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SOUTH PLATTE BASIN WELL MANAGEMENT

COLORADO OPTIONS ANALYSIS

by Reagan M. Waskom, Colorado Water Institute, Colorado State University

INTRODUCTION

In 2012, the Colorado Legislature passed House Bill 12-1278, entitled *Concerning The Authorization Of a Study of The South Platte River Alluvial Aquifer* (HB 1278). HB 1278 was a result of a decade of debate in the South Platte basin that initially concerned wells that lacked Water Court-adjudicated augmentation plans to repay out-of-priority depletions. Later, concerns arose regarding property adversely impacted by high groundwater levels. The sponsors of the bill sought further information about planned utilization of the groundwater resource as a basis for improving the system of water administration in the South Platte. HB 1278 directed the Colorado Water Institute (CWI) at Colorado State University to conduct a study of the South Platte alluvial aquifer along the mainstem from Denver to the state line and present a report to the General Assembly by December 31, 2013. This article is an abridged summary of the full report, which can be found at: www.cwi.colostate.edu/southplatte/.

BACKGROUND

GROUNDWATER USE AND SUPPLY CONCERNS

The South Platte basin is the most complex water use and administration basin in Colorado, with a long management history and some 18,600 decreed points of diversion. The South Platte River flows eastwards out of the Rocky Mountains to Denver then turns northeast and flows to Nebraska. The average annual flow in the South Platte at Julesburg (since 1969), near the Nebraska border, is approximately 478,000 **a**cre-**f**eet (AF), but within this period there has been variation in average annual flow between 55,000 and 2.1 million AF. Flows are bolstered by annual transfers of approximately 400,000 AF in transbasin diversions, mostly from the Colorado River.

There is rarely enough water to satisfy all of the demands for water in this growing basin, where the majority of Colorado's citizens reside. Return flows from irrigation make a large contribution to stabilizing river flows and are a critical component of water rights and water utilization in this basin. "Return flow" is the amount of water that reaches a surface or groundwater source after it has been released from the point of use and thus becomes available for further reuse. The alluvial groundwater system covers about 4,000 square miles (Map 1) and is widely used for irrigation. Due to the magnitude of surface and groundwater diverted for irrigation, agricultural water use exerts a large influence on groundwater flow conditions. A century and a half of irrigation development in the basin has resulted in an extensive network of diversion ditches, canals, and reservoirs, all of which seep large amounts of water into the alluvial aquifer. Large irrigation ditches with senior rights divert the entire flow of the river at certain places and times, yet the river regains flow from groundwater and return flows just below these dry-up points to serve the next downstream water right. More recently — particularly in the last 20 years — there has been extensive development of recharge projects that are used to augment out-of-priority groundwater diversions or withdrawals.

South Platte Wells

Outline of the South Platte River Alluvial Aquifer in Northeast Colorado Showing HB 1278 Study Area of Water Districts 2, 1, and 64

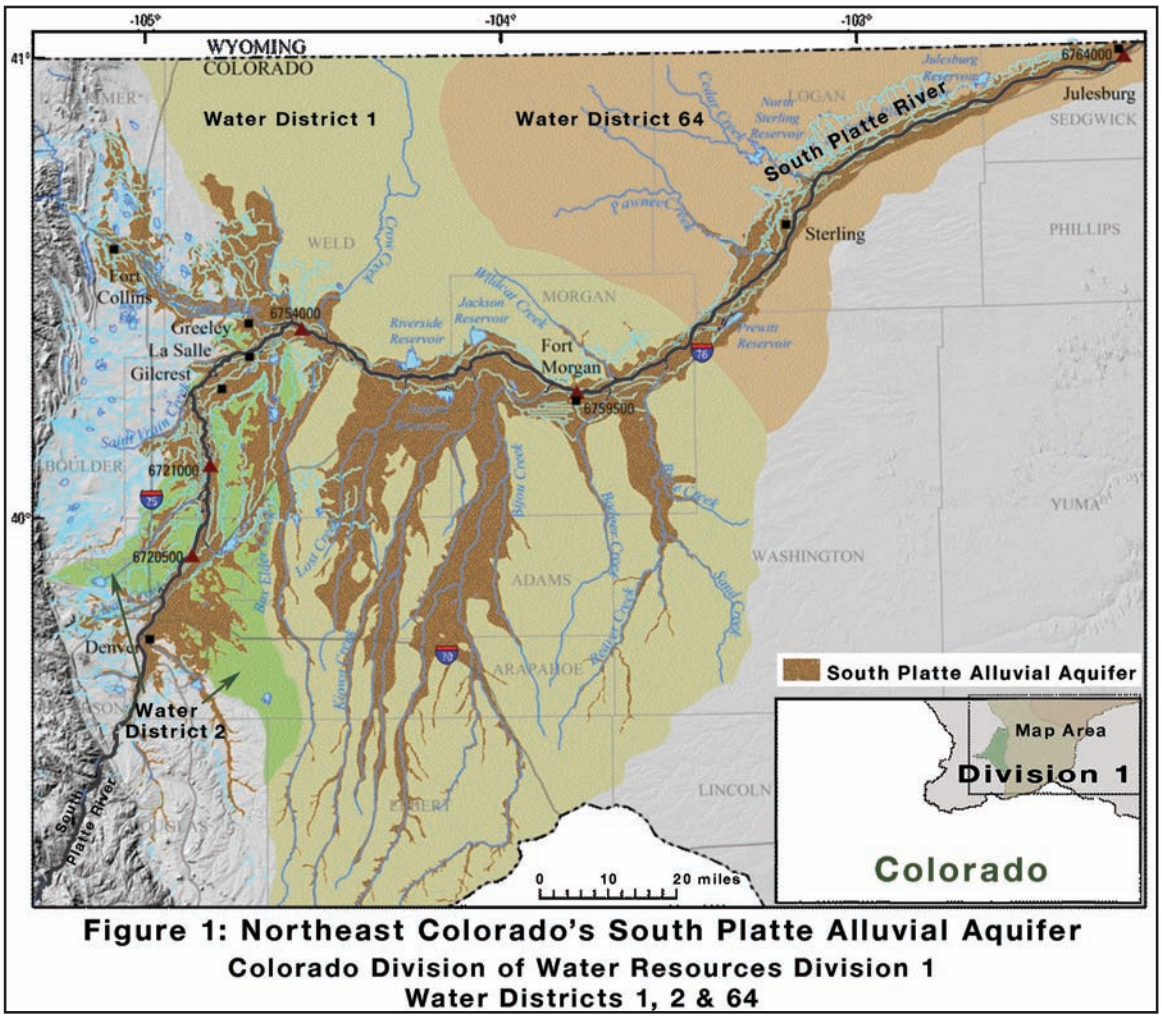

Figure 1: Northeast Colorado's South Platte Alluvial Aquifer
Colorado Division of Water Resources Division 1
Water Districts 1, 2 & 64

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260 North Polk Street,
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Editors: David Light
David Moon

Phone: 541/ 343-8504
Cellular: 541/ 517-5608
Fax: 541/ 683-8279
email:
thewaterreport@yahoo.com
website:
www.TheWaterReport.com

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The history of irrigation in the South Platte basin has been a cycle of over-appropriation followed by adjustment and supply enhancement. New canals, reservoirs, transbasin diversions, and wells were developed over time to deal with shortage and to firm up water rights and irrigable acreage, but conditions always quickly returned back to a fully appropriated system. The era of irrigation development on the South Platte began in earnest in the early 1860s, and the first large-scale irrigation project was initiated with the Union Colony in 1870 near Greeley. Chronologically speaking, the use of groundwater for irrigation was not far behind, as the first irrigation well of record was excavated in 1886 in the Lone Tree alluvium east of Eaton. As early as 1896, it was documented that the South Platte River was being augmented by canal seepage and irrigation return flow, benefiting those downstream. In *Comstock v. Ramsay,* (133 Pac. 1107 (1913), the Colorado Supreme Court clarified that return flows are tributary to the river and that the water right holder has no right to redirect return flows, thus establishing the "single use rule." In its 1913 ruling, the Court stated that all of the waters of the South Platte were appropriated, and that the entire normal flow was inadequate to supply the decreed irrigated lands. Additionally, the ruling stated that almost every water right decree — except possibly very early ones — were dependent upon return flows which enabled enlarged use of the streams.

It was not until the 1930s, when modern drilling technology and electrical pumps became available, that well yields became sufficient for large-scale irrigated crop production. By 1930, there were approximately 300 high capacity wells in the South Platte basin, and the drought of the 1930s resulted in an additional 1,400 wells constructed in the basin. William Code's 1943 report, *Use Of Ground Water For Irrigation In The South Platte Valley Of Colorado,* documented that there were 1,957 irrigation wells pumping an estimated 220,000 AF in 1940. Code determined that over 80% of the irrigation wells at that time were used to supplement the surface water rights owned by irrigators. Following World War II, the rural electrical associations brought electric power to rural areas and turbine pump technology became available, making diversion of groundwater more feasible. Severe drought during the 1950s resulted in the construction of an additional 1,200 wells. By this point, there was growing concern in the basin about the impact of unbridled well pumping on river flows. The legislature took the first step toward regulating tributary groundwater when it passed Senate Bill 120 in 1953. This 1953 Act, entitled "Underground

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Water," required well drillers to be licensed, filing of advance notice of well drilling, and filing of well logs after drilling, all under the supervision of the Colorado Water Conservation Board (CWCB).

Compared to some of the other western states, Colorado was relatively slow to enact legislation governing groundwater withdrawals. Several other western states addressed the groundwater issue in some form early in their development (Territory of Dakota, 1866; Kansas 1891, 1910; Idaho, 1899; Utah, 1903; Nevada and California, 1913; Arizona, 1919). The Colorado General Assembly took no meaningful action until 1957. The Colorado Ground Water Law of 1957 established that a permit from the State Engineer was a prerequisite to drilling a well and obtaining a water right, but the permit was "administrative only" — with no evaluation standards and therefore no basis to deny. The 1957 Act also established that a well permit "shall not have the effect of granting or conferring a groundwater right upon the user," and that the newly established Commission shall identify critical groundwater areas that "have approached, reached or exceeded the normal annual rate of replenishment" (1957 Colo. Sess. Laws, Ch. 289, 863-73).

Well Permit

Groundwater Control

The General Assembly first put groundwater within the regulatory authority of the State Engineer in 1965 by allowing the denial of a well permit application if the State Engineer found that there was no unappropriated water available or that the proposed well would materially injure other vested water rights. Although the 1965 Act subjected new wells to an injury analysis, it did not require wells to get a decreed water right, and did not provide for administration (regulation) in order of priority of permitted wells. During the mid-1960s, dry conditions and low streamflows resulted in more complaints by holders of senior surface water rights on the South Platte and Arkansas River. These "seniors" claimed that wells were causing depletions and should be regulated within the priority system like surface water rights. In June 1966, the Division Engineer in the Arkansas River basin attempted to regulate a limited number of wells. This led to the Colorado Supreme Court (Supreme Court) decision in *Fellhauer v. People,* 447 P.2d 986 (1968). In *Fellhauer*, the Supreme Court held that any regulation of wells must be preceded by the promulgation of reasonable rules and regulations, and that wells should only be regulated to the extent that it resulted in a reasonable lessening of material injury to senior water rights. *Fellhauer* contained the now famous statement by Justice Groves that "as administration of water approaches its second century, the curtain is opening upon the new drama of maximum utilization and how constitutionally that doctrine can be integrated into the law of vested rights." *Id*. at 994.

Well Regulation

In 1967, the Legislature passed Senate Bill 407, authorizing a two-year investigation of the relationship between surface and groundwater to evaluate the need for additional legislation to integrate administration of surface and groundwater. Following the SB 407 studies and the *Fellhauer* decision, the Legislature enacted comprehensive legislation entitled the Water Right Determination and Administration Act of 1969 (1969 Act).

Conjunctive Use

The 1969 Act was the Legislature's attempt to integrate surface and groundwater use. It intentionally brought all alluvial groundwater into administration based on the Prior Appropriation Doctrine. The legislative declaration of the 1969 Act provides that "it is the policy of this state to integrate the appropriation, use, and administration of underground water tributary to a stream with the use of surface water in such a way as to maximize the beneficial use of all of the waters of this state."

Augmentation Plans

The 1969 Act introduced the concept of a "plan for augmentation," by which a well or other junior water right could divert or operate out-of-priority so long as replacement water was supplied in time, location, and amount sufficient to prevent injury to senior water rights. The 1969 Act called for adjudication of all such augmentation plans by the Water Court. However, in order to ease the transition, the 1969 Act further provided the State Engineer with the authority to approve augmentation plans on a temporary basis, pending court adjudication of the final plans. The State Engineer's continued approval of temporary plans would eventually cause a major crisis in 2002. In the wake of the 1969 Act, most South Platte well users adjudicated their wells before the Water Court and received priority dates. Some sought Water Court approval of permanent augmentation plans. However, the vast majority of South Platte wells sought shelter for their augmentation plans by having the State Engineer approve them as **s**ubstitute **w**ater **s**upply **p**lans (SWSPs) — annual administrative approvals that allowed ongoing pumping on a year-by-year basis.

SWSPs

Because of the high cost of obtaining the replacement water necessary for the adjudication of permanent plans, two major well augmentation groups formed on the South Platte — one under the auspices of GASP (Groundwater Appropriators of the South Platte) was established in 1972 (approximately 4,000 wells), and the Central Colorado Water Conservancy District's (CCWCD's) Ground Water Management Subdistrict (Central GMS) was formed in 1973 (approximately 1,000 wells). Neither Central GMS nor GASP sought Water Court-approved augmentation plans in the 1970s, '80s, or '90s. The State Engineer continued to approve annual temporary SWSPs for these entities. Some South Platte water users became increasingly dissatisfied with the approval process, accusing Central GMS and GASP of providing inadequate replacement of depletions. However, from 1980 to 2000, the South Platte enjoyed 20 relatively wet years, masking supply shortages.

Augmentation Groups

South Platte Wells

State Engineer's Authority Ruling

Nondiscretionary Duty

Projection Tool

Quotas

Wells Curtailed

Year-Round "Calls"

Depletions Repayment

In 2000, litigation was initiated in the Arkansas River basin between the Empire Lodge Homeowners Association and the Moyers. The dispute involved property access issues, but a fight over water also developed. The issue was the State Engineer's approval of an SWSP under C.R.S. § 37-80-120 that allowed a pond to be filled by exchange out of the Arkansas River up a small tributary. The water judge ruled that the Legislature had not given the State Engineer authority to approve SWSPs. This ruling was appealed to the Colorado Supreme Court, and in December 2001, the Court's decision in *Empire Lodge Homeowner's Association v. Moyer*, 39 P.3d 1139 (2001), affirmed the Water Court's decision that the State Engineer did not have legal authority to approve SWSPs under the statute (C.R.S. § 37-80-120) that had historically been relied upon. The *Empire Lodge* case had a direct and immediate impact on the administration of water rights in the South Platte River basin, since the State Engineer no longer had authority to approve SWSPs, including the large plans covering thousands of wells operated by Central GMS and GASP. *Empire Lodge* affirmed that an augmentation plan is a legislatively created device to provide replacement water for senior water rights and thereby allow junior appropriators to divert water when they would otherwise be curtailed under strict prior appropriation administration. Under the priority system, depletions not adequately replaced result in curtailment of diversions by junior water right holders so as to protect more senior water rights — such curtailment is a nondiscretionary duty that the water administration officials must discharge.

2002 brought one of the worst drought years in recorded history. The "call" by senior water rights to regulate junior users began in June and stayed on throughout the rest of the year. The calls in 2003 lasted nearly the entire year, and in 2004 the situation was similar. As a result, replacement of depletions caused by wells required considerably more augmentation water, and GASP ultimately went out of business in 2006. In GASP's place other groups were formed to develop and file augmentation plans. The "South Platte Well Owners" filed two applications for augmentation plans with the Water Court and, subsequent to legislation granting temporary relief, sought temporary approval of an SWSP for 380 wells in June 2003. This group was comprised of former members of GASP. In 2004, CCWCD established the Central WAS, which included the above 380 wells and 61 additional wells, for a total of 441 wells. Meanwhile, the Central GMS application (Case No. 02CW335) was being prepared for a 2005 trial in the Water Court. In May of 2005, the Central GMS case settled on the eve of trial. The resulting consent decree was the result of extensive settlement negotiations and contained numerous restrictive terms and conditions for the protection of senior water rights. The Central GMS decree utilized a projection tool to forecast future depletions and anticipated replacement of Central GMS member wells. After lengthy multi-party negotiations, Central GMS settled out of court with water users opposing its plan, and presented a stipulated augmentation plan to the judge. The Central GMS plan did not have enough water to cover depletions from pumping its member wells at 100% capacity. As a result, they needed to limit pumping such that depletions would never exceed replacement supply. Since the entry of its decree, Central GMS has been only able to declare quotas ranging from 15% to 40% of calculated total crop demand.

The Central WAS plan was unable to settle out of court. Senior surface rights owners opposed their application, principally because the opposers believed that Central WAS did not have enough augmentation supplies to justify the entry of an augmentation plan decree. WAS wells did not receive temporary approval to operate in 2006, and were curtailed. This curtailment was an extreme hardship on well owners, and drew attention from national media. The most immediate economic impact of well curtailment fell on farmers who relied disproportionately on alluvial groundwater for irrigation. These producers had little recourse but to fallow land or convert formerly irrigated acres to dryland farming.

From 1995 to 2007 the number of augmentation plan decrees in Colorado went from 400 to over 750. During this same period the number of mainstem "calls" went from less than 100 days per year to essentially year-round. This change in the call regime resulted in reduced use of groundwater and increased reliance on surface rights during the summer. From 1995 to 2007 the number of water rights for which daily diversions are recorded went from 3,250 to almost 4,900. This increase in surface water diversion was in large part made possible due to junior recharge projects coming online and decreed augmentation plans, and changes of water rights that required daily recording of diversions. The historical lack of river calls from November through March has ceased as reservoir managers place calls to assure that they can fill their reservoirs and not have to compete for water that otherwise would be diverted by junior recharge water rights and storage rights.

RIVER CALLS

Tributary groundwater users are responsible under Colorado law to repay injurious river depletions taken out-of-priority during times the river is under senior call or administration. "Tributary groundwater" is water present below the earth's surface that is hydrologically connected to a natural surface stream. One of many changes that have occurred in the South Platte basin over time has been the percentage of time during which the river is under administration, particularly outside of the typical irrigation season.

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"Gentlemen's Agreement"

At one time there was a so-called "gentlemen's agreement" in the South Platte regarding how surface reservoirs would be filled during the off-season. The agreement was that following a normal irrigation season, surface reservoirs would begin storing river flows from the top of the basin down, and lower river seniors would avoid making a priority call. This resulted in minimal wintertime calls on the river and thus the wintertime stream depletions caused by groundwater pumping from previous years did not have to be replaced by irrigation well owners. This was a major benefit for well augmentation plans and particularly for GASP and CCWCD. The gentlemen's agreement began to break down in the late 1990s as more aquifer recharge projects were developed for augmentation plans, taking advantage of "free river" periods (i.e., periods when the river was "free" of being under "call" administration) by using water available when reservoirs were filling under the gentlemen's agreement. The loss of the agreement increased the period of time the river was under call and, hence, increased the depletions owed back to the river system by well users. Division 1 staff still attempted to facilitate the filling of upstream reservoirs by working with water users to encourage cooperation and efficiency in the spirit of the gentlemen's agreement, but this strategy could only work when adequate water was available in the river.

"Calls" Increase & Impacts

Analysis of the call data from 1982 to 2012 shows that administration of the river has changed considerably in the recent decade. In the past, the number of days the river was under administration was typically a function of water supply from snowpack and precipitation. This changed beginning in 2000 when additional calls were put on the river during both the irrigation season and the reservoir-filling season. Average days under call in the period of 2002-2012 has tripled in District 2, quadrupled in District 1, and more than doubled in District 64 compared to the 1982-2001 period. Off-season calls account for much, but not all, of this change in administration. The net impact is a double whammy of more days that well depletions must be repaid and fewer days of free river when junior augmentation rights can be exercised.

"Bypass Calls"

It should be noted that not all river calls impact irrigation wells. Most of the high capacity irrigation wells in the basin have 1930s-1960s priority dates. Any call that is junior to a well's adjudicated priority date does not trigger augmentation requirements for that well's depletions. The oldest augmentation calling right on the river is the 1972 Fort Morgan Plan. While post-1972 augmentation plans include recharge rights that occasionally are in priority as the calling right, wells with water rights senior to 1972 do not have to replace depletions called by post-1972 augmentation plans. In most cases, post-1972 recharge calls function as "bypass calls" to the benefit of senior users. [Editor's note: In Colorado a "bypass call" exists when a user may only divert a portion of their water right's appropriation and must "bypass" the remainder of the water.] The post-1972 recharge calls almost all operate as bypass calls to rights senior to most wells when there was enough water to meet the senior demand, but not enough to go to free river. These calls maximize beneficial use by allowing the well depletions to be in priority (and thus not require augmentation), while also keeping the most junior rights out of the river so that call administration does not yo-yo between senior calls and free river. The Division 1 Engineer estimates there are approximately 6,000 cfs of decreed water rights in Districts 1 and 64 for recharge and augmentation with post-1972 priority dates. Recharge and recharge calls happen primarily in two periods — the spring and fall shoulder months (when neither direct use nor diversions for storage are at their peak), or in the dead of winter.

Recharge Calls

HIGH WATER TABLES

Rising Groundwater

In 2008, there were homeowner reports of rising groundwater levels in the Sterling and Greeley areas. Subsequent wet years in 2009, 2010, and 2011 increased the frequency and locations of complaints. Homeowners reported failing septic systems and flooding basements that had not previously been a concern. Some farmers reported waterlogged fields and damaged crops. Local attempts to address flooding concerns were not successful, as inadequate information existed to precisely isolate the cause of the waterlogging.

Basis for Study

Some well owners who had been curtailed due to lack of adjudicated augmentation plans believed the high water table was an outcome of the recent changes in groundwater management. These parties appealed to the state Legislature, asking if there was a way to insert some institutional mechanisms to create more flexibility and opportunity for agricultural water users. Homeowners with flooded basements asked why recharge structures continued their operations when the local water table was near the surface. Eventually, the Legislature passed HB 1278 to study these problems and propose solutions.

GROUNDWATER PUMPING, CONSUMPTIVE USE & REPLACEMENT

Tributary Groundwater

All groundwater in the South Platte basin that is not either designated basin groundwater or Denver Basin groundwater is presumed to be tributary groundwater, in direct hydraulic connection to the surface stream system. Prior to 2003, on average nearly 500,000 AF of groundwater was pumped annually in the South Platte basin from approximately 8,200 high capacity wells. Agricultural pumping between the years 1950 to 2000 was calculated to average 438,000 AF/yr with municipal and industrial pumping growing to approximately 50,000 AF/yr during this same period. There are now approximately 6,500 high capacity

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Well Metering

Stream Depletion

Injury

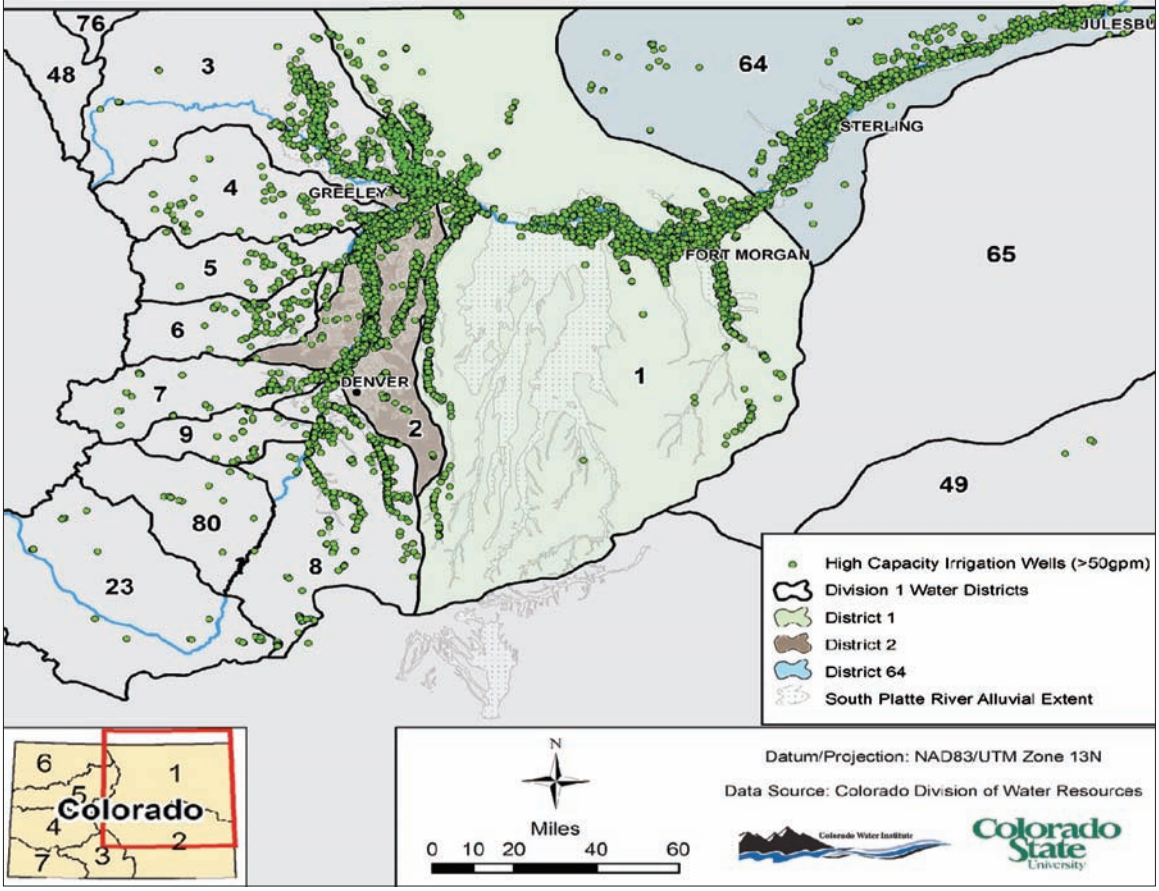
Agricultural Pumping

wells in the basin and total annual groundwater pumping in the basin is now closer to 450,000 AF/yr, with agricultural pumping in the 400,000 AF/yr range (Figure 2). Central Colorado Water Conservancy District has approximately 1,200 wells in the WAS and Central GMS plans that are on a quota system and not able to pump anywhere near 100% of full crop **e**vapo**t**ranspiration (ET) — the Central GMS quota has been around 35% since 2006; WAS quotas have been even less. Most of the other irrigation wells in adjudicated augmentation plans have full or near full allocations in most years. While new rules implemented in 2013 now require well owners to meter and provide pumping records, it will likely be several years before we have accurate accounting of wells' metering records to determine exactly how much individual wells are pumping and how much water is extracted from the various reaches of the alluvium in the basin.

For the purposes of augmentation plans, two methods are generally used to determine the amount of stream depletion caused by well pumping: 1) crop potential consumptive; or 2) presumed depletive factor. The most commonly used method for estimating stream depletion is the **p**resumed **d**epletive **f**actor (PDF). In this method, well volume is recorded or calculated and a specified percentage of that pumping is assumed to be consumptively used by the crop depending upon irrigation method (and hence the streamflow depletive amount). In most plans, sprinkler irrigation is assumed to have an 80% PDF and surface irrigation is assumed to have a 60% PDF. The amount, timing, and location of stream depletion due to pumping depend on proximity of the well to the stream, the pumping rate and duration, the direction and rate of groundwater flow, the amount of groundwater recharge, and hydraulic properties of the aquifer. Whether a pumped depletion causes injury depends on if it impacts the stream while under administration (priority water rights regulation) and if senior diverters are thereby shorted by the out-of-priority pumped depletion.

The method used for the HB 1278 analysis for estimating agricultural pumping — where groundwater is the sole source — is based upon crop consumptive use and an estimation of irrigation efficiency using 80% for sprinkler irrigation and 60% for flood irrigation. The average annual agricultural pumping demand for the period of 1991 to 1994 is estimated at 432,838 AF per year. Annual pumping rates are known to vary as a function of streamflow, precipitation, and ET; thus, modeled estimates attempt to incorporate these variables. Pumping rates for agricultural wells range from zero during the non-growing season months (generally November through March), and reach peak values in July of each year. Annual agricultural pumping values range from 176,000 AF in 1951 to 714,000 AF in 2002 in Division 1. July has the highest average pumping rate of 127,000 AF followed by August, June and September.

Figure 2: High Capacity Irrigation Wells of CDWR Division 1



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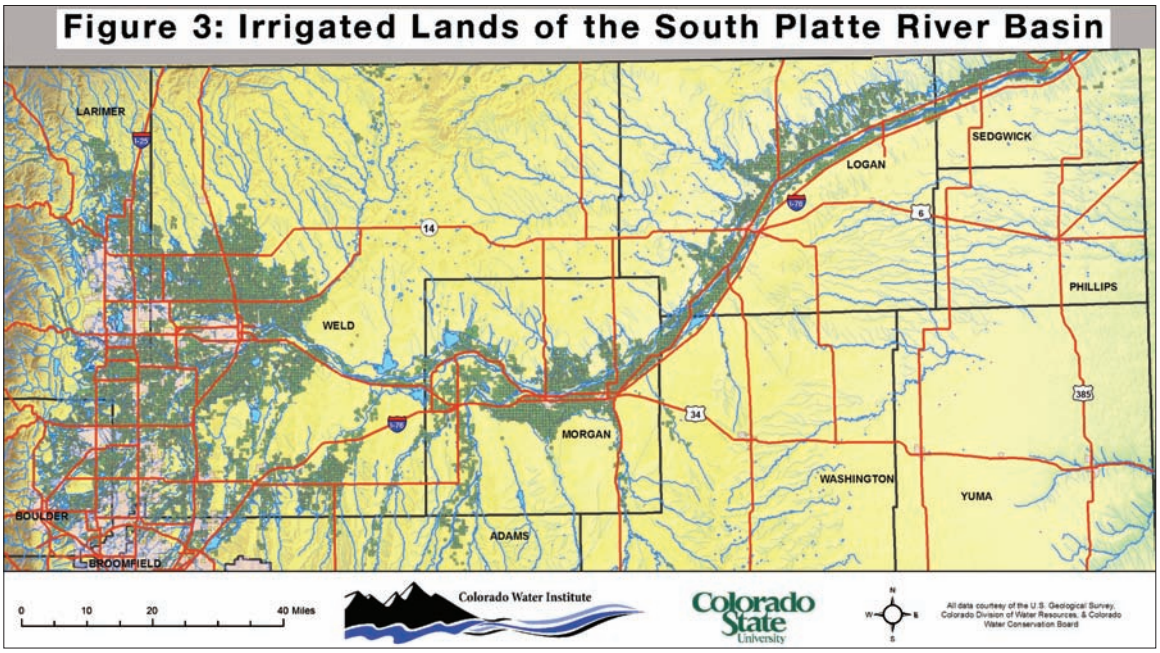
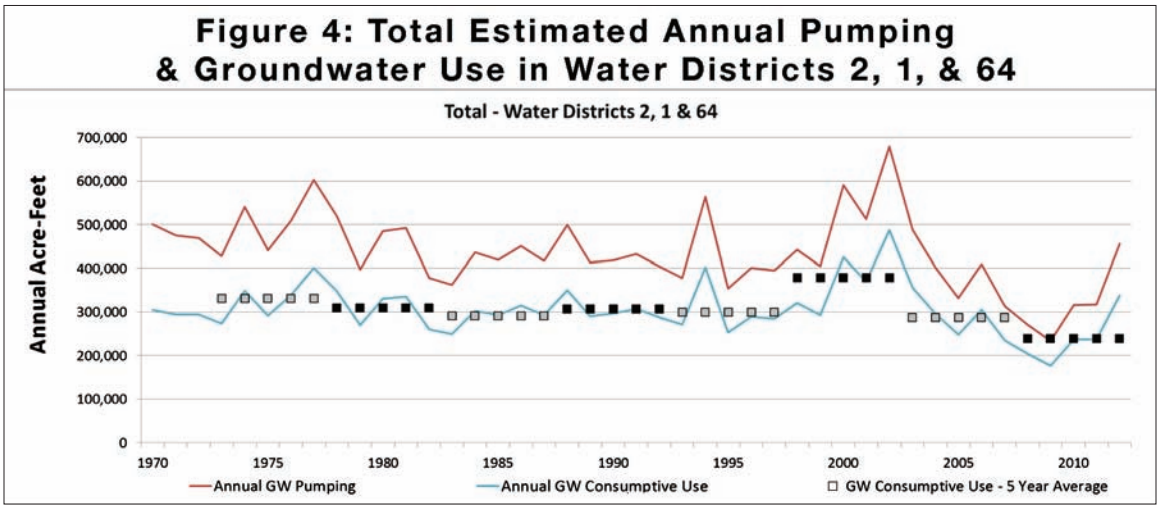


Decreasing Irrigation

Irrigated lands have decreased in the South Platte basin since reaching a peak of slightly over one million acres in the mid-1970s to approximately 830,000 acres presently (Figure 3). Much of this loss of irrigated lands is a result of urban growth over agricultural lands along the Front Range / I-25 corridor, but some of it can also be attributed to the purchase of senior agricultural surface water rights and the subsequent dry-up of these lands.



Consumptive Use

Estimated pumping amounts for Water District 2, 1 and 64 were based on crop irrigation water requirements plus an on-farm application efficiency value associated with flood and sprinkler application methods less any surface water supplies, using analysis developed for the South Platte Decision Support System (SPDSS) (Figure 4). The difference between pumping and consumptive use reflects the portion of the pumped water that is not consumed by the crops and returns to the river or aquifer. The difference between annual pumping and consumptive use generally decreases over time, reflecting the gradual increase in sprinkler irrigation over the past several decades.

Augmentation Supplies

Annual variability of the pumping volumes can be attributed primarily to varying climate conditions, plus some changes in irrigated acreage. The greatest pumping and consumptive use occurs in Water District 1, which correlates with the large amount of acreage served only by groundwater in that district. Reduced pumping in Water District 2 after the 2002 drought occurred because many wells were not fully covered under augmentation plans and were forced to reduce pumping. Water District 64 has the most recharge and surface augmentation sources, and increased pumping reflects limited surface water due to drier conditions. It is important to note that consumptive use values shown in these graphs do not take into account the time-lagged depletive impacts to the river. Five-year averages are used to smooth out the data and approximate the effect of lagged depletions. Note that groundwater pumping has shown an increase since 2009 as additional augmentation supplies have been acquired and adjudicated.

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AUGMENTATION

Senior Protection

Plans for augmentation allow diversions of water out-of-priority while ensuring the protection of senior water rights. Decreed water rights receive a replacement water supply that offsets the out-of-priority depletions caused by well pumping. Replacement water can come from any legally available source of water such as mutual ditch company shares, reservoir storage releases, successive use of transbasin water, nontributary water, augmentation wells, and/or artificial recharge of aquifers to generate augmentation credits. Where surface water is fully appropriated, Colorado law presumes that groundwater depletions through well pumping *will* result in injury to senior appropriators absent a showing to the contrary. The South Platte River basin is fully appropriated and thus the presumption of injury accompanies all out-of-priority depletions by tributary wells.

Plan Elements

Elements of a well augmentation plan typically include:

- Accounting of river depletions in time, amount, and location due to well pumping
- Replacement/augmentation sources for all injurious depletions
- The plan for operation of augmentation water to cover depletions

Timed Recharge of River

The most cost effective method of augmentation is to develop recharge structures that can take surface water during times of free river (availability) and allow the water to seep into the aquifer and back to the river. These structures may be ponds, unlined ditches, or low lying areas that overly the alluvium and are hydraulically connected to the river, are permeable, and have enough unsaturated material above the water table to allow recharge. The concept is to time the recharge so that it will flow underground back to the river coincident with the timing of injurious well depletions impacting the river. The returned recharge water is then available to senior surface water rights in lieu of the river baseflow that was taken out-of-priority by well pumping. The accuracy of calculating the timing of this recharge water return flow to the river is important as it determines whether the recharge suitably replaces water in the river at the time it is needed by senior water rights.

Augmentation Details

Augmentation plan decrees by the Water Court typically specify an assumed period of senior call that must be protected from injury, often all of the irrigation season. The plan may also be required to demonstrate that depletions from irrigation, augmentation, and recharge wells can all be replaced, if necessary, for the entire year. Plan operators are required to submit monthly reports of their daily depletion and accretion accounting to the Division Engineer. Net out-of-priority well depletions are calculated by multiplying the sum of net depletion by the percentage of time the wells were out-of-priority. Shortfalls in accretions to cover net depletions necessitate replacement with alternative augmentation water or curtailing well pumping to the extent needed to avoid a deficit. Augmentation plan operators are bound by the terms and conditions of the decree and the Division Engineer has the nondiscretionary responsibility to enforce the terms and conditions of the decree upon the wells and the lands included in the decree, as well as the successors and assignees until all obligations under the decree has been fulfilled.

Net Depletions

Augmentation supplies can be divided into two general categories:

Supply Categories

- **Recharge Augmentation Supplies** include water diverted for in-ditch recharge or to recharge ponds. The lagged timing of these recharge supplies is not specifically considered. Instead, the monthly diversions to recharge are summed on an annual basis, and trends are considered based on a five-year average. Note that recharge augmentation supplies accrue to the river regardless of whether a call requires augmentation during that time period.
- **Surface Augmentation Supplies** include controlled water released from a storage reservoir; water diverted and released to the river via an augmentation station; and reusable effluent. Surface augmentation supplies are only released to the river when a call requires augmentation.

Recharge Accounting

Recharge structures in the South Platte are designed to introduce water into the alluvium that will result in water accretions to the river (Figure 5). The structures are optimally sited at a distance from the river that most efficiently covers lagged pumping depletions that are incurred during the summer growing season, but may hit the river days, months or years later during a period when the river is under administration. A recharge structure may be a designated section of unlined ditch or canal, or a pond or group of ponds that receive water designated for recharge or augmentation. Flow into and out of each recharge structure must be metered and equipped with a continuous flow recorder or similar approved equipment. Recharge water must be deemed fully consumable and accretions are calculated as inflow minus evaporation plus consumptive use by vegetation plus water retained and outflow. Recharge accounting is done daily and monthly summations are provided to the Division Engineer within 30 days of the end of the month.

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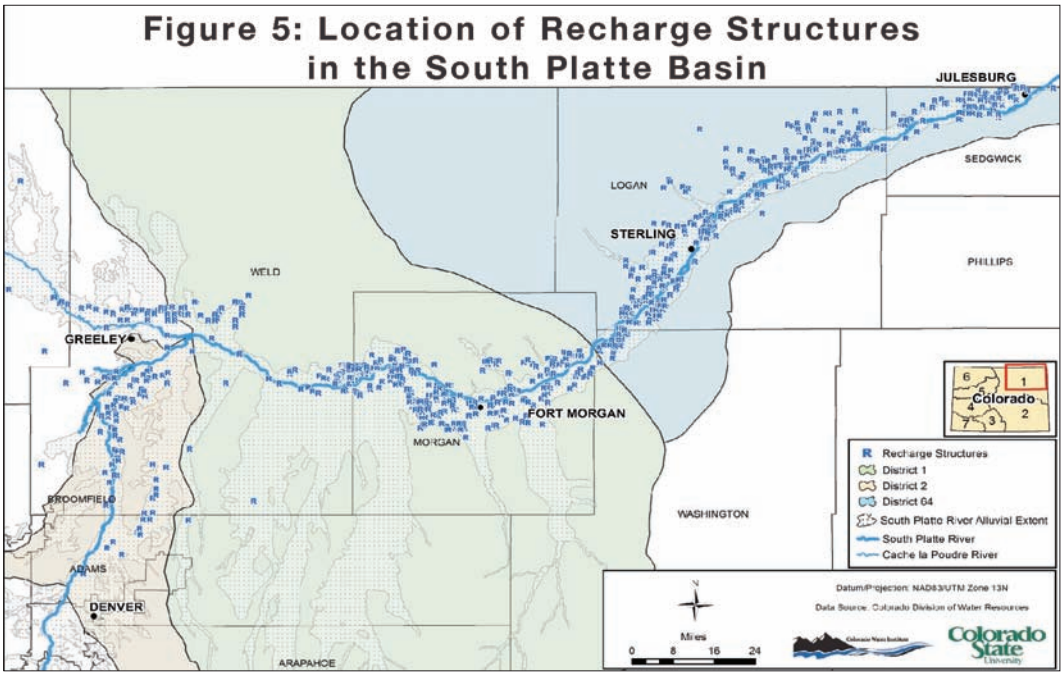
Recharge Increase

As discussed above, not all groundwater pumping causes depletions to the river. Also, depletions do not require augmentation if there is not a senior call on the river. The annual potential augmentation requirements shown in Figure 6 below does not represent lagging or periods that the river is not under call. The result is that the lack of lagging underestimates depletion, while the assumption of 100% call overestimates the owed depletions. A calibrated groundwater model is needed to more precisely quantify lagged augmentation requirements at this scale.

The increase in recharge augmentation supply in the 2000s is a result of an increase in recharge areas constructed in the basin, specifically in Water District 64 and to a slightly lesser degree in Water District 1 (Figure 6). District 2 has seen the development of many lined gravel pits which may or may not provide augmentation water, but do not serve as a source of recharge. Augmentation supplies in District 2 are inadequate to serve the needs, thus wells remain on restricted quotas. Surface augmentation supply reflects releases for augmentation from reservoirs that are able to release directly back to the river, groundwater diversions from augmentation/recharge wells, bypassed diversions measured at augmentation stations, reusable effluent, and other sources of direct augmentation.

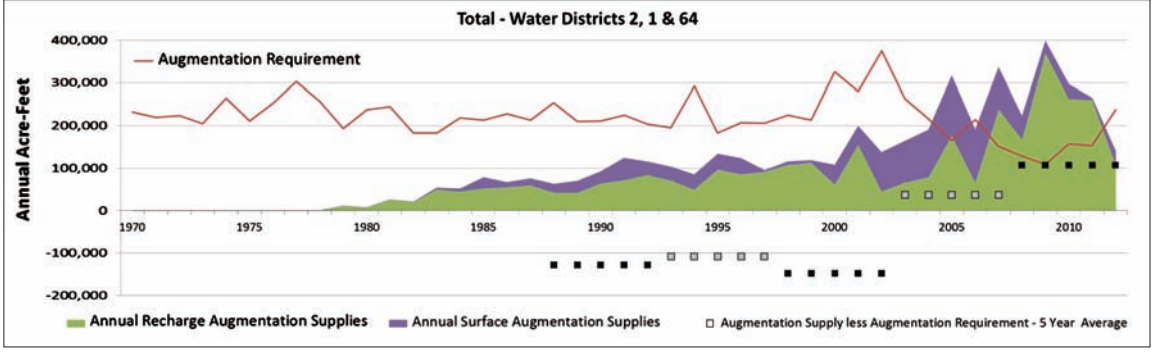
Figure 5: Location of Recharge Structures in the South Platte Basin



Potential Maximum

The five-year averages shown in Figure 6 indicate that potential estimated augmentation requirements exceeded augmentation supply prior to more strict administration beginning after the drought in the early 2000s. However, since days of administrative call were considerably less in these water districts prior to 2000, the actual augmentation requirement would have been much less than the potential maximum requirement based upon consumptive groundwater pumping.

Figure 6: Total Annual Surface & Groundwater Augmentation Supplies Versus Estimated Potential Augmentation Requirements & Five-Year Average Augmentation Supplies Less Potential Augmentation Requirement in Water Districts 2, 1, & 64



South Platte Wells

Excess Cause

Augmentation from recharge in excess of requirements may occur because junior recharge rights are only in priority in short windows of time and thus augmentation plan operators must recharge as much as possible when they are in priority — and thus allowed to divert water for recharge. Since recharge operators cannot know when the next drought period will occur, they are compelled to operate in a manner that assumes that drought could occur next year, or for the next six years, depending upon their court decree. Additionally, the timing of when the recharge rights are in priority may not match the lagged timing of when water is needed from the wells to irrigate crops. The locations of recharge ponds and other recharge facilities relative to irrigation wells also may present timing difficulties for augmentation plans. For example, if recharge structures are located closer to the river than the irrigation wells in an augmentation plan, the recharge credits reach the river more quickly than the depletions. In these cases it is difficult to recharge only the amount of water ultimately needed to offset the well depletions. As a result, many augmentation plans have excess capacity to provide adequate supplies to cover depletions year round.

Flexible Plan

A good augmentation plan must have a blend of recharge structures close to the river for use following dry periods and structures further away to provide much longer recharge credits for protection during prolonged drought periods. Table 1 and 2 below show the changes in pumping and augmentation before and after strict administration of wells, which began being implemented in 2000 and was completed in 2006. Augmentation through recharge has greatly increased between these two time periods.

Changes in Pumping & Augmentation

Table 1. Average Surface Diversions, Pumping, Consumptive Use Groundwater Pumping, and Augmentation for Water Districts 2, 1, and 64, for the period of 2008-2012.

	WD 2	WD 1	WD 64	Total
	----- Average (2008-2012) in AF/yr ----------			
Total Surface Diversion	376,583*	673,869	257,766	1,308,217
Total Pumping	31,195	177,490	110,612	319,298
CU GW Pumping	23,138	134,872	80,781	238,791
Surface Augmentation	18,487	6,067	5,493	30,047
Recharge Augmentation	11,166	131,287	91,819	234,271
Total Augmentation	29,653	137,354	97,312	264,318

*2011 diversion data not included for WD 2 Source: HydroBase Version 20130710.

Table 2. Average Surface Diversions, Pumping, Consumptive Use Groundwater Pumping, and Augmentation for Water Districts 2, 1, and 64, for the period of 1999-2004.

	WD 2	WD 1	WD 64	Total
	------ Average (1999-2004) in AF/yr ----------			
Total Surface Diversion	397,916	573,433	209,553	1,180,902
Total Pumping	89,840	277,685	145,095	512,620
CU GW Pumping	62,418	205,907	102,630	370,954
Surface Augmentation	9,105	30,961	25,861	65,927
Recharge Augmentation	3,786	46,432	36,653	86,871
Total Augmentation	12,891	77,393	65,514	152,798

Trading Credits (Banking)

A new water cooperative (commonly called the South Platte Cooperative or the Northeastern Colorado Water Cooperative) has been proposed to facilitate more efficient use of excess augmentation water in the lower South Platte basin through quantification and trading. The proposed Cooperative would create a mechanism for temporarily moving augmentation credits from plans with unused credits to plans that need additional credits. The Cooperative anticipates being operational in 2014 and aspires to eventually serve as a water bank for the lower river where any source of tradable water can be deposited and transferred on a temporary basis.

South Platte Wells

Unused Credits

Preliminary studies for the cooperative found the following:

- Amounts of unused recharge credit vary annually
- The amount of unused recharge credit appears to be less variable in District 64
- Annual amounts of unused recharge credits in District 64 varied from 5,000 to 10,000 AF
- Annual amounts of unused recharge credits in District 1 varied from 6,000 AF in 2008 up to 50,000 AF in 2010
- It is expected that during drought unused recharge credits will be greatly reduced if not eliminated

A similar effort or water bank is likely needed for other reaches of the South Platte to help provide inexpensive augmentation water to well users in wet and average years. In dry years it could also provide water to municipalities.

GROUNDWATER LEVELS IN THE ALLUVIAL AQUIFER

Gaining Stream

Prior to irrigation development, the South Platte River was an intermittent stream often dry during late summer. As irrigation became widespread by the late 1870s, the river became a perennial stream, as the riverbed lies below what became the new water table. USGS Water Supply Paper 1378 (Bjorklund, 1957) mapped groundwater levels in the basin and reported that alluvium varies in thickness from a foot at the edge of the valley to 293 feet deep. The water table generally slopes diagonally downstream and toward the river. Groundwater discharges to the river, making it a gaining stream for most of the year and for most of the distance downstream of Denver to Julesburg. During low flow periods, virtually all of the streamflow is groundwater baseflow to the stream. Coarseness and thickness of alluvium and the underlying bedrock surface and slope affect the water table depth and flow vectors. Lack of uniformity of bedrock and overlying alluvium are reflected in the variation of water table shape and slope.

Water Table Fluctuations

The Bittinger Wright 1968 study reported a stable water table over the 35-year period from 1933 to 1968. The water table was generally at its highest in the fall and lowest in the spring. Wright concluded this pattern indicated that surface water *additions* from ditches, reservoirs, and irrigated fields during the irrigation season exceeded the net withdrawal of water from wells at that time. In winter, the river serves as a drain and lowers the water table built up during the previous crop season.

Recharge

The water table rises and falls with recharge (from irrigation, canal and reservoir seepage, precipitation) and discharge (withdrawal by pumping and baseflow). In parts of the basin the water table is lowered during the pumping season and recovers in the off-season. In areas that are chiefly watered by canals the water table rises during the irrigation season and declines during the off-season as it drains back to the river. Periods of above average precipitation may cause local water table rises, while periods of drought generally cause it to decline. Heavy pumping in Bijou, Beaver, and Kiowa drainages has caused a long-term trend of declining water levels that appears different than most of the other reaches of the South Platte and its tributaries.

OBSERVATION WELL DATA

Data Tools

The general plan of work for the HB 1278 study was to use the existing data tools in the South Platte Decision Support System (SPDSS) developed for CWCB as part of the Colorado DSS (CDSS) but not the SPDSS groundwater model, which was released during the HB 1278 study. The South Platte Decision Support System (SPDSS) has been under development over the past decade and provides a wealth of data, data tools, and data synthesis through the many Technical Memoranda that may be accessed online at http://cdss.state.co.us/basins/Pages/SouthPlatte.aspx.

The HB 1278 study included two analyses of groundwater level data — one analysis by Colorado State University (CSU) and an independent analysis by the USGS. CSU's analysis utilized publicly available data from six groundwater observation networks. In addition, CSU asked stakeholders in the basin to self-report on a CSU website and via paper forms handed out at public meetings to indicate where they were experiencing adverse impacts of high groundwater such as waterlogging and flooded basements. Such impacts were consistently reported in the vicinity of Greeley and Sterling. Localized high groundwater levels have been reported in the basin going back to the early1900s and at one time there were a number of drainage districts in the South Platte to keep fields from waterlogging. Analysis was performed based on bi-annual (spring and winter) data to determine if systematic trends existed.

High Groundwater

High groundwater has been reported for almost a century in areas near the South Platte. The question CSU sought to answer is whether the trend data indicate a rising water table, and whether this trend could be connected to current management. The 2012 drought provided a valuable observation year for the HB 1278 study, as many observation wells showed a decline that year and did not continue the rising trend observed over the past decade. This indicated that unusually large lagged return flows were not in transit back to the river or to unfortunate homeowners' basements, at least on a regional scale. On the whole, the

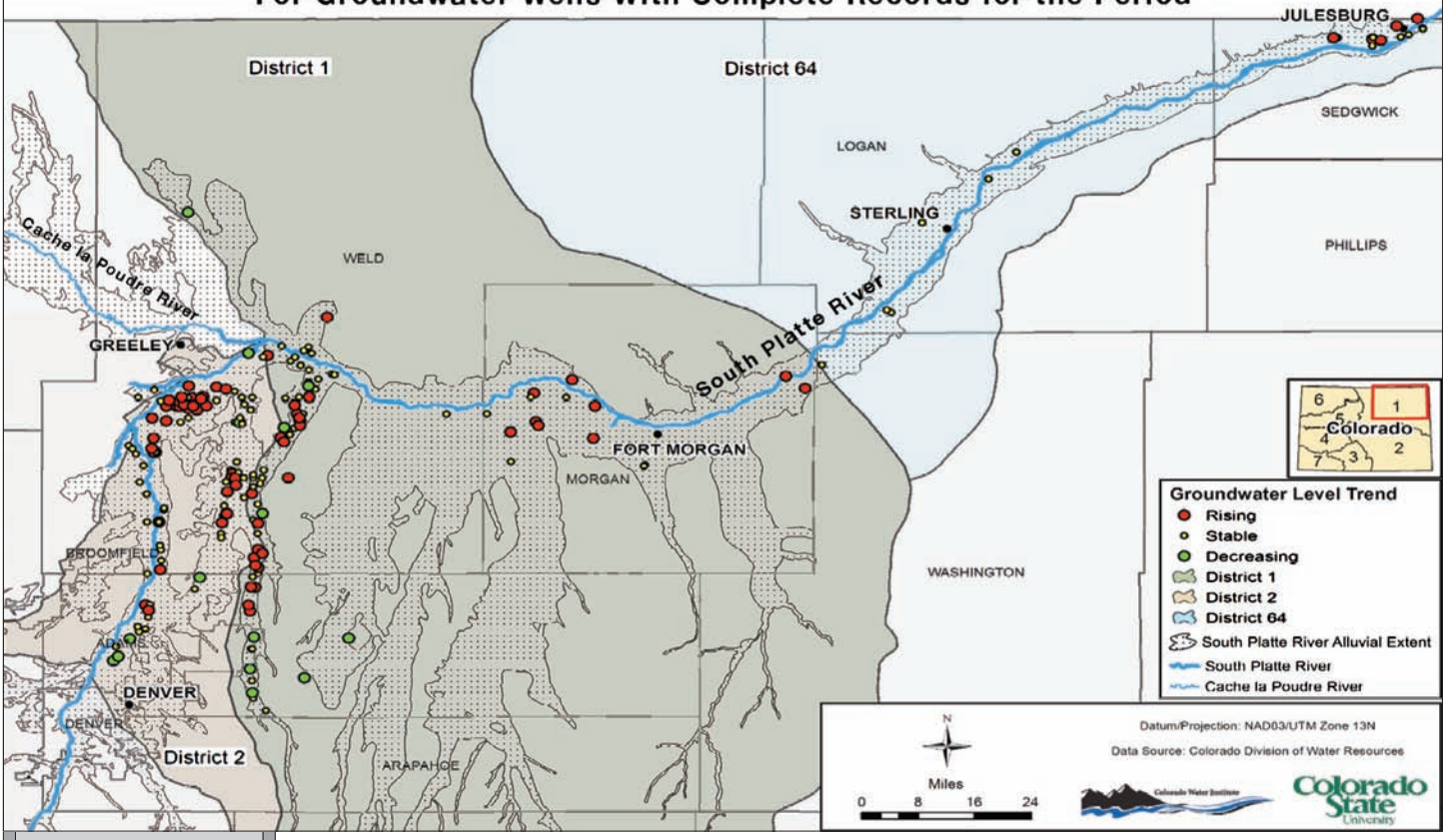
South Platte Wells

USGS Trends Analysis & Monitoring Proposal

majority of the observation wells either did not have an adequate data record or there was too much noise in the data to detect a statistically significant trend. However, a much greater percentage of observation wells show increased water levels over the recent decade than declining water levels. This is not surprising, as we know this period started at a drought induced low point in 2002, and recharge increased at the same time there was an increased reliance on surface water due to well curtailment. Indeed, it would be a surprise if groundwater levels did not react to these changes.

USGS conducted an independent analysis of groundwater level data for the HB 1278 study for the years 1953 through 2012. Water levels were evaluated at point locations (at each well) and over aggregate areas defined by subwatershed boundaries in the study area. Temporal and spatial relations of high groundwater levels were examined using ArcGIS and algorithms developed specifically for this study. Based on results of the analyses, a groundwater monitoring plan was proposed for the basin that accounts for statistical relations and could be used to test potential conditions that cause high groundwater levels in the future. In general, the USGS analysis corroborated the CSU findings of widespread rising groundwater levels. They found that groundwater levels in wells having significant trends appear to have been mostly in a state of decline for five decades from 1953-2002. Since 2002 there has been a reversal in groundwater levels — about 89% of wells indicate rising groundwater levels, and the remaining 11% show a decline.

Figure 7: South Platte River Basin Groundwater Level Trends 2000-2012
For Groundwater Wells With Complete Records for the Period



Subsurface Diversions

Surface Water Diversions and Administration

There are 56 major surface water diversion canals along the mainstem of the South Platte in Water Districts 2, 1, and 64. The largest change that can be observed in surface water diversions is the post-1969 diversions in the November to March period, when canals are taking water for reservoir filling and augmentation purposes. CSU analyzed mean annual diversion records, irrigation season and reservoir season diversion records for the periods of 1950-1968, 1969-1999, 2000-2012, as well as 1950-2012 and 1969-2012 to detect the presence or absence of trends, either positive or negative, and used the Mann-Kendall test to determine if the trends are significant (Kendall 1975; Mann 1945).

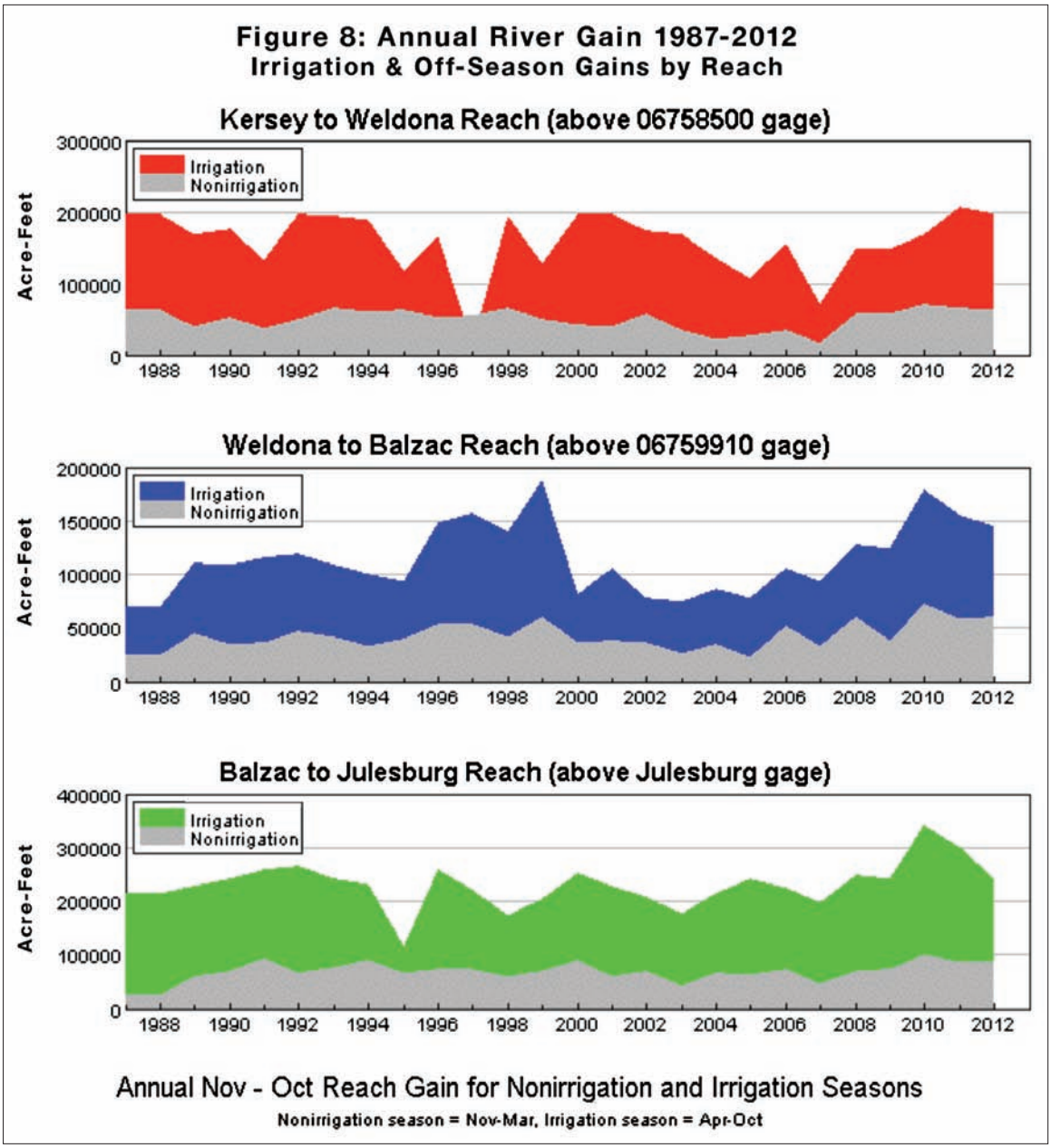
About a third of surface water diversions show some increase in mean annual diversion amounts between the 1969-1999 period and the 2000-2012 period (Table 3, next page). In Water Districts 1 and 64 these increases can mostly be attributed to increased reservoir fill season (Nov–March) diversions for the purpose of augmentation accretions.

South Platte Wells

Table 3. Average Total Annual Diversions for 56 Major Ditches in Water Districts 2, 1, and 64.			
Period	Irrigation Season (Apr-Oct)	Off-Season (Nov-Mar)	Irrigation Year (Nov-Oct)
	---------- AF/yr ----------		
1969-1999	818,151	151,479	969,630
2000-2012	901,600	343,912	1,245,512
Data Source: CO DWR HydroBase Version 20130710.			

Return Flows

A point flow analysis tool quantified the historical monthly, seasonal, annual, and decadal stream reach gains and losses between mainstem streamflow gages located in Water District 1 and 64. Stream gains are highest in the South Platte during the irrigation season and the lowest in November and December, ranging from approximately 3-9 cfs per stream mile. Reuse of return flows and accretions increases downstream, with the surface diversions in the lower reach being nearly equal to available stream gains. A rising trend in stream gain can be observed in recent years (Figure 8).



South Platte Wells

Rising Groundwater

Affordable Augmentation

Recharge Evaluation

Spring Interval

Alternative Management Pilots

Administrative Call

Annual Plan

RECOMMENDATIONS

IMPROVING WATER MANAGEMENT AND UTILIZATION IN THE SOUTH PLATTE

While variations in the South Platte basin's data record introduce some uncertainty in exact amounts of pumping or other parameters, various trends are apparent that allow us to make a number of observations, which taken together reveal certain generalizable findings that warrant further consideration and action. Specifically, the observation well record shows a large percentage of wells with rising water levels in the past decade, particularly near Greeley along the mainstem, and in Morgan, Logan, and Sedgwick Counties. As a likely response to curtailment of pumping after 2002 and increased recharge, groundwater levels have increased over the last decade (2003-2012).

CSU evaluation of the data leads to the conclusion that the current administration of groundwater in the basin works reasonably well for lower basin water users, and that senior surface water users are for the most part protected from injury due to well pumping by current administration. However, not all water users agree with this finding. Groundwater users in Water District 2 and parts of District 1 have been adversely impacted by the shortage of affordable augmentation supplies to offset pumped depletions. Presently, high groundwater conditions impacting landowners appear to be localized and thus, local solutions are recommended. In the consideration of any changes to the system, it should be acknowledged that senior water rights must be protected in any adjustments to the system and that wells cannot be relieved from the obligation to replace out-of-priority depletions that cause material injury to senior water rights.

Mitigating High Groundwater

Several areas on the South Platte mainstem, most notably Sterling and the Gilcrest/LaSalle regions, are experiencing high groundwater conditions that should be mitigated to prevent further damage to property and loss of water through non-beneficial consumptive use. There are over 500 recharge projects now in place in the South Platte basin. According to Division 1 staff, as many as 800 total recharge structures are planned in existing augmentation plans. Future groundwater recharge projects should be designed, located, constructed, and managed so as to avoid creating groundwater mounds that cause harm to third parties. When the State Engineer and the Water Court currently evaluate a recharge project, they are primarily determining whether it will offset out-of-priority depletions, with no explicit responsibility to determine if recharge is at risk of causing property damage to others in the flow path of recharged groundwater. Recharge structures should only be placed near urbanizing areas after an analysis of potential impact to down gradient properties. In some cases, more complete geotechnical analysis is warranted to identify aquitards, perched water tables, confining layers or clay lenses, and consideration of flow paths that may affect return time to the river. A spacing interval between recharge structures may need to be established to avoid cumulative impacts. The State Engineer's Office (SEO) should be authorized to work with local parties to establish remedies that allow augmentation plans to continue operating without causing impact from high groundwater levels.

Pilot approaches may include permitted pumping or decreased recharge as determined to be locally appropriate to test alternative management strategies. Groundwater levels and surface diversions in the pilot areas must be accurately monitored in real time to determine impacts from the pilot management approach, and a plan to augment any injurious depletions must be established. Calibrated numerical groundwater models should be developed and tested against analytical methods in the pilot project areas. SEO should be authorized to work with recharge site operators in pilot project areas with mounded groundwater to replace injurious groundwater depletions in ways that will achieve the goals of augmentation plans without further raising water levels. Additionally, a stakeholder group should be authorized to develop local input to the SEO for alternative management in the pilot project areas. The pilot projects should sunset after a three to five year period, and an analysis of what was learned should be provided to the Legislature.

Increased Administrative Flexibility

Developments in Water Court and administrative practice have diminished the Division Engineer's ability to play a management role in the distribution of water supplies. The mass movement of irrigation wells into augmentation plans is widely considered to be nearly completed. The decrees are considered final and to the extent that any room exists for adjustment in augmentation requirements, it has to do with the administrative call. Augmentation plans respond to the administrative call, and this is the one adaptable part of the decrees. Reducing the number of days of administrative call on the river system will allow for additional groundwater use and allow more days of free river, whereby well users can acquire recharge supplies. However, downstream senior rights cannot be shorted and must have guarantees that they will not be harmed if they operate without placing a priority call.

Datasets related to both surface and groundwater should be used by the Division Engineer to guide the development of an annual management plan, which can be adjusted throughout the season in response

South Platte Wells

"Full" Aquifer

to changing conditions. For areas in the basin experiencing damaging high groundwater conditions, there is the potential for rules to establish standards to determine when portions of the alluvial aquifer are "full" and additional augmentation or curtailment is wasteful. In these regions, it is likely that the aquifer's accretive contributions to the river have reached maximum potential, and additional replacement or curtailment merely contributes to evaporation or evapotranspiration losses without any increase in water supply for senior rights. At such times, the Division Engineer could set the administrative call affecting the augmentation plan so that additional replacement is not required and/or authorize pumping to mitigate damaging conditions and return the aquifer to optimal accretive levels.

Basin Wide Management: Conjunctive Use

Oversight Need

Achieving optimum conjunctive use of surface and groundwater in the South Platte that is sustainable over the long term is best accomplished through implementation of a basin-wide approach that would have the goal of fuller utilization of the river and the alluvial aquifer for all water users' benefit. Better data and science will only improve water management if we are better organized to use the science. Presently, no one organization in the basin has oversight of the whole system for the benefit of all. Admittedly, there are many political, jurisdictional, and funding impediments to implementing basin-wide management in the South Platte. However, the basin faces a critical water supply gap in the future. Meeting that gap requires optimizing the use of the resource. Water lost downstream in the recent flood of 2013 and the inability to more effectively use the aquifer during the 2012 drought demonstrates that the basin is not positioned well to deal with extreme hydrologic events or future shortages.

New Entity

A new entity, such as a South Platte Water Conservation District, with a mandate to work with water users across the entire basin could work towards augmenting water supplies and facilitating more flexible management in the basin. The basin-wide entity could capture and store groundwater and put it in the river in times of drought and replenish it in times of plenty.

Management Tasks

Water users would run the organization and tasks could include:

- Build and operate new storage projects, including underground storage
- Serve as the water banker and develop a fully operating spot market for the basin
- Develop more augmentation water supplies
- Create a basin-wide augmentation bank
- Provide ongoing data collection, analysis, and display
- Provide SPDSS oversight
- Develop an annual river forecast and operating plan that determines sustainable yield
- Develop annual plans for distribution of sustainable yield by priority, using surface and groundwater withdrawals
- Work with the SEO to keep the call period minimized through cooperation and communication
- Find and protect environmental flows
- Implement phreatophyte management
- Provide coordination and communication among water users

Better Monitoring and Models

Data Need

In an age when water is becoming increasingly scarce and supplies uncertain, robust data networks and decision support tools are critically needed for day-to-day operations and to build a long-term data archive to serve the needs of the people of the State of Colorado. The HB 1278 study has revealed that our groundwater monitoring data collection network is irregular and incomplete but could rather easily be substantially upgraded. Better management decisions require higher quality and more easily accessible data. We need to install, instrument, and maintain a groundwater level monitoring network that can be used for real time management decisions. Additionally, water management organizations in the basin should share data and collaborate on data collection. The USGS has developed a statistically robust groundwater monitoring network as part of the HB 1278 study, based on existing monitoring wells, that can greatly improve our ability to track and manage groundwater for very low initial cost. The complete network includes wells managed by federal, state, and local agencies — demonstrating the need to gather community resources collaboratively in a unifying manner to establish an optimal network for the region.

Basin-Wide Model

We also need a basin-wide model and a common technical platform that all water users in the basin agree to employ. The South Platte Decision Support System (SPDSS) is the best mechanism to provide this platform over time. However, the Colorado Water Conservation Board needs to work with basin water interests to develop stakeholder ownership of the SPDSS to ensure it continues to improve and meet the needs of basin water users. A more robust and adequately funded network of weather stations with high spatial representation across the state should be considered to ensure Colorado meets the data needs of stakeholders across the state. Improving the monitoring network is in the interest of all water users and could be coordinated under the basin-wide entity.

South Platte Wells

Balancing Recharge & Pumping

CONCLUSION

The South Platte basin faces significant water shortages that will impact Colorado's economic, agricultural, and environmental future. The planned conjunctive use of surface and groundwater has the potential to offer benefits in terms of economic, environmental, and social outcomes through increased drought protection, water use efficiency, and the control of shallow groundwater levels and consequent soil salinity. Retrofitting conjunctive use into a prior appropriation system that favors surface water use is made difficult by the many layers of management and local interests that have evolved over time. To avoid over-appropriation of the groundwater resource, the sustainable use of the South Platte alluvial aquifer requires us to find the right balance between long-term recharge and diversion by pumping. The economic and population growth expected in the South Platte basin over the next several decades and the anticipated water shortages compels Colorado to get better organized to capture and store excess flows, reduce waste from nonbeneficial consumptive use, and put the alluvial aquifer to optimum sustainable use.

For Additional Information:

Reagan Waskom, Colorado Water Institute, CSU, 970/ 491-6308 or Reagan.Waskom@colostate.edu

Colorado Water Institute website: www.cwi.colostate.edu/

Full HB 1278 Study, appendices, and associated data are available at: www.cwi.colostate.edu/southplatte

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Current Colorado Legislative Actions

During the 2014 session of the Colorado Legislature, three bills have been introduced to address high groundwater and augmentation requirements in the South Platte basin. Senate Bill 14-072 sought to relieve augmentation requirements based upon the incidental recharge provided by the September 2013 flood in the South Platte (the bill has since been postponed indefinitely). At press time for this article, two bills remain under consideration: Senate Bill 14-147 seeks to instigate a five-year pilot program to increase unaugmented well pumping by 20% in Water District 2 of the S. Platte. House Bill 14-1332 was introduced to implement virtually all of the recommendations of the HB1278 study on which this article was based.

To track bills: www.leg.state.co.us/clics/clics2014A/cslFrontPages.nsf/HomeSplash?OpenForm

Reagan Waskom currently serves as the Director of the Colorado Water Institute and the Chair of the Colorado State University Water Center. Dr. Waskom is a member of the Department of Soil & Crop Sciences at CSU, where he has worked on various water related research and outreach programs for the past 27 years, conducting statewide educational and applied research programs on water quality, water quantity, water policy, and natural resource issues related to water use. Dr. Waskom's current research emphasis is on the integrated use of surface and groundwater in the South Platte Basin, the impacts of shale gas development on water resources, and agricultural water conservation in the Colorado River basin.

Stormwater LID

STORMWATER LOW IMPACT DEVELOPMENT

AN UPDATE ON LID REGULATIONS AND PRACTICES

by Neil Alongi, Ada Banasik, and Jacqueline Gruber
Maul Foster & Alongi, Inc. (Seattle and Vancouver, Washington; Portland, Oregon)

INTRODUCTION

Reduced Impact & Runoff Reuse

Low Impact Development (LID) techniques have been used by engineers for decades to manage stormwater runoff from urban developments. The recent focus on reducing surface water quality impacts from stormwater discharges and the beneficial reuse of runoff has broadened the audience of LID practitioners to include regulators, municipal stormwater managers, developers, landscape architects, and the public.

LID Generally

The term "LID" has been adopted by stormwater professionals to apply to the management of rainfall and runoff. Though stormwater-related LID practices are the subject of this article, it is important to note that the original definition of LID included a broader set of practices and technologies designed to reduce the impact of the built environment on the natural environment. In the United Kingdom, for instance, the term applies more generally to development practices that impose minimal environmental impact or otherwise enhance environmental quality.

Stormwater LID

The US Environmental Protection Agency (EPA) defines stormwater LID as "a land development approach that is intended to reduce development related impacts on water resources through the use of stormwater management practices that infiltrate, evapotranspirate, or harvest and use stormwater on the site where it falls." (*see* EPA 841-R-13-004, August 2013). Unlike traditional stormwater infrastructure that uses pipes to convey stormwater to offsite rivers and streams, LID focuses on using vegetation and soil to manage stormwater in ways that mimic the pre-development hydrologic cycle, reducing the likelihood of flooding and combined sewer overflows, while replenishing groundwater aquifers.

Integrated Implementation

The concept is implemented by integrating natural systems with the built environment to manage stormwater, and the pollutants it carries, as close to the source as possible. Stormwater LID practices include bioretention and biofiltration basins and swales, rain gardens, vegetated rooftops, rain barrels, green streets, pavement minimization, and permeable pavements. LID may be implemented during initial construction, site redevelopment, or even through the retrofit of existing infrastructure.

WHY LID? — REGULATORY AND MARKET DRIVERS

Drivers

The use of LID for stormwater management was initially driven by the market, as LID could often be implemented at a lower cost than the traditional collect, convey, treat, and discharge approach. Developments with significant green space that brand themselves as sustainable or green have an advantage in many urban markets. These drivers allowed developments that had ample space, as well as suitable topographic, groundwater, and soil conditions, to implement LID ahead of any regulatory pressure, while sites that were deemed less suitable for LID could implement conventional stormwater management techniques.

Eventually, regulatory agencies began to recognize that LID techniques, when feasible and properly applied, result in several beneficial outcomes that stretch far beyond an individual development.

Benefits

LID benefits include:

- Reduction of pollutant mass loading to streams
- Reduction of flooding, stream erosion, and combined sewer overflows
- Augmentation of groundwater recharge
- Carbon sequestration and air quality improvements
- Urban heat island mitigation and enhanced urban streetscapes

Recognition of these benefits slowly moved the regulatory framework towards promoting LID, in some cases requiring the use of LID techniques unless it could be shown that site conditions are unsuitable.

Property Values

Property Values Benefits

The Seattle Public Utilities District has instituted a Natural Drainage System program that promotes the use of low impact development techniques to capture and address water-borne pollutants. Research indicates that streets retrofitted with LID infrastructure can add as much as 6% to the adjacent property values.

Stormwater LID

CWA Permits

Industrial & Municipal

Stormwater Management Programs

"Measurable" Goals

LID Use

Industrial Applicability

No MSGP Requirement

2015 Proposed EPA Budget

Management Manuals

REGULATORY FRAMEWORK

FEDERAL

The Federal Water Pollution Control Act of 1948 was the first major legislation addressing pollution in US waters. Extensive amendments, made in 1972, established the basic structure for regulating pollutant discharge and granted EPA the authority to implement pollution-reducing programs. The law became commonly known as the Clean Water Act (CWA). Initially, the CWA and the EPA focused on controlling pollutants discharged with municipal sewage and industrial wastewater through a National Pollutant Discharge Elimination System (NPDES) permit program. The NPDES program issued permits to publicly owned treatment plants and private industries that generated process wastewater. In 1987, the CWA was expanded to cover stormwater discharges from both **m**unicipal **s**eparate **s**torm **s**ewer **s**ystems (MS4s) and industrial sources.

MS4 NPDES permits require that municipalities develop and implement a **s**torm**w**ater **m**anagement **p**rogram (SWMP) to: reduce the contamination of stormwater runoff; prohibit illicit discharges; and use **b**est **m**anagement **p**ractices (BMPs) to reduce pollutants to the "**m**aximum **e**xtent **p**racticable" (MEP). In most states, the administration of MS4 permits has been designated to state regulatory agencies. The first MS4 permits were issued beginning in 1990 to Phase I municipalities (with a population of 100,000 or more), while Phase II municipalities (with a population under 100,000) were issued permits starting in 1999. Today, there are approximately 750 Phase I MS4s and 6,700 Phase II MS4s throughout the US.

EPA regulations and MS4 permits require that the individual municipality set "measureable goals" through which to monitor compliance, but do not set limits or require compliance with numerical effluent benchmarks. Recognizing the benefits of LID, some municipalities identified the use of LID techniques for new developments or redevelopments as a measureable goal for post-construction stormwater management and began incorporating incentives or mandates for LID use into their SWMPs and municipal codes. Additionally, some state agencies have recently incorporated LID practices as a required component of MS4 permits.

Similar to MS4 permits, industrial NPDES permits require development of stormwater plans that identify site-specific pollution-control BMPs. However, industrial stormwater permits also require compliance with numerical effluent benchmarks and/or limits. The historical use of LID by industrial facilities has largely been limited to rural industries, such as wood products facilities, that have sufficient space to utilize BMPs such as vegetated swales to treat stormwater prior to discharge. Industrial stormwater permits do not require the use of LID techniques. Due to the high pollutant load in some industrial stormwater, pre-treatment may be required prior to discharge to LID features. There is, however, an increased recognition of applicability of LID for managing industrial stormwater in order to lessen the impact on receiving surface waters from pollutants that impact aquatic species, but do not pose a high risk for impacts to soil and groundwater.

EPA has not included language in the 2013 draft of the Multi-Sector General Permit (MSGP) for industries encouraging or requiring the consideration of LID techniques. Considering the broad applicability of the MSGP, it is not surprising that EPA avoided requiring that LID techniques be considered.

President Obama's proposed 2015 budget for EPA dedicates $8 million and 30 staff to strengthen the green infrastructure program and further sustainability goals, particularly in urban, underserved, and economically distressed communities. The proposed funding increases EPA's commitment to expanding the use of green infrastructure and improving the quality of urban waters through collaborative partnerships between states, tribes, municipalities, and private parties. Resources are also being realigned for the MS4 program to provide technical support to select communities with newly regulated MS4s that must develop effective stormwater permits for the first time.

WESTERN STATES

The following sections outline how several western states have administered the CWA-driven NPDES permits, including LID incentives and mandates.

Washington State

The Washington State Department of Ecology (Ecology) issues MS4 and industrial stormwater permits to municipalities and industries in the state. Due to geographic and other demographic differences, Ecology publishes separate stormwater management manuals for the eastern and western parts of the state. These manuals provide guidance regarding the applicability, design, operation and maintenance of stormwater management systems — including LID. The 2012 Stormwater Management Manual for Western Washington requires that developers incorporate LID elements into the site design unless the developer can prove that LID components are not feasible on the property.

Stormwater LID

Municipal LID Requirement

The most recent Washington State MS4 permits became effective on August 1, 2013 for Phase I and Western Washington Phase II municipalities. The Phase I permit covers unincorporated areas of Clark, King, Pierce, and Snohomish Counties; and the cities of Seattle and Tacoma, including the ports of Seattle and Tacoma. Phase II jurisdictions include most incorporated cities and counties. A municipal stormwater permit is also issued to the Washington State Department of Transportation.

Litigation and legislative action mandates that most permitted municipalities require the use of LID, whenever feasible, for all new development projects by December 31, 2016. This major policy change is intended to shift LID from a fringe technology to standard practice. The Phase II permit for Western Washington requires municipalities to revise their development standards in order to require LID, when feasible, to make LID the preferred and commonly-used approach. The revisions should include provisions to minimize impervious surfaces, native vegetation loss, and stormwater runoff, as outlined in 2012 Puget Sound Partnership guidance document *Integrating LID into Local Codes: A Guidebook for Local Governments*.

Guidance

Puget Sound Restoration Priorities

Changes in public policy in Washington State have been spurred by a series of studies. The Puget Sound Partnership, a state agency serving as the leading organization for environmental recovery in the Puget Sound, drafted an action agenda to provide a pathway to restoring the health of the Puget Sound by 2020. The plan identifies priorities that would have the greatest regional impact. The 2012/2013 Action Agenda set three basic goals: 1) to prevent pollution from urban stormwater runoff; 2) to protect and restore habitat; and 3) to restore and re-open shellfish beds. The plan is backed by research from Ecology's Puget Sound Toxics Loading Study, which indicates that non-point source pollution, largely resulting from stormwater runoff, is a major factor contributing to degraded water quality in the sound. (*See* Ecology Publication No. 11-03-010, April 2011).

Grant Program

Findings from this research, coupled with dramatic changes in the regulatory framework, have spurred a number of public funding programs. In an effort to mitigate the financial burden placed on municipalities, the State of Washington has established a new grant program to support planning, design, and implementation of LID. Over $80 million in appropriations were secured during the 2013 legislative session in order to supply cities and counties in Washington with the resources necessary to carry out project-specific planning, design, and construction projects that reduce stormwater impacts from existing infrastructure and development. $66 million of those funds will be distributed to communities through a competitive grant program, anticipated to launch in September of 2014.

Industrial Benefits

Industrial stormwater permits in Washington State do not mandate the use of LID. However, many industrial facilities have implemented LID techniques to treat stormwater and reduce the frequency of discharges and the related need for monitoring. Many industrial pollutants (e.g., metals) pose a risk to aquatic species in Washington's surface waters, including salmon. Plants and compost-amended soils used in LID features remove pollutants prior to discharge to groundwater. Additionally, groundwater quality standards for many metals (e.g., copper and zinc) are significantly less stringent than surface water quality standards and permit effluent benchmarks, reducing the level of pretreatment necessary to discharge to groundwater.

Groundwater Quality Standards

Excerpt from the Western Washington Phase II Permit:

"No later than December 31, 2016, Permittees shall review, revise and make effective their local development-related codes, rules, standards, or other enforceable documents to incorporate and require LID principles and LID BMPs. For Permittees in Lewis and Cowlitz counties, the deadline for this requirement is no later than June 30, 2017; for the City of Aberdeen the deadline for this requirement is no later than June 30, 2018."

Oregon

Municipal LID Requirements

The Oregon Department of Environmental Quality (ODEQ) issues and administers MS4 and industrial stormwater permits to municipalities and industries throughout the state. ODEQ has issued Phase I MS4 permits to the cities of Portland (under a joint permit with the Port of Portland), Salem, Eugene, and Gresham, as well as groups of municipalities in Clackamas, Multnomah, and Washington counties. Phase II MS4 permits have been issued to 15 smaller cities and counties. As part of the permit requirements, many Oregon municipalities, including the City and Port of Portland, Salem, and Gresham have developed stormwater management plans that require the use of LID for new developments and redevelopment, where feasible.

Stormwater LID

Municipal LID Promotion

The City of Portland Stormwater Management Manual, adopted by many Oregon counties and municipalities, establishes a "Stormwater Infiltration and Discharge Hierarchy" that requires on-site infiltration for new developments or redevelopments, unless otherwise deemed infeasible. The City of Gresham's Water Quality Manual establishes several LID techniques as "first priority…for stormwater control and treatment." Gresham requires that all new streets incorporate "green street" elements, and its Green Development Practices for Stormwater Management manual requires that "green development practices" be used to manage 100% of the stormwater runoff from private properties in the Johnson Creek watershed, prior to discharge off-site into the stormwater conveyance infrastructure. The Cities of Salem, Eugene, and Ashland also promote LID in their stormwater management plans and/or manuals, and the Oregon Environmental Council, a non-governmental/nonprofit organization that fosters environmental stewardship, is working on a state-wide LID manual.

Financial Incentives

The City of Portland's Clean River Rewards is a stormwater utility discount program that creates financial incentives for LID techniques. The program discounts utility charges based on the amount of impervious space that drains to LID features. In addition, the City's Sustainable Stormwater Management Program funds, incentivizes, and promotes green streets, ecoroofs, trees, and other green infrastructure in Portland. The program also provides public outreach and educational opportunities.

Industrial Incentives

Even Oregon's 2012 industrial stormwater permits (1200-Z and 1200-COLS) provide incentives for stormwater infiltration by allowing permittees to request a waiver from the permit's Tier II corrective action requirements (additional treatment) by demonstrating that the reduction in discharges of stormwater to surface waters through LID practices resulted in a reduction of the mass load of pollutants to below the mass-equivalent calculated based on the permit's effluent benchmarks. As an example, a site that infiltrates 80% of its runoff can demonstrate that although the remaining 20% of site stormwater that continues to discharge to surface waters is above the effluent benchmark concentration, the overall mass of pollutants discharged is lower than the mass that would have been discharged if 100% of the runoff continued to drain to surface waters at the benchmark concentration. At first glance, the Oregon provision does not seem to be much of an incentive to promote LID practices; however, it is a tangible benefit to industries that may be struggling to meet more stringent benchmarks in their stormwater permits.

Portland Downspout Disconnection Program

This City of Portland program has disconnected over 56,000 downspouts from the city's combined sewer system. This work eliminates an estimated 1.2 billion gallons of stormwater runoff each year from the combined sewer system.

Portland Gray to Green Initiative

Between 2008 and 2013, the Grey to Green initiative and public-private partnership expanded the city's green infrastructure through a series of projects designed to improve stormwater quality in the City, including, planting of over 32,000 street trees, constructing 867 green street facilities and 191 ecoroofs, removing culverts that block fish passage, protecting open spaces, controlling invasive species, and restoring native vegetation on thousands of acres of parks and natural areas.

Phase II MS4s: Strong LID Preference

California

The State of California has recognized stormwater LID in their Phase II MS4 general permit for small municipalities issued in February 2013. The permit requires regulated projects (projects that create or replace over 5,000 square feet of impervious surface) to implement LID standards "to the extent feasible." Although this term is not defined in the permit, it is referred to several times as a technical feasibility determination, indicating that there is a strong preference for LID solutions that reduce runoff, treat stormwater, and provide hydromodification management.

California's current industrial general stormwater permit was adopted in 1997 and a new draft permit is anticipated for adoption in 2014. Unlike to the state's Phase II MS4 permits, the draft industrial permit does not have any provisions that encourage permittees to adopt stormwater LID practices.

Alaska

Watershed Planning

Indentifying Opportunities

The State of Alaska has transitioned from EPA administration to EPA-authorized state administration of their CWA programs as of October 31, 2012. Alaska continues to use the MS4 permit developed by EPA along with the industrial stormwater Multi-Sector General Permit (MSGP) developed by EPA. The MS4 permit, titled the "Alaska Pollutant Discharge Elimination System Permit," covers the Municipality of Anchorage and the Alaska Department of Transportation and Public Facilities. The permit requires that an element of the Stormwater Management Program address watershed planning and identify opportunities for the use of LID techniques. New development and redevelopment ordinances must require that LID techniques be used for the first one-half inch of storm precipitation. A strategy must also be developed for incentivizing the use of LID techniques for public and private sector development projects.

As discussed earlier in the Federal section, the EPA's MSGP for industrial facilities does not contain requirements or incentives for LID or infiltration.

Stormwater LID

Barriers & Opportunities Studied

Challenges

Water Rights (Reuse)

Physical Factors

Economic Benefits

Reduced Discharges

POTENTIAL IMPEDIMENTS TO LID IMPLEMENTATION

The practice of LID has evolved over the past two decades to effectively overcome the significant challenges that can impede LID feasibility for new and retrofit projects. The remaining impediments are surprisingly less about the financial implications of capital improvements and often more about administrative barriers, physical limitations of the site, and the cost and responsibility of ongoing operations and maintenance. The information presented in this section provides a glimpse into why LID techniques are just emerging into the mainstream.

Administrative Barriers

Although the municipalities and agencies noted in this article have been at the forefront of LID, overcoming administrative barriers remains a challenge in many parts of the US due to: the lack of knowledge of LID features; potential performance, operation and maintenance needs; and water rights relating to the use of captured stormwater.

A 2008 study by Oregon State University (OSU) and Oregon Sea Grant explored the barriers and opportunities for LID implementation (see OSU website: http://seagrant.oregonstate.edu/sgpubs/onlinepubs/w06002.pdf). The study found several key issues facing Oregon communities. Experience in other areas of the American West tends to support these findings as being common to the larger region.

Administrative challenges include:

- Lack of understanding of the connection between land use planning and the impact of development as it relates to infrastructure capacity, stormwater management, and water quality
- Need for active leadership to incorporate LID practices into codes and permits in order to remove barriers and set the stage for broader use
- Need for technical information and assistance, such as guidance manuals to facilitate the use of LID by developers, municipalities, and engineers
- Economic incentives and funding for local jurisdictions, as well as developers, to use LID practices for new and retrofit projects

The water rights aspect of stormwater LID has occasionally created a barrier due to the varied legal framework that exists in each state. Although the infiltration of rainwater is not usually a concern, the reuse of water can often hinder innovative approaches for stormwater reuse in larger developments and industrial settings. The policies and rules of each state regarding stormwater reuse must be investigated prior to determining if a potential stormwater reuse LID technique can succeed.

Physical Limitations

The physical limitations of a site can make the implementation of LID techniques more difficult due to factors such as: space availability; topography; setback criteria; groundwater protection areas; high vehicle traffic; soil suitability; and depth to limiting ground layers (i.e., groundwater, bedrock, hardpan). In addition, sites with steep slopes, high groundwater, or poorly infiltrating soils make LID implementation more difficult, more expensive, and thereby potentially infeasible. The impacts of groundwater mounding need to be considered in the design of larger infiltration facilities at sites that experience high seasonal groundwater elevations. Groundwater protection areas and sites that are adjacent to private or municipal drinking water wells are often prohibited from infiltrating stormwater. On some brownfield sites, remaining low-level contamination may limit the use of LID to ensure that infiltration does not mobilize the legacy contamination in the soil or groundwater. Given these concerns, the use of stormwater LID techniques can be an engineering challenge and may not be achievable in all circumstances.

Financial Considerations

The financial implications of implementing stormwater LID techniques depend on a number of factors. However, in many situations the use of LID facilities — such as rain gardens and bioretention swales — can be far less costly than the installation of catch basins, conveyance pipes, and treatment BMPs that are often required to collect, treat, and transport runoff to the nearest municipal stormwater collection system.

EPA published summaries of several case studies that included an analysis of the cost of LID techniques and illustrated that there is often, but not always, an economic benefit of this approach. The first study, conducted in 2008, looked solely at actual costs and did not monetize environmental and aesthetic benefits of the projects. The second study, conducted in 2013, included case studies that often took a broader look at the cost-benefit analysis and, in one case, used the "triple-bottom-line" approach, which considers financial-social-environmental aspects in the analysis. (These studies are referenced later in the article.)

One financial factor that is often overlooked is the ability of a facility that is covered under an NPDES permit to avoid or reduce the possibility of a stormwater discharge. Fewer discharges means fewer monitoring events, which lessens the potential for permit benchmark exceedances that can expose the permittee to regulatory enforcement fines, CWA citizen lawsuits, and the additional expense of providing source control and treatment BMPs in order to comply with the permit. These factors can be significant

Stormwater LID

Reducing CWA Liability

Agency Approval

Soil Infiltration

Test Pitting

Setbacks

Successful Projects

incentives to consider LID techniques that either eliminate or reduce the frequency of discharges. In the case of industrial facilities where stormwater discharge is eliminated completely, it can mean the termination of the permit and the end to permitting, monitoring, and reporting expenses. Settlements and consent decrees resulting from advocacy group lawsuits alleging violations of the CWA can incur significant costs for both industrial and MS4 permittees, and LID can reduce the potential for these lawsuits by reducing or eliminating permit violations.

EARLY EVALUATION OF FEASIBILITY

The first step in determining the ability to use LID techniques for a particular project is to determine if it will be administratively acceptable to the overseeing jurisdiction. In some cases, an agency may initially deny an application due to perceived conflicts with the development code or other existing regulations. However, follow-up discussions may lead to the allowance of an exception or an update to the regulatory code, should the project prove reasonable. Stormwater management has been a rapidly developing field of practice over the past decade and it is often difficult for agency personnel to stay current with the latest approaches. Information provided by other jurisdictions and agencies may be useful in demonstrating the effectiveness of LID approaches and assist in receiving agency approval.

Technical feasibility can be a challenge depending on the site conditions. The soil infiltration rate is usually one of the first criteria that should be evaluated to determine feasibility. Soil survey information can contain general information on infiltration capacity with which to screen a site. There is not a good substitute, however, for a field visit to observe surface soils in the specific location being considered for LID. The digging of test pits and other infiltration testing has become a necessity to satisfy both regulatory agencies and the need to provide an engineered design that will perform as desired once constructed. Soils can change dramatically with depth, so understanding the proposed grade of the LID feature is important in order to test the actual conditions that will exist after construction. The soil characteristics (cation exchange capacity, organic content) relative to its ability to provide treatment as the water infiltrates through it can also be assessed during test pitting. These characteristics can be remedied by soil amendments, if they are not naturally adequate. Test pitting, if deep enough, or installation of a piezometer is also needed to understand the depth to groundwater, bedrock or impermeable layer, which can be limiting factors regardless of how well the soils drain.

The topography and physical setting of the site needs to be fully understood in order to determine if an LID feature can be located on the site considering setbacks from: slopes; wells; septic systems; buildings; streams; down-gradient properties; and groundwater protection areas. The soil infiltration capacity will help define the size of the LID feature based on the estimated runoff from the site. It is important to include any treatment units that may be required prior to infiltration when determining the overall space demands of the feature. Unfortunately, there is no rule of thumb that can be applied to determine the area needed, since each site tends to have its own set of site-specific characteristics that dictate the required area.

LID CASE STUDIES

There are a number of publications on residential and public works projects with case studies of installed LID features that are well documented. We have provided a few examples of particularly informative websites in the box below. Although there are a significant number of commercial LID projects and a fair number of industrial LID projects that have been completed, documentation on successful projects of these types is not as prevalent. Summaries of several successful projects with which your authors' company (Maul Foster & Alongi, Inc. (MFA)) had direct experience are provided below as examples of the diverse applications of LID solutions at commercial and industrial sites.

Case Studies for Residential and Public Works LID Projects

USEPA Case Studies (2007):
http://water.epa.gov/polwaste/green/upload/2008_01_02_NPS_lid_costs07uments_reducingstormwatercosts-2.pdf
USEPA Case Studies (2013):
http://water.epa.gov/polwaste/green/upload/lid-gi-programs_report_8-6-13_combined.pdf
Michigan LID Case Studies Search website:
www.semcog.org/data/lid.cfm
Washington Ecology LID Example Case Study for Residential Subdivision:
www.ecy.wa.gov/programs/wq/stormwater/manual/2012SWMMWWLIDcaseStudyTrainingHandout.pdf

Stormwater LID

Forest Products

Forest Products Facility, Washington

Forest products facilities generally have a stormwater NPDES permit that requires monitoring for specific benchmarks, such as pH, metals, solids, and chemical oxygen demand. MFA conducted an infiltration feasibility study in an industrial area within Washington State and designed an infiltration facility to manage stormwater runoff from a large log yard and mill site. This infiltration facility included: a pre-settling forebay; a settling basin; and an infiltration basin to manage stormwater impacted by suspended solids and organic material from log sorting, storage, and mill operations. The project also included modifications of the site stormwater system and installation of a pump station to collect and convey stormwater to the infiltration facility — located along one edge of the property to minimize disturbances of the industrial operations. The system was designed according to the requirements of Ecology's stormwater manual, which requires the facility to be able to handle 91% of the runoff volume. Since the facility continues to discharge stormwater during large storms (instead of infiltrating 100% of the runoff), the stormwater permit was retained to cover these discharges.

The system has performed as designed and has not required significant operations and maintenance to keep the facility performing as desired. Annual cleaning of the pre-settling forebay, where the majority of the settleable solids and floatable material are removed, is the primary operations and maintenance activity.

Brownfield Challenges

Marine Industrial Facility, Oregon

Stormwater management can be a challenge at brownfield sites. MFA incorporated stormwater LID features on a 56-acre brownfield property along the Willamette River waterfront that encompasses an active industrial facility and undeveloped land. The site was remediated, making it ready for redevelopment into a mixed-use commercial and residential neighborhood. Stormwater infiltration facilities manage much of the stormwater at this site to satisfy brownfield pollutant source control needs, as well as industrial permit requirements. Infiltrating stormwater on site reduces the volume and mass load of pollutants discharged to the Willamette River with stormwater, reducing the potential for recontamination of a recently-completed remedial sediment cap. Stormwater from more than half of the facility's ongoing industrial operations is managed in a vegetated infiltration basin and two infiltration trenches. The infiltration facilities have significantly decreased the volume of stormwater discharged to the river, reducing the frequency of stormwater discharges and the associated cost of stormwater monitoring and reporting, while allowing for continued industrial operations. The facility realized over $2,000 in monthly savings by applying for the Clean River Rewards utility rate discount from the City of Portland.

Infiltration Considerations

Contaminants' Behavior

MFA also studied the potential impacts from stormwater infiltration through the legacy low-level contamination that remains underneath the upland soil cap onto the shallow groundwater aquifer in areas deemed for redevelopment. Due to the nature (low mobility and solubility) and extent of the contaminants, stormwater infiltration was shown not to impact the beneficial uses of groundwater, saving significant fees and mitigation costs required to connect to the nearby city storm sewer system and allowing the planners and engineers to redevelop the site into a green neighborhood that fits the City Master Plan for the Willamette Waterfront and the real estate market demand.

Infrastructure Upgrade

LID Site and Green Street Design, Oregon

MFA designed and implemented LID features for a private green office development and associated public street improvements in the northwest industrial district of Portland, Oregon. Existing stormwater infrastructure consisted of degraded stormwater collection basins and conveyance pipes draining to a historical combined sewer system. On-site LID features included: pervious concrete pavers for vehicle access ways and parking areas; and infiltration planters to collect, treat, attenuate flow, and dispose of stormwater runoff from building roofs and walkways. MFA also designed green street improvements, which included new stormwater bioswales where no treatment systems previously existed. The bioswales treat and infiltrate stormwater, and reduce runoff volume draining to the aged combined sewer system. All street and stormwater improvements were designed and permitted through a joint effort with the Portland Bureau of Transportation and the Portland Bureau of Environmental Services.

Shoreline LID Landscaping & Bioretention

Port Administration Offices and Interpretive Center, Washington

The Port of Kalama Administration Offices and Interpretive Center project proposes redevelopment of approximately 2.55 acres of Port-owned industrial land located along the Columbia River shoreline. MFA employed LID features incorporated into the site landscaping to retain and infiltrate stormwater runoff without causing flooding or erosion impacts. Site landscaping requirements are met with the vegetation in the infiltration facilities to conserve space. LID elements such as bioretention facilities will treat stormwater prior to infiltration. All of the LID features are connected to increase the performance and reliability of the system. An overflow that discharges into an existing stormwater outfall will be provided for emergencies and storms exceeding the 100-year storm event. This project has been approved and is currently under construction.

Stormwater LID

LID Trend

Research Ongoing

Guidance & Certification Options

CONCLUSION

WHAT'S NEXT?

Federal, state, and local agencies have begun to emphasize the use of LID techniques and are encouraging this movement through regulations on public and private development and redevelopment. The amount of information available to assist communities, developers, engineers, and the public in learning about and implementing LID is growing as agencies designate additional resources to support LID-related studies. Whether more agencies move toward requiring the application of LID as the preferred technique for managing urban runoff is difficult to predict. However, LID appears to be the current trend and regulatory agencies are under increased pressure to qualify their requirements by including a determination of technical and economic feasibility.

Additional research is needed to provide information on the long-term effectiveness, construction techniques, and operation and maintenance needs for the various types of LID features. In 2010, Washington State established the Washington Stormwater Center in Puyallup and Tacoma, which conducts research and educational workshops regarding stormwater control methods, including LID. The center is supported by both Washington State University and the University of Washington. Oregon State University has launched a series of stormwater research projects, as well as a training and technical assistance program known as the "LID Academy."

Non-profit environmental organizations are stepping up to the challenge as well. The Oregon Environmental Council has initiated LID projects, studies, workshops, and development of a state-wide guidance. Numerous other agencies and municipalities are developing guidance documents that can be used by public agencies, developers, and engineers to determine how best to apply LID techniques in the built environment. Cities and counties are jumping on the LID bandwagon, as a solution to combined sewer overflows, aging infrastructure, and overall urban health. Property owners and private citizens are increasingly interested in implementing LID on their property to increase its environmental sustainability and property value. Environmental site certifications, like the Leadership in Energy and Environmental Design (LEED) or Salmon Safe, are recognizing the importance of LID and green infrastructure in the protection of our watersheds.

It is safe to say that LID is "here to stay."

For Additional Information:
Neil Alongi, Maul Foster & Alongi (Vancouver, WA), 360/ 694-2691 or nalongi@maulfoster.com
Ada Banasik, Maul Foster & Alongi (Portland, OR), 971/ 544-2139 or abanasik@maulfoster.com
Jacqueline Gruber, Maul Foster & Alongi (Seattle, WA), 206/ 858-7620 or jgruber@maulfoster.com

Neil Alongi, PE, is an environmental engineer with 35 years of experience including: industrial and municipal stormwater management; industrial facility siting and expansion; and recycling, compost and solid- and hazardous-waste facilities. His stormwater experience includes development and application of low-tech, Low Impact Development (LID), and advanced industrial stormwater treatment systems to address contaminated runoff from a variety of industries including metals recycling, wood preservation plants, trucking, waste handling facilities, and wood product operations. He has served as an expert witness regarding stormwater permitting issues for the construction and wood products industries and has assisted numerous clients with settlement of Clean Water Act third-party lawsuits.

Ada Banasik, PE, has over 10 years of experience in environmental engineering, including stormwater management, environmental compliance, site remediation, and construction management. She works with industries in the Pacific Northwest to develop adaptive management and innovative solutions to challenging environmental regulations, permit requirements, and liabilities. Ms. Banasik produces innovative low-impact designs and advanced treatment system designs, and implements cost-effective best management practices and pollution-control measures.

Jacqueline Gruber has several years of professional experience in the field of environmental and land use planning, involving both public- and private-sector clients. She has experience with environmental permitting, municipal code, and regulatory compliance. Ms. Gruber's experience working in both the public and private sectors provides her with the perspective necessary to quickly adapt her approach to meet the needs, expectations, and resources of her clients.

WATER BRIEFS

CLEAN WATER ACT JURISDICTION – PROPOSED RULE RELEASED

On March 25th, the US Environmental Protection Agency (EPA) and US Army Corps of Engineers (Corps) jointly released a long-awaited proposed rule to define the scope of waters protected under the federal Clean Water Act (CWA). Determining CWA protection for streams and wetlands became confusing and complex following US Supreme Court (Court) decisions in 2001 and 2006 (*SWANCC* and *Rapanos* rulings respectively) that interpreted the regulatory scope of the CWA more narrowly than previously, but created uncertainty about the precise effect of the Court's decisions. In April 2011, EPA and the Corps proposed guidance on policies for determining CWA jurisdiction to replace guidance previously issued in 2003 and 2008. The 2011 proposed guidance was extremely controversial. The 2014 proposed rule would replace the existing 2003 and 2008 guidance, which remain in effect because the 2011 proposed guidance was not finalized.

The proposed rule clarifies protection for streams and wetlands. Proposed definitions of waters will apply to all CWA programs. The proposed rule would revise the existing regulatory definition of "waters of the United States" consistent with legal rulings (especially the Supreme Court cases) and science concerning the interconnectedness of tributaries, wetlands, and other waters to downstream waters and effects of these connections on the chemical, physical, and biological integrity of downstream waters. Waters that are "jurisdictional" are subject to the multiple regulatory requirements of the CWA, including: standards; discharge limitations; permits; and enforcement. Non-jurisdictional waters are not subject to federal legal protection of those requirements.

Under the proposed rule most seasonal and rain dependent streams are protected; wetlands near rivers and streams are protected; other types of waters may have more uncertain connections with downstream water and protection will be evaluated through a case specific analysis of whether the connection is or is not protecting similarly situated waters in certain geographic areas or adding to the categories of waters protected without case specific analysis.

The proposed rule preserves CWA exemptions and exclusions for agriculture. EPA and the Corps have coordinated with the US Department of Agriculture (USDA) to develop an interpretive rule to ensure that 53 specific conservation practices that protect or improve water quality will not be subject to Section 404 dredged or fill permitting requirements. Any agriculture activity that does not result in the discharge of a pollutant to waters of the US still does not require a permit.

The proposed rule clarifies the regulatory status of waters located in isolated places in a landscape, i.e., the types of waters with ambiguous jurisdictional status following the Court's 2006 ruling. The proposal does not modify some categories of waters that currently are jurisdictional by rule (traditional navigable waters, interstate waters and wetlands, the territorial seas, and impoundments). Changes proposed in the proposed rule would increase the asserted geographic scope of CWA jurisdiction, in part as a result of the agencies expressly declaring some types of waters categorically jurisdictional (such as all waters adjacent to a jurisdictional water), and also by application of new definitions, which give larger regulatory context to some types of waters, such as tributaries. The proposal does not identify specific streams or ponds that would be jurisdictional.

Beyond the categories of waters that would be categorically jurisdictional is a category sometimes referred to as "other waters." The regulatory term "other waters" applies to wetlands and non-wetland waters such as prairie potholes that are not considered traditionally navigable or meet other of the proposed rule's jurisdictional definitions. Much of the controversy since the Court's rulings has focused on the degree to which "other waters" are jurisdictional. According to the agencies' analyses, 17% of these "other waters" would be determined to be jurisdictional under changes in the proposal. The proposed rule also lists waters and features that would not be jurisdictional, such as prior converted cropland and certain ditches.

The agencies believe that the proposed rule does not exceed the CWA's coverage or protect any new types of waters not protected historically. That is, while it would enlarge jurisdiction beyond that under the 2003 and 2008 EPA-Corps guidance — which the agencies believe was narrower than is justified by science and the law — they believe that it would not enlarge jurisdiction beyond the Court's narrow reading of jurisdiction. Overall, the agencies estimate that approximately 3% of US waters will additionally be subject to CWA jurisdiction compared with current field practice.

EPA and the Corps estimate that costs of the proposed rule, resulting from additional permit application expenses for example, range from $162 million to $279 million annually. Benefits from the rule, including the value of ecosystem services provided by waters and wetlands protected as a result of CWA requirements (such as flood protection), are estimated to range from $318 million to $514 million per year.

The Congressional Research Service (Library of Congress) has prepared a report on the proposed rule: *EPA and the Army Corps' Proposed Rule to Define "Waters of the United States."* This report, authored by Claudia Copeland (ccopeland@crs.loc.gov), discusses the proposed rule and its expected impacts. In addition, the report includes a very informative table that comprehensively compares the existing regulatory language that defines "waters of the United States" with proposed regulatory language and also provides explanatory comments on the language.

The proposed rule will be open for public comment for 90 days from publication in the Federal Register. The interpretive rule for agricultural activities is effective immediately.

EPA's Science Advisory Board (EPA/SAB) has announced two upcoming public teleconferences (April 28 and May 5th) of the SAB Panel to discuss its draft advisory report concerning the EPA document titled *Connectivity of Streams and Wetlands to Downstream Waters: A Review and Synthesis of the Scientific Evidence* (September, 2013 External Review Draft, EPA/600/R-11/098B). *See* Fed Reg Vol 79 #62 (April 1) pp. 18293-18294. This document was used by EPA and the Corps as a scientific underpinning to their proposed rule. For information concerning these teleconferences: Dr. Thomas Armitage, EPA/SAB, armitage.thomas@epa.gov or EPA website: www.epa.gov/sab.

For info: Julia Ortiz, EPA, 202/ 564-1931, ortiz.julia@epa.gov or www.epa.gov/uswaters

CRS Report available at: www.fas.org/sgp/crs/misc/R43455.pdf

WATER BRIEFS

TRIBAL WATER LAWSUIT MT STATE V. FEDERAL JURISDICTION

On February 27, the Confederated Salish and Kootenai Tribes (Tribes) filed a lawsuit in federal district court in Missoula, Montana, seeking a "declaration of the ownership of irrigation water that is collected, stored, diverted and delivered by the Flathead Indian Irrigation Project" (FIIP) of the Bureau of Indian Affairs. *Confederated Salish and Kootenai Tribes v. U.S. Dept. of Interior Secretary, et al*., Case No. CV-14-44-M-DLC (Feb. 27, 2014), *Complaint*, page 7. The irrigation project is located on the Flathead Indian Reservation (FIR) in northwest Montana.

The Tribes filed the lawsuit to enjoin two State Court proceedings and a Water Court case, alleging that "the parties to those multiple suits appear in each case to be attempting to relitigate issues already settled by the Federal Courts; that the Hellgate Treaty impliedly reserved all waters on the FIR to the Tribes, that such waters, being reserved, water rights could be obtained only as specified by Congress, and that the waters collected and distributed by the FIIP are subject to federal law. They also appear to be attempting to circumvent the McCarran Amendment requirement for a general *inter sese* water rights adjudication in the absence of necessary and indispensable parties, the Tribes and the United States." *Id*.

The Complaint went on to note that an underlying problem is that the "litigants in each case seek rulings that either individual irrigators own private water rights delivered by FIIP, that the defunct Flathead Joint Board of Control owns water rights to the water delivered by FIIP or that the three Defendant irrigation districts own water rights for the irrigation water delivered by the FIIP." *Id*. The Tribes are complaining that several parties are making water right claims in the District Court of the Twentieth District of Montana in Cause Nos. DV-12-327 and DV-13-105, and neither the Tribes nor the US are part of those lawsuits.

The Tribes' lawsuit is not seeking a federal adjudication to quantify tribal water rights. "The Tribes do not seek in this case to quantify the volume of any water rights of the Tribes or of any person or legal entity who may assert a claim to water rights on or off of the Flathead Indian Reservation (hereafter 'FIR')." *Id*. at 8. Instead of a quantification, the Complaint sets forth that the "Tribes seek this declaration of ownership to frame the federal law under which water for irrigation on the FIR will be adjudicated and quantified in a proper general *inter sese* water rights adjudication under the Montana Water Use Act that satisfies the McCarran Amendment, 43 U.S.C. § 666." *Id*.

The Tribes' Complaint later points to the issue of "piecemeal water rights adjudication in violation of the McCarran Amendment (43 U.S.C. § 666) requirement that federal and Indian reserved and aboriginal water rights be adjudicated in a general *inter sese* adjudication, thereby seriously threatening the legal adequacy of the Montana Water Use Act state-wide general adjudication." *Id*. at 41.

The Complaint requests the court to enter a declaratory judgment reaffirming and declaring that:
the Hellgate Treaty did not implicitly diminish aboriginal water rights; the US reserved all waters on, under and flowing through the FIR for the Tribes when the reservation was created; the chain of title to land on the FIR has never been broken and thus no lands within the borders of the FIR have ever been part of the public domain or subject to general public land laws; all waters of the FIR for consumptive use were reserved by the Tribes pursuant to the *Winters* doctrine, with a priority date for Tribal and individual Indian consumptive water use of July 16, 1855 (date of the Hellgate Treaty); water rights on FIR could only be acquired as specified by Congress; and no person has ever been issued a "final certificate of water right" by the Secretary of the Interior. *Id*. at 43-44.

The Prayer for Relief asks that the District Court of the Twentieth District of Montana and the Water Court of the State of Montana be enjoined from "taking any action to determine who owns water rights, or claims to water rights made available through any FIIP irrigation facility, structure, reservoir ditch or other means" in two different cases before the District Court and one case before the Water Court. The Tribes also requested that they be awarded reasonable attorneys fees and costs. *Id*. at 44-45.

On April 2, the Flathead Irrigation District (FID) filed a Verified Complaint for Declaratory and Injunctive Relief. FID contains approximately 87,088 acres of fee-owned land. The FID Complaint seeks to compel "federal officials to obey a 1908 act of Congress that mandates the transfer of the management and operation of the Flathead Project to the 'owners of the lands irrigated thereby,' represented by the Plaintiff and two other irrigation districts and a representative of the interests of trust land owners… ." FID Complaint at 5 (labeled "Turnover Complaint" on FID's website). Although the FID Complaint named various federal officials and agencies as defendants, it did not name the Confederated Salish and Kootenai Tribes as a party.

For info: Complaint available upon request from TWR; Flathead Irrig. Dist. Turnover Complaint available at: www.flatheadirrigationdistrict.com/BIA%20Complaint%204-2014.pdf

SPECULATION DENIED OR APPLICATION REJECTED

On March 7, the Oregon Water Resources Department (OWRD) denied a water rights application filed by the Willamette Water Company (the Company) on the basis that the application was an attempt to speculate on water, contrary to Oregon water law. Final Order in Contested Case, OWRD Case No. S-87330 (March 7, 2014)(hereafter "Order"). The Company submitted Application No. S-87330 to OWRD for a permit to use 34 cubic feet per second (cfs) of water from the McKenzie River for a quasi-municipal use. WaterWatch of Oregon, a Portland-based nonprofit group, protested the application. OWRD's

decision follows the recommendation issued by an **a**dministrative **l**aw **j**udge (ALJ) in April of 2012. For additional information, see Moon, *TWR* #94, and Water Briefs, *TWR* #99.

The speculative nature of the application ultimately led to its demise: "The ALJ reasoned that although there is potential demand for all of the 34 cfs requested, the demand was entirely inchoate in light of the fact that the Company 'has no contracts to sell water and has not established that it will obtain such contracts in the future.' (APO, p. 40.) The ALJ also pointed out that the service area is equally inchoate since applicant had not obtained written authorizations or easements to cross non owned lands, and that moreover it could not, in light of the fact that it had yet to determine 'what if any conveyance facilities it will need, where they will be located, where the places of use will be, or whether it will supply treated or untreated water or both.' *Id*." Order at 52.

OWRD adopted the ALJ's conclusion that a permit issued for a quasi-municipal use is subject to the five-year limit to complete construction of any proposed system, in accordance with ORS 537.230(1): "…the evidence produced at hearing, and namely evidence that the Company has not developed plans for its PODs [points of diversion] nor begun seeking the approvals it needs for such PODs, has not pursued necessary land use approvals, and has not established any certainty regarding the place of use where it may deliver water, leads the Department to conclude that applicant could not begin or complete construction within five years of permit issuance, but rather intends to rely on an unlimited number of extensions to begin and complete construction of its works and apply water to beneficial use." *Id*. at 53. After further discussing the five-year development period, OWRD concluded, "[I]n sum, where, as in this case, it is clear than an applicant cannot commence and complete construction of works within five years of permit issuance, the proposed use appears to be a reservation of a large block of water for future use rather than an appropriation for present beneficial use." *Id*. at 53-54.

The Order also provided discussion of the consideration of public interest factors — issuance of a permit must not impair or be detrimental to the public interest (*see* ORS 537.170(8)). OWRD noted that the Oregon Water Resources "Commission is charged with securing the maximum beneficial use and control of the state's water resources." *Id*. at 54. OWRD cited evidence introduced in the hearing which established that the Company cannot actually use the requested 34 cfs within the five years required by statute and further that since the Company is not a municipality, it is not entitled to the extended development time allowed for municipalities to develop their water rights in Oregon. "In sum, the ALJ found that although the type of use is beneficial, the proposed use is not a beneficial use because it is speculative and therefore wasteful." *Id.* at. 55.

OWRD's Order provides additional analysis regarding application of water to beneficial use. "Beneficial use without waste includes the concept that an appropriator may not request more water than can be developed and put to actual use within a reasonable time." *Id*. "In this case, it is clear that the scope of the project construction far exceeds what may be completed within five years of permit issuance. In addition, it is unclear what present demand the applicant may actually serve where the service area appears only aspirational. The applicant seeks to set aside with a priority date of 2008, 34 cfs of water for a use that it contemplates may take as long as 50 years to develop if it can be developed at all. This reflects not a contemplation of the application of water to beneficial use upon specific lands, but a monopoly of the waters of a stream for later indeterminate sale. *Cookinham v. Lewis*, 58 Or 484,491, 114 P 88 (1911)." *Id*. at 56.

This 83-page Order provides an extensive discussion of Oregon law as it relates to water rights' applications, beneficial use, public interest factors, wasteful or unreasonable use of water, land use approvals, and control of water by the state agency (OWRD) among other issues. Given the increasing value of water, it is likely that other efforts to speculate in water will arise elsewhere in the West. The Company has filed exceptions to the Final Order (as has WaterWatch) so the matter will now go before the Oregon Water Resources Commission for a final decision, after which the case could be appealed to the Oregon Court of Appeals.

For info: David Moon, Editor, 541/485-5350 or thewaterreport@yahoo.com; Order available at: http://waterwatch.org/updates

INSTREAM USE CHANGE NV

IRRIGATION TO INSTREAM

On March 20, Nevada State Engineer Jason King (State Engineer) granted an application by the National Fish and Wildlife Foundation (NFWF) to change decreed water rights from irrigation to wildlife purposes. *In the Matter of Application 80700*, Ruling #6271 (March 20, 2014). The State Engineer's decision is the first permanent transfer on the Walker River system of irrigation rights to instream flow for the benefit of wildlife, fish, and the recovery of Walker Lake.

NFWF applied to change the place and manner of use of 7.745 cubic feet per second of decreed water rights (Walker River Decree), with priority dates ranging from 1874 to 1906. NFWF proposed to leave the water instream at the proposed place of use, within the Walker River and flowing downstream to Walker Lake, rather than diverting the water at the former point of diversion. NFWF acquired the water rights involved from willing sellers and sought the change to increase flows into Walker Lake, for restoration and maintenance of the Nevada natural desert terminal lake. The application also stated that NFWF intended to withdraw 646.16 acres of supplemental groundwater rights in the existing place of use following approval of the changes.

Protests to the application were filed by several individuals and entities, including irrigators, the Walker River

Paiute Tribe, and the Bureau of Indian Affairs (US Dept. of Interior). The federal Water Master and the US Board of Water Commissioners also opposed NFWF's application (see Ruling at 7-8). As noted in the State Engineer's Ruling, "[D]uring his testimony, the Water Master testified he did not know how to manage an instream use as proposed by Application 80700; however, the State Engineer observes that other temporary changes have been granted by the State Engineer and approved by the Decree Court for the benefit of the Tribe." *Id*. at 20. Stipulations were entered into between some of the parties that resolved certain protest issues, but other issues remained, resulting in a hearing before the State Engineer.

The State Engineer concluded that when the water rights "are limited to the consumption use amount of 3.10 acre-feet per acre, the proposed change of NFWF's senior decreed rights does not conflict with existing rights in violation of the Decree or Nevada law, and does not threaten to prove detrimental to the public interest." *Id*. at 23. As for the remainder of the water rights, the "Water Master retains discretion to administer the non-consumptive portion of the water rights to avoid conflicts or to mitigate hydrologic system losses." The State Engineer ruled that through the use of this discretion, "the proposed change will not adversely affect the cost of water to other rightholders…nor will it lessen the efficiency of the District in its delivery of water." *Id*. As noted earlier in the ruling, "[T]he State Engineer finds that the *WRID Stipulation* provides the Water Master with sufficient discretion to use the non-consumptive portion of the water rights to mitigate any conflicts or efficiency issues downstream of the point of non-diversion." *Id*. at 17.

Another way in which NFWF avoided causing additional costs to other water users is that it "stipulated to continue payment of the operation and maintenance charges, including ditch charges assessed as if the water rights were still appurtenant to the land." *Id*. at 22-23.

Another issue involved the impact of NFWF making a "continuous call" for water so that it would call to exercise its rights to their full extent and for the full period of use. Some protestants asserted that historically, senior irrigators might not call for water due to variable weather or land conditions or that they might curtail use or not call for water during harvest. *Id*. at 13. The State Engineer, however, found that the "consumptive use figure of 3.10 acre-feet per acre in the Walker River Basin for alfalfa takes into account the variable irrigation start date and multiple simulated cuttings during the irrigation season." *Id*. at 16. The State Engineer also discussed the Prior Appropriation Doctrine, which applies in Nevada, and the fact that the "Walker River Decree Court recognized that with one exception, all parties to the decree litigation stipulated that the law of prior appropriation governed the determination of the claims to the waters of the Walker River and its tributaries. *U.S. v. Walker River*, 11 F.Supp. at 168…The *Decree* and *Administrative Rules* recognize the right to change decreed rights and the Decree specifically specifically provides that priority of the rights shall be respected with regard to changes to decreed rights. Application 80700 does not change the decreed season of use, which had always provided NFWF's predecessor rightholders the ability to call for water on March 1st through the entire irrigation season, when in priority." *Id*. at 14.

This article discusses some of the major issues addressed, but readers should refer to the full Ruling for additional information. For example, one section deals with "Alleged Impacts to Storage Rights" (*Id*. at 11).

For info: Ruling available at: http://images.water.nv.gov/images/rulings/6271r.pdf

TEXAS V. NEW MEXICO TX/NM

US MOTION TO INTERVENE

On March 11, New Mexico Attorney General Gary King filed a response to the United States' Motion to intervene in the US Supreme Court case Texas filed against New Mexico and Colorado.

Texas claims it has not received all of the Rio Grande Compact water it is entitled to because New Mexico has allowed its water users to deplete the river and hydrologically connected groundwater. Texas alleges that New Mexico farmers in the lower Rio Grande who are pumping groundwater are taking water away from the Rio Grande and Texas's portion of the Rio Grande Project. The US has agreed and has asked the court to force New Mexico to shut down some ground and surface water uses leaving only those water uses authorized by contracts for Project water. New Mexico opposes both these claims.

"The United States' recent filing is an attempt to grab our groundwater," says Attorney General King. "Last year a New Mexico court ruled against the federal government and determined that New Mexico groundwater belongs to New Mexico. Now the federal government is hoping to maneuver around that New Mexico ruling by taking Texas' side at the high court but I will do everything within my power to protect ground and surface water for New Mexicans."

New Mexico did not object to the US becoming a party to the lawsuit so long as it does so based on the existing pleadings. New Mexico asserted that the US should not be allowed to inject a new issue of whether the sources of water for its water right in the Rio Grande Project include groundwater. "The United States is required to adjudicate its water right in the Rio Grande Project in the current state adjudication court. *United States v. City of Las Cruces*, 289 F.3d 1170 (10th Cir. 2002) (affirming that the United States must adjudicate the Rio Grande Project water right in New Mexico state court). The adjudication court has already determined that the United States did not appropriate groundwater for the Project and that therefore groundwater is not a source of water for the Project." *Response* at 2.

New Mexico also maintains that jurisdiction in the Supreme Court is "dependent on the Texas Bill of Complaint, and the Court has allowed New Mexico to file a motion to dismiss

in the nature of a motion under Rule 12(b)(6) of the Federal Rules of Civil Procedure. If the Court grants New Mexico's motion and dismisses Texas' Complaint, the United States Complaint in Intervention should also be dismissed. An adequate alternative forum – the United States federal district court – exists to resolve the claims related to the Rio Grande Project that the United States elects independently to pursue." *Id.* at 2.

The third point raised by New Mexico is that the US' Complaint in Intervention "fails to state a claim because it misconstrues the respective rights and obligations of the Bureau of Reclamation and the states under the Reclamation Act. 43 U.S.C. §§ 371 et seq." *Id*. at 2-3.

For info: NMAG King's website: www.nmag.gov/News >> search for March 11, 2014 News

STORMWATER RULE US

CONSTRUCTION & DEVELOPMENT FINAL EPA RULE

On March 6t, EPA published a final rule that changes existing regulations that apply to stormwater discharges from construction activities (Fed Reg Vol79, #44, 3/6/2014, pp12661-12667). EPA stated that compliance with this regulation will result in significant reductions in the discharge of sediment and other associated pollutants to water bodies. The rule also furthers the EPA's goals of improving resiliency of the nation's waters and infrastructure to climate change by requiring permittees to provide and maintain buffers around many surface waters at construction sites and reducing downstream siltation and flooding. *See* http://water.epa.gov/scitech/wastetech/guide/construction/index.cfm

The regulations apply to all construction sites that are subject to NPDES permit requirements (generally, sites with one or more acres of land disturbance).

Construction site owners and operators are required to:

- implement erosion and sediment controls;
- stabilize soils;
- manage dewatering activities;
- implement pollution prevention measures;
- provide and maintain buffers around surface waters;
- prohibit certain discharges, such as motor fuel and concrete washout; and
- utilize surface outlets for discharges from basins and impoundments.

An earlier EPA rule (2009) established a numeric limitation on allowable turbidity from certain construction sites. Following promulgation of the 2009 rule, several parties filed petitions identifying deficiencies in the dataset used by EPA to set the numeric limits. On December 10, 2012, EPA entered into a settlement agreement to resolve the litigation. The current rulemaking is intended to satify EPA's agreements under that litigation. Under the current rule, EPA is withdrawing the numeric turbidity limitation and monitoring requirements.

For info: Jesse Pritts, EPA, 202/ 566-1038 or pritts.jesse@epa.gov

EPA website: http://water.epa.gov/scitech/wastetech/guide/construction/index.cfm

WASTEWATER/QUAKES OK

USGS STUDY - WASTEWATER INJECTION

In a new study involving researchers at the US Geological Survey (USGS), scientists observed that a human-induced **m**agnitude (M) 5.0 earthquake near Prague, Oklahoma in November 2011 may have triggered the larger M5.7 earthquake less than a day later. This research suggests that the M5.7 quake was the largest human-caused earthquake associated with wastewater injection.

"The observation that a human-induced earthquake can trigger a cascade of earthquakes, including a larger one, has important implications for reducing the seismic risk from wastewater injection," said USGS seismologist and coauthor of the study Elizabeth Cochran.

Historically, earthquakes in the central United States have been uncommon. Yet in the year 2011 alone, numerous moderate-size earthquakes occurred in Colorado, Texas, Oklahoma, Ohio and Arkansas. Many of these earthquakes occurred near wastewater injection wells, and some have been shown to be caused by human activities.

The 2011 Oklahoma earthquake sequence included the November 6, 2011, M5.7 earthquake that ruptured a part of the Wilzetta fault system, a complex fault zone about 200 km (124 mi) in length near Prague, Oklahoma. Less than 24 hours prior to the M5.7 earthquake, a M5.0 foreshock occurred on November 5, 2011. That foreshock occurred near active wastewater disposal wells, and was linked in a previously published study to fluid injection in those wells. The earthquakes have not been directly linked to hydrofracturing.

The research published this week suggests that the foreshock, by increasing stresses where M5.7 mainshock ruptured, may have triggered the mainshock, which in turn, triggered thousands of aftershocks along the Wilzetta fault system, including a M5.0 aftershock on November 8, 2011. If this hypothesis is correct, the M5.7 earthquake would be the largest and most powerful earthquake ever associated with wastewater injection. All three earthquakes of magnitude 5.0 and greater along the Wilzetta fault exhibited strike-slip motion at three independent locations along the fault, suggesting that three separate portions of the Wilzetta fault system were activated.

The paper, *Observations of Static Coulomb Stress Triggering of the November 2011 M5.7 Oklahoma Earthquake Sequence* by D.F. Sumy, E.S. Cochran, K.M. Keranen, M. Wei, G.A. Abers, from the University of Southern California, USGS, Cornell University, Brown University, and the Lamont Doherty Earth Observatory at Columbia University, was published in the "Journal of Geophysical Research" in early March.

For info: Susan Garcia, USGS, 650/ 346-0998 or garcia@usgs.gov

Paper available from: http://onlinelibrary.wiley.com/doi/10.1002/2013JB010612/abstract

WATER BRIEFS

BAY DELTA DECISION CA
SMELT PLAN UPHELD

On March 13 the US Ninth Circuit Court of Appeals (Court) ruled to uphold a federal plan of protection for California's San Francisco Bay-Delta ecosystem. The court sided with the Natural Resources Defense Council (NRDC), Earthjustice, The Bay Institute and the federal government in its determination that protections for the threatened delta smelt — a bellwether species that indicates the health of the vital San Francisco Bay-Delta estuary — are fully justified and necessary to restore the health and water quality of this largest estuary on the west coast of the Americas.

The Court's ruling stems from several lawsuits filed in 2008 contesting the US Fish & Wildlife Service's protections for threatened and endangered fish in the Delta. These protections, described in a 2008 biological opinion, were issued to address the Delta's ecological collapse, which threatens the regional water supply and health, as well as local fisherman and farmers.

Kate Poole, senior attorney with NRDC, stated, "The court reaffirmed the facts and recognized that science needs to guide our management of the Delta in order for our farms, cities and wildlife to thrive…Today's ruling recognizes the importance of the Delta's fishing and farming community, which deserves to have its livelihood preserved. We now look forward to working with the State to advance real long-term solutions to our water needs."

For info: Opinion available at: http://docs.nrdc.org/water/wat_14031301.asp

GROUNDWATER TRENDS US
COLUMBIA WATER CENTER WHITE PAPER

On March 18, the Columbia Water Center, part of the Earth Institute at Columbia University, announced the release of a new white paper — "*Assessment of Groundwater Level Trends across the United States*" — that analyzes long-term groundwater trends across the United States. The study found that historic groundwater levels have declined across much of the country over the last 60 years, suggesting that current groundwater management is broadly unsustainable. The paper was released as part of the Water Center's new "America's Water Initiative."

According to Tess Russo, a postdoctoral fellow and lead author, her research took a different approach from most previous national studies of groundwater by using historic well records rather than computer models to assess long-term trends of groundwater depletion. "Many of the other broad assessments of groundwater depletion or changes in groundwater levels across the country have been based on modeling studies," says Russo. "Those studies tend to aggregate model results of individual aquifer systems, or use a combination of field observations and recharge estimates."

In addition to being a broad wake-up call for the entire nation to reassess its approach to groundwater use, according to Russo, the study could be used to inform future, smaller scale studies that target hot spots to better understand the dynamics of extraction and recharge so as to manage water use more sustainably. The study found that in addition to well-known areas in Central California and the Great Plains that suffer from severe groundwater depletion, numerous wells had seen long-term water level declines in the Lower Mississippi, the Atlantic Coast, and the southeastern part of the country.

The study was conducted as part of the Columbia Water Center's "America's Water Initiative," a program that aims to support a network of academic institutions, government agencies, and private businesses to determine a research agenda for developing and implementing innovative management solutions, new technologies, and new policies to inform water management improvements in the US. Previous papers written as part of the initiative include an analysis that highlighted rising water rates, deteriorating infrastructure and the growing debt of many utilities across the country, and a study that exposed the lack of sustainable water use throughout much of the country. Future planned releases include a paper on green infrastructure and a case study of water use and infrastructure in San Diego.

The initiative has received support from Veolia Water North America, a leading global water services operator and engineering firm. Veolia Water North America and the Columbia Water Center were two of the founding members of the Executive Committee of Growing Blue, a web-based information platform initiated by Veolia to raise awareness and provide resources for decision makers in regard to the water-growth nexus.

According to Ed Pinero, Veolia Water North America's Chief Sustainability Officer, "Veolia felt that leveraging the expertise of Columbia would provide excellent research and analysis of key issues," in particular "how rates relate to specific parameters as well as how climate change and drought impact water resources and availability." This kind of information, he adds, "is very useful to decision makers, especially municipal leaders who are trying to do as much as they can with limited finances.

For info: White Paper available at: http://water.columbia.edu/files/2014/03/USGW_WhitePaper_FINAL.pdf

CALENDAR

April 14-17 TX
Texas Water 2014 Conference, Dallas. Hilton Anatole Hotel & Convention Ctr. For info: http://www.texas-water.com/

April 16 CA
Climate Change & the Future of Groundwater in California Workshop, Davis. UC Davis Conference Ctr., 2nd Annual Climate Change Water & Society State of Science Workshop. For info: http://ccwas.ucdavis.edu/State_of_the_Science_and_Policy_Workshop/2014/

April 16 CA
Sustainable Groundwater Management: Proposed Solutions Workshop, Sacramento. Cal/EPA Hdqrts. Bldg., 1001 I Street, 9am. Presented by California State Agency Team. For info: www.opr.ca.gov/s_groundwater.php

April 17-18 OR
Pacific Northwest Timberlands Management Seminar, Portland. World Forestry Center. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net

April 22-25 NV
The Environmental Bootcamp, Las Vegas. Residence Inn Hughes Center. For info: www.epaalliance.com/environmentalbootcamp-apr14.html

April 23 NE
Managing Water Resources for Multiple Benefits Seminar, Lincoln. UNL East Campus, Hardin Hall Auditorium, 3:30-4:30pm. Presented by Nebraska Water Center. For info: http://watercenter.unl.edu/

April 23-25 CA
Central Valley Tour, Sacramento. Presented by Water Education Foundation. For info: www.watereducation.org/toursdoc.asp?id=2979

April 24 WA
Wild & Scenic Film Festival, Seattle. SIFF Uptown Cinema. Presented by Washington Water Trust. For info: www.washingtonwatertrust.org

April 24 CA
Reforest Restore Renew: Forest Fete, San Francisco. St. Francis Yacht Club, 6 pm. Presented by Pacific Forest Trust. For info: www.forestfete.org/

April 25 WA
Climate Change: The Rules are Changing CLE, Seattle. Seattle University School of Law. Presented by Center for Environmental Policy. For info: www.celp.org/

April 30-May 2 WA
2014 Salish Sea Ecosystem Conference, Seattle. Washington State Convention Ctr. Presented by Puget Sound Partnership. For info: www.wwu.edu/salishseaconference/

May 1-2 PA
Special Institute on Shale Plays, Pittsburgh. Sheraton Station Square. For info: Rocky Mt. Mineral Foundation: www.rmmlf.org

May 3 CO
Sagebrush of Colorado: Focus on Western Colorado's Riparian & Upland Sagebrush Communities Workshop, Grand Junction. Presented by Tamarisk Coalition. For info: http://tamariskcoalition.wildapricot.org/

May 4 CO
Estimating Rates of Groundwater Recharge Course, Denver. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/125may14.aspx

May 4 CO
Introduction to Mountain Hydrogeology Course, Denver. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/322may14.aspx

May 4-7 CO
NGWA Groundwater Summit 2014, Denver. Westin Downtown. Presented by the National Ground Water Ass'n. For info: http://groundwatersummit.org/

May 5-6 CA
California Wetlands Conference, San Francisco. Hotel Nikko. For info: CLE Int'l, 800/ 873-7130 or www.cle.com

May 5-6 WA
Clean Water & Stormwater Seminar, Seattle. Washington State Convention Ctr. For info: Law Seminars Int'l, 800/ 854-8009, registrar@lawseminars.com or www.lawseminars.com

May 6-7 TX
2014 Environmental Trade Fair & Conference, Austin. Convention Ctr. Sponsored by Texas Commission on Environmental Quality. For info: www.tceq.texas.gov/p2/events/etfc/etf.html

May 6-9 CA
ACWA 2014 Spring Conference & Exibition, Monterey. Portola & Marriott Hotels. Presented by Ass'n of California Water Agencies. For info: www.acwa.com/events/acwa-2014-spring-conference-exhibition

May 7-9 CN
Third International Forum on Integrated Water Management, Quebec City. For info: http://rv-eau.ca/en/call-for-communication/

May 7-9 OR
American Water Works Ass'n Annual Pacific Northwest Section Conference, Eugene. Hilton Hotel & Conference Ctr. For info: www.pnws-awwa.org/

May 8 CO
Characterization of Deep Groundwater Conference, Denver. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/conferences/Pages/5042may14.aspx

May 8-9 CO
Environmental Forensics Course, Denver. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/183may14.aspx

May 8-9 NM
Public Land Law, Regulation & Management, Santa Fe. Eldorado Hotel. Presented by Rocky Mt. Mineral Law Foundation. For info: www.rmmlf.org

May 9 OR
Tight Lines: Auction & BBQ Dinner, Bend. Aspen Hall, Shevlin Park, 5 pm. Presented by Deschutes River Conservancy. For info: www.deschutesriver.org/

May 12 OR
4th Annual Water Research Symposium, Corvallis. OSU - CH2M Hill Alumni Ctr. Highlighting Student Research. For info: http://groups.oregonstate.edu/hydro/2014-water-research-symposium-oregon-state-university

May 12-13 CA
Tribal Environmental Quality Protection Seminar, Cabazon. Morongo Casino Resort & Spa. For info: Law Seminars Int'l, 800/ 854-8009, registrar@lawseminars.com or www.lawseminars.com

May 12-14 UT
2014 Spring Specialty Conference on GIS & Water Resources VIII, Salt Lake City. Snowbird. Presented by American Water Resources Ass'n. For info: www.awra.org/

May 13-16 IL
Environmental Awareness Bootcamp, Chicago. Hilton Orrington/Evanston. For info: www.epaalliance.com/environmentalbootcamp-may14.html

May 14 AZ
Hydrology for Lawyers Seminar, Phoenix. Arizona Biltmore. For info: Law Seminars Int'l, 800/ 854-8009, registrar@lawseminars.com or www.lawseminars.com

May 14-15 CA
Flood Management Tour, Stockton. Presented by Water Education Foundation. For info: www.watereducation.org/toursdoc.asp?id=2979

May 14-16 MN
National Pretreatment & Polution Prevention Workshop, Minneapolis. Deport Renasissance Minneapolis Hotel. Presented by National Ass'n of Clean Water Agencies. For info: www.nacwa.org/index.php?option=com_content&view=article&id=7&Itemid=4

May 15-17 OR
3rd Symposium on Urbanization & Stream Ecology, Portland. Crowne Plaza Hotel. Joint Meeting of Society for Freshwater Science & Ass'n for the Sciences of Limnology & Oceanography. For info: http://urbanstreams.wordpress.com/

May 16 OR
Oregon State Bar Agricultural Law Section Annual "Round-Up" CLE, The Dalles. Columbia River Gorge Discovery Ctr. For info: Helen Nelson, 541/ 917-0100 or helen@eechlaw.com

May 16 CA
Overview of Water Law & Policy in California Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, http://extension.ucdavis.edu/

May 16 CA
Orange County Water Summit, Anaheim. Disney's Grand Californian Hotel. Presented by Orange County Water District. For info: www.ocwatersummit.com/

May 19-20 NV
18th Annual Water Reuse & Desalination Research Conference, Las Vegas. Westin Hotel. Presented by WateReuse Ass'n. For info: www.watereuse.org/foundation/research-conference-18

May 19-20 Germany
Sustainability in the Water-Energy-Food Nexus Conference, Bonn. For info: http://wef-conference.gwsp.org/

May 21-22 ID
2014 Water Reuse Conference, Boise. Riverside Hotel. For info: www.deq.idaho.gov/assistance-resources/conferences-trainings/2014-water-reuse-conference.aspx

May 21-23 Mexico
Water, Energy & Climate Conference 2014 - IWA, Mexico City. Presented by the International Water Ass'n. For info: www.iwahq.org/28b/events/iwa-events/2014/wecmexico2014.html

May 28-30 TX
Southwest Stream Restoration Conference, San Antonio. Hyatt Regency Riverwalk. For info: http://southweststream.org/

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CALENDAR

(continued from previous page)

May 30 — **CO**

Plant Identification on the Dolores River: Plants of the Riparian Corridor Workshop, Bedrock. Presented by Tamarisk Coalition. For info: http://tamariskcoalition.wildapricot.org/

June 2-5 — **OR**

Water Without Borders: ASCE Environmental & Water Resources Institute Congress, Portland. For info: www.asce.org/conferences/ewri-congress/

June 3-4 — **CA**

California Bioresources Alliance Symposium, Davis. UC Davis, Buehler Alumni & Visitors Ctr. For info: UC Davis Extension, http://extension.ucdavis.edu/

June 5 — **CA**

Tribal Water Law & Policy Course, Sacramento. Sutter Square Galleria, 2901 K Street. For info: UC Davis Extension, http://extension.ucdavis.edu/

June 5-6 — **TX**

Endangered Species Act Conference, Austin. Omni Hotel at Southpark. For info: CLE Int'l, 800/ 873-7130 or www.cle.com

June 5-6 — **CO**

Water & Air Quality Issues Associated with the Oil & Gas Boom: The Evolving Framework of Regulation & Management - Martz Summer Water Conference, Boulder. Wolf Law Bldg. Presented by Getches-Wilkinson Center. For info: Doug Kenney, Getches-Wilkinson Center, douglas.kenney@colorado.edu or www.colorado.edu/law/research/gwc/events

June 8-11 — **MA**

American Water Works Ass'n Annual Conference & Exposition, Boston. Boston Convention & Exhibition Ctr. For info: www.awwa.org/conferences-education/conferences/annual-conference/program.aspx

June 9-11 — **OH**

Field Methods: Groundwater Sampling & Analysis Course, Westerville. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/226jun14.aspx

June 9-12 — **NV**

New MODFLOW Course: Theory & Hands-On Applications, Las Vegas. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/258jun14.aspx

June 9-13 — **TX**

Seventh International Conference on Environmental Science & Technology, Houston. Crowne Plaza. Presented by American Academy of Sciences. For info: www.aasci.org/conference/env/2014/index.html

June 12-13 — **CA**

California Water Law Conference: Recent Cases & Water in the 21st Century, San Diego. The Westin. For info: CLE Int'l, 800/ 873-7130 or www.cle.com

June 12-13 — **WY**

Wyoming Water & Energy Law Conference, Cheyenne. Little America. For info: CLE Int'l, 800/ 873-7130 or www.cle.com

June 12-13 — **CA**

Practical Applications for Green Roofs & Rainwater Harvesting Course, Davis. Da Vinci Bldg., 1632 Da Vinci Ct. For info: UC Davis Extension, http://extension.ucdavis.edu/

June 18-20 — **CA**

Bay Delta Tour, Sacramento. Presented by Water Education Foundation. For info: www.watereducation.org/toursdoc.asp?id=2979

June 18-20 — **MA**

Water Systems, Science & Society Under Global Change: UCOWR/NIWR/CUAHSI 2014 Conference, Medford. Tufts University. Presented by Universities Council on Water Resources. For info: http://ucowr.org/conferences/ucowr-niwr-annual-conference-registration

June 19-20 — **WA**

Washington Water Law Seminar, Seattle. TENTATIVE. For info: Law Seminars Int'l, 800/ 854-8009, registrar@lawseminars.com or www.lawseminars.com

June 23-25 — **OH**

Principles of Groundwater: Flow, Transport & Remediation Course, Westerville. Presented by National Ground Water Ass'n. For info: www.ngwa.org/Events-Education/shortcourses/Pages/131jun14.aspx

June 25 — **WA**

Stormwater Law & Regulation Seminar, Seattle. City University of Seattle, 521 Wall Street. For info: The Seminar Group, 800/ 574-4852, email: info@theseminargroup.net, or website: www.theseminargroup.net