Groundwater Pumping Allocations under California's Sustainable Groundwater Management Act

CONSIDERATIONS FOR GROUNDWATER SUSTAINABILITY AGENCIES

Environmental Defense Fund
Christina Babbitt, *principal co-author*
Maurice Hall

New Current Water and Land, LLC
Daniel M. Dooley, *principal co-author*
Richard M. Moss
David L. Orth
Gary W. Sawyers

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Introduction

The Sustainable Groundwater Management Act (SGMA) became law on January 1, 2015, forever changing the manner in which groundwater will be managed in California. It requires local Groundwater Sustainability Agencies (GSAs) to be formed and Groundwater Sustainability Plans (GSPs) to be prepared in order to achieve sustainable groundwater management within 20 years of adopting a GSP.

SGMA applies to 127 medium and high priority groundwater subbasins[1] around the state.[2] Over 100 of the medium and high priority groundwater subbasins are in conditions of chronic overdraft (DWR, 2018), meaning average annual groundwater extractions exceed average annual water replenishment to many of the subbasins. These conditions have resulted in a variety of undesirable impacts to the subbasin, including, but not limited to, increasing depth to groundwater, reductions of groundwater storage, seawater intrusion, degraded water quality, and land subsidence.

In many subbasins, groundwater overdraft conditions will require GSAs to impose reductions in pumping in order to achieve sustainable conditions in the subbasin. To do this, GSAs will need set a limit or "cap" on the overall amount of groundwater that is removed from the subbasin, assigning portions of this capped amount to groundwater pumpers in the form of a pumping allocation.

Making pumping allocation decisions will be a difficult task for GSAs, as it will require restricting access to groundwater resources upon which the agricultural community, cities and towns, and others depend. SGMA expressly does not create or adjust groundwater rights and the basic law of groundwater rights remains largely unchanged. Simply put, this means that while GSAs are tasked with managing groundwater with the goal of bringing groundwater conditions into balance and stopping further depletions and other undesirable impacts, they do not have the authority to change or modify groundwater rights. Thus, GSAs should be mindful of the basic law of groundwater as articulated by the common law and a series of adjudicatory court decisions over the last 100 plus years.

The subject of this paper is how to address this dilemma, with the reasoning that if GSAs devise groundwater allocation schemes in a manner consistent with the fundamental principles of groundwater law, the schemes are likely to be more durable, and GSAs are more likely to achieve sustainable groundwater management in a legally defensible manner. To do this, we first provide background on the nature of groundwater rights and how the hierarchy of groundwater rights may affect the legal defensibility of pumping allocations imposed by GSAs upon pumpers. We then discuss the role of groundwater allocations and methods for allocating groundwater pumping rights, and then offer a suggested allocation approach with criteria for consideration when using this approach. To help readers work through the allocation process, the paper includes a hypothetical decision tree graphic. We also discuss the importance of measurement, tracking, and enforcement, as well as additional considerations under SGMA before offering some concluding remarks.

Groundwater Rights Overview[3]

This section summarizes various groundwater rights and their relationship to each other in order to provide a better understanding of how groundwater allocations might be developed within the context of SGMA. Groundwater rights in California have largely emerged from English common law and a series of California court rulings over the years.

Prior to 1903, California courts generally applied the English common law rule that a landowner owns whatever is beneath the surface of his or her property to "the depths of the earth and up to the heavens." This rule was known as the "absolute ownership" rule because it resulted in a landowner having the right to use as much groundwater as s/he could physically extract from beneath his or her property.

There was no limitation on this right until, in a landmark case decided in 1903, the California Supreme Court determined that the absolute ownership rule had no place in the arid climate of California (*Katz v. Walkinshaw*, 141 Cal. 116 (1903)). In the wake of the rejection of English common law rule, subsequent court rulings established categories of groundwater rights. For a definition of what constitutes groundwater, see Box 1 - What is Groundwater?

Box 1 - What is Groundwater?

In California, waters are classified into three main categories 1) surface water, 2) subterranean streams, and 3) native percolating groundwater.

The first two categories are managed as surface water, whereas the third category is what is legally defined as "groundwater." Percolating groundwater, or more simply groundwater, refers to water which infiltrates into the ground and flows through the subsurface strata without having a definite channel or discoverable course of flow.

Groundwater Rights in California

There are three categories of groundwater rights established in California with respect to percolating groundwater derived from sources within the watershed. They are overlying rights, appropriative rights, and prescriptive rights.

Overlying (or "Correlative") Rights

Overlying rights are used by the landowner for reasonable and beneficial uses on lands they own overlying the subbasin from which the groundwater is pumped. The quantification of each overlying user's correlative (or shared) right depends entirely on the facts and circumstances of hydrogeology and water demand as they exist in the basin. The facts and circumstances are discussed below.

The courts have consistently upheld the right of a landowner whose land is overlying a groundwater basin to extract and use that groundwater on the overlying land but have restricted that right to an amount which is reasonable in light of the competing demands of other overlying users (the "correlative right"), and which considers the safe yield of the basin (See Box 2). Among overlying users, it is generally irrelevant who first developed the groundwater.

Further, the overlying right may only be used for reasonable and beneficial uses on land owned by the pumper. However, water devoted to public uses (for example, water acquired by municipalities and public utilities for distribution to the public) has been determined not to be an overlying use by the courts.

Appropriative Rights

Any party that 1) does not own land overlying the basin, 2) owns overlying land but uses the water on non-overlying land, or 3) sells the water to another party, or to the public, generally is considered an "appropriator" and not an overlying user. The courts generally acknowledge the right of an appropriator to take water surplus to the needs of overlying landowners and the safe yield of a groundwater subbasin and apply it to beneficial use inside or outside the basin. Except where restricted under statutes, such as county ordinances, there is no restriction as to where the water may be used, and no requirement that the appropriator be a landowner.[4] The water may generally be used for private or public uses without restriction, subject to the requirement that the use of the water must be reasonable and beneficial.

Box 2 - Defining Safe Yield

Safe yield is usually defined as the maximum quantity of water which can be withdrawn annually from a groundwater supply without causing a gradual lowering of the groundwater levels resulting in the eventual depletion of the supply. The long-standing concept of "safe yield" utilized by the courts in adjudication of groundwater rights has been complimented by SGMA's use of the term "sustainable yield," which is defined in California Water Code section 10721(v) and includes avoiding specified undesirable results.

Among appropriators, the priority of each appropriator's right is determined by the relative timing of the commencement of use, i.e., first in time is first in right. Once a groundwater basin reaches a condition of overdraft, no new appropriative uses may be lawfully made. If overlying users (who, as discussed below, have priority over appropriative users) begin to consume a greater share of the safe yield, the existing appropriators must cease pumping in reverse order of their priority as against other appropriators. Typically, however, appropriators continue extraction activities unless and until demand is made and/or suit is brought to stop them by those holding rights to extract groundwater that are adversely affected by the appropriation.

Prescriptive Rights

A prescriptive right (a groundwater right acquired adversely by appropriators) is acquired by taking

groundwater adverse to existing right holders for a period of normally 5 years). Prescriptive rights do not accrue until a condition of overdraft exists. Therefore, it is first necessary to determine when a condition of surplus ends and overdraft begins.

The definition of overdraft was articulated by the California Supreme Court (City of Pasadena v. City of Alhambra, 33 Cal. 2d 908 (1949); City of Los Angeles v. City of San Fernando, 14 Cal. 3d 199 (1972)). There, the Court held that overdraft begins when extractions exceed the safe yield of a basin plus any temporary surplus. Typically, monitoring data related to the depth to groundwater over time have provided the basis of determining when a condition of overdraft exists.[5]

If a pumper extracts water for a non-overlying use (i.e., pursuant to an appropriative right) from an overdrafted basin, the right may ripen into a prescriptive right if the basin overdraft is notorious and continuous for at least 5 years. As noted above, municipal water supplies developed from groundwater have been determined not to be an exercise of an overlying right. Thus, it is common for municipal water purveyors to assert that their appropriative rights have ripened into prescriptive rights in circumstances where the basin has been in a state of overdraft for an extended period.

Box 3 - Rights to Groundwater Imported to a Subbasin

Water for which a credit is derived is water imported from outside the watershed or water which is captured that would have been otherwise lost to the subbasin and which is recharged into the groundwater basin. Imported water does not include the return flow from extracted groundwater from the basin since that water does not add to the overall groundwater supply. Assuming no prescriptive rights have attached to imported water used to recharge a basin, the imported water generally belongs solely to the importer, who may extract it (even if the basin is in overdraft) and use or export it without liability to other basin users. There are well defined rules regarding leave behinds to address migration of water necessary to keep the subbasin whole. Note: There is an open question as to whether prescription of imported water from the subbasin can occur.

Priorities among Different Groundwater Right Holders

The category of groundwater right determines, in large part, who has the greater priority for using that right in times of scarcity. However, none of the rights discussed above exist in a vacuum. The various groundwater rights within a given basin or subbasin and their respective priorities are interdependent and bear directly on how GSAs allocate pumping rights. In this section, we discuss priorities among the three categories of groundwater rights.

Priorities among Overlying Users and Appropriators

If there is a condition of overdraft, the overlying user will generally prevail against an appropriator in a dispute over priority of rights (even if the appropriator is a public entity) unless the appropriator can establish prescriptive groundwater rights. This is because the appropriative right applies only to surplus groundwater; if there is no surplus, there is no possibility of an appropriative right (although a prescriptive right may develop or exist). Therefore, it is unlikely an appropriator could prevail against individual overlying users in a dispute over the right to pump native groundwater.

However, as mentioned above, groundwater rights do not always conform strictly to a given priority structure. While, generally speaking, overlying groundwater users have priority over appropriators, overlying users cannot always prevent extractions by an appropriator, as the timing of an action against the appropriator and the appropriator's use of the water must also be considered. For example, where the appropriated water has been put to public use, a permanent injunction prohibiting further appropriation is seldom issued. Courts typically use their equitable powers – their authority to decide cases based on equity – to protect public benefits. In the Raymond Basin, for example, the court established the Doctrine of Mutual Prescription (see "prescriptive rights" above) which awarded rights based on historical pumping and not the usual priority system under California groundwater law – a scenario that arguably benefits municipal pumpers (Langridge, et al., 2016). However, the courts have subsequently limited the doctrine (City of Los Angeles v. City of San Fernando, 14 Cal. 3d 199 (1949)); (City of Barstow v. Mojave Water Agency, 23 Cal. 4th 1224 (2000)).

Box 4 - Groundwater Adjudications in California

Many asserted groundwater rights are not quantified but are simply claimed and/or exercised without objection by other parties. When competing demands for a common groundwater supply become too great, formal "adjudications" are sometimes initiated by one or more of the competing claimants. Court adjudications are the only process that can definitively determine groundwater rights.

Frequently, the result of an adjudication is an equitable apportionment of water that does not "track" with a technical application of the groundwater law principles summarized above. The Court may impose a "physical solution" upon parties to a stipulation to reduce extractions to safe yield levels. Typically, the court retains continuing jurisdiction over the implementation of an adjudication order, making the court an ongoing "player" in the administration of the basin.

Adjudications typically take many years (or even decades) to complete because of the often complex legal and factual issues involved. They are complex, expensive, and disruptive, and there are no guarantees that a long-term resolution to the issues at hand will be reached – parties often return to court as they attempt to resolve ongoing disputes (Langridge, et al., 2016; Ayres et al, 2017).

Priorities among Overlying Users and Prescriptive Users

A prescriptive right to use groundwater is senior to the right of the overlying users whose right to groundwater was taken by prescription. The priority between such users depends on the amount used by the overlying users during the prescriptive period. If the overlying users continue to pump at the same or increased levels of pumping during the prescriptive period, then neither the prescriptive user nor the overlying user has priority over the other. Rather, in effect, the prescriptive user will obtain equal priority proportionate to their respective pumping during the prescription period.

When a prescriptive right is vesting,[6] and an overlying user continues to pump during the prescriptive period, the overlyer's right to continue pumping will usually be protected under the doctrine of "self help."

Priorities among Appropriators and Prescriptive Users

A prescriptive right has priority over an appropriative right. Technically, this condition does not often exist, since one cannot be an appropriator in a basin in overdraft. Nevertheless, a prescriptive user is simply an appropriator whose use has continued for a sufficient period of time in the face of a chronic overdraft condition.

Subordination[7]

In the case *In re Water of Long Valley Stream System* ("*Long Valley*") (25 Cal.3d 339, 355, 357-359 (1979)), the California Supreme Court approved the State Water Resources Control Board's subordination of the dormant riparian rights in the surface water context. To date, the courts have not applied the same principle to subordinate dormant overlying rights (*Wright v. Goleta Water District* 174 Cal.App.3d 74, 87-89 (1985)). However, as part of the recent groundwater basin adjudication reform law, the legislature explicitly permits the court to apply the principles set forth in Long Valley within a comprehensive groundwater basin adjudication (Code Civ. Proc. § 830(b)(7)). Moreover, the California Supreme Court in Mojave explained that the subordination principle applied in Long Valley may need to be applied in the future to subordinate dormant overlying rights "to harmonize groundwater shortages with a fair allocation of future use." (*Mojave*, 23 Cal.4th at 1249, n. 13).

Prioritization of Groundwater Rights in Practice

While the legal principles summarized above are those that govern groundwater throughout the state and thus can inform how GSAs prioritize groundwater rights when devising an allocation scheme, it is important to understand that the courts will follow water law priorities to the extent that they do not lead to an unreasonable use of the resource. Courts will apply equitable principles to the extent that they are applicable and appropriate, and not inconsistent with water right priorities. Thus, the failure to use groundwater in accordance with the principles summarized above does not necessarily mean that a water user is violating the law or is without rights to the groundwater in question.

Also, court rulings demonstrate that every adjudication is different and that the results of future adjudications

will be hard to predict, despite the legal principles summarized above, particularly given the fact that adjudication rulings are often the result of consent decrees and stipulated judgments (see Box 5).

Box 5 - Examples of Groundwater Adjudication Consent Decrees

A number of adjudicated basins in California have established allocations with equal priority, blurring the distinction between overlying and appropriative rights (EDF and Mammoth Trading, 2017). For example, in the Tehachapi Basin adjudication, individual pumping was limited to two-thirds of the highest continuous annual extractions over any five year periods after overdraft began. The Mojave Basin established water allocations based on historic pumping – determining base allocations or the "Base Annual Production Right" as the highest amount of water produced by a party in one year, during a five-year pre-adjudication period (Langridge, et al. 2016).

However, it is important to note that in the Mojave Basin Area adjudication (2000), the California Supreme Court held that adjudication decisions that do not attempt to determine the priority of rights, and instead allocate pumping rights based on prior production, improperly elevated the rights of appropriators over overlyers. Nevertheless, the court acknowledged that parties may freely stipulate, or agree, to different treatments of their rights, highlighting the importance of stakeholder inclusion and buy-in to the allocation process (*City of Barstow v. Mojave Water Agency, 23 Cal. 4th 1224 (2000)).* The ability of overlying landowners to market their allocated pumping right was a strong motivating factor resulting in the stipulated judgment in Mojave.

Groundwater Allocations in the Context of SGMA

SGMA mandates that GSAs develop GSPs that achieve groundwater sustainability within 20 years. SGMA specifically authorizes GSAs to control groundwater by regulating, limiting, or suspending extractions from individual wells or extractions in the aggregate (California Water Code § 10726.4(a)(2)).

GSAs in groundwater subbasins are confronted with the need to consider demand management of groundwater as well as supply augmentation. Many are considering setting up markets that will permit landowners to market their groundwater pumping allocations.[8] Some are also considering creating crediting programs to incentivize landowners to engage in programs that benefit the groundwater subbasin. These programs include temporary or permanent land fallowing, on-farm recharge, private banking, conservation, and conversion to lower water use crops. To address the variety of diverse stakeholder interests within subbasins, stakeholders are encouraging GSAs to develop such programs in ways that achieve multiple benefits, including benefits to habitat, water quality, and disadvantaged community water supplies, wherever possible.

It is important to understand that groundwater trading programs (also referred to as groundwater markets) or groundwater credit systems necessarily involve volumetric limitations on groundwater extraction and use. Absent such restrictions, it is unlikely that such incentive-based systems could meaningfully exist. While many GSAs have expressed interest in groundwater trading and crediting programs, few (if any) have clearly established the nexus between such programs (which are attractive to many groundwater users) and the need to establish pumping limits (which are equally unpopular). Most GSAs are just now becoming fully engaged in developing their GSPs, which will need to address these issues.

In order for trading and crediting systems to work effectively, GSAs will need to establish effective means of allocating the ability to pump groundwater from subbasins in a condition of overdraft. Establishing baseline allocations presents significant challenges for GSAs when considered against the complex backdrop of groundwater rights law. Furthermore, given that GSAs do not have the authority to change or modify groundwater rights, allocation schemes should reach a balance between respecting groundwater rights and conforming to the local needs of the basin. If local agreement cannot be reached, groundwater users may turn to the courts, increasing costs and likely delaying progress towards achieving sustainability. However, basins are still subject to SGMA during the litigation process – and the streamlined adjudication act (AB 1390 and SB 226, 2015) may shorten the adjudication timeline.

Following is a discussion of how allocations could be made in the context of the law while also taking into consideration some of the practicalities that exist in the implementation of an allocation system.

Methods of Allocation[9]

In this section, we discuss potential methods for establishing baseline groundwater pumping allocations that may be considered by GSAs (see Table 1). Each assumes that the GSA has developed the necessary technical information to determine the average annual sustainable yield of the subbasin and has established a corresponding pumping limit or a cap.

Table 1: Methods for Establishing Groundwater Pumping Allocations

Method	Description	Advantages and Disadvantages
Pro Rata Allocation per Overlying Acre	This approach divides the available groundwater between overlying landowners proportionate to property size. This system treats all landowners equally, irrespective of whether the landowner has developed groundwater resources.	Approach Advantages ▪ Recognizes the underlying correlative right of each overlying acre to share in the reasonable use of the water within the subbasin. ▪ Is simple in approach and calculation. Approach Disadvantages ▪ Does not recognize some of the legal limitations and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin (see Box 3), and others (or make adjustments to the allocations based upon such limitations and nuances). ▪ It allocates a portion of the sustainable yield to overlying lands that may have not yet exercised the right to use groundwater. This raises significant questions about how you provide water for such lands, if at all, and how allocations will be adjusted when, and if, such lands exercise the right to a share of the sustainable yield. ▪ It creates inequities between those who have invested nothing to develop the right and those who have invested heavily to utilize the right.
Pro Rata Allocation per Irrigated Overlying Acre[10]	This approach certifies all existing overlying groundwater use (e.g. irrigated acres) and develops an allocation proportionate to land use. In this approach, each irrigated acre would be given a specific quantity of groundwater (e.g. inches/acre per year) that can be applied to the land. This approach grandfathers in existing groundwater users but does not give differential allocations based on historic use. Further, any reductions in the allocations to reduce overdraft would be felt proportionately across all historic users.	Approach Advantages ▪ Acknowledges existing pumping by overlying landowners. ▪ Is reasonably simple in approach and calculations. Approach Disadvantages ▪ Does not address the unexercised pumping rights on some overlying lands (to the extent such rights have not been lost to prescription or subordination). ▪ Does not consider historic quantities of groundwater pumped, which could disproportionately impact users of high water demand crops grown on overlying acreage. ▪ Does not recognize some of the legal limitations to and nuances that affect groundwater rights in a subbasin such as prescription, public use, imported water to the subbasin and others (or make adjustments to the allocations based upon such limitations and nuances).

Table 1: Methods for Establishing Groundwater Pumping Allocations

Method	Description	Advantages and Disadvantages
continued		
Allocation Based Upon a Fraction of Historic Pumping[14]	This approach establishes allocations based off historic groundwater use, grandfathering in existing users and excluding those who have not yet developed groundwater resources. This method does not make necessary determinations as to whether historic pumping is supported by claims of overlying users.	Approach Advantages ▪ Can reduce conflict among existing pumpers. Approach Disadvantages ▪ Does not apply the law of correlative rights. ▪ Does not identify appropriative or prescriptive rights. ▪ Does not recognize potentially disproportionate impacts by pumpers on groundwater overdraft. ▪ Does not account for those who have surface water supplies and rely on groundwater only as a supplemental or dry-year supply. ▪ Treats all pumping, regardless of amount, the same and may be perceived as unfair by grandfathering in higher per-acre allocations. ▪ Requires baseline information about individuals' historic groundwater use, which may not exist.
Comprehensive Allocation Method (Recommended Method)	This approach establishes allocations based on a comprehensive consideration of California groundwater law to the extent practical. This approach preserves the relative priority of overlying, prescriptive, and appropriative users and can address the unexercised rights of overlyers. See Figure 1 for a decision tree graphic description of how this approach might be applied.	Approach Advantages ▪ This method would apply California groundwater law to the conditions existing in the subbasin and make allocations accordingly. ▪ If an allocation methodology is developed in this manner, it has a reasonable probability of surviving judicial scrutiny in the context of adjudication, especially if the majority of rightholders in the subbasin find the methodology acceptable. Approach Disadvantages ▪ The law is in many cases vague and ambiguous, and also requires the exercise of interpretation and judgment. ▪ The process for applying this method is complicated and requires information to undertake. ▪ Implementing this process leaves open the possibility that someone will disagree and consider triggering an adjudication.

Selecting an Allocation Method

Any of the methods discussed above could be utilized by a GSA if the GSA establishes broad consensus among the groundwater right holders and other stakeholders in the subbasin. Below we discuss allocation based upon comprehensive application of California groundwater law (referred to as "Comprehensive Allocation Method") as the recommended approach, which offers GSAs the important advantage of presenting to the Court an allocation methodology that tracks judicial precedent if an adjudication is initiated.

Recommended Method of Allocation

Utilizing the comprehensive allocation approach that respects the law of groundwater rights is the recommended approach for allocating groundwater extraction limits under SGMA. This approach applies the known conditions of existing groundwater law which increases the probability that the approach will be supported if judicial review ensues (Szeptycki et al., 2018; McGlothlin and Acos, 2016). This approach will require considerable engagement with all stakeholders within the subbasin in order to develop the essential buy-in to the method. This will require some explanation of the law and discussion of why other simpler allocation approaches are inconsistent with the law. While the engagement process will take time, it will improve the likelihood of developing a legally defensible allocation method that helps achieve sustainability within the subbasin in a fair and equitable manner.

Factors GSAs Should Consider When Using the Recommended Formula to Allocate Groundwater Pumping

There are a number of steps that a GSA will need to work through in order to develop a groundwater allocation scheme. The factors below are those that will need to be addressed when using the recommended method – comprehensive allocation based upon the application of California groundwater law – to allocate groundwater pumping rights.

Determine the Overall Water Balance

Each GSA should begin by characterizing the conditions of the subbasin, including the overall water balance – the amount of water flowing into and out of the system. This will require development of technical information. Initial characterizations should be made using the best available information, which may require putting systems in place to improve data availability moving forward. Importantly, this determination is subject to all the sustainability criteria in SGMA, that is, avoidance of all six undesirable results.

The purpose of the characterization is to enable the GSA to define what sustainable groundwater management looks like in their subbasin. At the core of this determination is the need to establish how much water can be extracted from the subbasin on an average annual basis. Additionally, the GSA would need to identify supply enhancement programs and quantify how much additional overdraft can be tolerated in the transition to a level of sustainable extraction while avoiding undesirable results. Given the current state of knowledge in most basins, this determination will likely have to be adjusted as information improves over time.

Define and Characterize Appropriative, Prescriptive and Public Uses of Groundwater

The GSA should identify and quantify appropriative, prescriptive, and public uses of groundwater from the subbasin, including those defined by SGMA as de minimis. These uses will include public drinking water pumping programs undertaken by cities and community service agencies, as well as drinking water for disadvantaged communities. Prescriptive use of groundwater may also include groundwater moved out of the subbasin. These uses may reduce the allocations for overlying land.

Determine Initial Overlying Land Pumping Allocation

The GSA should consider what the initial allocation of the sustainable yield would be for each overlying acre within the subbasin, including acres that have not exercised the right. This requires a determination of the baseline water balance for the subbasin, which appropriately considers inflows to and outflows from the subbasin.

Develop a Policy for Unexercised Rights (Dormant Rights)

The GSA should develop a policy for unexercised overlying rights. Initially, the GSA should determine whether any valid unexercised rights exist. This will require a determination of whether such rights have been lost to prescription or subordination. Several policy options exist. One option would be to make an allocation of the sustainable yield to unexercised rights just like it has been done for exercised overlying rights. Another option would be not allocating to lands with unexercised overlying rights. This policy option would require a clear articulation of how allocations would be adjusted if and when overlying landowners elected to exercise their right to use groundwater. The GSA could consider a lower priority tier for unexercised rights. The GSA could also consult with the county (or city) about adoption of a land use policy, which would limit further development of lands with unexercised rights lost to prescription or subordination without identification of a sustainable water supply.

Identify and Quantify Recharge Resulting from Imported Water

The GSA should identify all surface water that has been imported to the subbasin, surface water captured that would have otherwise been lost to the subbasin, and contaminated or otherwise unusable subsurface water in the subbasin that can be made usable via treatment or other investments.

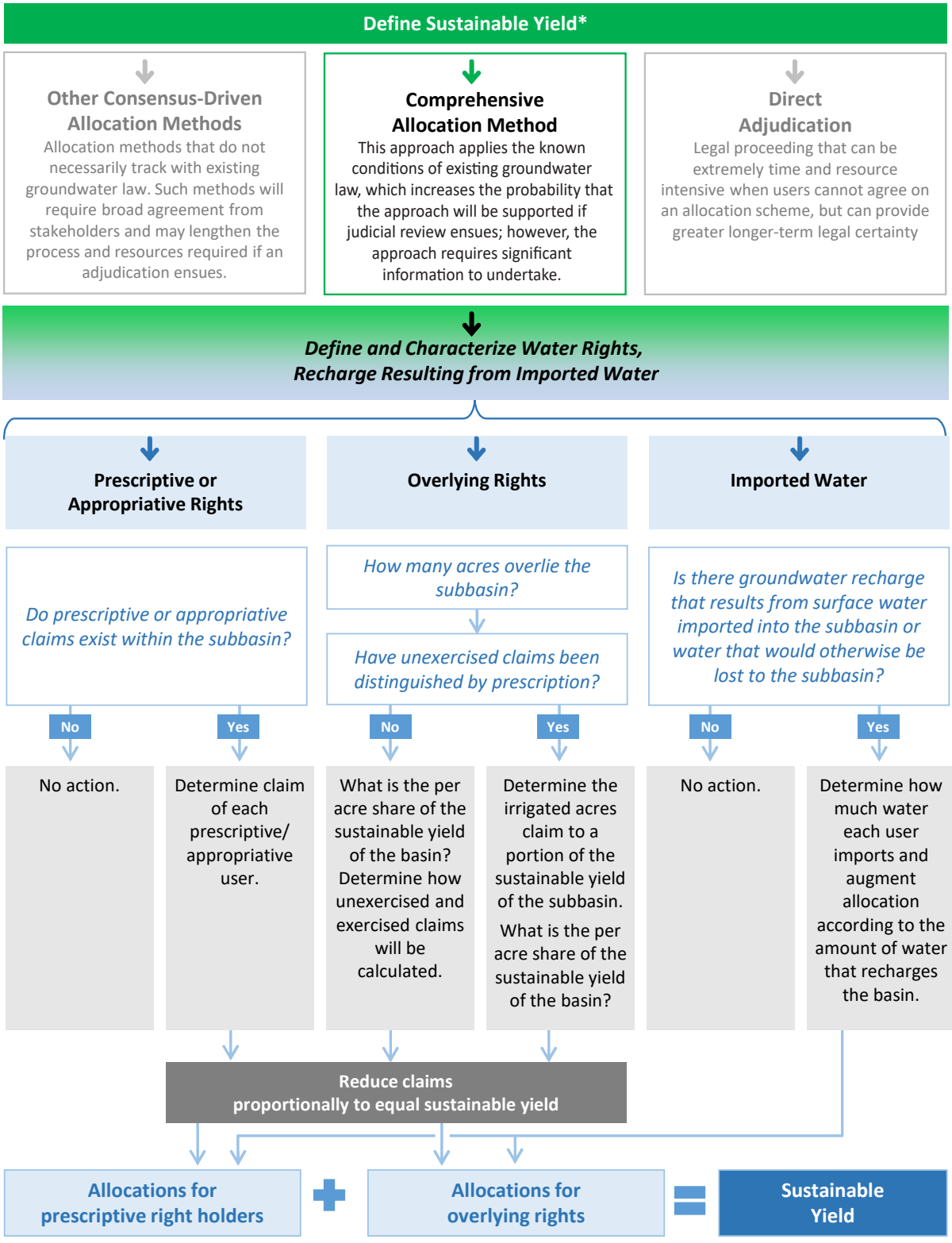
The GSA should identify and quantify the amount of water that provides direct or indirect recharge to the subbasin. Such water could include water that is directly recharged by diversion to dedicated recharge facilities or water indirectly recharged by seepage from distribution and delivery systems. The GSA should determine who is responsible for such recharge, as the landowner or agency responsible for such waters might be assigned an additional right to extract such water from the basin. Importantly, surface water intentionally stored underground and not abandoned is not subject to the regulatory authority of the GSA.

Importantly, the GSA will need to address questions as to how and to whom the credits accrue. For example, if the recharge is undertaken by an irrigation district, does the credit accrue to the landowners within the district boundaries? If landowners within the district do not utilize imported surface supplies, do they benefit from the indirect recharge activities? It will be necessary for GSAs to develop policies for making these determinations and apply them consistently. It will be equally important for the GSA to monitor such efforts on an ongoing basis.

Hypothetical Decision Tree Example using the Comprehensive Allocation Method

In order to illustrate how all of these factors might be utilized by a GSA to make pumping allocations consistent with groundwater rights law, Figure 1 provides a hypothetical scenario.

Figure 1: Comprehensive Allocation Method Decision Tree Example[11]



** If conditions in the subbasin change, allocated shares of the sustainable yield of the subbasin may need to be adjusted.*

The Importance of Measurement, Tracking, and Enforcement

In order to effectively manage allocated pumping rights within a basin, each GSA must implement effective mechanisms for monitoring pumping, tracking transfers, and enforcement of groundwater use rules. Many GSAs or members of GSAs have monitored and measured surface deliveries and use for decades. Yet, few have had the responsibility to monitor and measure groundwater extraction and use by private entities. Nonetheless, they can draw upon their experience in managing their own wells, which often includes detailed accountings of extractions. The years of experience gained in monitoring and measuring inputs and extractions to groundwater banks and acquifers can also inform best practices from measuring, tracking, and enforcing groundwater allocation approaches.

The following are important considerations in the development of a measurement, tracking, and enforcement system.

Measurement

There are many potential methods of measuring groundwater extractions (EDF and Mammoth Trading, 2017). The most obvious is metering of wellhead discharges. There are also emerging technologies utilizing satellite and/or drone technologies to measure water use based on evapotranspiration which could be adapted for this purpose. The GSA should determine what technology makes the most sense in its area considering costs, reliability, management capacity, maintenance, and necessary precision.

Monitoring and Tracking

The GSA may have a multitude of activities that it must monitor and track. The most obvious is monitoring groundwater levels and tracking groundwater extractions in the context of sustainable yield. This likely will include tracking extractions over multiple years to assure that average annual extractions do not exceed the long-term allocations of sustainable yield.

GSAs may choose to adopt programs to incentivize practices that result in water savings or that otherwise contribute to additional water stored in the basin. In such programs, associated accounting and crediting for these practices would be needed. If GSAs adopt such an incentive and crediting program, they will need to monitor and track groundwater banking and/or recharge inputs and extractions by individual landowners to assure compliance with GSA policies. Similarly, if fallowing programs are adopted, the GSA will need to track acreages, forgone extractions (and corresponding credits given), and extractions of credits.

To the extent water is/has been imported to the subbasin and provides some recharge, GSAs will need to monitor and track such imports on an ongoing basis to assure baseline conditions affecting allocations are updated to consider actual conditions.

If a GSA elects to create a market for groundwater pumping allocations or groundwater credits, it will need to have the capacity to record transactions and monitor compliance with conditions of the transaction, including, but not limited to, reductions in extractions by the transferor and transferee. Other factors that will need to be monitored include potential impacts in the area from which the water is transferred and within the area where the transfer water is actually extracted.

There are many potential systems that could be implemented to keep track of these issues. Whether GSAs are tracking groundwater pumping, or some combination of additional programs (recharge banking, water trading, and/or fallowing programs), developing and maintaining a "registry" or ledger to track activities and transactions is highly recommended. GSAs should also review existing monitoring and tracking systems for surface waters to determine if they can be modified to meet the groundwater needs. Municipal water supplies have systems that monitor water extractions and usage that may have applications as well. There are many for-profit providers of trading platforms or accounting systems that are testing market opportunities in the post-SGMA world as well. While no endorsement is offered for any particular provider, a list is provided of known venders for GSA consideration.[12]

Enforcement

In order to achieve groundwater sustainability within the time periods specified in SGMA, GSAs need to establish clear enforcement protocols. SGMA provides GSAs with substantial powers and authorities (California Water Code §10725 et seq.) and it will be important to clearly specify the consequences of violating the rules regarding allocations based upon subbasin sustainable yield established by the GSA. Development of a registry, as noted above, will help provide validity to enforcement efforts and could also help instill confidence in financial institutions who might be interested in supporting

banking efforts or other incentive-based groundwater management strategies.

Additional Considerations in Devising Allocation Schemes under SGMA

In addition to the considerations discussed thus far, there are several other SGMA-related factors for GSAs to consider as they approach allocation decisions. In this section, we discuss the role of 1) incentive-based programs as a tool to help achieve sustainability goals, 2) allocation adjustment mechanisms, 3) counties in regulating groundwater, and 4) adjudicated water rights under SGMA.

The Role for Private Groundwater Banking, Recharge, and Fallowing Programs

In many subbasins, GSAs will need to find ways to address groundwater overdraft conditions to achieve sustainability goals under SGMA. As discussed in this paper, devising allocation schemes based on a sustainable yield is one tool to help GSAs meet sustainability goals. Additionally, to help achieve sustainability and provide a softer landing to potential groundwater use reductions, GSAs should consider incentive programs to encourage individual landowners to voluntarily bank or recharge on their property, to import surface water that reduces reliance on groundwater, and to make investments to treat and deliver otherwise unusable water in the subbasin. Similarly, incentive-based programs to encourage landowners to voluntarily fallow land or to reduce groundwater use from historic levels could be explored. GSAs should establish policies and procedures identifying the circumstances in which landowners could gain credit and/or extract water developed through such programs pursuant to implementation. For example, extractions from banked or recharged water would be in addition to pumping allocations based on the sustainable yield of the subbasin.

It is also important to consider that the total recharge to a basin, and therefore the basin's sustainable yield, is affected by ongoing activities that contribute to recharge. Notable among these is irrigation of lands overlying the groundwater basin with surface water, where the deep percolation from this irrigation becomes groundwater recharge. It important for a GSA to understand and monitor these activities and estimate to the degree possible how much these activities contribute to basin recharge. The GSA should consider policies about how such activities may affect allocations, if at all, and if programs might be warranted to encourage continuation or enhancement of such activities.

Allocation Adjustment Mechanisms

Under SGMA, the target date for achieving groundwater sustainability is 2040 if the basin is designated as critically overdrafted or by 2042 if designated as a high or medium priority basin. As GSAs develop GSPs, which must be developed by 2020 or 2022, respectively, incorporating allocation strategies that allow groundwater pumpers to adjust gradually to pumping reductions over some period of time could help ease the transition. Such "rampdown" strategies have been used, for example, in the Mojave Basin adjudication. In this case, an "initial" aggregate water right total was established that was purposefully higher than the estimated safe yield. The watermaster was authorized to reduce the allowable extractions until they came into balance with the estimated safe yield. Under the program in Mojave, allocations can be reduced by up to five percent from the previous year's allocation based on aquifer conditions (EDF and Mammoth Trading, 2017).

Additionally, given the lack of historical pumping data in many locations, and the likelihood that improved monitoring and modeling efforts will certainly increase understanding of basin conditions over time, incorporating mechanisms into GSPs that allow for adjustments to allocations overtime should be considered as an "adaptive management" approach. This could be done, for example, by building requirements into the GSP to review the basin's sustainable yield and associated allocations at set intervals (e.g., every five years) based upon observed basin conditions.

The Role of Counties in Groundwater Management

While counties have generally not attempted to regulate groundwater extractions (except with respect to well drilling, abandonment standards, and health and safety concerns), increasing demands on groundwater have inspired counties to become more proactive in groundwater management over the past 20 years. In particular, many counties have become concerned with potential mining of groundwater resources and have enacted ordinances prohibiting or conditioning

exportation of groundwater from the county in which it was pumped. Some have even gone so far as limiting movement of groundwater from one subbasin to another within the county. Counties also have direct land use authorities pursuant to their general police powers. In areas of critical overdraft, under certain conditions, counties could prohibit development without a demonstrable and sustainable water supply or adopt ordinances that coincide with and compliment the GSA's allocation authorities under SGMA.[13]

The extent to which counties can or will regulate groundwater in the future is an open question in light of SGMA. In part, the courts found that regulation of groundwater is within a county's police powers because it had not otherwise been preempted by comprehensive statewide groundwater legislation. Now that SGMA is law, that rationale may no longer apply. In addition, county groundwater ordinances may conflict with management under SGMA, in which cases, resolution of conflicts between GSAs and corresponding counties may be warranted.

Box 6 - Examples of County Groundwater Ordinances

#1 The Merced County ordinance precludes the mining of groundwater within the unincorporated areas of the county, in excess of extraction patterns established between 1995 and 2013, in place as of the date of adoption of the ordinance. The provision shall prohibit the construction of wells and the export of groundwater from the respective groundwater basin in which it originates.

#2 The Kings County ordinance provides that a permit is required to export groundwater from the basin of origin for use outside the boundaries of the groundwater basin from which the groundwater originates, or for use outside of the Tulare Lake Hydrologic Region. Specific findings of no impact are required for a permit to be issued.

Adjudicated Water Rights under SGMA

In 2015, largely as a "follow on" to the enactment of SGMA, two bills - AB 1390 and SB 226 - were enacted and became law on January 1, 2016. Those two bills restructured the groundwater adjudication process in California by attempting to streamline the process and to provide clarification as to how adjudications relate to SGMA. These laws require that any judgments issued in an adjudication be consistent with SGMA and allow the courts to issue preliminary orders to achieve consistency. Among other things, these bills allow GSAs, cities, counties, and the State to intervene in adjudication actions and require the court to manage proceedings consistently with the timeframes laid out for groundwater sustainability in SGMA (Langridge, et al., 2016).

Under SGMA, unreconciled differences over GSP provisions are likely to result in adjudications. However, even with the new legislation, adjudications will remain complex, lengthy, and expensive to pursue (Ayres et al., 2017).

Conclusions

The California law of groundwater is complicated and, in some cases, ambiguous and confusing. The decision of the courts, whether by judgment or consent decree, have often applied groundwater law subject to recognized, albeit ambiguous, principles of equity. Implementation of the allocation approach recommended here will require significant effort by GSAs in a variety of ways. More data and information will be required to make allocations consistent with the law and to best inform local circumstances. Significant outreach will also be required with stakeholders to explain the law, information requirements, and how the method of allocation will impact the subbasin, and its landowners and its water users.

Notwithstanding these difficulties, if GSAs spend the time and exert the effort on the front end of the process to adopt allocation formulas consistent with common law principles, they will hopefully be more legally defensible, equitable, and respectful of each landowner and pumpers' legal rights. If an adjudication ensues, the GSAs will be able to intervene and assert that they have made allocations consistent with the law, and this assertion will have a high probability of being validated by the court.

Endnotes

1 The terms "basin" and "subbasin" are interchangeable under the definition in SGMA.

2 This number reflects the California Department of Water Resources - California Groundwater Elevation Monitoring, Basin Prioritization Process released in June 2014. In 2016, DWR released Basin Boundary Modifications, which, under SGMA, requires DWR to reassess basin prioritization. Draft 2018 prioritization results has changed the status of some basins and the final basin prioritization is expect in February 2019.

3 The references to rights related to groundwater are not intended to provide legal advice and should not be relied upon for that purpose. Please consult a lawyer for legal advice. These references are intended to provide context for the discussion of allocations of groundwater in the context of SGMA.

4 Many counties have adopted groundwater ordinances that may restrict the appropriation and/or movement of groundwater. See discussion later in the paper.

5 An adjudication or other court proceeding is necessary to confirm the existence and scope of prescriptive rights. *See Box 5 - Groundwater Adjudications in California*

6 The term "vesting" refers to pumping that occurs during the necessary period to establish the prescriptive right (i.e. five years).

7 Analysis provided by Russell M. McGlothlin Brownstein Hyatt Farber Schreck, LLP.

8 Use of the term "pumping allocations" in this section is intended to mean that GSAs have exercised their authority to impose pumping limitations and not that they have made a final determination of individual rights to groundwater.

9 The examples of allocation methodologies are not intended to be exhaustive. They are intended to illustrate the range of methods that GSAs have begun to explore.

10 Variations of this method could base allocations on actual pumping over a defined period of irrigation (i.e. historic, recent, etc.). The allocation could also be based upon applied water for irrigation regardless of water source (i.e. surface or groundwater).

11 Decision tree graphic developed with helpful input from Andrew Ayres, Environmental Defense Fund.

12 Known providers include Aquaoso (aquaoso.com), AquaShares (aquashares.com), Center for Economic Research & Forecasting, California Lutheran University (www.clucerf.org), Mammoth Trading (mammothtrading.com), North American Water Exchange (nawex.co), and Waterfind (waterfindusa.com)

13 County ordinances should be structured in a manner that takes into account potential takings claims.

14 This alternative assumes that the allocation is made based upon historic pumping without determining the basis of the right to pump. Historic pumping could include a combination of rights.

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