Truckee Meadows Water Authority Manages Conjunctive Use across Five Hydrogeologic Regions

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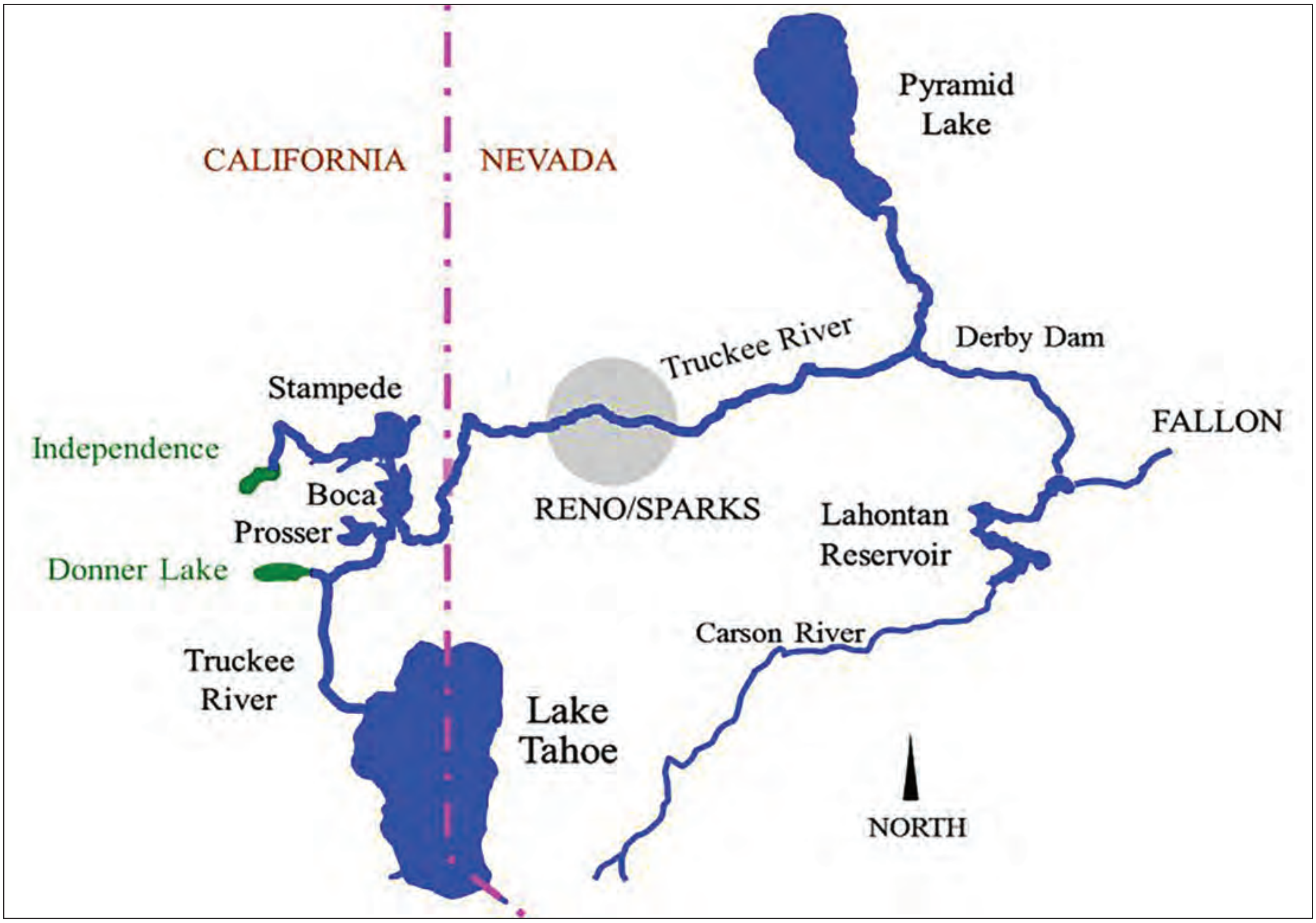

THE TRUCKEE MEADOWS WATER Authority (TMWA) serves 400,000 residents in a 157-square-mile service area that includes the Reno-Sparks Metropolitan Area (RSMA) and small rural communities and irrigated acreages in northwestern Nevada. Although aquifer storage and recovery (ASR) has been used in the region for almost a quarter century, the 2014 consolidation of the Washoe County Department of Water Resources (DWR) and the South Truckee Meadows General Improvement District (STMGID) into TMWA facilitated conjunctive use in areas that relied heavily on groundwater. Previously, those areas did not have the ability to rest wells or the flexibility to address water level declines associated with drought and population growth. Before consolidation, the three large water purveyors also had areas of duplicate transmission, storage, and treatment facilities.

Surface water from the Truckee River system, including water released to the river from Lake Tahoe, Boca, Prosser and Stampede reservoirs, Independence Lake, and Donner Lake, provides most of TMWA's water supply. Groundwater is pumped from over 80 wells throughout the service territory and, depending on the location, either supplements surface water during the summer months or provides water supply year-round. Recharge water originates from the Truckee River and is treated at the Chalk Bluff Treatment Plant (90 million gallons a day (MGD) or at the Glendale Water Treatment Plant (37 MGD) for distribution to customers. In the winter months, TMWA currently distributes up to 10 MGD of recharge water into 26 active recharge wells.

Planned expansions to the distribution system, a new surface water treatment plant, and additional recharge wells are projected to increase that amount to 15 MGD via 40 recharge wells. Because the recharge/production wells are integrated into the distribution system, treated water from the surface water treatment plants can easily make its way to the wells for recharge.

An Experiment That Worked

TMWA's groundwater recharge program began in 1993 as an experiment to determine the possibility of injecting water into production wells to enhance drought supply and improve water quality. The wells are located in five geographically and hydrogeologically unique regions with differences in natural recharge, water quality, and availability. A common saying about drilling in Nevada goes, "If you want a different well, move over five feet." That variability makes it difficult to locate wells in a sustainable and potable aquifer. Likewise, geologic controls, such as transmissivity, porosity, fractures, and faulting constrain the ability to extract water. In the arid to semi-arid climate of the RSMA, precipitation falls as snow and rain from November through April, approximately six to ten inches a year on the valley floor and as much as 40 inches in the mountains, which provides most of the natural aquifer recharge.

Conjunctive-Use Tool Kit

Almost all recharge wells in the system are dual-purpose. Wells with vertical turbine pumps have been the easiest and most successful to recharge because they are not equipped with check valves and don't have the annular space crowding limitation common in wells with submersible pumps. When annular space is available, many wells with submersible pumps have been converted to recharge wells via a separate downhole recharge line. After a well is rehabilitated to increase its efficiency, well house and downhole piping are improved to convey the calculated volume of water based on aquifer storage parameters (specific yield, hydraulic conductivity, and depth to water), and the well's specific capacity. All new production wells are designed and constructed to accommodate recharge with stainless-steel recharge lines that penetrate the casing below the static water line and can accommodate either vertical turbine or submersible pumps.

The Projects

Project Area 1: East Lemmon Valley. *Topographically closed, typical basin fill aquifer; five production wells completed in unconsolidated sediments: approximately 1,400 domestic wells primarily in thin alluvial sediments or fractured granitic aquifers. No active recharge wells. Average perennial yield: 700 acre-feet a year (AFY); average groundwater production over the past five years: approximately 550 AFY.*

In 2006, Washoe County DWR began an in-lieu (passive) recharge program to address decades of water level declines and elevated nitrate from septic system effluent. The project focused primarily on a 511-lot subdivision served by 475 domestic wells in a low-yield fractured granite aquifer. With funding from the U.S. Environmental Protection Agency, DWR extended municipal water service and converted 14 percent of the domestic wells to municipal service. With fewer domestic wells and new metered customers using water more carefully, the project reduced net groundwater pumping by 50 AFY. Between 2006 and 2014, DWR was able to reduce pumping from nearby municipal wells by over 40 percent. Within five years, water level decline stopped and began to stabilize. In 2015, TMWA reduced pumping to 20 percent of previous levels, facilitated by groundwater from the Fish Springs Ranch importation project. Recent data indicates that a water level rebound may be occurring.

Project Area 2: West Lemmon Valley. *Topographically closed, typical basin fill aquifer adjacent to East Lemmon Valley where TMWA has been storing water for drought supply since 2000; three production/recharge wells in unconsolidated sediments with approximately 730 domestic wells in a fault-separated aquifer; estimated average perennial yield: 600 AFY; 50-foot drop in water levels from domestic and municipal pumping. Since 2012, TMWA groundwater production has averaged about 250 AFY.*

In 2000, to maximize groundwater storage, TMWA instituted a rotational peak demand only pumping protocol and active recharge while supporting base-level demands with imported surface water year-round. Three existing production wells were converted to dual purpose wells by constructing bypass piping above ground and rerouting water down the vertical turbine pump column. The project has successfully augmented groundwater reserves, averaging more than 300 AFY and totaling more than 5,000 AF of recharge since inception. This has resulted in water level stability across the basin and up to 20 feet of recovery near ASR wells. Active recharge water represents almost 70 percent of the water produced from the valley, while passive recharge has allowed 385 AF (roughly 40 percent of what would have been pumped in a typical year) to remain in the aquifers in East and West Lemmon Valley combined.

Project Area 3: Spanish Springs Valley. *Highly transmissive fractured volcanic rock aquifer on the east with four production wells produces up to 3,000 gallons per minute (gpm) at a single well, and a moderately transmissive alluvial aquifer on the west with four wells produces up to 750 gpm at a single well. A separate granitic aquifer also supports approximately 380 domestic wells. Average perennial yield is estimated at 1,300 AFY, with TMWA pumping averaging 1,100 AFY since consolidation.*

Spanish Springs Valley has traditionally relied solely on groundwater and only recently began using surface water to meet base-level demands. In 2015, TMWA increased surface water deliveries to help reverse declining water levels and in 2016 reduced pumping to 800 AFY, a 65 percent decrease from the previous 15 year average. Recharge began on the east side of the valley in 2008. A new production/recharge well was designed and constructed with a three-inch recharge line affixed to the outside of the steel casing, penetrating the well just above the well screens. The line can accommodate approximately 600 gpm of recharge although the aquifer could handle much more.

In 2015, the well was retrofitted with bypass piping to allow up to 2,100 gpm to flow back down the vertical turbine pump column for a combined maximum recharge rate of 2,700 gpm. That well alone recharges up to 1,000 AFY, replacing all the municipal water pumped in the basin in 2016. Passive recharge kept 650 AFY of groundwater in the aquifer in 2016.

Septic system effluent from a high density area of more than 2,000 homes has resulted in nitrate concentrations in shallow groundwater, reaching in excess of 100 parts per million (ppm), compared with the maximum contaminant level (MCL) of 10 ppm. The contamination has shut down production at two municipal wells and threatened three more. In 2002, DWR began to reduce pumping on the west side and increased pumping on the east side where water quality has not been affected. In addition to supplying demand with surface water, DWR began a recharge pilot project in 2012 on the west side. One well was taken offline because of high nitrate and arsenic concentrations and converted to a 200 gpm recharge-only well to help reduce nitrate concentrations in the area below the MCL. Since pilot recharge activities began in 2012, nitrate concentrations have decreased by as much as 70 ppm in nearby shallow groundwater.

Project Areas 4 and 5: North and South Truckee Meadows (Reno and Sparks). *North Truckee Meadows (NTM) is a basin-fill aquifer dominated by coarse unconsolidated material deposited by the Truckee River; South Truckee Meadows (STM) is an alluvial fan and fractured volcanic rock aquifer dominated by the Mt. Rose/Galena Fan and its perennial streams originating in the Sierra Nevada. Estimated combined perennial yield: approximately 27,000 AFY; groundwater production: approximately 7,500 AFY in NTM and 4,200 AFY in STM.*

In the NTM, dual-purpose production/recharge wells force contaminants away from production wells and dilute contamination at the edges of the fresh water recharge bubble in the aquifer. The Washoe County Central Truckee Meadows Remediation District (CTMRD) has identified eight tetrachloroethylene (PCE) contamination plumes in the NTM, the result of commercial/industrial use of PCE as a solvent since the 1930s. CTMRD's program has successfully contained plumes by implementing a prescriptive pumping schedule for five TMWA wells fitted with PCE removal equipment and prevented contamination at other TMWA wells through recharge. The result is that the PCE plumes do not appear to be migrating or expanding.

Recharge has also helped reduce arsenic concentrations and saved TMWA customers more than $9 million in contaminant treatment at two well sites. Before recharge, water levels in areas under southwest Reno were declining by two to five feet per a year. Once recharge began in 1993, within a few years water levels rebounded by 50 feet and have remained mostly stable, with only modest year-to-year declines of less than a foot per year, even under the influence of drought.

The consolidated and/or fractured rock aquifers in the alluvial fans in the STM have experienced more than 20 years of groundwater level declines, up to 75 feet in some areas since 2001. Numerous faults crisscross the alluvial fans, serving as barriers to natural recharge from the mountains. This aquifer system, which is thin and/or lacks sufficient transmissivity, provided almost 100 percent of municipal demand before consolidation while supporting more than 1,200 domestic wells.

A $7.8 million three-phase Mt. Rose Fan Conjunctive-Use Facilities plan will deliver treated surface water from the Truckee River, allowing the wells to rest and the aquifer to recover. The $2.8 million Phase 1 of the plan (three booster pump stations and approximately 3,600 feet of 10-inch pipe) became operational in early 2016 and is delivering up to 1,500 gpm of surface water, primarily during the winter months to recharge and rest wells until needed to meet peak summer demand. TMWA has also expanded ASR in this area and has completed retrofit modifications and tested recharge at five wells.

In Phase 2, $1.2 million in improvements will deliver surface water into the upper portions of the Mt. Rose fan water system to recharge additional wells. Construction is scheduled for 2017. Phase 3, the $3.8 million conjunctive-use facilities, will use a new booster pump station and approximately 8,100 feet of 10-inch pipe to deliver about 1,000 gpm primarily during the winter months. Phase 3 facilities will be constructed in 2017/2018. A fourth project will include a $10 million surface water treatment plant. The plant will treat water from eastern Sierra Nevada creeks, serve water to customers high on the fan and recharge treated creek water into stressed aquifers during the winter when surplus is available. Completion is scheduled for 2018. Once fully operational, the STM active recharge system could contribute up to 3,000 AFY to the fan aquifer. In 2016, pumping was reduced by half, resulting in approximately 2,200 AFY of passive recharge. Water levels in several municipal and domestic wells have responded favorably, with water level declines stabilizing and some municipal wells recovering by approximately 15 feet since 2015.

All conjunctive-use projects are financed as capital improvement projects. The total annual costs to treat and deliver water to individual ASR wells ranges from $250,000 to $350,000.