Department of Water Resources

# Water Available for Replenishment

White Paper

4/1/2016

Public Draft

## Contents

## Boxes





Public Draft

# 1. Introduction, Purpose, and Summary

In 2014, California passed three legislative bills (Senate Bill [SB] 1168, Assembly Bill [AB] 1739, and AB1319) that provide a framework for statewide sustainable groundwater management. This legislation is referred to as the Sustainable Groundwater Management Act (SGMA), and is consistent with California's preferred bottom-up approach to providing local water managers the tools and authority they need to implement sustainable management practices through the creation of Groundwater Sustainability Agencies (GSAs). As part of the SGMA legislation, California Water Code (WC) 10729§(c) instructs:

> "The department shall prepare and publish a report by December 31, 2016, on its Internet Web site that presents the department's best estimate, based on available information, of water available for replenishment of groundwater in the state."

In addition, the legislation requires that GSAs with high- and medium- priority basins prepare a groundwater sustainability plan (GSP) that includes (among other things):

> "A description of surface water supply used or available for use for groundwater recharge or in-lieu use (California Water Code 10727.2§(d)(5))."

These two legislative requirements provide direction for a planning process associated with water available for replenishment. The California Department of Water Resources' (DWR's) initial estimates of water available will provide a starting point for GSAs as they consider potential projects that can make use of available water in their respective regions. As GSAs move on to project planning and potential implementation, project-specific water available analyses associated with water available for replenishment will be required. As part of its report, DWR will also provide general guidance for developing water available methods and replenishment methods that can be used by GSAs as their planning progresses.

The purpose of this white paper is to present DWR's initial response to "water available for replenishment" requirements from SGMA legislation, provide background information needed to support these requirements, and include the next steps for completing the necessary analysis that will be presented in the final report.

This white paper first defines and describes "water available for replenishment" by separating the concept into two constituent parts (Section 2): (1) water available, and (2) for replenishment of groundwater. An implementing entity (such as a GSA) would likely need to develop a project in two parts — first, to identify the timing and amount of water available, and second, to determine the location and logistics for groundwater replenishment. Consequently, two water resources planning processes and analytical approaches are identified: (1) planning and quantifying water available from various water available methods, and (2) planning and analyzing the replenishment response of a groundwater basin. Within this two-part approach, current technical, legal, and institutional challenges and future uncertainties associated with calculation of water available for replenishment statewide are described. Recognizing these challenges and uncertainties (Section 3), DWR aims to integrate the technical assistance described in the SGMA legislation with useful information the GSAs could use in development of their GSPs, while outlining potential opportunities that would support water available for replenishment in the state (Section

4). Finally, this white paper presents the next steps for completing the “Water Available for Replenishment” (WAFR) report, due December 31, 2016 (Section 5).

The information in the WAFR report will provide water availability estimates from different water available methods: surface water (including stormwater), water conservation, recycled water, desalination, water transfers, and others. The report will also identify sources of information and roadmaps to plan for and implement groundwater replenishment projects. This technical guidance will include water availability analysis for the different water available methods and analysis of potential groundwater replenishment methods.

A flowchart is shown in Appendix A that describes DWR’s overall procedure to develop the WAFR report based on “water available for replenishment of groundwater” definitions, and input from stakeholders and the SGMA Practitioners Advisory Panel. The stakeholder outreach and outcomes (Section 4), and the definitions (Section 2) contributed to the WAFR report outline are presented in Appendix B and provide the foundation for the WAFR report.

# 2. Description: “Water Available for Replenishment of Groundwater”

As introduced above, the notion of *“*Water Available for Replenishment of Groundwater*”* includes two parts. The first part, “Water Available*,”* represents a quantity of water that could be developed by one of the water available methods and matched to specific groundwater replenishment projects. The second term, “for Replenishment of Groundwater*,*” designates the physical process of the augmentation of a groundwater basin, by natural or artificial means. This section defines and discusses both parts of water resources planning associated with water available for replenishment of groundwater.

## a. “Water Available”

### i. Overview

Water available methods are water management techniques or strategies, including surface water, water conservation, recycled water, desalination, and water transfers, that can either increase water supply directly or reduce demand from an existing water supply source. DWR recognizes the interest in specific additional water management strategies, such as urban stormwater management and precipitation enhancement. For purposes of the WAFR report, a discussion about urban stormwater management will be included with surface water. Other management strategies will be described more generally. As noted in California Water Plan Update 2013 (Update 2013), these strategies have limited capacity to strategically address long-term regional planning needs.

Developing available water can be challenging. Societal factors influence the development of laws, regulations, and environmental needs, as well as multiple facets of water demand and usage; however, technical factors are related specifically to the technological capacity to generate, convey, and store water. Timing and location are additional key factors when evaluating water availability. Water that is developed by a water available method can be used for any potential use, including more traditional agricultural, urban, and environmental uses. Now, SGMA has highlighted the potential use of available water for the purpose of replenishing groundwater basins and supporting sustainable groundwater management.

### ii. Terminology

Historically, DWR has not used the term, “water available,” except as related to water rights. The State Water Resources Control Board (SWRCB) requires a “Water Availability Analysis” for all water right applications to divert water from a source and put to beneficial use, as described in the State’s water right law. Pertinent provisions of the Water Code, related to water availability analysis, are summarized as follows:

- Every water right application submitted to the SWRCB must include "sufficient information to demonstrate a reasonable likelihood that unappropriated water is available for appropriation" (WC 1260§(k)).
- "...In determining the amount of water availability for appropriation, the SWRCB shall take into account; whenever it is in the public interest, the amounts of water needed to remain in the source for protection of beneficial uses..." Instream beneficial uses include, but are not limited to, recreation and the preservation of fish and wildlife habitat (WC 1243§).
- Before the SWRCB can grant a water right permit, it must find that there is unappropriated water available to supply the applicant (California Water Code 1375§(d)).

More information related to *“*Water Availability Analysis*”* can be found on the SWRCB website: http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_availability/.

For pragmatic purposes, DWR’s use of the term "water available" is a variant of the SWRCB use of the term. This is especially relevant in the case of surface water, but water available also has application for the other methods in the WAFR report. The term will be used by DWR for the WAFR report to support development of a water available planning estimate, consistent with the SGMA legislation, that will consider a limited number of factors that are included in a water availability analysis (as used by SWRCB). For example, while DWR will include existing water uses and instream requirements, the planning estimate will not include an assessment of the new need and requirement for instream flow that may be associated with a diversion project applicant. Since the planning estimate is not related to a specific project, DWR will not include several factors that are essential components, such as a new instream requirement, of the SWRCB’s water availability analysis.

A broader definition of “Water Availability” is provided by the U.S. Geological Survey (USGS):

> “Water availability traditionally has meant securing a volume of water to meet a current and projected demand on the basis of existing and projected usage (U.S. Geological Survey, 2005).”

This definition supports both the regulatory perspective of the SWRCB (considering existing water demand or water rights and environmental needs) and DWR’s planning considerations, including uncertain future conditions, such as hydrologic variability, climate change, and population growth. This definition also does not limit itself to surplus surface water and suggests potential support of sustainable water management, a key element of SGMA and the California Water Action Plan.

A core message of Update 2013 is “a diverse portfolio approach is required.” DWR will incorporate the diverse portfolio approach here by considering a range of water management actions that can effectively make water available for use. For this effort, DWR will use the term “water available methods” to describe a portfolio of potential actions that could support replenishment of groundwater basins.

### iii. Potential Water Available Methods

DWR recognizes several potential water available methods: surface water, conserved water (to the extent it frees up new supply by reducing demand), recycling water, desalination, water transfers, and several other methods. All of these methods can contribute to water available for replenishment.

#### *1. Surface Water*

*Surface water* describes water in streams, rivers, channels, lakes, and reservoirs. Surface water is often subject to quantity and quality regulations or requirements which may affect water availability. For example, a river can be designated fully appropriated as a result of water right law, considering hydrology uses, instream flow requirements, and water quality standards. This reduces the amount of available surface water along the course of the river. Nonetheless, there is still surface water available for appropriation in the state, though the location and timing of water availability varies. Surface water is generally considered available during higher flow events, when streamflow exceeds existing water right allocations and provides some opportunity for additional beneficial use.

*Stormwater*, for purposes of this white paper and the Water Available for Replenishment report, is included with the surface water method. Stormwater is defined by the U.S. Environmental Protection Agency (EPA) as the runoff generated when precipitation from rain and snowmelt events flows over land or impervious surfaces without percolating into the ground. The SWRCB and the regional water boards are actively involved in initiatives to improve the management of stormwater as a resource. The regional water boards have noted that stormwater should be managed as a resource to maintain and restore infiltration/recharge and achieve multiple benefits, including water supply augmentation and groundwater recharge.

Large water supply projects like the State Water Project (SWP) and Central Valley Project (CVP) should be considered as sources of surface water. The CVP and SWP are the two largest water projects in California, providing essential infrastructure to store, divert, and deliver water supplies. Interestingly, some of the infrastructure for these projects was built specifically to address groundwater management challenges. For example, the Friant, Sacramento River, and San Felipe divisions of the CVP were constructed to provide surface water to areas with declining groundwater levels. Future project improvements like WaterFix and North-of-the-Delta Offstream Storage could provide additional available surface water.

#### *2. Water Conservation*

*Water conservation* is defined by the California Water Code as “the efficient management of water resources for beneficial uses, preventing waste, or accomplishing additional benefits with the same amount of water” (California Water Code 10817).

By definition, water conservation reduces water demand while providing the same level of service or beneficial use. Agricultural and urban water use efficiency and conservation are often provided through technological enhancements in delivery and application methods. The volume of water conserved can remain where it was generated, potentially making it available to serve additional water uses rather than developing new water supplies. Conservation may make water available in some cases; water rights are an important consideration for the potential of conserved water to become available. Conservation also has the potential of reducing groundwater extractions, although project-specific GSA analyses would need to look at all impacts to a groundwater basin water balance.

### *3. Recycled Water*

The California Water Code defined recycled water as "water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefor considered a valuable resource" (California Water Code 13050§(n)).

*Recycled water* is wastewater from homes, businesses, and industry that as a result of treatment, has been made reusable for various uses. The key for this source of water is the level of treatment that is appropriate for the intended end use. All wastewater must be treated to meet standards set by State and federal government agencies before being released into the environment. Generally, these standards are met with varying levels of treatment, up to and including advanced wastewater treatment, to the extent it is needed for the eventual uses. Recycled water will require the same level of treatment as any wastewater with a specific condition outlined in the California Code of Regulations, Title 22, in order to protect the public health. Similar to conservation, recycled water may make water available in some cases and water rights are an important consideration.

### *4. Desalinated Water*

Desalinated water can be developed from multiple sources including seawater (i.e., saline) and brackish water; in addition, saline and brackish water can both be found in surface and subsurface locations.

Oceans and connected bays, which are surface saline sources, have the potential to be a more significant source of new water in California, as per other seaside locations of the world. This water available method is unique because ocean water is effectively independent of the freshwater hydrologic cycle. Consequently, desalinated water is assumed to produce freshwater at a reliable rate, independent of runoff or existing water use. The Poseidon seawater desalination facility at Carlsbad in Southern California has recently been completed and illustrates the potential of desalinating water, with a design delivery capacity of 56,000 acre-feet per year.

Subsurface saline and brackish water sources are groundwater aquifers that are fully or partially saline. Currently, brackish groundwater located inland from the ocean is the most common source of water for desalination in California. The sources of salinity in the groundwater may be natural or caused by human activity.

Desalinated water is similar to recycled water in that the water is made available by treatment. Depending on the source (seawater and brackish), location (surface and subsurface), and use, the level of treatment for desalinated water will differ.

### *5. Water Transfers*

A *water transfer* can be a temporary or permanent sale of water or water rights by the water right holder, a lease of the right to use water from the water right holder, or a sale or lease of a contractual right to water supply. More generally, a water transfer is a change in place of use, purpose of use, and/or change in method of water diversion. Water transfers can also take the form of long-term contracts for the purpose of improving long-term supply reliability. Three types of water transfers are often employed:

- Stored water — Release of stored water that would remain in storage in the absence of the water transfer. Storage reduction caused by a transfer must be refilled at a time when downstream users would not have otherwise captured the water.

- Cropland idling/crop shifting — Reduction in surface water use resulting from reduced evapotranspiration of applied water to agricultural crops that would have been planted in the absence of the water transfer.
- Groundwater substitution — An entity's reduction in surface water use that is offset with additional groundwater pumping, allowing transfer of the surface water supply to another entity.

All water transfers involve moving water made available by the transfer from one location to another. Therefore, water available from transfers is dependent on the type of transfer and the availability of that water and conveyance from its source in its original location.

## b. "For Replenishment of Groundwater"

### i. Overview

Replenishment of groundwater, also referred to as *groundwater recharge*, is a naturally occurring part of the hydrologic cycle, whereby precipitation, runoff, and surface water flow infiltrate into the subsurface aquifer system. Although this type of recharge takes place naturally, it can also be induced through specific water management actions.

### ii. Definition

SGMA defines groundwater recharge as: "The augmentation of groundwater, by natural or artificial means." For purposes of the WAFR report, the term "for replenishment" has a similar intended meaning. Simply, if recharge has been managed successfully for a groundwater basin, then that basin has been replenished.

In Update 2013, three methods of recharge are outlined: direct spreading, injection, and in-lieu recharge. Of the three methods, this white paper defines direct spreading and injection as active recharge methods, while in-lieu recharge is considered an indirect method.

### iii. Methods of Groundwater Replenishment

Groundwater replenishment depends on many physical, legal, and institutional factors. These factors are related to water use, recharge rate, the land area available for recharge, the surface soil characteristics, hydrogeological and geochemical properties, the availability of water for recharge, water rights, and the infrastructural ability to distribute water to users or into the aquifer system.

As noted, two methods are often used to replenish groundwater: (1) active recharge, and (2) in-lieu recharge. The following methods employ facilities or management actions that enable replenishment of groundwater in excess of what would happen naturally.

#### *1. Active Recharge*

*Active recharge* includes direct spreading recharge and aquifer injection.

*Direct spreading* is accomplished by ponding water in percolation basins where it infiltrates downward into unconfined aquifers. Direct spreading in areas with highly permeable geologic materials can result in a rapid, efficient, and economical way to recharge the aquifer. This recharge method usually requires large dedicated land areas. A current study by the University of California, Davis, suggests that flooding agricultural land during fallow or dormant periods has the potential to increase groundwater recharge substantially. The study shows the potential to increase groundwater levels using some of California's 3.6 million acres of farmland with suitable topography and soil conditions to recharge aquifers during winter months without disrupting agricultural production.

*Aquifer injection* is another active recharge technique. Water is injected into confined aquifers using aquifer storage and recovery wells, which allow for injection and extraction of water. Aquifer injection has the advantage of working in many geologic conditions and in relatively small areas where direct spreading recharge is less suitable; however, this technique is prone to clogging, and some degree of maintenance is needed to sustain well injection performance. A combination of a build-up of materials, brought in by the recharging water, and chemical changes, brought about by the recharging water, is the primary cause of clogging. Aquifer injection has a higher energy requirement as a result of maintaining adequate water pressure for injection.

#### *2. In-Lieu Recharge*

In some areas, recharge may be accomplished by providing an alternative source to users who would normally use groundwater, thereby leaving groundwater in place and therefore increasing the potential to improve the groundwater levels or for later use. This indirect method of managed recharge is known as *in-lieu recharge*. Unlike direct recharge, in-lieu recharge can be implemented under virtually any soil and geologic conditions. Some agencies also consider programs that reduce demands on groundwater via water conservation or water recycling as in-lieu recharge because these programs have the same effect in restoring groundwater levels as the provision of surface water.

# 3. Challenges and Uncertainties

The descriptions and definitions of "water available" and "replenishment of groundwater" provide a foundation for analysis and potential implementation of projects. The next step is to develop a clear understanding of the complex issues associated with performing estimates of water available for replenishment of groundwater statewide. For example, water available methods and methods to replenish groundwater need to be considered with spatial, temporal, and physical mechanisms which allow interconnectivity between water available and groundwater basins. Complex challenges and uncertainties can potentially affect the accuracy of estimates of water available for replenishment.

This chapter describes the current challenges and future uncertainties associated with estimates of water available for replenishment of groundwater as well as potential implementation of projects. The current challenges include the spatial and temporal extent; data availability; water quality; operation and infrastructure capacity; institutional, regulatory, and financial issues; and environmental concerns. There are also uncertainties about how these factors will change in the future with the impacts of climate change, population growth, and land use changes.

## a. Current Challenges

### i. Spatial and Temporal Connectivity

When evaluating or implementing groundwater recharge projects, the spatial and temporal extent of interconnectivity between potential water available methods and groundwater are important considerations. Incomplete understanding can lead to an inaccurate assessment of either water available from a particular method or the potential response of a groundwater basin to replenishment actions.

In California, as in other states, water management practices and the water rights system treat surface water and groundwater under separate doctrines. Groundwater and surface waterbodies are connected physically in the hydrologic cycle and interact with each other. At some locations or at certain times of the year, groundwater will be recharged through infiltration from the streambed. At other locations or at other times, groundwater may discharge to the stream, contributing to its base flow.

The areal and subsurface profiles associated with the transport over time of a water available method to and into a groundwater basin or between basins are also important factors, when considering the spatial and temporal extent of a study.

### ii. Data Availability

Lack of data is a significant barrier to quantifying water availability and its potential use for groundwater replenishment.

DWR, USGS, National Oceanic Atmospheric Administration (NOAA) and other federal, State, and local entities collect a significant amount of water resources information. Nevertheless, in some locations climatic and hydrologic data are often either not collected, or data collection is inadequate for meaningful analysis. For example, some streams are not gauged, leading to considerable uncertainties in the results, especially when evaluating extreme events like droughts and floods. Sufficient groundwater data exists for some, but not all basins. The lack of data may lead to uncertainties about the connection between surface water and groundwater.

General information about recycled water, desalinated water, and water conservation are available for many areas. Data associated with water conservation and recycled water methods are often coarse estimates. These estimates often differ from the actual usage. As technology or monitoring improves, the accuracy of water estimates from these methods can increase.

Accurate information on water demands is also required for quantifying water availability. Update 2013 separates water use into urban (municipal, commercial, and industrial), agricultural, and environmental sectors. Water demand can be difficult to quantify since it can be dependent on climatic and hydrologic conditions at a specific location under specific conditions. Agricultural water demand depends on land use (crop type), soil moisture, precipitation, temperature, water delivery and application methods, and other factors.

Water rights are one of the principal pieces of information required when evaluating water availability, even though water rights, diversions, and return flows are often challenging to quantify. This is a result of three factors related to the occurrence of multiple types of water rights and the associated complexities among the management and regulatory authorities:

### iii. Water Quality

Depending on the water available method and the intended use of the water, water developed for replenishment will be subject to specific water quality standards, which may limit its use. For example, the SWRCB requires that all recycled water used for groundwater recharge projects or public use must be reviewed and permitted on a site-specific basis following CDPH's water quality standard and have the same level of treatment as any wastewater treatment.

For aquifer injection, water treatment is again very important. The water for injection must be free of turbidity, organic material, bacteria, and viruses, and the water chemistry of the injected water must be compatible with the water quality in the aquifer system. Concerns with water quality, clogging of well screens, or clogging of the pore space within the aquifer system surrounding the injection well may also present challenges.

### iv. Operations and Infrastructure Capacity

Operations and the capacities of the system facilities are important as well. For example, conveyance of water to a defined site will have specific physical characteristics; operations may limit water available to a specific site and period of time during the year.

In federal, State, and local reservoirs, conveyance and pumps are essential to store and convey water to either direct groundwater recharge or to existing groundwater users for in-lieu recharge. For example, the SWP and CVP employ a system of reservoirs, conveyance, and pumps to deliver water from the Bay-Delta watershed to local and regional users in the Central Valley, the Bay Area, Central Coast, and Southern California. These systems require complex operations that must be coordinated with local users, ecosystem, flood, and power requirements, as well as each of the water contractors. Facilities and requirements (both operational and regulatory) limit capacity throughout the year.

Additionally, for groundwater recharge, capacity constraints can limit the conveyance of water near a groundwater recharge location, during the application of a water available method on the ground, and the aquifer's capacity to store the water. For example, replenishment can be challenging to achieve in an area where water available methods are not readily feasible or if new water technologies and facilities must be constructed to provide surface water into areas that have historically relied upon groundwater.

### v. Institutional and Regulatory

As previously noted, institutional and regulatory issues can be challenging. Water infrastructure in California is owned and operated by a wide range of federal, State, and local agencies, as well as several private companies, including hydropower companies. These facilities are subject to numerous regulations. Flexibility of the system has been reduced over the years as a result of the increasing institutional and regulatory complexity of water management in California. For instance, recent legal decisions and endangered species protection have narrowed the time window of Sacramento-San Joaquin Delta (Delta) pumping operations. Deliveries from the SWP and CVP have become increasingly less reliable because of the recent drought and deterioration of environmental conditions in the Delta, leading to more stringent water quality and environmental requirements. The increasing uncertainties associated with surface water supplies from the SWP and CVP consequently increases uncertainties for local water users as their total portfolio water supply reliability is diminished. In many places, less reliable surface water has led to an increase in the use of other water supplies, including groundwater.

### vi. Environmental

Environmental concerns related to groundwater replenishment include potential impacts on habitat, water quality, and wildlife caused by shifting or increasing patterns of groundwater and surface water use. For example, floodwaters can serve as an important ecosystem function. Removing or reducing flood flows may cause undesirable ecosystem effects. A key challenge is to balance beneficial uses, including the instream flow and other environmental needs, with water available for groundwater replenishment.

There may also be environmental impacts from construction and operation of groundwater recharge basins and new conveyance facilities. Conversely, reconnecting groundwater to streams (or maintaining such connections over the long term) could have significant environmental benefits, and groundwater recharge facilities in some locations may provide important habitat for a variety of wildlife. Consequently, it will be imperative to address short-term and long-term impacts and benefits to the environment, which might best be done in collaboration with environmental resource agencies.

#### vii. Financial

Financial feasibility plays an important role in determining how to effectively manage water resources today and in the future. Although State funds might provide some support, local entities must have sufficient authority and flexibility to raise the funds needed to carry out sustainable water management. Water managers must consider costs for the construction of facilities, environmental mitigation, and operation and maintenance.

### b. Uncertainties about Future Conditions

Changing institutional and regulatory constraints, uncertainties about the performance of proposed or existing infrastructure, climate change, population growth, and land use changes can affect water available for groundwater replenishment. Identifying and quantifying these uncertainties is important for long-term sustainable water management in California, especially in the context of adaptation to future changes for these factors. Management of uncertainties may be especially challenging for water managers and decision-makers as they seek to implement water resources solutions.

#### i. Climate Change

Climate change is already altering the water cycle, with increases in extreme events and shifts in seasonal patterns, requiring adaptable solutions from water managers. These changes are expected to continue in the future, and more of our precipitation will likely fall as rain instead of snow.

DWR provides climate change guidance (see http://www.water.ca.gov/climatechange/) for water resources planning, which includes global climate model selection, scenario development for extreme event analysis, and climate data downscaling. The timing and magnitude of a wide range of potential climate change effects may lead to different conclusions and decision-making, which necessitates the need to consider the impact of climate change in water availability estimates.

#### ii. Population and Land Use Change

Future water demand will be affected by a number of factors, including land use changes and population growth. Land use changes include agricultural practices and management (e.g., planting decisions by farmers), and size and type of urban landscapes. For example, when estimating future urban water demands, water managers need to account for future population growth. In this case, water managers will not only need to plan for when changes occur, but also for the level of uncertainty in population changes and development density. Population and development density will also influence the encroachment into agricultural lands.

### iii. Infrastructure

Proposed infrastructure improvements may increase system flexibility with better conveyance, storage, or management of water. These changes could have either positive or negative effects to water availability for groundwater replenishment for specific locations and times. Therefore, a fuller understanding of potential infrastructure implementation and its effects is essential.

In November, 2014, California voters passed Proposition 1, the Water Quality, Supply, and Infrastructure Improvement Act of 2014, a $7.5 billion water bond that will make investments in California's water infrastructure and management systems. The bond dedicated investments in multiple projects and plans that range from storage and water recycling projects to groundwater management planning. The distribution of the bond has already started for some local projects, but for others, regulations and guidelines are still in development. We will not know the benefits from many of the projects funded under Proposition 1 for several years.

### iv. Institutional and Regulatory

Institutional and regulatory challenges have evolved and will continue to change over time. Water managers need to consider how endangered species may be affected with a changing climate. SGMA may require water managers to reduce reliance on groundwater in areas experiencing overdraft. Relying more on other water available methods may further stress water supply reliability, water quality standards, and water right holders.

# 4. Water Availability for Groundwater Replenishment in Sustainable Groundwater Management Planning

This section describes how the WAFR report, including "DWR's best estimate of water available for replenishment of groundwater in the state" and roadmap guidelines, will support GSA planning, decision-making, and assist in ultimately achieving sustainable groundwater management. The section first lays out the legislative requirements of GSAs and the State, including a timeline for completion of SGMA actions. Also included is a discussion of selected comments received during stakeholder outreach, including those from potential GSA constituencies. Finally, the section describes the WAFR report and its intended usefulness to GSAs and relationship with the Water Action Plan.

## a. Legislative Requirements and Timeline

SGMA requires that DWR provide "a best estimate of water available for replenishment of groundwater in the state" by December 31, 2016 (California Water Code 10729§(c)). In addition, SGMA includes additional requirements with specific timelines. DWR, SWRCB, and GSAs have been given lead responsibility in specific actions to meet SGMA requirements. Appendix C presents major actions and a timeline, and identifies the responsible entity for SGMA.

The GSPs submitted by GSA(s) will include, if applicable, a description of the surface water supply used or available for use for groundwater recharge or in-lieu use (California Water Code 10727.2§ (d) (5)). This GSA requirement to determine water available for replenishment will be the basis for the contents of the second half of the WAFR report. The roadmaps developed in the WAFR report will provide guidance for GSAs in water available and for replenishment planning. These roadmaps will specifically include guidance in evaluating "Water Available" and "For Replenishment" to support selection and implementation of projects that support groundwater sustainability. GSAs will develop GSPs that include WAFR analysis by December 31, 2020, for critically overdrafted basins and two years later for all remaining high- and medium-priority groundwater basins.

### b. Stakeholder Outreach and Outcomes

The SGMA Program has been conceived to maximize the effectiveness of GSAs, in part by developing an extensive outreach program. Robust communication with stakeholders and interests has been a hallmark of SGMA. Since early 2015, DWR conducted outreach with stakeholders, including the Sustainable Groundwater Management Practitioner Advisory Panel, to receive early input on a number of SGMA issues to help guide DWR's activities and resources. Outreach indicated that water managers and experts understand the complexity of the systems, current challenges, and future uncertainties that water resources managers in California will encounter as we invest in groundwater sustainability. Among many items of interest, outreach indicated concern related to water available for replenishment specifically. DWR met with or invited SGM Advisory Groups specifically on water available for replenishment, including the Practitioner Advisory Panel, the Tribal Advisory Group, non-governmental organizations, and the Association of California Water Agencies.

There appears to be an understanding that management of water available for replenishment includes challenges such as institutional issues, regulations, and infrastructure limitations. These issues and limitations require that GSAs and the State realistically develop additional replenishment solutions. Stakeholders noted that the report should describe:

- The geographic scope of the estimates as well as characterize the quality of data and information.
- Additional water potentially available with existing infrastructure and institutional/operational restrictions.
- Challenges and uncertainties as previously noted, including those associated with climate change, land use, and regulatory changes.
- Opportunities and threats that may be associated with future statewide and local projects, and potentially changing regulations.

The WAFR report should promote future discussion among local, State, and federal agencies on how coordinated efforts can provide additional water for replenishment. In addition, the report should also be useful to the GSAs in implementing GSP solutions. Finally, several experts suggested the report should connect with the Governor's Water Action Plan to assure a sustainable environment and economy in California.

### c. Report Usefulness to GSAs

DWR's objective is twofold: (1) to estimate water available for groundwater replenishment, and (2) to make sure the information generated will be useful to GSAs as they pursue sustainability. As noted in the previous section, DWR's water available estimates will provide a starting point for GSAs as they consider water available method options as well as replenishment method options for their basins.

From there, GSAs will want to complete a planning process where project concepts and then alternatives to make water available for replenishment can be considered and compared to support potential implementation. SGMA's goal is that GSAs achieve groundwater sustainability. DWR's objective, in SGMA terms, is to support GSAs as they move through a planning process from big-picture water available estimates (i.e., "best estimate of water available") to project-level implementation analysis for both water available methods and for groundwater replenishment methods at the GSA level. Among other things, some GSAs will need to develop groundwater sustainability plans that include a description of surface water supply used or available for use for groundwater recharge or in-lieu use. Here, the GSAs are also required to calculate their own water availability at a local level for inclusion in their GSPs. DWR will not attempt to determine water availability at a local level since that is the responsibility of GSAs. Instead, DWR will estimate water availability at the hydrologic region and planning area level (as defined by Update 2013). Also, DWR will provide guidance in the form of roadmaps, that describe how planning can proceed for each water available method, as well as each replenishment method. The roadmaps will describe how to quantify water available as well as the potential effectiveness of replenishment.

### d. Water Action Plan and Sustainable Groundwater Management

The California Water Action Plan provides a planning framework for sustainable and successful water resources management in California. The strategies identified in the Water Action Plan will move California toward successful implementation of SGMA and more sustainable management of our groundwater resources. In this sense, this SGMA WAFR report effort should include important management considerations from the Water Action Plan. For example, diversifying regional water portfolios will relieve pressure on foundational supplies and make communities more resilient against drought, flood, population growth, and climate change.

**Box 1 The Governor's Water Action Plan Key Actions**

- Make conservation a California way of life.
- Increase regional self-reliance and integrated water management across all levels of government.
- Achieve the co-equal goals for the Delta.
- Protect and restore important ecosystems.
- Manage and prepare for dry periods.
- Expand water storage capacity and improve groundwater management.
- Provide safe water for all communities.
- Increase flood protection.
- Increase operational and regulatory efficiency.
- Identify sustainable and integrated financing opportunities.

## 5. Next Steps

Estimating and analyzing water available for replenishment of groundwater is a complex task that will require an ongoing commitment from DWR and GSAs to support sustainable groundwater management. DWR's approach to supporting sustainable groundwater, and specifically water available for replenishment, will include two major parts, both of which will be included in the WAFR report. First, DWR will provide planning estimates of water available for each of the state's ten hydrologic regions. For each region, DWR will provide an estimate for each of the five potential water available methods (surface water, water recycling, conservation, desalination, and water transfers) by making use of available data and information. Second, DWR will develop roadmaps or guidelines describing analytical approaches, highlighting the steps necessary in selecting and implementing projects that would provide water available for replenishment of groundwater for potential implementation.

As noted previously, project-level evaluation of water available for replenishment likely requires two analyses: "water available" and "for replenishment," which ultimately will need to be integrated for effective implementation. From the GSA's perspective, the WAFR report will first provide a starting point for water managers, including regional scale estimates of the amount of "water available" beyond existing developed water supplies for a portfolio of water available methods. These estimates will help GSAs begin a planning process by identifying potential water available methods within their region. In addition, the report will include clear roadmaps (i.e., guidelines) to support GSAs as they determine both "water available" and "for replenishment" projects that can be combined to achieve sustainability goals in their GSPs. This two-part planning support approach by DWR has been developed in coordination with SGMA advisory and stakeholder groups.

DWR is currently developing technical approaches to support the content described in the WAFR report annotated outline (Appendix B). The foundational work efforts are regional planning estimates of water available and roadmaps describing a recommended planning process for GSAs. First, DWR is developing an analytical approach to estimate water available for each of the water available methods, by planning area and by hydrologic region.

For surface water, DWR is proposing to use a modified water available analytical approach that will provide a simple planning estimate of available water for each region (as distinctive from a water available analysis as required for a water right permit). Rather than limit the water available to a quantity that could be made available by a project, DWR will estimate the entire quantity that is in excess of total water use, using current operations and regulatory requirements.

For conservation, recycled water, desalinated water, water transfers, and other water available methods, DWR will use available planning estimates of potential water available from Update 2013. These estimates are for potential projects in each of the method categories, and reflect amounts that local agencies estimate will be implemented in their service areas. However, like the surface water estimate, this quantity of water could be used for any number of purposes, of which groundwater replenishment is just one.

DWR is also developing roadmaps or guidelines for GSAs to use in their project planning processes. Roadmaps will be developed for each of the water available method types to determine and evaluate water available from a project. In addition, DWR will develop roadmaps or guidelines to determine and evaluate how much of the water available could support replenishment of a local groundwater basin. These roadmaps are intended to give GSAs the analytical tools, as well as the issues and challenges associated with implementing projects that (1) make water available, and (2) manage that water for the purpose of groundwater replenishment.

GSAs should now begin to think broadly about management options for achieving sustainability of groundwater resources. DWR urges leaders of GSAs to identify a potential portfolio of water available options that could be part of their sustainable future and to gather information that will support planning determinations of feasibility. In addition, water managers should explore methods for replenishing groundwater. Meanwhile, DWR will refine both their regional estimates of water available for all water available methods as well as the roadmaps for both water available and replenishment options.

Finally, DWR will continue to interact with stakeholders and GSA representatives as the WAFR report is in development. Ongoing communication with local, regional, and stakeholder interests will help make the WAFR efficient and effective in guiding WAFR planning in California.

## Appendix A: Water Available for Replenishment Flowchart

# Water Available for Replenishment

**Water Code Section 10729(c):** The department shall prepare and publish a report by December 31, 2016, on its Internet Web site that presents the department's best estimate, based on available information, of water available for replenishment of groundwater in the state.

### Outreach

Initial Outreach

- Include uncertainty; present range of estimates
- Recognize regional variation in capability
- Recognize value of surface storage and other strategies
- Link to Water Action Plan

Practitioner Advisory Panel

- Difficult for DWR to quantify Water Available For Replenishment that is meaningful to sub-basins
- Provide a general summary, like in the Water Plan Update
- Provide statewide analysis; data availability, gaps, and constraints; and describe future DWR efforts
- Provide solid framework and guidelines that GSAs can use
- Assist in planning, particularly related to statewide projects

Pros and Cons

- Capturing geographic scale
- Capture uncertain climate, land use, and regulatory changes
- Capturing range of existing and possible future water management strategies

*Considerations*

- What is desired level of geographic analysis and reporting?
- What are the important statewide and local water management options to consider?
- What are key climate, growth and regulatory uncertainties?
- How important is quantifying State/ Federal project operations?
- How should DWR work with stakeholders to develop the report?

### Definitions

#### "Water Available"

***Water availability traditionally has meant securing a volume of water to meet a current and projected demand on the basis of existing and projected usage. (USGS, 2005)****

*"Water available" is used extensively by SWRCB, as in, "Every water right application submitted to the SWRCB must include sufficient information to demonstrate a reasonable likelihood that unappropriated water is available for appropriation." (Water Code section 1260(k))***

**Source: Anderson and Woosley, 2005, Water availability for the Westren United States-- Key scientific challenges: U.S. Geological Circular 1261, 85 p.*
***http://www.waterboards.ca.gov/waterrights/water_issues/programs/water_availability/*

#### "For Replenishment"

***Replenishment may be accomplished using two potential methods: active recharge and in-lieu.***

*"Groundwater recharge" is defined by SGMA as, "the augmentation of groundwater, by natural or artificial means."*

*"Water budget" is defined by SGMA as, "an accounting of the total groundwater and surface water entering and leaving a basin including the changes in the amount of water stored."*

### Report Outline

**Chapter 1: Introduction and Purpose**
- Introduction: Conjunctive Water Management in California
- Overview of the Sustainable Groundwater Management Program
- How this report connects to SGMP
- Description of consistency with GSP regulations

**Chapter 2: How to Use this Report**
- Suggested planning process for GSA is presented to achieve replenishment objective
- Uncertainty in the estimates and information
- Description of remainder of the report

**Chapter 3: Description of Water Available for Replenishment**
- Potential water available methods
- Types of replenishment
- Guidance for hydrologic variability, climate change, and integrated planning

**Chapter 4: Water Available Information and Estimates by Hydrologic Region**
- Background Information associated with water availability
- Regional estimates of water available by methods
- Regional considerations for replenishment of water available

**Chapter 5: State Water Project and Central Valley Project**
- Description of the SWP and CVP in the context of water available
- Current water available at various location of the Central Valley
- Potential water available from WaterFix and new storage, including system reoperation

**Chapter 6: Roadmaps for Water Available by Methods**
Step by step water availability analysis roadmaps with project-specific examples for:
- Surface water
- Conservation
- Recycling
- Desalination
- Water transfers
- Others

**Chapter 7: Roadmaps for Replenishment by Methods**
Step by step replenishment analysis roadmaps with project-specific examples for:
- In-lieu
- Active Recharge

**Chapter 8: Next Steps**
- How GSAs can support their sustainability planning process with information from this report
- Data gaps, permitting and regulatory requirements, and uncertainties
- How to move from regional estimates to project-specific analysis to project implementation

# Appendix B: Water Available for Replenishment Report, Draft Outline (DWR December 2015)

California Water Code Section 10729(c): The department shall prepare and publish a report by December 31, 2016, on its Internet Web site that presents the department's best estimate, based on available information, of water available for replenishment of groundwater in the state.

## 1. Introduction and Purpose

*This chapter will begin with a history of conjunctive management in California, including a description of the roles of groundwater and surface water and other water available methods. Next, this chapter will give an introduction to the Sustainable Groundwater Management Program and the role of "water available for replenishment of groundwater" in sustainability planning. All topics (including hydrologic variability, climate change, etc.) will be presented consistent with how they will be handled in GSP regulations currently being developed by DWR.*

## 2. How to Use This Report

*This chapter will describe how to use the information included in the report, both quantitative and qualitative. This section will describe a suggested groundwater sustainability planning process that GSAs and water resources planners can use to identify, screen, select, and implement feasible strategies and alternatives for estimating water available for replenishment at the basin level. A flowchart of the suggested groundwater sustainability planning process will be included to help guide planning, from regional considerations and solutions to project-specific selection and implementation. This chapter will also describe uncertainty in report information and results, and distinguish specifically between the regional estimates and the project-specific examples. This chapter will conclude with a description of the remainder of the report that will include a description of water available for replenishment (Chapter 3), planning information and estimates of water available by hydrologic region (Chapter 4), and a discussion of water available associated with the State Water Project and Central Valley Project (Chapter 5). The report will also include roadmaps and project-specific examples of water available analysis by potential source type (Chapter 6), as well as roadmaps and project-specific examples of potential methods for replenishment of groundwater, showing how the replenishment method affects the analysis and results (Chapter 7). Finally, the report will include a next steps section (Chapter 8) that will describe how GSAs can apply the analytical techniques described in the project-specific examples section and the process for moving projects from planning concept to implementation.*

## 3. Descriptions of "Water Available for Replenishment"

- Water available for replenishment in two parts.
- Potential water available methods.
- Types of replenishment in the form of increased "managed recharge," as defined and discussed in Update 2013. Generally, replenishment can be accomplished by active recharge or in-lieu methods.
- Variability by hydrology, demand, conveyance, climate change, etc.

*This chapter will provide a statewide generalized overview of water available for replenishment, including an introduction to the potential water available methods that could be used to support groundwater sustainability. Potential water available methods considered will include all existing water available methods that are not fully being utilized, including but not limited to surface water, recycled water, conserved water, brackish or saline water, and transferred water — all in the context of increasing the amount of "managed recharge" for both direct and in-lieu components. This chapter will also describe how SGMA will compel water managers and GSAs to consider replenishment of groundwater as a water resources management objective in local, regional, tribal, State, and federal project investigations. This chapter will provide guidance in the form of recommended approaches for GSAs to assess and incorporate hydrologic variability and climate change vulnerability (including scenario planning) into their GSP development and implementation (as they may be supplemented by information in the following Chapter 4). Finally, the chapter will also describe factors contributing to uncertainty.*

## 4. Water Available: Information and Estimates, by Hydrologic Region

- Information Associated with Water Availability.
  - Water Supplies, reported by planning area.
  - Water Use, reported by planning area.
  - Service Areas.
  - Storage.
  - Conveyance.
  - Water Rights.
  - Hydrology.
  - Tools.
  - Uncertainties.
    - Institutional and Regulatory Constraints.
    - Climate Change.
  - Challenges, including data gaps by hydrologic region with recommendations for GSAs and DWR to close those gaps.
- Regional Estimate of Water Available, reported by planning area.
  - Surface Water.
  - Conservation.
  - Recycling.
  - Desalination.
  - Water Transfers.
- Regional Considerations for Replenishment of Water Available.
  - Aquifer storage available for recharge.
  - Regional potential of aquifer recharge (includes a map of potential groundwater recharge areas).
  - Description of aquifers that could employ in-lieu strategies to replenish groundwater.
    - Storage volume associated with the intersection of potential recharge areas, in-lieu areas, and existing aquifer storage space.

*This chapter will provide a standard presentation of information that can support water available estimates, as well as an estimate of water available for replenishment for each of the state's 10 hydrologic regions. Much of this information may come from continuing work in support of updates to the*

*California Water Plan, including the most recent 2013 update. The information and estimates of water available will focus on opportunities and constraints associated with each of the potential water available methods. In general, the discussion and presentation will consider water available with the existing infrastructure and constraints, new infrastructure, and modified constraints. Qualitative and quantitative elements will be included as appropriate. Input and guidance with local and regional water managers — as well as coordination through their respective GSAs — will be essential in identifying and understanding current and potential future infrastructure and constraints.*

*This chapter will conclude with identification of realistic regional opportunities to develop additional water available for groundwater replenishment for each region. It will also address, in a general way, the uncertainties in operational constraints for future facilities, and show linkages between those constraints and the extent to which SGMA sustainability goals can be achieved. Finally, this chapter will consider uncertainties related to climate change and list specific challenges associated with potential implementation of projects.*

## 5. Water Available and State Water Project and Central Valley Project

- Overview of water availability and the SWP and CVP.
- Water available associated with California WaterFix and new storage, including system reoperation.
- Central Valley water available information from SWP and CVP tools.

*This chapter will provide a description of water available associated with the SWP and CVP. The description will include project capability reporting as well as potential water available associated with projects that are being studied, including California WaterFix and future water storage. Finally, planning tools associated with the SWP and CVP also provide water available information at various locations in the Central Valley.*

## 6. Roadmaps and Project-specific Examples of Water Available by Methods

- Surface Water.
- Conservation.
- Recycling.
- Desalination.
- Water Transfers.
- Other.

*This chapter will describe how GSA's should consider water available for replenishment in two parts. First, a source-of-water project should be selected from the list above and then a method-for-replenishment project will need to be selected. Examples of replenishment projects will be presented in Chapter 7. This chapter will describe and analyze project-specific examples of water available so that the reader will understand, in detail, how to determine water available for potential projects that a Groundwater Sustainability Agency may consider. Examples will be chosen to demonstrate how to analyze, in a step-by-step manner, water available for the specific of water available methods listed above. This chapter will also include a summary graphic that reflects the project planning and implementation principles illustrated with the project examples.*

## 7. Roadmaps and Project-specific Examples of Water Available for Replenishment Analysis, by Replenishment Method

- In-lieu.
- Active Recharge.

*This chapter will describe and analyze project-specific examples of replenishment projects so that the reader will understand, in detail, how to determine water available for replenishment of groundwater. The project examples will demonstrate how a source of water can be used to replenish a groundwater basin by either active recharge or in-lieu management. Examples will be chosen to demonstrate how to analyze, in a step-by-step manner, how a source of water can support groundwater sustainability for a groundwater basin and a GSA. This chapter will also include a summary graphic that reflects the project planning and implementation principles illustrated with the project examples.*

## 8. Next Steps

*This chapter will describe how GSAs can support their sustainability planning process with the information and guidance provided in this report. Next steps in sustainability planning will be suggested, including how to address data gaps, permitting and regulatory requirements, and uncertainties. The section will also highlight an array of potential planning decisions, including the identification, screening, and selection of water available methods for implementation and replenishment that GSAs may consider as they complete the sustainability planning process. Finally, this chapter will describe how to move to project-specific analysis and ultimately to project implementation.*

## Appendix C: Timeline for major actions with responsible party to implement SGMA