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MANAGED AQUIFER RECHARGE

MAR AS A MECHANISM TO ADVANCE WATER POLICY GOALS: A PERSPECTIVE

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Introduction

The imbalance between water supply and demand is of growing concern globally. Rarely a day goes by without news about the dwindling surface water supplies, with the Colorado River as the poster child. Coverage of approaches to addressing the supply/demand imbalance is broad, with strategies including augmentation, reuse, market mechanisms, and conservation. The dialogue involves not only diminishing surface water supplies but also the increasing role of, and threats to, groundwater — which accounts for 99% of Earth's liquid freshwater (UNESCO World Water Assessment Programme 2022, *see* References, below). Not coincidentally, heightened dialogue on groundwater has coincided with World Water Day's 2022 theme: "Groundwater — Making the Invisible Visible" and the annual *United Nations World Water Development Report* with the same moniker. Next August, the annual Stockholm World Water Week has the theme of "Seeing the Unseen: The Value of Water." Next December, the 2022 UN-Water Summit on Groundwater will continue 2022's global focus on groundwater.

A key component of discussions regarding groundwater, including conjunctive management of groundwater and surface water, is **m**anaged **a**quifer **r**echarge ("MAR" — sometimes referred to as artificial recharge). MAR is increasingly being recognized as an important mechanism for addressing water quantity and/or water quality concerns. The 2021 compendium *Managing Aquifer Recharge - A Showcase for Resilience and Sustainability* (2021 Compendium) defines MAR as "intentionally replenishing aquifers to stabilize water storage and improve water quality" (Zheng, Ross et al. 2021, 16). Alternatively, Australia's National Guidelines for Managed Aquifer Recharge define MAR as "the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. It is not a method for waste disposal" (Natural Resources Management Ministerial Council, et al. 2009, 1). MAR "…can be done in a myriad of ways that respect other uses of water or harness otherwise wasted water. The enthusiasm for MAR schemes and their popularity and success are enhanced by significant auxiliary benefits such as in protecting against seawater intrusion, improving environmental flows, banking water for drought relief and purifying water through natural processes" (Zheng, Ross et al. 2021, 16). As noted by Dillon et al. in the editorial paper for the volume, *Managed Aquifer Recharge for Water Resilience*: "Managed aquifer recharge…is part of the palette of solutions to water shortage, water security, water quality decline, falling water tables, and endangered groundwater-dependent ecosystems. It can be the most economic, most benign, most resilient, and most socially acceptable solution, but frequently has not been implemented due to lack of awareness, inadequate knowledge of aquifers, immature perception of risk, and incomplete policies for integrated water management, including linking MAR with demand management. MAR can achieve much towards solving the myriad local water problems that have collectively been termed 'the global water crisis'" (Dillon, Fernández Escalante et al. 2020, 12).

Managed Aquifer Recharge

Policy Aspects

Regulatory Frameworks

Context

Recharge

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Growing along with the stresses on groundwater and surface water systems is the increasing interest in learning about MAR practices. As someone who has worked on policy aspects of MAR for about 30 years, I jump at the chance to share information on the role MAR can play in furthering water policy goals, with the hope that the information and insights shared are useful to others working on MAR. It is with this objective that I offer this perspective article, the content of which is based on several recent contributions to the MAR dialogue. In addition to contributing to the World Water Development Report and the two compendia cited above, I have recently participated in three conferences/workshops that have explored technical aspects (i.e., the how) of MAR, along with policy aspects (i.e., the why). At the March 2022 "International Conference on Water Resources Management and Sustainability: Solutions for Arid Regions," held in Dubai, The United Arab Emirates, I delivered a keynote opening lecture, "Managed Aquifer Recharge in Semi-Arid Regions." At the April 2022 11th installment of the triennial "International Symposium of Managed Aquifer Recharge" (ISMAR), held in Long Beach, California, I organized the first-ever ISMAR workshop on governance and policy aspects of MAR. This workshop featured experts from the US and abroad who informed participants on how sound MAR governance and regulatory frameworks can facilitate meeting jurisdictional water management goals. I also organized a conference plenary panel on "MAR in Action." Finally, at the May 2022 workshop on "The Future of Managed Aquifer Recharge in the United States" (convened by two boards of the National Academies of Science, Engineering, and Medicine) my contribution considered the regulatory framework for MAR.

After providing a brief overview of MAR work globally, this article focuses on Arizona as a case study. After addressing Arizona's regulatory framework and successes, the article concludes with consideration of some outstanding issues.

MAR Information Resources

SOME CONTEXT AND A GLOBAL OVERVIEW

Context is important to understanding "on-the-ground" water policy and management. Of course, the water cycle, the scale and jurisdictional features of the geographic setting, and location of water demands and supplies are key determinants. Societal values and the legal framework, including the degree of (de)centralization of decision-making, are key factors as well. Increasingly, the interconnected nature of water challenges with other problems — such as climate change, poverty, and geopolitics — necessitates working intensely over time on a solutions pathway. Indeed, the problems (often termed "wicked water problems") rarely have quick or easy solutions (Beutler 2021). Understanding how MAR can be part of the suite of strategies addressing the problems has been aided by the publication of international volumes of MAR case studies.

Recharge is the process of adding water to an aquifer. Recharge happens naturally from precipitation and streamflow, incidentally after various human uses (such as irrigation uses or leaks in water lines), and intentionally through facilities or projects that are developed for the purpose of adding water to an aquifer. It is this last type of recharge that is considered managed aquifer recharge. Since 2001, The International Association of Hydrologeologists (IAH) has hosted a Commission of scientific experts focused on "Managing Aquifer Recharge." According to IAH's website, the MAR Commission aims to expand water resources and improve water quality in ways that are appropriate, environmentally sustainable, technically viable, economical, and socially desirable. It will do this by encouraging development and adoption of improved practices for MAR.

The MAR Commission fulfills its mission by:

- Increasing awareness of MAR among IAH members and the greater groundwater community
- Facilitating international exchange of information between members
- Disseminating results of research and practical experience
- Informing policy development that enables benefits of MAR to be realized
- Facilitating members to conceive, undertake, and deliver joint projects of international value

(International Association of Hydrogeologists website).

Over time, IAH MAR Commission members have dutifully furthered these objectives through global collaborations, including those related to conferences and publications. Numerous compilations of papers have emerged, with two recent, freely available volumes providing excellent overviews of MAR in action globally. *Managed Aquifer Recharge for Water Resilience* includes 23 papers based on content of the 10th edition of ISMAR, held in May 2019 in Madrid, Spain (Dillon, Fernández Escalante et al. 2021). The editorial paper for the volume categorizes the papers based on stated goals of the projects, which could be multiple. Thirteen papers covered projects to improve water security (quantity), with an equal number of papers focused on water quality. Only three discussed improving the environment, and nine were about assessing MAR opportunities. Though not a complete or necessarily representative sampling of types of projects presented at the ISMAR10 conference, these papers draw from experiences in at least 16 distinct geographic areas and illustrate a wide range of management objectives.

Managed Aquifer Recharge

Adapting Solutions

Case Studies

Negative Lessons

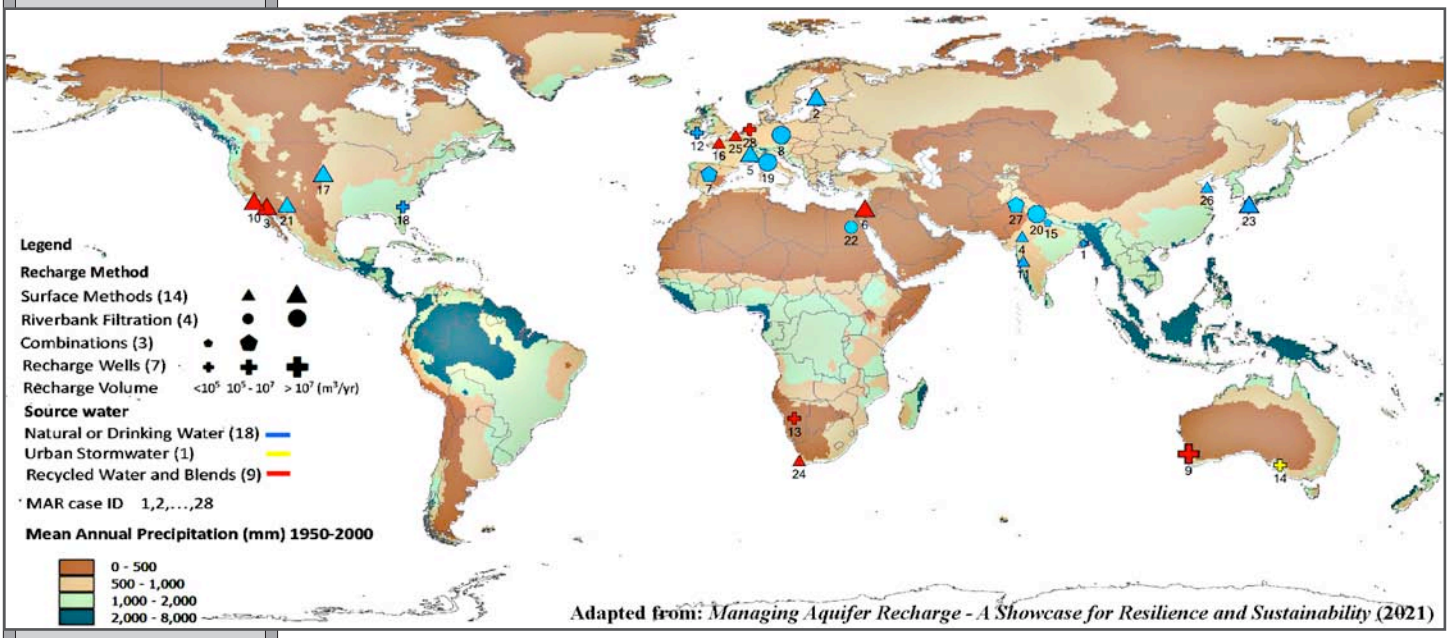
A collaboration of the IAH MAR Commission with the UNESCO Intergovernmental Hydrological Programme and the Groundwater Solutions Initiative for Policy and Practice (GRIPP) resulted in the aforementioned 2021 Compendium. This collection of 28 case studies represents 21 different countries. Notably, the USA and India are most represented, each with four case studies.

Comments from the 2021 Compendium's Executive Summary indicate the purposes of the volume:

> This book offers hope. It puts on a pedestal 28 real-life examples where, at village to state level, people have collaborated concertedly to manage their water resources to improve quantity and quality of supplies, while buffering against drought and emergencies. The cases show that precedent is no prerequisite, and are offered to help inspire leaders, and assure followers that people at ground level who develop an understanding of their groundwater can adapt and design workable solutions to sustainably meet their needs. (page 14)

The **locator map below** is adapted from the 2021 Compendium. The map shows that the 28 case studies are predominantly located in more arid regions of the world, where water quantity issues are often coupled with water quality concerns, such as is the case with seawater intrusion. Though it is beyond the scope of this article to provide a detailed summary of the case studies, a webinar featuring an overview by lead editor Yan Zheng, summaries of the four case studies from the USA (Arizona, California, Nebraska, and South Carolina), along with the single Mexican case study, can be accessed at: https://wrrc.arizona.edu/sites/wrrc.arizona.edu/files/WWD-MAR-Combined-2.pdf.

Sharing both positive and negative lessons learned has value, especially for those embarking on MAR. At the Dubai conference, a questioner asked if the written compendia shared problems encountered with MAR projects, explaining that he was working on developing some water projects where developers would benefit from hearing about project performance that did not meet expectations. Articles and project write-ups often do include discussion of challenges, whether they be technical (clogging of basins or injection wells), financial, institutional-legal, or stakeholder related (Bouwer, Pyne et al. 2008).



Permits: 1) Facility 2) Storage 3) Recovery

Recharge Types

Arizona MAR

The Regulatory Context

Arizona's 1980 Groundwater Management Act established groundwater regulation in areas of the state designated as Active Management Areas. Mid-1980s legislation introduced a legal framework for recharge and recovery, which was updated in 1994. The statutory framework for managed aquifer recharge is titled "Underground Water Storage, Savings and Replenishment Program." In fact, MAR is not a term officially used by the Arizona Department of Water Resources, the agency charged with implementing and enforcing the Groundwater Management Act. Written on extensively, the statutory framework includes three types of permits: facility; storage; and recovery (Megdal 2012 and Megdal, Dillon, et al. 2014). There are two categories of facilities: 1) **u**nderground **s**torage **f**acility (USF); and 2) **g**roundwater **s**avings **f**acility (GSF). USFs are where what may be called "direct" recharge occurs and include constructed infiltration basins and injection wells. GSFs are where what could be considered "indirect" recharge occurs: a water source (surface water or effluent) is used in place of groundwater that would have been used, thereby "recharging" the aquifer through the non-use of groundwater. A GSF is most often an irrigating entity, but can also be an industrial water user, such as a mine. GSF's have different permitting requirements (Arizona Department of Water Resources 2022).

Managed Aquifer Recharge

"Managed Recharge"

Facility Permit

Storage Permit

Recovery Permit

Marketable Asset

Predictability

Required Principles

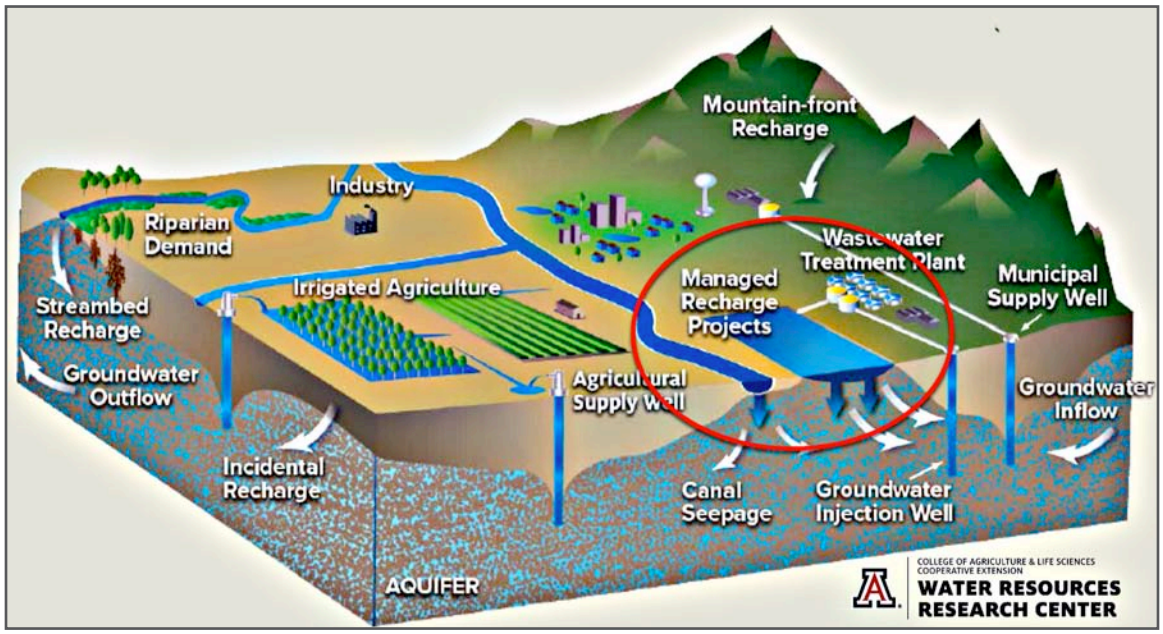
Interestingly, there is a third type of USF which is called a "managed recharge" USF. Managed recharge is when a natural streambed is used for recharge. I have always had a problem with this nomenclature, not because of its similarity to what is commonly referred to as MAR but because these facilities are not required to have the operational management required of constructed infiltration basins. Though permitted, with recharge carefully measured, these streambed facilities are closer to "unmanaged" from an operational point of view.

A facility permit, whether for a USF or for a GSF, is typically held by the facility operator. The facility permit establishes the permitted volume and operating and monitoring requirements. Water quality requirements vary by the water source for recharge, with the Arizona Department of Environmental Quality review required for storage of Colorado River water delivered through the Central Arizona project, but an aquifer protection permit required if effluent is to be stored at the facility (Arizona Department of Water Resources 2019).

Storage permits, on the other hand, are applied for by those intending to store water at a facility. Multiple entities can hold a storage permit for a given facility; the permitted volume gives the holder of the permit the potential opportunity to store up to the permitted amount at the facility. The totality of permitted storage volume at a facility may exceed the annual permitted capacity of the facility. However, the amount of actual storage each year may not exceed the facility's annual permitted volume. Stored water accounting, which is carefully done annually, depends on any evapotranspiration deductions and the timing of recovery.

A recovery well permit must be issued in order to recover stored water. Permitting considerations differ depending on whether the recovery well is within or outside of the stored water's area of hydrologic impact. If stored water is recovered in the same calendar year in which it was stored, the water use is considered "Annual Water Storage and Recovery" and there is no "cut" to the aquifer. If stored water remains as of December 31 of the year in which the water was stored, a five percent cut to the aquifer is typically assessed before a **l**ong-**t**erm **s**torage **c**redit (LTSC) is accrued. Recovered water bears the legal character of the stored water, regardless of where it is recovered. LTSCs likely represent the most marketable water asset in Arizona. They can easily be bought and sold, provided the associated water recovery occurs in the same Active Management Area as the storage (Bernat, Megdal et al. 2020).

Though seemingly complicated, key to Arizona's regulatory framework is the predictability it provides once permits are issued. It is clear who is responsible for operating recharge facilities, which may be different than those storing the water and gaining the credits for the stored water. It is clear who has annual reporting responsibilities for which actions. And it is clear who has legal right to recover the stored water. Knowing who is doing what MAR-related activities when and where is critical to the utilization of MAR as a water management mechanism. Whether or not the details of the Arizona framework are transferrable to other jurisdictions, the principles of clarity, predictability, and reporting are important elements to incorporate. As with any activity, the rules of engagement are of critical importance. Of course, I should acknowledge that having the hydrologic conditions conducive to storage and recovery and the water source(s) for storage are absolutely fundamental prerequisites of a successful MAR effort!



Managed Aquifer Recharge

CAP Water

Under Utilization

Uneven Access

Groundwater Replenishment

Colorado River Utilization (Banking)

MAR to Arizona's Rescue

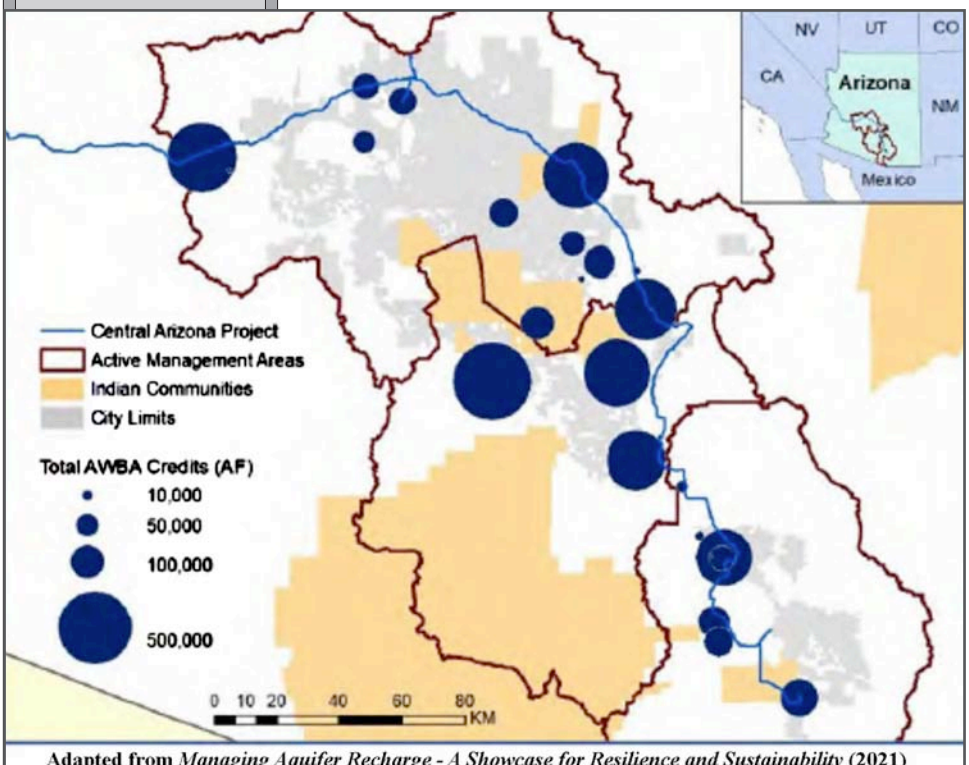
It is hard to believe that about 30 years ago, Arizona was flush with Colorado River water. Following some very wet years, the Central Arizona Project (CAP) canal was nearing completion. Utilization of water delivered through the CAP canal, known as CAP water, was well below annual entitlements. The problem was significant underutilization of CAP water relative to available water, as opposed to the significant shortage of Colorado River water currently being experienced. In the first half of the 1990s, dialogues, debates, and actions ensued on: what to do about this underutilization; the economic implications of completion of the canal, including the unaffordability of CAP water for farmers; and the infrastructure and community fiasco that occurred when Tucson Water replaced half of all its heretofore groundwater water deliveries with treated CAP water (Megdal and Forrest 2015) (McGuire and Pearthree 2020). In Nevada and California, as in Arizona, water demand was only expected to grow. Use of Arizona's regulatory framework for MAR was a key component to addressing several challenges. The following briefly summarizes how MAR assisted in addressing some key water challenges.

Challenge 1: Uneven Access to CAP Water for Central Arizona Builders and Developers

The 1980 Groundwater Management Act required an assured water supply program in order to curtail development's dependence on mined (over-drafted) groundwater. CAP water was key to Central Arizona's switch to renewable supplies. However, some did not have access to CAP water because they were "not there" when CAP water allocations were distributed and/or they were too far from the CAP canal, making access to the water cost-prohibitive. The development community, which was essential to codification of assured water supply rules, required accommodation. That accommodation came in the form of legislative establishment of the Central Arizona Groundwater Replenishment District (CAGRD) in 1993, two years before the formal codification of the Assured Water Supply Rules. The CAGRD allows the MAR framework to be used for replenishment of groundwater pumped to serve new development (Avery, Consoli et al. 2007) (Ferris and Porter 2019). Later discussion summarizes some outstanding issues related to the CAGRD.

Challenge 2: Underutilization of Arizona's Entitled to Colorado River Water

The Governor's Central Arizona Project Advisory Committee was the successor to a Department of Water Resources Task Force on underutilization of CAP water. A key 1995 recommendation of the committee was legislative establishment of the Arizona Water Banking Authority (AWBA). Authorized by the Arizona Legislature in 1996, the AWBA was to make use of recharge to assist with meeting groundwater management goals, enhancing the reliability (firming) of Colorado River water entitlements of certain priorities, and supporting settlement of Indian Water Rights. The agency began operating in 1997. Based on multiple funding sources, partnerships, and federal approval that storing water was a "beneficial use" of Colorado River water, the AWBA through 2019 stored almost 4.3 **m**illion **a**cre **f**eet (MAF) of Long-term Storage Credits, with almost 3.7 MAF on behalf of intrastate entities and over .6 MAF for interstate purposes involving Nevada (Arizona Water Banking Authority). The AWBA, along with others, has stored large quantities of water at GSFs, where the cost per acre-foot of storage is lower than that associated with USFs. The main cost is that associated with buying down the cost of the surface water used in place of groundwater for the agricultural partner. Almost 55% of AWBA's LTSCs emanated from GSF storage. This large amount of storage, and that of others who have partnered with GSF operators, helped



Adapted from *Managing Aquifer Recharge - A Showcase for Resilience and Sustainability* (2021)

Arizona Water Banking Authority Storage Locations

Managed Aquifer Recharge

Storage Benefits

Public Concerns

Storage & Recovery

Blended Water

Long-Term Storage

Flexibility

Extinguishment

Hydro-Disconnect

Groundwater Depletion

address in a substantial way the problem of CAP water affordability for agricultural use. However, GSF storage by the AWBA occurs only if CAP water is available to the AWBA. Colorado River shortage conditions have eliminated the availability of CAP water for AWBA storage. Of key importance is that the millions of acre-feet of LTSCs are available for when Colorado River shortage conditions deteriorate enough to trigger recovery of the stored water. In fact, AWBA storage is one of the reasons central Arizona cities and towns holding CAP contracts for Municipal & Industrial priority water are not panicking. The deposits into the AWBA are there, underground.

Challenge 3: Tucson's Problem with Public Acceptance of Direct Delivery of Treated CAP Water

Direct delivery of treated CAP water resulted in some instances of cloudy tap water and the bursting of some homeowners' pipes. Public resistance to direct delivery of treated CAP water became fierce. Public confidence in Tucson Water, the utility serving 80 percent of Tucson metropolitan area residents, sank. In 1995, City of Tucson residents took things into their own hands by passing an initiative limiting the utility's ability to utilize Tucson's first large-scale surface water treatment plant. Tucson had previously relied on pumping groundwater for meeting potable water demands and, responding to the public pressure, Tucson Water moved to an all-recharge plan for CAP water utilization. Tucson Water made use of the aquifer below Avra Valley farmland it had purchased several years earlier (for the groundwater rights) to develop a large-scale storage and recovery system. Rather than utilizing the treatment plant it had built and operated for a short time, CAP water would be delivered to large spreading basins. There, after reaching the water table hundreds of feet below, the soil-aquifer-treated surface water would blend in situ with very good quality groundwater. A system of recovery wells would be built in the same area to transport the water back to the point at which they had intended to deliver the conventionally treated CAP water. This blended water met the quality requirements established by citizen action and, most importantly, met with public acceptance. Deployment of the Avra Valley system of storage and recovery has enabled Tucson Water to use the region's basin-fill aquifers for not only annual delivery of CAP water but for storage for the long-term. Tucson is now drought-ready with about five years of water demand in storage and pumping capacity in place.

These summaries provide key, but by no means the only, examples of how the MAR framework has helped Arizona address some key water challenges. Arizona's regulatory framework for MAR has been there for water managers to utilize. However, some concerns exist and some issues have not been addressed. As noted above, many water problems do not have quickly identified, implementable solutions.

Outstanding Issues

Arizona's MAR regulatory framework includes quite a bit of flexibility in the location of storage and/or recovery, *provided* the various permit conditions are met and storage and recovery occur within the same Active Management Area (AMA). The stored water associated with an LTSC can be recovered anywhere in the same AMA as the storage, so long as the well is permitted for recovery. There is also the opportunity to purchase a LTSC for extinguishment, when, for example, the CAGRD must replenish, after the fact, what is reported as excess groundwater pumping. Then, no active recovery is required because the water pumping already occurred. Instead, the LTSC is extinguished; that it, it is taken off the books. The regulatory framework provides other opportunities. For example, it has been used voluntarily via intergovernmental agreement with Arizona by the sovereign Gila River Indian Community (GRIC) to further GRIC's achieving its water priorities (Hauter and Mock 2021). But flexibility can be a two-edged sword. The following are some outstanding issues related to Arizona's use of MAR to meet water policy objectives. I caution the reader against being discouraged by the following discussion. Wicked water problems require continuous attention.

Outstanding Issue 1: The Hydrologic Disconnect Between Pumping and Storage

The flexibility in location of recovery can be advantageous when recovery outside the area of hydrologic impact is desired. Often the hydrologic disconnect between pumping/recovery and the storage is not desirable. Arizona's assured water supply program allows localized drawdown of aquifers, and there are questions about what happens when depth to water gets too large for pumping to be economic. This long-recognized issue has been difficult to address. A committee of the Governor's Water Augmentation, Innovation, and Conservation Council (Governor's Council) defined the Hydrologic Disconnect problem in 2021 as the following: "The storage and recovery of water supplies in hydrologically disconnected areas within AMAs has the potential to create or worsen localized groundwater depletion. Similar issues may arise in the context of hydrologically disconnected pumping and replenishment to meet requirements of the Assured Water Supply Program" (Governors Water Augmentation Innovation and Conservation Council Post-2025 AMA Committee 2021). Due to the

Managed Aquifer Recharge

long-standing dependence on the current framework and the lack of agreed-upon approaches for reducing the disconnect, addressing the undesirable implications of localized aquifer drawdown has been elusive.

Safe Yield

Outstanding Issue 2: The Implications of the Popularity of the CAGRD for Meeting the Assured Water Supply Program's Requirement that Groundwater Use be Consistent with the AMA Management Goal

A key aspect of the 1980 Groundwater Management Act was specification of management goals for the Active Management Areas. The CAGRD operates in Central Arizona for the benefit of the Phoenix, Pinal, and Tucson AMAs. Safe-yield —the attempt to balance groundwater withdrawals with natural and artificial recharge — is the statutorily defined goal for the Phoenix and Tucson AMAs, with 2025 specified as the year for meeting the goal. The Pinal AMA statutory management goals allow for groundwater overdraft to preserve the agricultural economy as well as preserve groundwater for future non-agricultural use. In all three AMAs, membership in the CAGRD has been robust and the CAGRD has future replenishment obligations that exceed the CAGRD's current claims on water supplies for replenishment. The committee of the Governor's Council that considered the hydrologic disconnect also formulated an Issue Brief on the CAGRD. That agreement on the issue statement was not possible is indicative of how challenging it will be to come up with any modifications as to how the CAGRD functions, especially any proposals to limit membership. Even without expansion of the replenishment obligation due to membership growth, concerns exist about the supplies available for replenishment to the CAGRD, including questions regarding the projections for replenishment water availability and costs. The fundamental disagreement of parties as to the extent to which the dependence on and growth of the CAGRD is a problem renders agreeing on any solutions nearly impossible.

Replenishment Obligations

Outstanding Issue 3: Recovery, Including Multiple Straws in the Aquifer

Due to the temporal disconnect between storage and recovery, especially recovery of water stored by the Arizona Water Banking Authority, regional recovery planning initially took a back seat to other recharge matters, such as getting facilities built. It was argued that it did not make a lot of sense to develop a detailed recovery plan when that plan could well be outdated before recovery was envisioned. Last decade, the AWBA, the Arizona Department of Water Resources, and the Central Arizona Project collaborated on an 81-page recharge plan (Arizona Water Banking Authority, Arizona Department of Water Resources et al. 2014). In 2021, the agencies issued a 199-page updated joint plan (Arizona Water Banking Authority, Arizona Department of Water Resources et al. 2021). Recovery planning is necessarily complex. The complexities of the institutional interrelationships are clearly beyond the scope of this perspective article. What is noteworthy is that the recovery plan's importance grows larger with each month of declining water levels in Colorado River's two large storage reservoirs — Lake Powell for the Upper Basin and Lake Mead for the Lower Basin. Declines in the water levels of Lake Mead have become so severe that a Tier 3 shortage — once considered not very likely prior to the 2026 expiration of the US Bureau of Reclamation's "*2007 Colorado River Interim Guidelines for Low Basin Shortages and Coordinate Operations for Lake Powell and Lake Mead*" — is becoming more probable as early as 2024. According to the 2007 Guidelines, a Tier 3 shortage would trigger cutbacks of CAP water deliveries to holders of Municipal & Industrial (M&I) Priority, those for whom the AWBA has been storing water. With the Lower Basin Drought Contingency Plan overlay to the 2007 Guidelines, M&I priority water deliveries are expected to be cut modestly under a Tier 2b shortage (Arizona Water Banking Authority 2021, 30) (United States of America, Colorado, et al. 2019).

Recovery Planning

Shortage Triggers (M&I)

Simultaneously, Arizona Department of Water Resources groundwater modeling for the Pinal AMA has called into question the recoverability of some amount of long-term storage credits accrued through GSF storage, something I must admit I do not fully understand. With a LTSC comes the right to recover that water. Regardless, this is an important point related to expectations regarding recovery of water stored at groundwater savings facilities. The area of hydrologic impact for a GSF is the boundary of the facility. For a farmer or irrigation district, that means the lands where farming occurs. Though groundwater was saved by the water storage, and there is a holder of the LTSC by the partner who provided the surface water to the farming entity, the farming entity never gave up its grandfathered irrigation right — i.e., its right to pump groundwater. As Tier 1 shortage cutbacks reduce surface water availability to Pinal AMA farmers, those not fallowing their fields are returning to groundwater pumping. Their grandfather irrigation rights to pump groundwater exist in perpetuity. So long as their pumping adheres to groundwater regulations in terms of annual quantities, conservation requirements, and depth to groundwater restrictions, they can pump indefinitely. While economic considerations or quality considerations might intervene at any time, the point is that they continue to have the right to have a "straw" in the aquifer — at the same time there may be intentions to recover water pursuant to long-term storage credits held in the Pinal AMA. This is an outstanding issue.

Recoverability Issue

Groundwater Irrigation Rights v. Storage Rights

Managed Aquifer Recharge

Conclusion

This perspective article is designed to provide a glimpse of the role of MAR globally and for Arizona. Though not comprehensive — even for Arizona — I have provided examples of how the Arizona water community has been innovative and forward-looking in its approach to MAR. Conjunctive management of Colorado River water delivered through the Central Arizona Project has occurred in a state where surface water law and groundwater law are disconnected (administratively). Members of the Arizona water community have worked in partnership with those within and outside its jurisdictional boundaries to use the storage capacity of Arizona aquifers to the benefit of many.

Groundwater is a finite and invisible resource. Surface water availability is being adversely impacted by the changing climate. The One Water concept, where all water sources are considered when planning future water use, is highly relevant as the Colorado River Basin and other regions grapple with addressing the imbalance between demand and supply. We need all hands on deck and all contributing to understanding the potential role of the various tools in the toolbox. Though the use of the tools will depend on the individual circumstances, I hope that this perspective article on managed aquifer recharge as a mechanism to further water policy goals is helpful.

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Gila River Indian Community MAR 5 at Ceremonial Opening, March 2019

MAR 5 Recharge Project: October 2021

Photos by Sharon Megdal

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Kansas Groundwater

Over-Appropriation

Conjunctive Management

"All Water" Included

Appurtenant Property Right

Enforcement of Rights

Public Interest

High Plains Aquifer

KANSAS GROUNDWATER

TOOLS, TIPS, & LESSONS FOR MANAGING A DECLINING RESOURCE

by Kenneth Titus, Kansas Department of Agriculture (Manhattan, KS)

Introduction

Kansas has a long history of taking affirmative legislative steps to manage the state's water resources. Although some legislative attempts have been more successful than others, Kansas history provides some lessons in how to approach the management of over-appropriated water sources. Kansas has long recognized the connection between surface water and groundwater, the need to balance preservation and beneficial use of those resources, and the need for good data in order to make informed decisions. In addition to legislatively enacted tools available to state administrators, Kansas law continues to recognize the key role that local leaders and individual water users should play in determining the future of water resources in the state. The same tools that Kansas has employed to conjunctively manage water resources and meld centralized regulatory authority with local control can also provide solutions to other over-developed regions.

Foundations of the Kansas Water Appropriation Act (KWAA)

Several ideas central to the KWAA have set Kansas apart from other Western states since the law's passage in 1945. Importantly, when it comes to conjunctive management of surface water and groundwater supplies, Kansas has always been forward thinking — at least in a legal sense — even if practical applications of conjunctive management were slow to develop prior to hydrological data becoming more widely available. For example, in one of the Legislature's failed attempts to centralize administrative control of water and embed prior appropriation into law in 1917, the Legislature granted authority over "surface or underground waters" to a water commission. Contrast this to the 1920 Nebraska constitution, which limited state authority over water to every "natural stream." While this early attempt at adopting a prior appropriation system into state law was unsuccessful, the idea that surface water and groundwater was connected ultimately carried over to the KWAA in the form of a legislative mandate that "all water within the state" is dedicated to the use of the people and a directive to the chief engineer to administer the appropriation of "surface or groundwater." K.S.A. 82a-702 and K.S.A. 82a-707.

The Legislature was also clear in implementing the KWAA that appropriations did "not constitute ownership of such water" but rather are an appurtenant property right to use the water under certain conditions put in place by the state. K.S.A. 82a-707. Both these elements of the KWAA mark a critical distinction between Kansas and states that initially failed to recognize the relationship between ground and surface water. For example, laws in Arizona, California, and Texas treated groundwater more like personal property than a shared resource, and those states have subsequently had to create laws and regulations to try and undo years of unregulated development.

Finally, the chief engineer is empowered to enforce the KWAA in order to protect and enforce the basic attributes of each water right. Each water right in Kansas has a point of diversion, rate of diversion, place of use, type of (beneficial) use, priority number (seniority), and an authorized quantity. The chief engineer is authorized to ensure that each water right is able to divert its authorized quantity at its authorized rate of diversion according to its priority. The chief engineer also ensures water is not put to an unauthorized use or applied to unauthorized acres (place of use). In addition, the chief engineer may condition the approval of any new water right with any terms and conditions that may be necessary to protect the public interest. K.S.A. 82a-712. These foundational aspects of the KWAA would eventually allow for the implementation of some important basic tools for the management of water over the life of the KWAA, but it would take some time for practical implementation of these tools to gain traction.

Era of Over-Appropriation

Even with good foundational law, Kansas was unable to avoid early over-appropriation of the High Plains Aquifer. When the KWAA passed in 1945, development of Kansas' extensive groundwater resources was just beginning to gain momentum. At that time, the chief engineer was required to approve all applications for appropriations, within reasonable limitations, that did not conflict with existing uses, did not unreasonably affect the public interest, and did not impair an existing right. G.S. 82a-711 (1949). However, as groundwater use for irrigation purposes began to increase in the central and western parts of the state, a study commissioned by the Legislature determined that strict application of these standards

Kansas Groundwater

Impairment Definition

New Applications Only

Resource Depletion

Civil Enforcement

Metering & Reporting

Violations & Compliance

Litigation Rare

Closures (Safe Yield)

Forfeiture

would essentially prohibit full development of the High Plains Aquifer. *See: Report on the Laws of Kansas Pertaining to the Beneficial Use of Water*, Bulletin Number 3, Kansas Water Resource Board (November 1956).

Therefore, in 1957, the Legislature further defined impairment, in G.S. 82a-711, to state that a new use of water will only impair an existing water right by the "unreasonable raising or lowering of the static water level…at the water user's point of diversion beyond a reasonable economic limit." G.S. 82a-711 (1957). Further, G.S. 82a-711a (1957) was adopted, which required that each approved new application include language that "nothing herein shall be construed to prevent the granting of permits to applicants later in time on the ground that the diversions under such proposed later appropriations may cause the water level to be raised or lowered…so long as the rights of holders of existing water rights can be satisfied under such express conditions."

Although beyond the scope of this article, these expansions on the definition of impairment have led to disputes about whether the later-adopted definition should be applied only in the case of applications for new water rights or if it should also apply in the case of a subsequent claim of impairment between existing water rights. To date, Kansas courts have held that the "beyond a reasonable economic limit" standard only applies in the case of new applications. *See*, *Garetson Brothers et al. v. American Warrior*, 51 Kan. App.2d 370 (2015). That means impairment claims between existing water rights are examined under a stricter standard than an application for a new water right. This issue is likely to continue to see legal developments as supplies continue to dwindle.

The Legislature Attempts to Reassert Control

The 1957 developments in the definition of "impairment" were intended to foster the full development of water resources in Kansas, as is the underlying goal of a prior appropriation system. However, it did not take long for the negative aspects of this approach to become apparent. Less than twenty years after the passage of the KWAA, it became clear to the Legislature that the High Plains Aquifer was already on its way to being over-appropriated. Thus began a series of Legislative efforts to slow the depletion of the resource. Some of these efforts took the form of broad grants of regulatory authority to the chief engineer, while others sought to incentivize participation from local water users.

Basic Management Tools: Chief Engineer's Authority

Two of the most important general water resource management tools available to the chief engineer are the ability to monitor nearly all non-domestic water use in the state and the ability to achieve compliance with the KWAA through civil enforcement. In 1957, the Legislature granted the chief engineer "full authority to require any water user to install meters, gages, or other measuring devices" and further authority to read meters or require reports at any time. K.S.A. 82a-706c. Although these requirements were not implemented immediately, local groundwater management districts, and later the chief engineer, eventually put requirements in place that resulted in nearly 100% of non-domestic water rights being metered. A 1988 amendment to the KWAA also made it mandatory for the owners of all non-domestic water rights to submit an annual water use report to the chief engineer. K.S.A. 82a-732. Failure to do so may result in a civil fine or a criminal charge. These statutory monitoring and reporting tools have resulted in Kansas having world-class data on actual water use. They also complement the work of the Kansas Geological Survey, which works with the chief engineer to annually measure more than 1,400 wells in 47 counties over the High Plains Aquifer for the purpose of measuring water level changes.

The KWAA's robust monitoring and reporting requirements allow the chief engineer to be aware of many violations of the KWAA, and those provisions are complemented by the chief engineer's broad authority to enforce the KWAA in ways that incentivize compliance. Since 2001, compliance with the KWAA has been primarily maintained through civil enforcement. K.S.A. 82a-737 gives the chief engineer broad authority to issue fines for any violation of the KWAA, and water rights may also be modified as a result of violations. This often results in a reduction or suspension of authorized quantity in subsequent years. The reporting requirements and civil enforcement tools have led to the establishment of a robust system for ensuring water users do not exceed their authorized quantity. The civil enforcement tools have been so successful that it has become exceedingly rare for a water right dispute regarding use or quantity to end up in the judicial system. Local groundwater districts and the chief engineer also have various methods in place to close areas to new appropriations or implement safe yield standards, which prevents over-appropriation. Traditionally, western states have also enacted laws that allow forfeiture or abandonment of part or all of a water right if it is not put to a beneficial use for a set number of consecutive years. This can lead to a "use it or lose it" mentality that results in pumping water that may not be needed in order to preserve the water right. In 2012, the Legislature addressed this issue by amending the Kansas forfeiture statute to exempt groundwater rights in areas closed to new appropriations from forfeiture. K.S.A. 82a-718.

Kansas Groundwater

Chronic Depletion

Local Groundwater Districts

Management Plans

Mixed Results

Potential

Specific Tools to Address Over-Appropriation

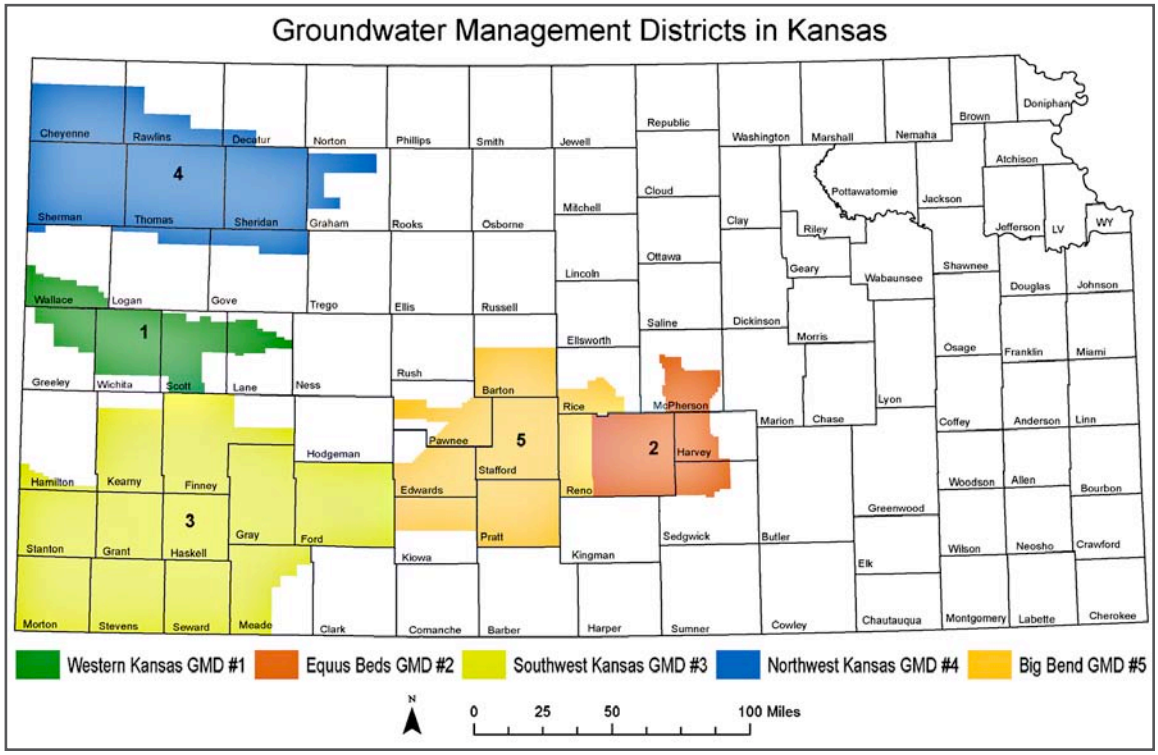
While mandatory metering and water use reporting combined with the chief engineer's enforcement authority have proven very effective for their intended purposes, those tools alone do not per se lend themselves to comprehensively addressing issues of over-appropriation and chronic groundwater depletion. These remaining issues led the Legislature to create frameworks that allowed local leaders, and eventually individual water users, to undertake conservation measures with the goal of stabilizing water level declines long-term.

By the late 1960s, it was clear that declines in the High Plains Aquifer were continuing, despite the developments of the preceding decade. Since the chief engineer at the time was not inclined to expand state regulatory authority to deny applications or close areas to new development, the creation of local groundwater districts to help develop plans for the use of groundwater was authorized. After a false start in 1968, the Groundwater Management District Act, K.S.A. 82a-1020 et seq., was passed in 1972. This led to the creation of five districts that encompass different regions of the state overlying the High Plains Aquifer. Each district has a board elected by water users and some landowners within the district and may tax land and water use. The districts were primarily charged with developing management plans for their areas and could request that the chief engineer adopt specific regulations that would apply only within the district boundaries. The initial results were positive, and over the first twenty years of their existence, these districts:

- closed over-appropriated areas to new applications;
- developed well spacing rules;
- required installation of meters (where the chief engineer had not yet been exercising this authority to its full extent); and
- developed planned depletion policies.

The districts began to assist with compliance and field checks and otherwise were able to complement the groundwater management work the state was doing.

However, the creation of groundwater management districts did not ultimately cure the issue of significant groundwater level declines in the High Plains Aquifer. Many of the efforts the districts undertook to curb development of the Aquifer were not implemented until after over-appropriation had already occurred. Since the initial twenty-year period following their creation, the results from the districts have been quite varied. Some districts are proactively seeking to extend the life of the Aquifer, and others are taking no measurable actions to prevent further water level declines. Despite these mixed results, the districts have the potential to act as powerful catalysts in extending the life of the Aquifer, as evidenced by work in northwest Kansas discussed below.



Kansas Groundwater

Use Control Areas

Public Process

Corrective Controls

Impairment Origins

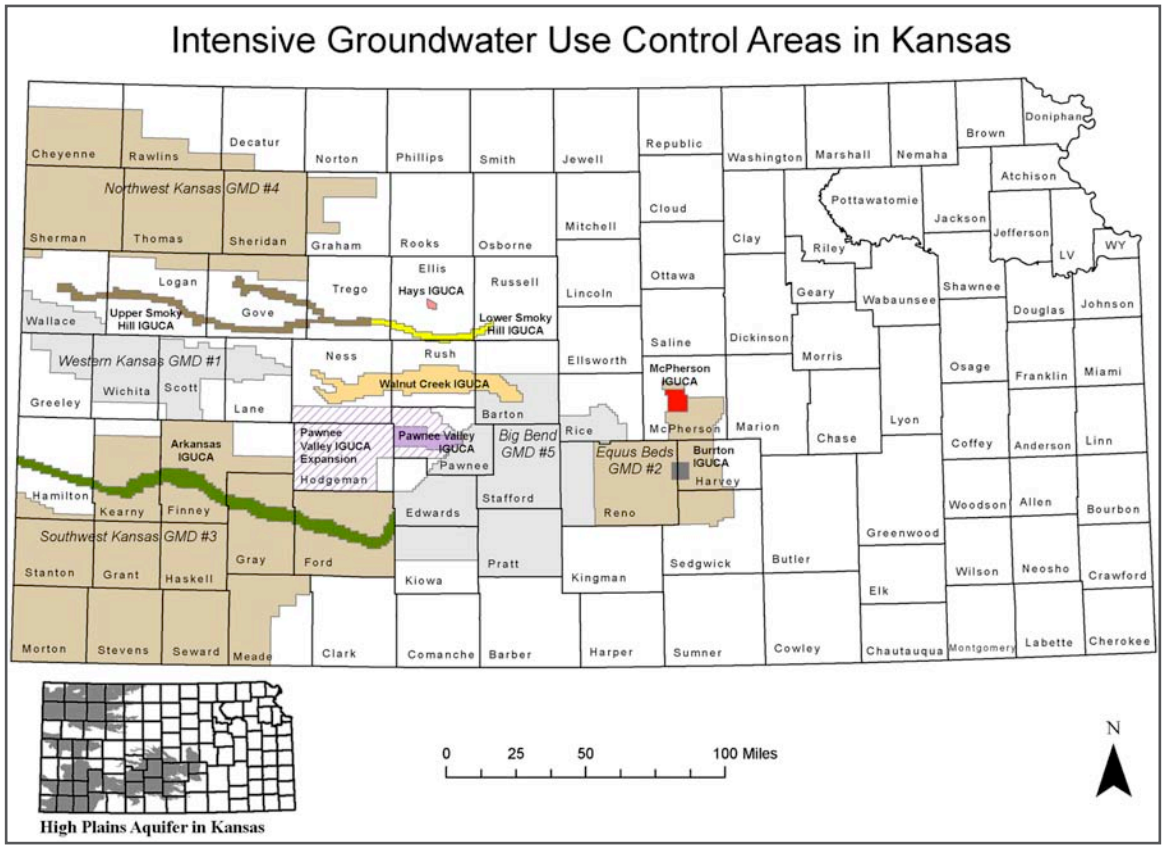
Intensive Groundwater Use Control Areas

Once the groundwater management districts were created, one of the first tools the Legislature provided to help correct over-appropriation was the ability to establish Intensive Groundwater Use Control Areas (IGUCA). K.S.A. 82a-1036 through 1038. An IGUCA proceeding may be initiated either by petition of eligible voters within a district or at the request of a district board. Such a proceeding can also be initiated by the chief engineer on his own initiative when the chief engineer "has reason to believe" that any of the following conditions exist in an area:

> (a) Groundwater levels in the area in question are declining or have declined excessively; or (b) the rate of withdrawal of groundwater within the area in question equals or exceeds the rate of recharge in such area; or (c) preventable waste of water is occurring or may occur within the area in question; (d) unreasonable deterioration of the quality of water is occurring or may occur within the area in question; or (e) other conditions exist within the area in question which require regulation in the public interest. K.S.A. 82a-1036.

Once IGUCA proceedings are initiated, public hearings are held to determine the extent of the problem(s) that the IGUCA will be intended to address, and then additional hearings are held to determine the appropriate corrective controls to address those problem(s). Such corrective controls may include closing an area to new appropriations, rotating the use of existing water rights, or reducing withdrawals. K.S.A. 82a-1038. Eight IGUCAs have been established in Kansas, although none of them have directly addressed the declining High Plains Aquifer, as the Legislature intended when it created the IGUCA framework. Rather, they have been primarily related to water quality issues, municipal supplies, and alluvial systems.

The most interesting of the existing IGUCAs is the Walnut Creek IGUCA. Situated at the bottom of Walnut Creek is Cheyenne Bottoms Wildlife Refuge ("the Refuge"), a system of shallow pools that is a key stopping point for migratory birds that need freshwater ecosystems in the central flyway of the US. The origins of the Walnut Creek IGUCA stem from the impairment of the 1948 senior surface water right that supplies the Refuge and is now owned by the Kansas Department of Wildlife and Parks. Junior groundwater development exceeded safe yield in the area in approximately 1965 as irrigation wells in the alluvium began depriving the senior right of supply in dry years.



Kansas Groundwater

Water Reallocation

Following public hearings in 1991 and 1992, the chief engineer divided water rights in the Walnut Creek alluvium into two classes: "seniors" that had rights prior to the full appropriation of the stream in 1965 and "juniors" that had rights later than 1965. The corrective controls of the Walnut Creek IGUCA imposed on average a one-third reduction in authorized quantity on the senior rights and approximately a two-thirds reduction in authorized quantity on the junior rights. A group of water users in the basin filed a lawsuit challenging the chief engineer's authority to reallocate water in this fashion in a prior appropriation system but ultimately withdrew their petition when it became clear that the alternative to the Walnut Creek IGUCA's allocation scheme was strict administration based on priority. The chief engineer's authority to regulate alluvial groundwater pumping in the Walnut Creek basin due to its connection with and effect on the streamflow in Walnut Creek was never a serious issue of contention, likely thanks in part to the KWAA's early recognition of the conjunctive nature of surface water and groundwater.

Local Enhanced Management Areas (LEMAs)

Severity Concerns

While the IGUCA framework provides powerful tools for slowing water-level declines, it is not without drawbacks. The underlying problem with establishing an IGUCA is that once the proceedings are initiated, the chief engineer is directed to develop a solution to address the problem based on the evidence presented at the public hearings. Should a groundwater management district request development of an IGUCA, the district could not be certain how severe the resulting corrective controls might be. This fear of the unknown, coupled with the potentially high political cost should the chief engineer unilaterally initiate an IGUCA and make cuts in water use, eventually led to a new tool.

New Tool (LEMA)

In 2011, the Legislature authorized the development of Local Enhanced Management Areas (LEMA). K.S.A. 82a-1041. LEMAs were a joint project developed between the chief engineer and the Northwest Kansas Groundwater Management District No. 4 (GMD No. 4). GMD No. 4 wanted to implement IGUCA-like corrective controls to slow groundwater declines, but without the risk of stricter than expected corrective controls being implemented following a public hearing. LEMAs may be established under the same circumstances as an IGUCA (although the broad "other conditions" that require regulation in the public interest was dropped from the LEMA statute), and the same types of corrective controls may be applied. Public hearings are also held as in IGUCA proceedings. The most significant difference between IGUCAs and LEMAs, and a protection for the district that is requesting a LEMA, is that in the case of LEMA proceedings, the board of directors of the district develops a plan with proposed corrective controls and submits it to the chief engineer — any corrective controls approved by the chief engineer following the public hearings cannot be stricter than those contained in the plan. The chief engineer also has the authority to reject a LEMA plan that he finds is insufficient to address any of the prerequisite conditions that exist within the proposed LEMA boundary. K.S.A. 82a-1041.

Control Limitations

The first LEMA was located primarily in Sheridan County and was known as SD-6. This LEMA encompassed a relatively small area — it included a small portion of Sheridan County and only nine sections of Thomas County that had been identified as a high-priority area by the district because of excessive water level declines. After many public meetings, there was broad local support and a consensus to take action in the area. The SD-6 LEMA was ultimately designated, and its corrective controls required water use cuts of approximately 20% within the LEMA boundary. Water savings exceeded that goal during the first five-year term of the LEMA, and the district has now requested the LEMA be renewed for a third five-year term. Further, economic analysis has shown that reducing water use has not resulted in lower profit margins for irrigators since the designation of the LEMA. *See, Monitoring the Impacts of Sheridan County 6 Local Enhanced Management Area, Final Report for 2013-2017*, Bill Golden (November 15, 2018), available at: www.agmanager.info/ag-policy/water-policy/monitoring-impacts-sheridan-county-6-local-enhanced-management-area).

Water Use Cuts

Savings & Success

After the success of the SD-6 LEMA, GMD No. 4 requested the designation of a District-Wide LEMA that applied only in townships that had historically suffered water level declines of more than a half percent annually. The District-Wide LEMA was ultimately designated, and its corrective controls provided various allocations of inches per acre based on levels of decline and geographic location (less precipitation in the western part of the district meant a need for slightly higher allocations). Unlike the SD-6 LEMA, which was compact in geographical size and involved a relatively small number of water users, the District-Wide LEMA included all or parts of ten counties and impacted many more water users.

Although the required reductions in water use were modest compared to those imposed by the SD-6 LEMA, there was formal opposition to the GMD No. 4 District-Wide LEMA that resulted in a state district court challenge. In *Friesen v. Barfield*, 2018-CV-000010, District Court of Gove County, Kansas (2018), the court upheld the LEMA process and key elements of the District-Wide LEMA plan.

Process Upheld

The court found that the LEMA's corrective controls:

- were not required to treat different beneficial uses of water the same
- that the chief engineer was not required to reduce water use only according to priority
- that allocations made on a basis other than priority were not likely to result in uncompensated takings

The case was not appealed, but it stands as the only judicial challenge on the record regarding the

Kansas Groundwater

state's ability to regulate (and reduce) water use as needed under specific circumstances prescribed by the Legislature.

Large Cuts & Local Support

Another success story is the Wichita County LEMA. Wichita County has experienced severe declines in groundwater levels, with projections showing only 15 years or less of groundwater remaining in some areas. Due in part to the need to support a high-value cattle feeding industry within the county, local water users voluntarily banded together in the Wichita County Water Conservation Area (*see* below) to seek cuts in groundwater use of up to 35% over the first seven years, with two subsequent seven-year renewal periods to eventually reach a reduction of 50%. This group eventually served as the core proponents to push the Western Kansas Groundwater Management District No. 1 (GMD No. 1) to develop a LEMA plan, and the Wichita County LEMA was ultimately designated in 2020. In this case, strong local support was able to overcome indecision from the district board to move forward with cuts in water use.

Failed Attempts

There have also been several failed attempts at implementing LEMAs. In 2014, prior to implementing the Wichita County LEMA, GMD No. 1 developed a plan for a district-wide LEMA that would have cut water use by 20% throughout the district and put the plan to a district-wide vote. This type of general vote is not required by law, but the board elected to seek approval of the LEMA plan by two-thirds of the district's eligible voters prior to requesting adoption of the plan by the chief engineer. The plan mustered only 48% of the vote overall but was approved by a majority of voters in three of the district's five counties. The plan was least popular in the counties with the most water use. *See* https://www.circleofblue.org/2014/world/ogallala-water-conservation-setback-western-kansas/.

District Board Opposed

Another failed attempt occurred nearby in the Southwest Kansas Groundwater Management District No. 3 in 2017. Despite the area having experienced some of the largest water level declines in the state, a group of water users north of Garden City in parts of Kearney and Finney counties failed to generate enough support to convince the district board to move forward with a LEMA plan. The board was criticized for failing to support this conservation effort, as it insisted on unanimous or nearly unanimous support from all water users within the district before it would consider requesting adoption of a LEMA plan and otherwise failed to engage with the process in a meaningful way.

Chief Engineer Rejection

The third failed attempt at a LEMA occurred in 2019 in south-central Kansas in the Big Bend Groundwater Management District No. 5 (GMD No. 5). GMD No. 5 attempted to help protect irrigators from the potential impacts of a significant administration of water rights junior to the US Fish and Wildlife Service's (USFWS) 1957 water right for the Quivira National Wildlife Refuge. GMD No. 5 submitted a LEMA plan to the chief engineer that would have required endguns to be removed from all center pivot irrigation systems in the district. However, the plan failed to set any measurable goals for reducing water use. It also failed to clearly state the conditions that necessitated establishment of a LEMA (as groundwater levels were not generally declining throughout the area included in the plan). Ultimately the chief engineer rejected the plan after initial review. Appeal of the rejection was withdrawn after the USFWS and GMD No. 5 reached an agreement on a process to develop an augmentation system to supplement Quivira's water supply. LEMAs have proven to be successful tools for conservation in areas where the local groundwater management district has been willing to commit to reductions in water use, but the several examples of failed LEMAs illustrate the limitations that remain without buy-in from local leadership.

Local Leadership Key

Water Conservation Areas - Consent Agreements

Water User Agreements (Consent)

In 2015, the idea of Water Conservation Areas (WCA) was put forward to support water users who could not persuade their local groundwater management district to take any action towards establishment of a LEMA. K.S.A. 82a-745. The premise was straightforward: a water user would sign a consent agreement or contract with the chief engineer that required a reduction in water use and in exchange could gain flexibility in the way they used their water over the term of each WCA. Some of these flexibilities include the ability to exceed the annual authorized quantity of a water right, the ability to create multi-year allocations, and the ability to carryover unused portions of an allocation to a subsequent WCA. As of 2018, 53 WCA plans had been approved. Those plans cover 85,625 acres and are designed to save 11,951 acre-feet of water per year compared to recent historical use.

Voluntary Reallocations

Some WCAs, such as the Wichita County WCA, involve multiple water users over a larger geographic area and interact with the other conservation tools already discussed. The Wichita County WCA has 26 members who have voluntarily committed to larger reductions in water use than the mandatory reductions imposed on them by the Wichita County LEMA. Smaller WCAs have also proven attractive, as irrigation and livestock users look for flexible ways to use existing rights and conservation minded users seek to officially record their voluntary reductions in water use with an eye toward establishment of future LEMAs (K.S.A. 82a-1041 requires LEMA plans to give "due consideration" to water users who have already undertaken voluntary reductions in water use). As many of the initial five-year WCA terms are expiring or up for renewal, a commonly observed result is a reduction in water use greater than the goal of the original WCA plan. Even as some of these five-year plans are not renewed, it is clear that WCAs are causing permanent changes in behavior when it comes to water use and provide a useful option for water users who want to undertake individual conservation efforts.

Individual Conservation

Kansas Groundwater

Appropriation v. Conservation

Kansas' Tools

Political Willpower

Local Leaders

Good Data

Allocation Flexibility

Land Values

Conclusion

In some ways, Kansas has been progressive in dealing with the management of water in the state. Even those failed early attempts to transition from common law riparianism to prior appropriation show intent to better manage a vital resource. At the same time, the primary goal of a prior appropriation system is to ensure the beneficial use of water, and that is how the vast High Plains Aquifer was over-developed in Kansas. Even as Kansas has at times struggled to balance prior appropriation's emphasis on development with the increasingly apparent need for conservation efforts, the state has a solid statutory foundation to take action. The Kansas Legislature has acknowledged the state's hydrologic realities and has developed tools to address many of the problems that have resulted from over-development. Granting the same state agency authority over surface and groundwater and recognizing the interaction between the two helps avoid many problems that states with bifurcated water laws now face. Mandatory metering, annual reporting requirements, frequent well measurements, civil enforcement of violations, and specific tools to deal with over development are all tools that other states have struggled to replicate.

However, despite the Legislature's recognition that over-appropriation should be reined in by the enactment of IGUCAs, LEMAs, and WCAs, the problem of political willpower remains. Attempts to regulate existing property rights will inevitably meet with pushback, and without good information and local buy-in to big picture solutions, the political cost of taking action has so far proven too high except in a few cases. Accordingly, the following can be said about the successful efforts in Kansas to date: the best solutions are supported by local leaders. Hearing about ever increasing depletions and successful changes in practice from a state administrator or a university professor only go so far — genuine buy-in comes from local experience. The SD-6 LEMA and the Wichita County WCA both started out with a core group of water users in a relatively small geographic area, and, because local consensus was established, those efforts were not challenged in court. By contrast, the district-wide LEMA in GMD No.4 drew a significant legal challenge, and GMD No. 1's attempt at a LEMA was not supported in a district-wide election. These examples illustrate that even in localized areas, failure to get buy-in from a district board or to clearly identify the problem can stop a plan from being developed. The rare exception to this has been in cases like Walnut Creek, where, when faced with the reality of strict priority administration, proportional sharing with flexible allocations suddenly becomes a more realistic solution.

One of the primary ways to develop local support for meaningful water conservation measures is through good data, as quantifying local experiences (both positive and negative) can be persuasive in garnering support for water conservation measures. Kansas water users and regulators have substantially more information available to them regarding water use and the impacts of various policies than many other states do, and such a large data pool has allowed the state to serve as a laboratory for water policies. In addition, the promise of flexibility, such as through five-year allocations, allow for an overall reduction in water use while still allowing a water user to feel protected from a dry season. This is an area where other Western states looking for solutions to the difficult problems of water resource allocation can draw from the experiences in Kansas.

Even beyond basic water use data, it is becoming more accepted that available water is a vital component of future land values (*see The Value of Groundwater in the high Plains Aquifer of Western Kansas*, Nathan P. Hendricks & Gabriel S. Sampson, Kansas State University Department of Agricultural Economics Extension (2022), available at: https://agmanager.info/ag-policy/water-policy/value-groundwater-high-plains-aquifer-western-kansas). Data such as this, showing the positive local impact of conservation measures (particularly in economic terms), can be even more effective at achieving local buy-in than data quantifying water level declines or the years remaining of an aquifer's productive life. Regardless of the foundations of a state's statutory water law scheme or the specific tools it chooses to employ in the long-term management of its water resources, it is clear from these Kansas examples that local support is essential for conservation efforts to be politically feasible.

For Additional Information:
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Streamflow Grants

Legislation

Watershed Plans

Funding

Restoration Goals

Regulatory Framework

Permit Exempt Wells

Competitive Program

Project Options

Beaver Comeback

Ecological Improvements

STREAMFLOW RESTORATION GRANTS

WASHINGTON STATE STREAMFLOW RESTORATION PROGRAM

BEAVER DAMS, WATER RIGHTS, WATER STORAGE, & RESTORATION ALL IN THE MIX

by Mugdha Flores, Washington State Department of Ecology (Olympia, WA)

Editors' Introduction: In January 2018, the Washington State Legislature passed the Streamflow Restoration Act (RCW 90.94) to help improve streamflows. The law directed 15 planning groups to develop watershed plans that offset impacts from new domestic permit-exempt wells and achieve a net ecological benefit. The Legislature appropriated $300 million over 15 years to support projects that improve streamflows. The following material has been expanded from Washington State Department of Ecology (Ecology) online blogs (https://ecology.wa.gov/Blog) with the much-appreciated help of their author.

Washington State's Streamflow Restoration Act

Streamflow Restoration Act (2018) directed the Washington State Department of Ecology (Ecology) to "…implement a program to restore and enhance streamflows by fulfilling obligations under this act to develop and implement plans to restore streamflows to levels necessary to support robust, healthy, and sustainable salmon populations." To establish a regulatory framework for a grant initiative that fulfills the obligation above, Ecology adopted chapter 173-566 WAC— Streamflow Restoration Funding. This competitive grants initiative is designed to encourage and support the local implementation of projects and actions that meet the purposes of chapter 90.94 RCW.

The Streamflow Restoration Act was in response to the *Hirst* decision, a 2016 Washington State Supreme Court decision that limited a landowner's ability to get a building permit for a new home when the proposed source of water was a permit-exempt well. *See* Dickison& Haensly, *TWR* #155; Moon, *TWR* #153; and Pitre, *TWR* #169.

Streamflow Restoration Competitive Grants

The Legislature intends to authorize $300 million dollars over 15 years to support projects that improve streamflow. The funds are available statewide and administered through a competitive grant program. Grant funding will help incentivize state and local agencies, tribal governments, and non-profit organizations to implement local watershed plans and projects.

Application Summary for the 2022 Grant Round

Ecology will be overseeing investment of up to $40 million during the 2022 grant round. Ecology received 57 applications from organizations throughout the state, totaling a request close to $96 million. Applications include a variety of projects that aim to improve streamflows, such as, streamflow supplementation, water right acquisition, water storage, feasibility studies, and floodplain, riparian, and wetland restoration. The application period for 2022 closed in February. Grant recipients will be announced this summer. A summary of 2022 grant round grant applications is available from: https://apps.ecology.wa.gov/publications/SummaryPages/2211018.html.

Streamflow Restoration Project Examples

Beaver Benefits

HELPING HUMANS COEXIST WITH RODENTS OF UNUSUAL SIZE

Snohomish Conservation District is using Ecology grants to help people live with beavers. After near elimination by hunters and fur-trappers in the 1800s, beavers are slowly making a comeback in Washington. This is good news because beavers provide many ecological benefits. Beavers create their homes near rivers and streams across the state. Sometimes their habitats include human residential communities — which can create conflict. However, there are multiple benefits to living alongside beavers as they create healthy and diverse habitats that benefit local water supply.

Few species can shape landscapes the way beavers do when they build dams. Beaver dams create ponds and flood areas to increase vegetation the animals use for food and building material. By creating habitat for themselves, they also create better living spaces for other wildlife, such as juvenile salmon, elk, birds, and insects.

In 2020, Ecology awarded the Snohomish Conservation District $510,726 to increase community-based water storage in the Snohomish River watershed. One of the ways to improve water storage is allowing beavers to live in their natural habitat and build dams that create beneficial ponds.

Beaver Dam - Photo by Snohomish Conservation District

Photo by National Park Service

Beaver ponds allow sediment to settle at the bottom while helpful bacterial break down pollutants in the sediment, improving water quality. Beaver dams also help improve streamflows by ensuring there is a steady flow of water throughout the year. The beaver ponds also give that water time to flow downward to recharge groundwater, which can be helpful during drought months. Furthermore, during rain events, the ponds fill up and help mitigate flooding.

When beavers create dams near residential communities, it can create some challenges for humans, like flooding or loss of trees. Fortunately, there are solutions that can help us coexist with beavers. The Snohomish Conservation District uses simple and effective tools to help landowners manage their properties when beavers are present.

One such tool is a pond leveler. Pond levelers are flow devices that control flooding from beaver dams. Pond levelers and other flow control devices enable the control water level and/or dam height to find a compromise with the beavers. The goal is to retain as much of the beaver pond as possible while reducing flooding potential of human infrastructure. This allows the beaver ponds and associated benefits to stay in place while also managing potential flooding caused by the beaver dam.

Another simple tool is using fencing to protect trees from gnawing beavers. Relocating beavers is also an option that can benefit the ecosystem while reducing conflict with people.

"Our goal is to keep beavers on a landscape for their ecological benefits and encourage people to live with them," said Elyssa Kerr, habitat restoration project manager for the Snohomish Conservation District. "Beavers are part of the solution to help improve watersheds, along with projects that restore wetlands and increase water storage."

The Snohomish Conservation District also collaborates with Snohomish County, the Tulalip Tribes, and local nonprofits to raise community awareness about co-existing with beavers and sharing resources. The goal is to stop lethal removal of beavers and focus on solutions to manage living with beavers.

Ultimately, we need to re-think our relationship with beavers and become comfortable with how they change the landscape. Living harmoniously with beavers can help improve streamflows and protect endangered salmon.

Beaver Coexistence: Fencing & Pond Leveler Installation - Photos by Snohomish Conservation District

Streamflow Grants

Aquifer Recharge

Water Filtering

River Flows

Amphitheater

Stormwater Project

INNOVATIVE PROJECT REDUCES FLOODING WHILE PRESERVING STREAMFLOW

The Albany Street Stormwater Pond in downtown Rochester reduces flooding, recharges the local aquifer, and serves as a community space for residents. Thurston County received $1.2 million to complete the project through the streamflow restoration grants program. The county began construction in September 2019 and completed the pond in January 2020.

Before pond construction, rain frequently caused flooding on roadways and residential lawns. Thurston County worked with the Chehalis Basin Partnership to develop options for a stormwater project and to conduct community outreach to engage residents in the design process. Local community members provided feedback on the project's design. After hydrogeological analysis, the County finalized an innovative concept for an infiltration pond that included desired community amenities like a walking path and an amphitheater.

To address flooding, the County installed half-mile drainpipe that routes stormwater from 30 acres in Southwestern Rochester to the infiltration pond. The pond contains an engineered soil mix to ensure water is steadily absorbed into the ground. The soil also acts as a water filter, improving overall water quality and promoting native plant growth.

Water that enters the pond travels about 4.4 miles underground to recharge the local aquifer and the Black River. This water also offsets some residential well use. Thurston County hydrologists used mathematical models to estimate that in a year the pond will absorb the same amount of water as a football field flooded 12 stories high. Peak stormwater flows from winter months should reach the Black River from May to September, to support Chinook, Chum, and Coho salmon as well as Steelhead trout.

The open-air amphitheater is a gathering space for the community during summer months. There is a trail for walkers and runners around the pond, boulders where children can play, and drought-tolerant native plants that attract birds and other wildlife. The Chehalis Basin Partnership recently hosted a public tour and used the amphitheater to introduce residents to this project.

"When we took a group of Thurston County residents to the site, they were most excited about the aesthetic aspect of the project. That is, how it's nicely designed and creates a space for people to walk and gather. So often in restoration we focus on what we're doing for the fish, but this was a good reminder that the community will be more supportive of what we do for fish when there are real ways for them to engage and learn," said Kirsten Harma, Watershed Coordinator, Chehalis Basin Partnership.

Albany Street Stormwater Pond, Rochester

Streamflow Grants

Senior Water Rights

Water Rights: Antoine Valley Ranch

Western Rivers Conservancy, the Confederated Tribes of the Colville Reservation, and Trout Unlimited, acquired Antoine Valley Ranch in Okanogan County. Acquisition of the 2,524-acre ranch included senior water rights, estimated at over 1,200 acre-feet. The acquisition will improve streamflow in Antoine Creek, tributary to the Okanogan River, benefitting threatened steelhead and other native species.

Antoine Creek at Antoine Valley Ranch - Photo by Ellen Bishop, Western Rivers Conservancy

Forest/Riparian Restoration

Floodplain Restoration: Ohop Valley

As part of the Ohop Valley Floodplain Restoration Project, the Nisqually Land Trust acquired and permanently protected 100 acres along the south shoreline of Ohop Creek. This land was previously used for timber farming. The Land Trust is working on long-term projects to restore Ohop Creek and surrounding forests, floodplains, and wildlife habitat. Once the project is complete, the Land Trust will have protected 442 acres of forest through this grant.

Native Vegetation along Ohop Creek - Photo by Nisqually Land Trust

Mugdha Flores, a Communications Consultant at the Washington State Department of Ecology, leads communications for Ecology's Environmental Assessment Program. A scientist turned science-communicator, she has a Master's in Marine Biology. Ms. Flores started her career as a fisheries technician then worked as an informal educator and science communicator. She is passionate about connecting people to the environment through science and conservation stories.

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https://ecology.wa.gov/Water-Shorelines/Water-supply/Improving-streamflows

WATER BRIEFS

CRIMINAL ACTIVITY AZ
CWA & INTERIOR

The House Natural Resources Committee (Committee) notified the US Department of Justice (DOJ) on May 11 that it should investigate potential criminal activity from a top official in the Trump Administration, claiming that a decision to issue a Clean Water Act permit for an Arizona housing development was the result of a quid pro quo. In 2016, the Army Corps had suspended a Section 404 permit for the Villages at Vigneto, a 28,000-home development in southern Arizona. The permit was suspended because field staff at the US Fish and Wildlife Service (FWS) said they needed more detailed assessments of the development's impacts on endangered species.

Committee investigators allege that David Bernhardt, then deputy secretary of the Interior Department, intervened in 2017 to reverse the suspension. The committee alleges that payment from the Vigneto developer to Trump fundraisers just before the permit was reinstated suggests a reciprocal agreement.

The Conclusion of the 37-page Notification Letter dated May 11, 2022, set out the following investigation details at page 30:

"Prior to the Trump administration, FWS staff and DOI legal staff agreed for years that formal consultation on Vigneto's Clean Water Act permit was required under the Endangered Species Act. Once President Trump was elected, Vigneto's developer, Michael Ingram, had access to highranking officials across the administration, including personal email addresses and cell phone numbers. In August 2017, Mr. Ingram had a breakfast meeting in Montana with then–Deputy Secretary Bernhardt. The breakfast meeting was not disclosed in public calendars or in documents produced to the Committee.

After the meeting and apparently at Dep. Sec. Bernhardt's direction, Peg Romanik, a DOI attorney, handed down a directive to reverse FWS' position, a process through which the primary decisionmaker and whistleblower claimed he "got rolled" and deemed highly unusual. DOI career staff struggled to justify the about-face, claiming it created risks for the agency. Then, on Oct. 6, three things happened. The Army Corps officially announced the re-evaluation of the Clean Water Act permit; the developer and several others from Arizona made highly unusual out-of-cycle donations that day, and the days immediately prior and subsequent, totaling $241,600 to the Trump Victory Fund and the Republican National Committee; and Dep. Sec. Bernhardt held a meeting with Ms. Romanik, on an undisclosed topic. A few weeks later, FWS officially reversed its position regarding issuance of the Clean Water Act permit."

The Committee concluded that "…these facts raise serious concerns about a potentially criminal quid pro quo. We therefore refer this matter to the Department of Justice and request further investigation and, if warranted, criminal charges." *Id*.

For info: Notification Letter at: https://naturalresources.house.gov/imo/media/doc/2022.05.11%20Vigneto_DOJ%20Referral_FINAL_REDACTED.pdf

ARTIFICIAL BEAVER DAMS OR JUNIPER REMOVAL

On May 18 the Oregon Watershed Enhancement Board (OWEB) announced that it has awarded a grant of $587,919 to the Jefferson County Soil and Water Conservation District for two projects aimed at improving water quality and restoring habitat for fish and wildlife in two parts of the Deschutes River Basin in Oregon.

OWEB granted $121,007 to help the conservation district and partners install structures known as beaver dam analogs in Campbell Creek, which flows into the lower Deschutes River. Constructed of natural materials like untreated lodgepole posts and woody limbs, these artificial structures mimic the dams that beavers create, slowing water flow and trapping pollutant-laden sediment before it reaches the Deschutes River. The beaver dam analogs will be installed in early 2023.

"Beaver dam analogs act as natural water filters. They can help remove many of the pollutants present in the creek," said Ally Steinmetz, watershed coordinator for the Middle Deschutes Watershed Council, which is partnering with the conservation district on the project. "By slowing down the movement of water, they also help reconnect the floodplain to the creek, which promotes streamside vegetation and habitat."

OWEB also approved a second grant totaling $466,912 to the conservation district for a project in the Trout Creek watershed, an eastside tributary of the Deschutes River. Decades of grazing, fire suppression and climate change have allowed juniper trees to encroach into what should be grassland. The conservation district will first remove the junipers, then conduct five prescribed burns over the next four years to clean up the resulting biomass and invigorate the growth of the native grasses and shrubs. The area will also be re-seeded with native grasses.

"Removing the junipers will return the landscape to a healthy grassland ecosystem," said Adam Haarberg, a project manager with the conservation district. "A healthy grassland has native bunchgrasses and shrubs that enable the soil to capture, store and safely release what little precipitation the region receives. Juniper, on the other hand, are very thirsty and will hold on to the water, a detriment to the native plants that wildlife use." In addition, native grasses and shrubs provide much better habitat and forage than juniper for native wildlife species including mule deer, elk, and ground-nesting birds.

The project, which will be completed in fall 2026, covers more than 1,700 acres. Previously, OWEB funded two other juniper-removal projects that the conservation district has underway in the Trout Creek watershed, both of which Haarberg said are showing "great promise."

For info: OWEB website: www.oregon.gov/oweb/pages/index.aspx

REUSE TOOL US

The National Water Reuse Action Plan (WRAP) helps drive progress on reuse by leveraging the expertise of scientists, policymakers, and local experts across the country to create a more resilient water future for communities of all sizes. The collaborative launched in February 2020 with federal, state, Tribal, local, and water sector partners to build state and local capacity to pursue reuse practices that help to solve local water resource challenges. There are currently more than 100 organizations partnering on 50 actions in the plan, ranging from scientific and technical advancements in water reuse to better policy and coordination across jurisdictions.

WATER BRIEFS

A recent presentation highlighted progress across the WRAP actions and provided a demo of a new tool: Regulations and End-Use Specifications Explorer (REUSExplorer). The REUSExplorer compiles state water reuse regulations and guidelines and highlights the underlying scientific and technical basis of water quality metrics. This new web-based tool, developed by the EPA and partners under WRAP Action 3.1, is searchable by state, source of water and end-use application to assist states interested in developing regulations and help utilities and practitioners to better understand current regulations. The first end-uses available include potable water reuse, onsite non-potable reuse, and other centralized non-potable reuse applications, not including agricultural and landscape reuse applications.

For info: REUSExplorer available at: www.epa.gov/reusexplorer

STORMWATER FINE CA

ILLEGAL DISCHARGES

Following multiple inspections, years of unsuccessful negotiation, and the continued refusal of Baldwin & Sons and partners to stop unauthorized sediment discharges at a luxury home construction site in Orange County, the San Diego Regional Water Quality Control Board on June 8th approved a record $6.6 million penalty against the violating parties. From August 2015 to March 2016, the developer released 6.3 million gallons of untreated stormwater at its Portola Center South Project; failed to implement required best management practices; ignored numerous corrective and cease-and-desist orders; and for 162 days violated the site's Statewide Construction Stormwater Permit.

"The actions of Baldwin & Sons and its partners and contractors, which resulted in significant costs to the public and environmental harm to Aliso Creek and its tributaries, merits the harshest possible enforcement response," said David Gibson, executive officer of the San Diego Water Board.

The subdivision is built on 95 acres of steep, sloping terrain in the city of Lake Forest. During wet weather, sediment flows downstream and transports pollutants directly to Aliso Creek, its tributaries and offsite mitigation areas. The discharges cloud the receiving water, which reduces the amount of sunlight reaching aquatic plants, and can clog fish gills, smother spawning areas, and transport other materials such as nutrients, metals, and oil and grease that negatively impact aquatic life and habitat.

Under the stormwater permit, which includes a prevention plan to protect against weather-related environmental damage originating at building sites, developers must implement precautionary measures such as slope stabilization, erosion and sediment control and curtail activity when it rains, particularly since climate change-induced atmospheric rivers increasingly lead to extreme precipitation. Yet, despite repeated notices and orders issued by the city, the developer and contractors failed to control erosion and runoff or contain fluids leaking from equipment.

The investigation was complicated by a number of factors, including the company's refusal to provide information required by a subpoena; the complex relationship between Baldwin & Sons and numerous other entities with similar corporate officers; and lawsuits Baldwin filed against some project subcontractors. Besides Baldwin & Sons, the violating parties are the following: Sunranch Capital Partners, LLC; Sunrise Pacific Construction, Inc.; SRC-PH Investments, LLC; responsible corporate officers Shawn M. Baldwin, Randall G. Bone and Jose Capati.

The penalty will be deposited in the State Water Resources Control Board's (SWRCB's) Clean Up and Abatement Account that funds remediation projects and provides safe drinking water to Californians.

For info: Ailene Voisin, SWRCB, ailene.voisin@waterboards.ca.gov

CWA SETTLEMENT WA

PAYMENTS/IMPROVEMENTS

Timber giant Weyerhaeuser NR Company (Weyerhaeuser) reached an agreement with Columbia Riverkeeper (Riverkeeper) on May 9th settling Riverkeeper's Clean Water Act lawsuit against the timber company at its Longview, Washington mill. Under the settlement agreement, Weyerhaeuser is required to make a payment of $600,000 to the foundation Seeding Justice, which will award grants for projects benefiting water quality in the Columbia River Basin. The company will also be required to pay additional penalties up to $5,000 if certain violations recur in the future.

As part of the settlement, Weyerhaeuser also agreed to make significant changes to reduce the amount of pollution that flows off the 260-acre facility and into the Columbia River. Changes include rerouting a stormwater pipe to flow into a Waste Treatment Plant, instead of the Columbia River. Installation of aerators and particulate screens to reduce the biological oxygen demand and turbidity in discharges and installing flow meters to provide more timely data on stormwater discharges is also required under the agreement.

In their press release of May 9, Riverkeeper stated that "…the Columbia River Basin, an area the size of France, accumulates pollution from industry, wastewater treatment plants, and runoff from agricultural lands, logging, industrial sites, and city streets. As a result, the Columbia River and many tributaries are severely degraded by pollution. Toxic pollution threatens the health of people that eat local fish and jeopardizes the public's right to eat fish caught locally. Rising water temperatures also threaten the health of salmon and other aquatic life that rely on cool water for survival."

Weyerhaeuser also was ordered to pay Riverkeeper's attorney fees and costs in the amount of $119,625.00 in satisfaction of any claims Riverkeeper may have under the Clean Water Act (CWA) for attorney fees, litigation costs, and expenses. Columbia Riverkeeper's staff attorney and Kampmeier & Knutsen PLLC represented Columbia Riverkeeper in the case.

"By entering into this [Proposed] Consent Decree, Weyerhaeuser does not admit and expressly denies liability for all claims alleged by Riverkeeper in the notice letter and citizen suit." Consent Decree, pp. 2-3.

The consent decree must undergo a 45-day review period for the U.S. Department of Justice and then be approved by a federal district court judge before it can go into effect.

For info: [Proposed] Consent Decree available at: www.columbiariverkeeper.org/sites/default/files/2022-05/Proposed%20Consent%20Decree.pdf

WATER BRIEFS

QUALITY CERTIFICATION US CWA SECTION 401

On June 2, the US Environmental Protection Agency (EPA) announced a proposed rule to update the regulatory requirements for water quality certification under Clean Water Act (CWA) Section 401. This proposed rule would strengthen the authority of states, territories, and Tribes to protect their vital water resources while supporting an efficient, predictable, and common-sense certification process, restoring a long-held right, according to EPA's press release. The authority of the states, territories and Tribes were severely limited by the Trump administration's rule, which was promulgated in 2020. The Proposed Rule revises and replaces the Agency's 2020 regulatory requirements for water quality certification under Clean Water Act (CWA) section 401. For more detail about section 401, *see TWR* #189, Bellon.

Known as the "water quality certification rule," CWA section 401 provides states and authorized tribes with the ability to grant, condition, or deny certification for federally licensed or permitted projects that may result in a discharge into waters of the United States. When acting on a request for certification, states and authorized tribes consider whether the project will comply with effluent limitations, water quality standards, new source performance standards, toxic pollutant limitations, and any other appropriate requirement of state or tribal law. EPA maintains that this proposed rule would update the existing regulations to be more consistent with the statutory text of the 1972 CWA; to clarify, reinforce, and provide a measure of consistency with respect to elements of section 401 certification practice that have evolved over the 50 years since the 1971 Rule was promulgated; and to support an efficient and predictable certification process that is consistent with the water quality protection and cooperative federalism principles central to CWA section 401. EPA is also proposing conforming amendments to the water quality certification regulations for EPA-issued National Pollutant Discharge Elimination System permits.

Congress provided authority to states, territories, and Tribes under CWA Section 401 to protect the quality of their waters from adverse impacts resulting from federally licensed or permitted projects. Under Section 401, a federal agency may not issue a license or permit to conduct any activity that may result in any discharge into a water of the United States, unless the state, territory, or authorized Tribe where the discharge would originate either issues a CWA Section 401 water quality certification or waives certification.

As explained in the Proposed Rule, "…the 2020 Rule [Trump Administration] rejected nearly twenty-five years of Agency practice and Supreme Court precedent regarding the appropriate scope of certification review, i.e., rejecting "activity as a whole" for the narrower "discharge-only" approach. Additionally, the 2020 Rule introduced new procedural requirements that caused disruption to state and tribal certification programs that had evolved over the last half century. In this proposal, the Agency is returning to some of those important core principles, such as an "activity as a whole" approach to the scope of certification review and greater deference to the role of states and tribes in the certification process, while retaining (and adding) elements that provide transparency and predictability for all stakeholders." Proposed Rule at 8. The Proposed Rule also alleviates the deadline pressure of a one-year deadline strictly enforced by regulators to make permitting decisions under the Trump-era 2020 Rule.

EPA is taking comment on this proposed rule for 60 days beginning on the date it is published in the Federal Register. For more information on submitting written comment on the proposal or to register for the virtual public hearing on the proposed rule, see www.epa.gov/cwa-401 or the Proposed Rule (link below).

For info: Lauren Kasparek, EPA, 202/ 564-3351 or cwa401@epa.gov; Proposed Rule at: www.epa.gov/system/files/documents/2022-06/Proposed%20CWA%20Section%20401%20WQC%20Improvement%20Rule_NPRM_20220601_pre-publication_508.pdf

POST-FIRE STREAMFLOW WEST CLIMATE IMPACTS

A recent journal article published on February 22 by PNAS — Proceedings of the National Academy of Sciences — addressed the considerable disagreement on how streamflow may change in post-wildfire watersheds. In the article, "Growing impact of wildfire on western US water supply," co-authored by Western Water Assessment (WWA)) Director Ben Livneh, the research team asks, "How will increasing wildfire activity affect water resources in the water-limited western United States?" Authors: A. Park Williams, Ben Livneh, Karen A. McKinnon, and Dennis P. Lettenmaier.

The research team analyzed streamflow observations from a large number of both burned and unburned watersheds in the western United States (WUS). They found that immediately post-fire, in a forest where at least 20% of the area burns, streamflow increases 20% to 30%, with the effect lasting approximately six years. The paper underscores the importance of improving our knowledge of post-fire environments to present and future regional water resources.

Over 2015 to 2020, several large WUS basins experienced >10% of forest burned. Climate projections and an exponential forest fire response to climate-induced drying suggest the next three decades will see repeated years when WUS forest fire area exceeds that of 2020, which set a modern record for forest area burned. If so, entire regions will likely experience more streamflow than expected, potentially enhancing human access to water but posing hazard management challenges. The article concluded that projections of water supply and runoff-related hazards must account for wildfire.

For info: Article available at PNAS: www.pnas.org/doi/full/10.1073/pnas.2114069119

MEXICO ENVIRONMENTAL US BINATIONAL COORDINATION

On May 13, the US Environmental Protection Agency (EPA) and its counterpart in Mexico, the Ministry of the Environment and Natural Resources (SEMARNAT), virtually held their first public National Coordinators meeting under the Border 2025 U.S.-Mexico Environmental Program. The National Coordinators for the US and Mexico shared their environmental priorities of tackling climate, addressing environmental justice and equity, and being more inclusive of Mexico's

WATER BRIEFS

indigenous and Afro-Mexican communities in solving environmental challenges.

The Regional Coordinators announced the Border 2025 projects selected and awarded for the border communities of Arizona and California, and in Mexico for the states of Sonora and Baja California and shared information on pending projects to be awarded for the border region. New environmental efforts address air monitoring and health surveillance, wastewater reuse design, waste management relating to community workshops that train community residents to manage household waste and evaluating emergency sister-city contingency plans. The meeting also included a binational roundtable on environmental justice through community participation where the public had the opportunity to share priorities and concerns about the Border 2025 Program.

Border 2025 is the latest environmental program implemented under the 1983 La Paz Agreement. The Program emphasizes a regional and community-level bottom-up approach for decision-making, priority setting, and project implementation to address environmental and public health challenges in the border region. The Border 2025 Program also strengthens its focus and efforts in areas where environmental improvements are needed most such as clean and healthy air, clean and safe water, sustainable materials management, and emergency preparedness and response.

For info: US-Mexico Border Program at: www.epa.gov/usmexicoborder

NUTRIENT LOADING US UTILITIES REDUCTIONS

On May 24th, the Water Environment Federation (WEF) recognized 15 utilities for significantly reducing nutrient pollution, one of the leading problems for the health of waterways across the US. The utilities were selected through Nutrient Smart (NSmart), a collaboration between WEF and the US Environmental Protection Agency (EPA) to recognize utilities that have demonstrated nitrogen or phosphorus reductions and developed robust community outreach programs. NSmart also provides information and tools to help utilities make large reductions in nutrients and discharge cleaner water to the environment.

According to EPA, more than 100,000 miles of rivers and streams, close to 2.5 million acres of lakes and ponds, and more than 800 square miles of bays and estuaries are impacted by nitrogen and phosphorus pollution in the US. Nutrient pollution can also lead to algal blooms that are harmful to humans and animals. "Nutrients are one of the most common pollution problems in U.S. waterways and WEF is glad to shine a light on utilities that are leading the way in reducing nitrogen and phosphorus and engaging their communities," said WEF President Jamie Eichenberger. "NSmart joins other WEF programs like Utility of the Future and ReNEW which aim to create bold, aspirational calls to action to accelerate resource recovery."

These utilities have reduced nutrients by at least 90%: Nine Springs Treatment Facility - Madison Metropolitan Sewerage District (Wisconsin); Upper Occoquan Service Authority (Virginia); Town of Cary (North Carolina); Dorsey Run Advanced Wastewater Treatment Plant (Maryland); Stafford County Utilities (Virginia); Rocky Gap State Park Wastewater Treatment Plant (Maryland); and Freedom District Wastewater Treatment Plant (Maryland).

These utilities have reduced nutrients by 85 to 90%: Lancaster Area Sewer Authority (Pennsylvania); and City of Boise (Idaho).

These utilities have reduced nutrients by 70 to 85%: Narragansett Bay Commission (Rhode Island); South Platte Renew (Colorado); Waterbury Water Pollution Control Facility (Connecticut); and American Bottoms Regional Wastewater Facility (Illinois).

These utilities are working toward nutrient reduction of 30 to 70% and beginning outreach to the community on the issue: City of Greensboro, North Carolina - Water Resources Department, Water Reclamation Division; and Centennial Water and Sanitation District - Colorado.

These utilities were additionally recognized as innovators for showcasing an outstanding example of treatment technology or leadership in nutrient management: Treatment Technology – City of Boise (*see* Malmen, *TWR* #129); Treatment Technology – Narragansett Bay Commission; Treatment Technology – Town of Cary; and Leadership in Nutrient Management – Upper Occoquan Service Authority.

For info: Nsmart at: www.wef.org/NSmart or contact PDube@wef.org

GROUNDWATER TRADING CA BASIC ELEMENTS FRAMED

On May 18, the California Water Commission (CWC) approved a white paper that contains its findings and the potential next steps for State engagement in shaping well-managed groundwater trading programs with appropriate safeguards for vulnerable water users: natural resources, small- and medium-size farms, and water supply and quality for disadvantaged communities. The white paper will be shared with the Secretaries for Natural Resources, Environmental Protection, and Food and Agriculture, who requested the Commission's engagement on this topic. The paper will guide the continued work on Water Resilience Portfolio Action 3.6 by the California Departments of Water Resources, Fish and Wildlife, and Food and Agriculture, and the State Water Resources Control Board.

Through extensive outreach and input that involved learning from the experience of others around the state, country, and world, the CWC's paper frames the basic elements of well-functioning, protective groundwater trading programs. Those elements start with trust, access to accurate data, and a sound, well-implemented groundwater sustainability plan that fully considers all beneficial groundwater users when setting sustainable conditions.

With California currently immersed in a third consecutive year of drought, the need to bring groundwater basins into sustainable conditions becomes more vital than ever. Groundwater trading can help achieve sustainable groundwater management in areas that have capped groundwater use; that have a system for tracking and accounting for groundwater levels, quality, and use; and that have allocated how much groundwater can be used by individual pumpers to reach a sustainable groundwater condition while avoiding undesirable results. With good governance in place and a careful,

thoughtful approach, groundwater trading programs can meet their goals without creating negative, third-party impacts.

The Department of Water Resources will put together a workplan for implementing Water Resilience Portfolio Action 3.6 based on the Commission's white paper.

For info: Paul Cambra, CWC, 916/873-5774 or paul.cambra@cwc.ca.gov

DROUGHT PREPAREDNESS CO

AGRICULTURE GRANTS

To help Colorado's agricultural industry mitigate the effects of the ongoing mega drought and improve the efficiency of agricultural water distribution systems, the Colorado Department of Agriculture (CDA) awarded 21 competitive grants totaling more than $1.68 million to agricultural businesses, tribal organizations, water management entities, and watershed improvement projects across the state. The funds supported a variety of projects, including weed treatment and reseeding in drought stricken areas, improvements to the infrastructure and efficiency of water diversion and ditch projects, and improvements to grazing lands through a variety of methods that improve soil health and range condition. The project proposals were reviewed by a committee of experts, who selected the final grant recipients.

The competitive grants funded more than 100 projects involving irrigation, pasture, livestock distribution, or water diversion projects that promote environmental stewardship among ag producers and ag water users. The funding for the grants comes from SB 21-234, which appropriated $3M to CDA to fund drought mitigation, energy efficiency, and soil health projects, including $15,000 to each of Colorado's 74 Conservation Districts.

In the San Luis Valley, the Rio Grande Headwaters Restoration Project (RGHRP), a non-profit whose mission is to restore the Rio Grande and watershed health, partnered with the Billings Ditch Co. to identify and mitigate headgate and canal issues. The drought stimulus funds gave RGHRP and their partner expanded capacity for improvements beyond the original project scope. Now, the infrastructure supports efficient use of flood irrigation, which additionally creates wetlands and wet meadows for wildlife use, and stabilizes the bank for improved fish habitat and aquatic connectivity. The timeliness of the funding created the opportunity for increased resilience and huge benefits to the agricultural community.

In San Miguel County on the Western Slope, the Farmers Water Development Company received a $139,315 grant to repair the slip of the Gurley Reservoir Dam. The improvements to the reservoir will allow it to be filled to capacity (approximately 3,199 acre-feet) and support the needs of producers on Wright's Mesa. This will help farmers irrigate longer into the season, allow the Town of Norwood to sell domestic water taps again, and give Norwood residents access to raw water services.

Other examples of projects include:

- Restoring a historic water conveyance system that supported a 130 acres irrigated pasture in Rio Grande County ($42,000 grant)
- Expand use of virtual fencing to enable rotational grazing of cattle to control livestock movements to improve watershed management and wildlife habitat in Eagle County ($16,595 grant)
- Improving the effectiveness and efficiency of a water diversion structure and construction of a control building for automation equipment in Logan County ($100,000 grant covers about 10% of total cost of project)
- Training for the Colorado Master Irrigator (COMI) program, which expanded into San Luis Valley and the Republican River basin and trained more than 70 people statewide on how to integrate advanced conservation and irrigation management practices for production agriculture ($150,000 grant)

Additionally, $75,000 was awarded to three of Colorado's Grazing Advisory Boards and $144,985 was awarded to Colorado State University for programs that include training on drought management, installation of soil moisture sensors to monitor agricultural drought, and expanding the WAVE program (the Watershed Assessment and Vulnerability Evaluations program provides post-wildfire land health assessment for private landowners).

For info: Gov. Polis' Website at: www.colorado.gov/governor

PFAS ROADMAP US

EPA COMMITMENTS

On April 28, EPA announced three actions to protect communities and the environment from per- and **p**oly**f**luoro**a**lkyl **s**ubstances (PFAS) in our nation's waters. The actions announced advance progress under the Biden-Harris Administration's Plan to Combat PFAS Pollution by improving methods to detect PFAS in water, reducing PFAS discharges into our nation's waters, and protecting fish and aquatic ecosystems from PFAS. These efforts complement the historic investment of $10 billion to address PFAS and emerging contaminants secured under the Bipartisan Infrastructure Law.

Robust, accurate methods for detecting and measuring PFAS in air, land, and water are essential to understand which PFAS are in the environment and how much is present. Detection methods are also essential for evaluating the effectiveness of different technologies for remediating PFAS and for implementing future regulations. EPA is publishing a new method that can broadly screen for the presence of PFAS in water at the part per billion level. EPA's new Screening Method for the Determination of Adsorbable Organic Fluorine (AOF) in Aqueous Matrices by Combustion Ion Chromatography (CIC) provides an aggregate measurement of chemical substances that contain carbon-fluorine bonds. PFAS are a common source of organofluorines in wastewater. This new method is especially useful for understanding the presence and forms of PFAS in wastewater when used in conjunction with methods that target individual PFAS. EPA's Draft Method 1621 has successfully completed single laboratory validation. Multi-laboratory validation will take place this summer and EPA intends to publish an updated version of the method later this year.

The National Pollutant Discharge Elimination System (NPDES) program interfaces with many pathways by which PFAS travel and are released into the environment and ultimately impact people and water quality. EPA is seeking to proactively use existing NPDES authorities to reduce discharges of PFAS at the source and obtain more comprehensive information through monitoring on

WATER BRIEFS

sources of PFAS. EPA issued a memo April 28 titled, *Addressing PFAS Discharges in EPA-Issued NPDES Permits and Expectations Where EPA is the Pretreatment Control Authority*. This memo provides instructions for monitoring provisions, analytical methods, the use of pollution prevention, and best management practices to address discharges of PFAS. These provisions will help reduce PFAS pollution in surface water as the agency aggressively embarks to promulgate effluent guidelines, multi-validated analytical methods, and water quality criteria recommendations that address PFAS compounds. EPA also plans to issue new guidance to state permitting authorities to address PFAS in NPDES permits in a future action.

EPA is also developing national recommended ambient water quality criteria for PFAS to protect aquatic life. States and Tribes may use EPA-recommended water quality criteria to develop water quality standards that protect and restore waters, issue permits to address PFAS discharges, and assess the impact of PFAS pollution on local communities and the environment.

EPA is proposing the first Clean Water Act aquatic life criteria for **p**er**f**luoro**o**ctanoic **a**cid (PFOA) and **p**erfluoro**o**ctane **s**ulfonic **a**cid (PFOS) — two of the most well-studied chemicals in this group. The criteria are intended to protect aquatic life in the US from short-term and long-term toxic effects of PFOA and PFOS. Following the comment period, EPA intends to issue final PFOA and PFOS recommended criteria and any new toxicity data. States and Tribes may consider adopting the final criteria into their water quality standards or can adopt other scientifically defensible criteria that are based on local or site-specific conditions.
For info: www.epa.gov/pfas/

NEPA **US**

CEQ RESTORES PROVISIONS

The Council on Environmental Quality (CEQ) issues this final rule to amend certain provisions of its regulations for implementing the National Environmental Policy Act (NEPA), addressing the purpose and need of a proposed action, agency NEPA procedures for implementing CEQ's NEPA regulations, and the definition of "effects." The amendments generally restore provisions that were in effect for decades before being modified in 2020.

CEQ is issuing this final rule to amend three provisions of its regulations implementing the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321 et seq., which are set forth in 40 CFR parts 1500 through 1508 ("NEPA regulations" or "CEQ regulations"). First, CEQ is revising 40 CFR 1502.13 on the requirement for a purpose and need statement in an environmental impact statement. The revision clarifies that agencies have discretion to consider a variety of factors when assessing an application for an authorization, removing the requirement that an agency base the purpose and need on the goals of an applicant and the agency's statutory authority. The final rule also makes a conforming edit to the definition of "reasonable alternatives" in 40 CFR 1508.1(z). Second, CEQ is revising 40 CFR 1507.3 to remove language that could be construed to limit agencies' flexibility to develop or revise procedures to implement NEPA specific to their programs and functions that may go beyond the CEQ regulatory requirements. Third, CEQ is revising the definition of "effects" in paragraph (g) of 40 CFR 1508.1 to include direct, indirect, and cumulative effects. CEQ is making these changes in order to better align the provisions with CEQ's extensive experience implementing NEPA and unique perspective on how NEPA can best inform agency decision making, as well as longstanding Federal agency experience and practice, NEPA's statutory text and purpose to protect and enhance the quality of the human environment, including making decisions informed by science, and case law interpreting NEPA's requirements
For Info: Amy Coyle, CEQ Deputy General Counsel, 202/ 395-5750 or Amy.B.Coyle@ceq.eop.gov; Fed Reg, Vol 87, #76, pp 23453-23470

EVAPORATION **WEST**

ATMOSPHERIC THIRST STUDY

The atmosphere across much of the Western US is demanding a greater amount of water than it used to, according to a new study by a team from DRI, University of California, Merced, and Scripps Institution of Oceanography at UC San Diego. The study was published in the Journal of Hydrometeorology and assessed trends in evaporative demand across the US during a 40-year period from 1980-2020 using five datasets. Evaporative demand, sometimes described as "atmospheric thirst," is a measure of the potential loss of water from the earth's surface to the atmosphere based on variables including temperature, humidity, wind speed, and solar radiation.

The team's findings showed substantial increases in atmospheric thirst across much of the Western US during the past 40 years, with the largest and most robust increases in an area centered around the Rio Grande and Lower Colorado rivers. These regions have experienced changes on the order of two-to-three standard deviations from what was seen during the baseline period of 1980-2000.

The team analyzed the relative influences of temperature, wind speed, solar radiation, and humidity. On average, increases in temperature were responsible for 57 percent of the changes observed in all regions, with humidity (26 percent), wind speed (10 percent), and solar radiation (8 percent) playing lesser roles.

For farmers and other water users, increases in atmospheric thirst mean that in the future, more water will be required to meet existing water needs. Some of these changes observed in this study are centered over areas where warming temperatures and lower-than-average precipitation are already creating stress on water supplies. For example, in the Rio Grande region, the study authors calculated that atmospheric thirst increased by 8 to 15 percent between 1980 and 2020. Holding all else equal and assuming no other changes in management, this means that 8 to 15 percent more water is now required to maintain the same thoroughly-watered crop.

Other impacts of increased atmospheric thirst include drought, increased forest fire area, and reduced streamflows. The team is now developing seasonal to sub-seasonal forecasts of evaporative demand.
For info: The study is freely available from the Journal of Hydrometeorology: https://journals.ametsoc.org/view/journals/hydr/23/4/JHM-D-21-0163.1.xml

CALENDAR

June 15 WEB
Tribal Beneficial Uses Tribal Summit, Lahontan Water Board (Region 6); 2:00pm-4:00pm Pacific Time. Attendance Limited to Tribal Government Reps or Invited Parties; RSVP by May 25 to Jennifer Watts, 530/ 542-5491 or jennifer.watts@waterboards.ca.gov. For info: State Water Board Tribal Affairs Team, 916/ 216-1126; or waterboards.ca.gov/tribal_affairs

June 15 WEB
The Effects of CAFOs on Environmental Justice Webinar, 12:00pm-1:30pm Eastern Time. Presented by the Environmental Law Institute: Free - Registration Required by June 13. For info: www.eli.org

June 16 WEB
Basics of the Clean Water Act - (ELI Summer School, 2022) , 12:00pm-2:00pm Eastern Time. Presented by the Environmental Law Institute: Free - Registration Required by June 14. For info: www.eli.org

June 22 TX
Dam Safety Workshop - Hybrid Event (Personal & Virtual), Austin. U.T. Commons Conference Center: J.J. Pickle Research Campus. Presented by the Texas Commission on Environmental Quality. For info: www.tceq.texas.gov/p2/events/dam-safety.html

June 22 WEB
Creating the Water Workforce of the Future Webinar: Women in Water - The Leadership Journey Forward, 1:00pm-2:00pm Eastern Time. Presented by US EPA. For info: www.epa.gov/sustainable-water-infrastructure/water-sector-workforce-webinars

June 22-23 AB
10th Annual National Symposium on Cumulative Effects - Assessment & Environmental Management, Calgary. Hotel Arts. Environmental Law Institute Members Save 10% - Code D10-999-ELI; Presented by the Canadian Institute. For info: www.canadianinstitute.com/cumulative-effects/agenda/

June 23 CO
Watershed (Shed) Summit '22, Denver. Denver Botanic Gardens. Re: Water Availability & Balancing Competing Needs; Collaborative Partnership Between the Colorado Water Conservation Board, Denver Water, Aurora Water, the One World One Water (OWOW) Center, Resource Central & Denver Botanic Gardens. For info: www.botanicgardens.org/programs/watershed-shed-summit-22

June 28-30 WY
2022 Wyoming Watershed Conference & Summer Tour, Riverton. Riverton Holiday Inn. 6/28 Tours; 6/29-6/30 Conference; Presented by the Wyoming Water Assoc. & Wyoming Assoc. of Conservation Districts. For info: conservewy.com

June 29 CA & WEB
Tribal Beneficial Uses Tribal Summit, San Diego. San Diego Water Board (Region 9); In-Person & Virtual Option: 1:30pm-3:30pm Pacific Time. Attendance Limited to Tribal Government Reps or Invited Parties; RSVP by June 22 to Jody Ebsen at jody.ebsen@waterboards.ca.gov. For info: State Water Board Tribal Affairs Team, 916/ 216-1126; or waterboards.ca.gov/tribal_affairs

June 29 WEB
Biostimulation, Cyanotoxin, and Biological Condition Provisions Project Workshop, Project Previously Referred to as the Statewide Biostimulatory and Biointegrity Objectives. Zoom Event: Broadcast Link at: https://video.calepa.ca.gov/. For info: www.waterboards.ca.gov/board_info/calendar/docs/2022/june/notice-biostimulatory.pdf

July 11-12 WEB
Cybersecurity Fundamentals for Water and Wastewater Utilities Course, For info: www.euci.com/events/

July 11-29 CA
Forecast Informed Reservoir Operations (FIRO) Colloquium, La Jolla. Scripps Institution of Oceanography. Presented by the Center for Western Weather & Water Extremes (CW3E). For info: www.acwa.com/events/forecast-informed-reservoir-operations-firo-colloquium/

July 12-13 WEB
Environmental Compliance & Permitting for Utilities - Virtual Event, For info: www.euci.com/events/all-conferences/

July 12-15 AZ
Arizona's Agricultural Outlook: Water, Climate, and Sustainability - WRRC 2022 Annual Conference, Tucson. TBA. 7/12: In-person Event w/ Livestreaming; 7/13-15: Additional Virtual Programming. Presented by Water Resources Research Center. For info: https://wrrc.arizona.edu/events

July 13-14 WEB
Zebra and Quagga Mussel Mitigation Course, For info: www.euci.com/events/

July 14-15 OR & WEB
Agriculture Law in the Northwest Conference, Hood River. Hood River Inn. For info: The Seminar Group: 206/ 463-4400, info@theseminargroup.net or theseminargroup.net

July 14-15 NM & WEB
Natural Resource Damages Conference, Santa Fe. La Fonda Hotel & Interactive Online Broadcast. For info: Law Seminars Int'l: 206/ 467-4490; register@lawseminars.com or www.lawseminars.com

July 21 WEB
Hazardous Waste and Sites (ELI Summer School, 2022), 12:00pm-2:00pm Eastern Time. Presented by the Environmental Law Institute: Free - Registration Required by July 19. For info: www.eli.org

July 21-23 CO
68th Annual Natural Resources and Energy Law Institute, Vail. The Hythe. Presented by The Foundation for Natural Resources and Energy Law (formerly Rocky Mountain Mineral Law Foundation). For info: fnrel.org/programs/ai68

July 26-28 ID
Western Governors Association 2022 Annual Meeting, Coeur d'Alene. For info: www.westgov.org

August 2-5 MT
Western States Water Council 2022 Summer Meeting, Polson. KwaTaqNuk Resort-Casino. For info: https://westernstateswater.org/upcoming meetings/

August 11-12 AZ
30th Annual Arizona Water Law SuperConference: Challenges & Collaborative Solutions, Scottsdale. Hilton Hotel. For info: CLE International: 800/ 873-7130 or www.cle.com

August 16-18 UT
2022 National Water Use Data Workshop, Salt Lake City. Utah Dept. of Environmental Quality Bldg., 195 North 1950 West. Collaboration Between Western States Water Council Water Information Management Systems (WIMS) Group, USGS, Interstate Council on Water Policy & Internet of Water. For info: westernstateswater.org/events/2022-national-water-use-data-workshop/

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Water Rights, Water Quality & Water Solutions in the West
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CALENDAR

(continued from previous page)

August 17-18 CA
7th Annual California Water Data Summit, Irvine. UC Irvine. For info: www.cawaterdatasummit.org/

August 18 WEB
Regulatory Compliance for Water & Wastewater - Virtual Event, For info: www.euci.com/events/all-conferences/

August 30-Sept. 1 TX
Texas Groundwater Summit, San Antonio. Hyatt Regency Hill Country Resort. Expert Presentations on All Areas of Groundwater Management. For info: https://texasgroundwater.org/news-events/events/texas-groundwater-summit/

September 6-8 OR & WEB
Oregon Conservation Education and Assistance Network (OCEAN) CONNECT+ Hybrid Conference, Seaside. Seaside Convention Center; In-Person or Virtual Event. Training Focused on Technical & Administrative Aspects of Conservation Implementation. For info: connectoregon.net

September 8-9 WA
5th Annual Water Law in Central Washington Conference, Ellensburg. Central Washington University, 400 E. University Way. Update on Water Rights Law, Updates from Regulators, and Updates on Recent Trends and Practices. For info: The Seminar Group: 206/ 463-4400, info@theseminargroup.net or theseminargroup.net

September 13 CO
Colorado Water Trust's Annual Riverbank Celebration, Denver. Denver Botanic Gardens. Includes Presentation of David Getches Flowing Water Award. For info: www.coloradowatertrust.org

September 20 TX
Texas Rainmaker Award Dinner, Austin. Bullock Texas State History Museum. Hosted by the Texas Water Foundation. For info: www.texaswater.org

September 21-24 TN
SEER 30th Fall Conference, Nashville. Renaissance Nashville Hotel. Sponsored by the ABA Section on Environment, Energy, and Resources (SEER). For info: ambar.org/SEERevents

September 22 WEB
Pollution Prevention Waste Management Virtual Workshop, Hosted by TCEQ Staff, U.T. Arlington & US EPA. For info: www.tceq.texas.gov/p2/events/pollution-prevention-waste-management-workshop

September 28-29 CA
World Water-Tech North America Innovation Summit, Los Angeles. For info: worldwatertechnorthamerica.com

September 29-30 MT
Buying & Selling Ranches and Farmland Conference, Billings. Northern Hotel. For info: The Seminar Group: 206/ 463-4400, info@theseminargroup.net or theseminargroup.net