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DEPARTMENT OF WATER RESOURCES

Water Available for Replenishment

White Paper

1/20/2016

Contents

1) Introduction, Purpose, and Summary

In 2014, California passed a group of legislative bills (SB1168, AB1739, 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 provide local water managers the tools and authority they need to implement sustainable management practices through the creation of Groundwater Sustainability Agencies, or GSAs. As part of the SGMA legislation, 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 (WC 10727.2§(d)(5))."

The purpose of this white paper is to present the Department of Water Resources' (DWR's) understanding of "*water available for replenishment*" requirements, provide background information needed to support these requirements, and include 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 – one to identify the timing and amount of water available and two to determine the location and logistics for groundwater replenishment. Consequently, two water resources planning processes and analytical approaches are identified: one for planning and evaluating water availability from various potential water supply sources, and the second for planning and analyzing replenishment of a groundwater basin. With 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 improve water availability in the state (Section 4). Finally, the 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 sources: surface water (including stormwater), water conservation, recycled water, desalination, water transfers and other sources. 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 sources and analysis of potential groundwater replenishment methods.

A flowchart which includes 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 is shown in Appendix A. The stakeholder outreach and outcomes (Section 4), and the definitions (Section 2) contributed to the WAFR Report outline 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 as an additional source of water supply and matched to specific groundwater replenishment projects. The second term, "for *Replenishment of Groundwater*", designates the physical process of the augmentation of groundwater, 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

Sources of water, including surface water (including stormwater), water conservation, recycled water, desalination, water transfers and other sources, come from a range of natural and man-made processes, where societal and technical factors can play an important role in determining water availability. Societal factors influence the development of laws, regulations, and environmental needs as well as multiple facets of water demand and usage; while 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. This water can be used for any other use, including agriculture, urban and environmental uses. In addition, SGMA has elevated the potential use of available water to replenish groundwater basins.

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 surface water, as described in the state's water right Laws. Pertinent provisions of the Water Code related to water availability analysis are summarized below:

- 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."* (WC 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/

A broader definition of, *"Water Availability" is provided by the United States Geological Survey:*

"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)."

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 sustainable water management, a key element of SGMA and the California Water Action Plan.

iii) Potential Sources of Water Available

DWR recognizes several potential sources of available water: surface water, conjunctive management, conserved water (to the extent it frees up new supply by reducing demand), recycled water, desalination, water transfers and several other sources of water. All these sources 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 fully appropriated due to water rights, instream flow requirements and water quality standards during some months or year. This reduces the amount of available surface water along the course of the river. However, there is still surface water available for appropriation in the state, though the location and timing of water availability varies.

In general, surface water is considered available during flood events, when streamflow exceeds existing water right allocations, and provides some opportunity for additional beneficial use. Stormwater runoff, another example of high streamflow, relates to water that is generated when precipitation from rain events flow over impervious surfaces and does not percolate into the ground.

Large water supply projects like the State Water Project (SWP) and Central Valley Project (CVP) should be considered as source 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 infrastructures for these projects were 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 NODOS would provide available surface water.

(2) Conjunctive Management

Conjunctive management or conjunctive use refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies in a region to meet various management objectives. Managing both resources together, rather than in isolation, allows water managers to deploy the advantages of both resources for maximum benefit. Conjunctive management thus involves the efficient use of both resources through the planned and managed operation of a groundwater basin and a surface water infrastructure. For example, water can be stored in the groundwater basin for future use by intentionally recharging the basin when excess surface water supply is available during years of above-average surface water supply. The necessity and benefits of conjunctive water management are especially apparent when surface water is directly connected to groundwater.

(3) 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" (WC 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.

(4) 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" (WC 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 to 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 but with stricter water quality standards for direct use as established by the California Department of Public Health (CDPH) to protect the public.

(5) 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 major source of new water in California, like in other Mediterranean seaside locations of the world. This water source 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. 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.

(6) 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 else 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 of agricultural crops that would have been planted in the absence of the water transfer.
- Groundwater substitution — Reduction in surface water use by an entity 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 from its source in its original location.

(7) Other Sources

There are other potential sources of water available: precipitation enhancement, dewvaporation or atmospheric pressure desalination, fog collection, etc. These sources are often related to innovations in technology and/or geoscience. A good example of this type of innovation is precipitation enhancement, commonly called "cloud seeding", which artificially stimulates clouds by injecting substances into the clouds to produce more rainfall or snowfall than they would naturally produce. This extra moisture can create more streamflow runoff. As technology evolves over time, new solutions with better performance may be devised to make additional water available.

b) "Replenishment of Groundwater"

i) Overview

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

ii) Definition

SGMA defines groundwater recharge as:

"The augmentation of groundwater, by natural or artificial means"

This definition generalizes the methods to replenish groundwater to natural or artificial management means. In the California Water Plan Update 2013 (CWP 2013), three methods of recharge are outlined: direct spreading, injection and in-lieu recharge. Considering the three methods characterized in the CWP 2013, 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 is dependent 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 properties, the availability of water for recharge, water rights, and the infrastructure ability to distribute water over or into the aquifer system.

As noted, two methods are often used to replenish groundwater: active recharge and in-lieu recharge. The methods described below 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. For example, a study currently underway by the University of California, Davis suggest 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 the 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 extraction and injection of water. Aquifer injection has the advantage of working in almost all 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 causes of clogging. Aquifer injection has higher energy requirement to maintain adequate water pressure for injection.

(2) In-Lieu Recharge

In some areas, "recharge" may be accomplished by providing surface water to users who would normally use groundwater, thereby leaving more groundwater in place for restoring 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

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, the source of water and the method to replenish groundwater need to be considered with spatial, temporal and physical mechanisms which allow interconnectivity between water sources and groundwater basins. Complex challenges and uncertainties can potentially impact the accuracy of estimates of water available for replenishment.

This chapter describes 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 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, one needs to consider the spatial and temporal extent of interconnectivity between sources of water available and groundwater. Incomplete understanding can lead to unintended consequences.

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 water bodies 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 baseflow.

The areal and subsurface profile associated with the transport over time of available sources of water to and into groundwater 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 quantify water availability and its potential use for groundwater replenishment.

In general, hydrologic and climatic information have good spatial and temporal coverage in California. DWR, United States Geological Survey (USGS), National Oceanic Atmospheric Administration (NOAA) and other federal, state and local entities collect a significant amount of water resources information. However, 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 gaged, 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 sources are often coarse estimates. These estimates often differ from the actual usage. As technology or monitoring improves, the accuracy of water estimates from these sources can increase.

Accurate information on water demands are also required for quantifying water availability. The California Water Plan Update 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 the type of land use (crop type), soil moisture, precipitation, temperature, and other factors.

Water rights are one of the principal pieces of information required when evaluating water availability. However, water rights, diversions, and return flows are often challenging to quantify. This is due to several factors:

- First, the amount of water use from older water rights (Riparian and Pre-1914 Appropriative Rights) is often difficult to quantify. Riparian right holders generally do not have priorities with respect to other riparian rights. Instead, each has a "correlative right" to the use of a reasonable share of the total riparian water available in the watercourse, to the extent the riparian can place that water to beneficial use on the riparian's land. Pre-1914 appropriative rights are also fairly difficult to quantify, and require evidence of original use prior to 1914 and continued use thereafter. These two types of water rights, in contrast to Post-1914 Appropriative Rights, did not require application to the SWRCB.
- Second, past reports on water use did not require quantifying use(s). Beginning in 2009, appropriative water right holders were required to quantify diversions before submitting reports, though right holders may still estimate diversions. Similarly, since 2012, riparian and pre-1914 water right holders are required to both measure and report diversion amounts. The recent improvements in reporting requirements allow the SWRCB's Division of Water Rights to better assess actual diversions throughout a stream system. Even with improved requirements

for submitting data, assessing data may be complicated because diverters may incorrectly report full water use or redundantly report a single diversion under multiple water rights.

- Finally, groundwater use, other than for adjudicated basins, will remain unreported until SGMA is fully implemented, and would need to be estimated using models and/or other forms of water balances.

iii) Water Quality

Depending on the source of water, water developed for active recharge or in-lieu recharge will be subject to specific water quality standards, which limit its use. For example, the SWRCB requires that all recycled water use 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 the aquifer injection, water treatment is again very important. The water for injection must be free of turbidity, biomater, 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 arise.

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.

Federal, state and local reservoirs, conveyance and pumps are essential to store and convey water to either direct groundwater recharge or to existing users for in-lieu recharge. For example, the State Water Project (SWP) and Central Valley Project (CVP) employ a system of reservoirs, conveyance, and pumps to deliver water from Northern California to the Bay Area, Central Coast, Central Valley 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. Deliveries from the SWP and CVP have become increasingly less reliable because of the recent drought, deterioration of environmental conditions in the Delta and water quality concerns, and more stringent environmental requirements in response to species declines. The increasing challenges in surface water availability from the SWP and CVP could be a critical limiting factor to effectively manage water resources and is relevant in order to understand the uncertainties associated with water supply reliability.

Additionally, for groundwater recharge, capacity constraints can limit the conveyance of water near a groundwater recharge location, during the application of sources of available water on the ground and the aquifer capacity to store the water. For example, in-lieu recharge can be very complex to implement if attempted in an area where water sources are not readily available or if water technologies and facilities must be constructed to provide surface water into areas that have historically relied upon groundwater.

v) Institutional and Regulatory

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 due to 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 Delta pumping operations. As a result, less water can be exported for delivery south and west of the Delta. In addition, local ordinances, which seek to manage land use or groundwater can affect availability of water or replenishment.

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 this type of 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 important to address short-term and long-term impacts and benefits to the environment, which might best be done in collaboration with environmental resource agencies.

i) Financial

Financial considerations play an important role in determining how to effectively manage water resources today and in the future. Although state dollars 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 performance of proposed or existing infrastructure, climate change, population growth and land use changes can affect water available for groundwater replenishment. Estimating these uncertainties is important for long-term sustainable water management in California, especially in the context of adaptation to future changes for these factors. A high level of uncertainties may be especially challenging for water managers and decision makers to manage.

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 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 and use is affected by a number of potential changes, including land use changes and population growth. Land use changes include planting decisions by farmers, and size and type of urban landscapes. For example, when estimating future urban water demands, water managers will need to accommodate future population growth. In this case, water managers will not only need to plan for when changes occur, but also 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 relieve some of the system inflexibility with better conveyance, storage or management of water. These changes could have either positive or negative impacts to water availability for groundwater replenishment. Therefore, it is difficult to determine future water availability without fully understanding infrastructure implementation in future years.

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 potential benefits for many projects funded under Proposition 1 for several years.

iv) Institutional and Regulatory

Institutional and regulatory challenges will continue to change over time. Water managers need to consider how endangered species may change with a changing climate. SGMA may require water managers to reduce reliance on groundwater in areas experiencing overdraft. Relying more on other sources 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 from 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 31st, 2016 (WC 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, a timeline and identifies the responsible entity for SGMA.

The GSPs submitted by GSA(s) will include, if applicable, a description of surface water supply used or available for use for groundwater recharge or in-lieu use (WC 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 31st, 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 a practitioner advisory panel to receive early input on a number of SGMA issues in order 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.

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. 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 two-fold: one, to fulfill the requirements of the legislation, and two, make sure the report itself will be useful to GSAs as they pursue sustainability. As noted in the previous section, providing accurate and precise water available for replenishment estimates will be challenging.

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 for replenishment") to project-level implementation analysis for both supply availability perspective and for groundwater replenishment at the GSA level. Here, the GSAs are also required to calculate their own water availability at a local level for inclusion in their GSP's. 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 the CA Water Plan Update).

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 towards successful implementation of SGMA and more sustainable management of our groundwater resources. In this sense, SGMA WAFR Report effort should outline important management considerations from the Water Action Plan. For example diversifying regional water portfolios will relieve pressure on foundational supplies and make

The governor's Water Action Plan key actions:

1. Make conservation a California way of life;
2. Increase regional self-reliance and integrated water management across all levels of government;
3. Achieve the co-equal goals for the Delta;
4. Protect and restore important ecosystems;
5. Manage and prepare for dry periods;
6. Expand water storage capacity and improve groundwater management;
7. Provide safe water for all communities;
8. Increase flood protection;
9. Increase operational and regulatory

communities more resilient against drought, flood, population growth, and climate change.

5. WAFR: Intended Outcome and Next Steps

a) Intended Outcomes of WAFR

Estimating and analyzing water available for replenishment of groundwater is a complex task that will require an on-going commitment from DWR and GSAs. DWR's approach to water available for replenishment will include two major parts, 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 five potential water sources (surface water, water recycling, conservation, desalination, and water transfers). 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 by GSAs 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 sources. These estimates will help GSAs begin a planning process by identifying potential water available sources 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 to achieve sustainability goals in GSPs.

b) Next Steps in WAFR

DWR is currently developing technical approaches to support the content as 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 source types by Planning Area and Hydrologic Region.

For surface water, DWR is proposing to use a modified water available analysis approach that will provide a simple planning estimate of available water for each region. 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, with current operations and regulatory requirements.

For conservation, recycled water, desalinated water, water transfers, and other sources, DWR will use available planning estimates of potential water supply available from CWP 2013. These estimates are for potential projects in each of the source 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 uses, of which groundwater replenishment is just one.

DWR will also develop roadmaps or guidelines for GSAs to use in their project planning processes. Roadmaps will be developed for each of the source 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 issues and challenges associated with implementing projects that 1) make water available and 2) manage that water for the purpose of groundwater replenishment.

DWR will continue to interact with stakeholders and GSA representatives as the WAFR Report is in development. On-going 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 Western 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 sources
- 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 source type
- 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

Chapter 6:Water Available Roadmap by Source

Step by step water availability analysis roadmaps with project-specific examples for:
- Surface water
- Conservation
- Recycling
- Desalination
- Water transfers
- Others

Chapter 7: Replenishment Roadmap by Replenishment Method

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, Draft Outline (DWR December 2016)

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 sources. 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 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. Description of "Water Available for Replenishment"

   a. Water available for replenishment in two parts
   b. Potential sources of "water available"

c. Types of replenishment in the form of increased "managed recharge" as defined and discussed in the 2013 Update to the California Water Plan. Generally, replenishment can be accomplished by active recharge or in-lieu methods.
d. 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 sources that could be used to support groundwater sustainability. Potential sources considered will include all existing water sources 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

a. Information Associated with Water Availability
    i. Water Supplies, reported by Planning Area
    ii. Water Use, reported by Planning Area
    iii. Service Areas
    iv. Storage
    v. Conveyance
    vi. Water Rights
    vii. Hydrology
    viii. Tools
    ix. Uncertainties
        1. Institutional and Regulatory Constraints
        2. Climate Change
    x. Challenges, including data gaps by hydrologic region with recommendations for GSAs and DWR to close those gaps.
b. Regional Estimate of Water Available, reported by Planning Area
    i. Surface Water
    ii. Conservation
    iii. Recycling
    iv. Desalination
    v. Water Transfers
    vi. Other
c. Regional Considerations for Replenishment of Water Available
    i. Aquifer storage available for recharge
    ii. Regional potential of aquifer recharge (includes a map of potential groundwater recharge areas)
    iii. Description of aquifers that could employ in-lieu strategies to replenish groundwater

iv. 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 ten 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 estimate of water available will focus on opportunities and constraints associated with each of the potential sources. 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

a. Overview of water availability and the SWP and CVP
b. Water available and California WaterFix and new storage
c. 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 Analysis by source type

a. Surface Water
b. Conservation
c. Recycling
d. Desalination
e. Water Transfers
f. Other

This chapter will describe that 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 sources of water 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

   a. In-lieu
   b. 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 sources 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.

Timeline	Action	Responsible Party
Jan 1, 2015	**Legislation goes into effect:** SGMA becomes effective.	
Jan 1, 2015	Local Agencies may no longer adopt or update GMPs for high and medium priority basins.	GSAs
Jan 31, 2015	**DWR must establish initial groundwater basin priority:** DWR establishes the initial priority-high, medium, low or very low-for each groundwater basin in the state by the end of January 2015.	DWR
2015 - 2016	DWR identifies basins subject to critical conditions of overdraft.	DWR
Jan 1, 2016	**DWR must set emergency regulations for basin boundary revisions:** DWR adopts emergency regulations for groundwater basin boundary revisions by Jan. 1, 2015. The regulations must include the methodology and criteria used to evaluate proposed boundary revisions, including the establishment of new subbasins (Water Code§ 10722.2).	DWR
Apr 1, 2016	Adjudicated basins submit final judgment to DWR and begin submitting annual reports to DWR.	GSAs
Jun 1, 2016	**DWR must establish emergency regulations for evaluating plans:** DWR adopts emergency regulations for evaluating Groundwater Sustainability Plans (GSPs), their implementation and coordination agreements among local agencies for groundwater sustainability planning. The regulations must identify GSP components and information to assist plan and coordination agreement development and implementation (Water Code§ 10733.2).	DWR
Dec 31, 2016	**DWR estimate of water available for groundwater replenishment due:** DWR publishes its estimate of the water available for groundwater replenishment on its website (Water Code§ 10729(c)).	DWR
2017	DWR publishes Bulletin 118- Interim Update with updated Basin Boundaries, updated Basin Prioritization, and reissues (as needed) basins subject to critical conditions of overdraft.	DWR
Jan 1, 2017	**DWR will establish best management practices for sustainable management:** DWR publishes best management practices for the sustainable management of groundwater on its website (Water Code § 10729(d)).	DWR
Jan 1, 2017	**Basin deadline to submit alternative to a GSP:** Medium- and high-priority basins choosing to meet sustainability objectives by ways other than groundwater sustainability planning (which includes not forming a Groundwater Sustainability Agency (GSA)) must submit	GSAs

	their alternatives to DWR (and then again every five years). (Water Code § 10733.6).	
Jun 30, 2017	**Deadline to form a GSA:** A local agency or agencies in each high- or medium-priority groundwater basin must have officially formed one or more (GSAs) for the entire basin (Water Code§§ 10724, 10735.2(a) (1)).	GSAs
Jun 30, 2017	**State Water Board can begin to put basins on probation:** The State Water Resources Control Board (State Water Board) can initiate probationary status to a medium- or high-priority basin if the basin lacks one or more GSA(s) that covers the entire basin or no alternative has been approved (Water Code § 10735.2(a)(1)).	SWRCB
Jul 1, 2017	**Those pumping in a probationary basin must report extractions:** Pumping groundwater in a basin that either has been designated as a probationary basin or lies outside a GSA's management area must be reported to the State Water Board. These reporting requirements do not apply to those extracting for domestic purposes 2 acre-feet per year or less, and some others (Water Code §§ 5202, 10724).	GSAs
Jul 1, 2017	Board adopts a fee schedule for "state backstop" related costs.	SWRCB
Dec 15, 2017	Board begins collection of annual reports from persons extracting more than two acre feet per year from areas not managed by a GSA.	SWRCB
Jan 1, 2018	Board may begin to develop interim plans if a local agency has not remedied the deficiency that resulted in the "probationary basin" status. The Board consults with DWR. Probationary basins may petition for un-designation. The Board consults with DWR to determine if the petition is complete. The Board acts on the petition within 90 days of submittal.	DWR & SWRCB
2020	DWR publishes Bulletin 118- Comprehensive Update	DWR
Jan 31, 2020	Board may hold a hearing to designate a critically overdrafted basin as "probationary" if DWR, in consultation with the Board, determines that the GSP is inadequate or will not achieve sustainability.	DWR & SWRCB
Jan 31, 2020	**GSP's required for critically overdrafted basins:** Basins designated as high- or medium-priority and subject to critical conditions of overdraft must be managed under a GSP or GSPs. The State Water Board can initiate probationary status for all or part of a basin if there is no GSP, if the GSP is inadequate, or the GSP implementation will not likely achieve sustainability (Water Code§ 10720.7(a)(1), 10735.2(a)(2), and 10735.2(a)(3)).	GSA's
Jan 2021	Board may begin developing interim plans for critically overdrafted "probationary basins" one year after the probationary designation, if	DWR & SWRCB

	the Board, in consultation with the DWR, determines that a local agency has not remedied the deficiency that resulted in the probationary status	
Jan 31, 2022	**GSP's required for all remaining high- and medium- priority groundwater basins:** All remaining basins designated as high- or medium-priority must be managed under a GSP or GSPs. The State Water Board can initiate probationary status in 2022 for all or part of a basin if there is no GSP, if the GSP is inadequate, or the GSP implementation will not likely achieve sustainability except for basins where groundwater extractions result in significant depletion of interconnected surface waters (Water Code § 10720.7(a) (2), 10735.2(a) (4), and 10735.2(a) (S) (A)).	DWR, SWRCB & GSAs
Jan. 31, 2022-2024	**DWR completes evaluation of all GSPs:** DWR must evaluate and issue an assessment of a GSP within two years of submission by a GSA. DWR may include recommendations for addressing any deficiencies in the GSP (Water Code § 10733.4(d)).	DWR & SWRCB
Jan 31, 2025	**State Water Board actions where extractions impact surface waters:** The State Water Board can initiate probationary status for those medium- or high priority basin where the GSP is inadequate or implementation is not likely to achieve sustainability AND the basin is in a condition where groundwater extractions result in significant depletion of interconnected surface waters (Water Code§ 10735(a) (S) (B).	DWR & SWRCB
Jan. 31, 2040- 2042	**Basins must achieve sustainability:** A GSP must include measurable objectives and milestones in increments of five years to achieve sustainability within 20 years of GSP adoption (Water Code§ 10727.2(b) (1)).	GSAs