Jim Barrett, General Manager, Coachella Valley Water District
David Pettijohn, Manager Water Resources Development, Los Angeles Department of Water and Power
Roger Patterson, Assistant General Manager, Metropolitan Water District of Southern California
Mike Markus, General Manager, Orange County Water District
Shane Chapman, General Manager, Upper San Gabriel Valley Municipal Water District
Robb Whitaker, General Manager, Water Replenishment District of Southern California

ACWA is a non-profit statewide association of public water agencies whose 450+ members are responsible for about 90% of the water deliveries in California.

ACWA
Association of California Water Agencies

www.acwa.com