FRAMEWORK for CHINO BASIN’S FUTURE: INVESTIGATING POTENTIAL IMPACTS of STORAGE and RECOVERY PROJECTS

By Mark Wildermuth and Peter Kavounas

THE CHINO BASIN WATERMASTER SHARES THE RESULTS of its initial investigation into how the groundwater basin it oversees is likely to respond to large-scale storage and recovery projects. Storage and recovery projects could boost regional water supply reliability but must be tailored to basin hydrogeology and carefully coordinated amongst groundwater users.

Photos courtesy of Inland Empire Utilities Agency.
The Chino Basin groundwater basin is located in the Inland Empire area, about 40 miles east of Los Angeles, and is overlain by the cities of Chino, Chino Hills, Eastvale, Fontana, Montclair, Ontario, Pomona, Rancho Cucamonga and Upland. With a safe yield of 135,000 acre-feet/year (AFY), Chino Basin groundwater is a significant water supply source for the region. Figure 1 shows the hydrologic boundary of the Chino Basin. This article discusses some of the features of the Chino Basin Judgment and, more specifically, the historical use of storage in the basin and the initial planning efforts to develop a storage management plan.

The Chino Basin Judgment

Pumping rights were adjudicated in the 1970s, culminating with the 1978 Judgment. The Judgment created a Watermaster for its administration. The Judgment acknowledged that there was unused storage space in the basin, created by pre-Judgment overdraft, and that this space could be used to store native and supplemental water for the benefit of the parties to the Judgment. The Judgment also gave Watermaster the authority to manage the use of this storage. At the time of the Judgment was entered, the unused storage space was estimated to be at about 1.5 million acre-feet (AF). One of the main features of the Judgment’s physical solution is the mitigation of overdraft.

Watermaster, with the direction of the Court, developed its Optimum Basin Management Program (OBMP) in 2000 and updated it in 2007. The OBMP is a comprehensive, long-range water-management program for the Chino Basin that, when coupled with the Judgment assures sustainability and, among many management features, includes a storage management plan.

Historical Storage Use

Parties can store water subject to an agreement with Watermaster and can, with Watermaster approval, transfer stored water among themselves. Some parties that pump more than their pumping rights purchase stored water from other parties for the purpose of augmenting their pumping rights and avoiding Watermaster replenishment assessments. In the last several years, about 80 percent of the replenishment obligation incurred by the parties has been satisfied from stored water. Parties can accumulate water in individual accounts, and since the Judgment was implemented, the Judgment parties have accumulated about 450,000 AF in storage.

Watermaster, the Inland Empire Utilities Agency (IEUA), the Three Valleys Municipal Water District and Metropolitan entered into storage and recovery program called the Dry-Year Yield Program (DYYP) in 2003 with a storage limit of 100,000 AF.

Storage Framework Investigation

Since the Judgment was entered, the parties and the IEUA have expressed great interest in developing storage and recovery programs to improve local water supply reliability: stored water can be used to meet water demands when imported and other surface water supplies are challenged by drought, maintenance outages, or catastrophic outages. As such, several of the Judgment parties and the IEUA are considering a joint powers agency called the Chino Basin Project. It is unclear how much storage space these storage and recovery programs will use, but they could collectively use more than 100,000 AF, and up to 300,000 AF.

To be effective and to avoid undesirable results, storage and recovery programs need to be tailored to the hydrogeology of the basin and carefully coordinated among themselves and with the Judgment parties’ individual storage activities. Figure 1 shows the Chino Basin and some of the key features of importance for storage management, including imported water pipelines that traverse the basin, areas of subsidence concern and major contaminant plumes. The specific challenges in the Chino Basin that need to be addressed in storage management include: accounting for and minimizing storage-induced reductions in recharge and safe yield; avoiding new land subsidence; ensuring sustainable pumping; and not interfering with contaminant plume remediation efforts.

With these concerns in mind, Watermaster began a two-part process to update the storage management plan in the Chino Basin. The first part, the Storage Framework investigation, was designed to describe how the basin responds to storage and recovery programs and the limitations on storage and recovery programs due to basin characteristics and the expected water management activities of Judgment parties. Watermaster is using the results of the Storage Framework investigation to update its storage management plan. The major features and results of the Storage Framework investigation are described below.

Baseline Storage Use

Watermaster conducted a comprehensive review of the current and future water supply plans of the Judgment parties to estimate future groundwater pumping, replenishment obligations and
the aggregate amount of storage space that would be used by the parties. This information was used to develop baseline planning scenarios that were simulated with Watermaster’s groundwater models to predict the basin response, which included: the amount of storage space required by the parties; the safe yield and how the safe yield changes due to the amount of storage space being used; areas that could experience new land subsidence; areas where pumping sustainability could be challenged; and the expected movement of major contaminant plumes. Multiple baseline scenarios that incorporated ranges in water conservation and expected pumping projections were developed and evaluated.

The amount of storage space required by the parties for their own water supply operations was estimated to increase from the present value of about 450,000 AF to 700,000 AF by 2030, declining slowly to about 420,000 AF by the end of the planning period (2050). Simulation of this pattern of storage use by the parties’ reduced basin recharge and safe yield, with the maximum reduction of about 5,000 AFY occurring near the peak of storage use. This reduction in recharge occurs because increasing storage suppresses recharge from the Santa Ana River.

A constraint surface was developed for the basin to assess the impact of storage use on new land subsidence. If projected groundwater levels fall below the land subsidence constraint surface, new land subsidence would likely occur. The constraint surface was developed from the review of historical piezometric levels at wells. A similar constraint surface was developed to assess the impact of storage use on pumping sustainability, using well owner estimates of the piezometric level required for sustainable pumping. Groundwater level projections were then compared to these constraint surfaces to assess if the baseline water management plans would cause new land subsidence and pumping sustainability challenges. Figures 2 and 3 are maps that illustrate the comparison of the model projected piezometric elevations to the constraint surfaces for new land subsidence and pumping sustainability, respectively. Areas grading in color from white to blue indicate marginal concern to no concern for these challenges. Areas grading in color from pink to red indicate concern to greater concern. The movement of each of the major contaminant plumes in response to the most probable baseline scenario was estimated using a solute transport model.

The baseline storage requirement for use by the parties was as-
assumed to be 700,000 AF. The Watermaster parties requested that another 300,000 AF of storage space be investigated for potential storage and recovery programs, in 100,000 AF increments. These 100,000 AF storage increments were called operating bands. Existing facilities were assumed to be used for the first 100,000 AF operating band. For this operating band, water pumped during the take periods was assumed to be used in the basin in lieu of using a like amount of imported water.

The facilities used for the second and third 100,000 AF operating bands incorporated the facilities for the first operating band and used new (assumed) and existing recharge facilities in the northeast part of the basin to effectuate the puts and new and existing wells in the same area to effectuate the takes. Some of the water pumped during the take years was assumed to be used in the basin in lieu of importing a like amount of water, and the remainder was assumed to be exported. Multiple scenarios were developed and evaluated in these two operating bands to bracket the mix in the use of existing and new (assumed) facilities.

All of these scenarios were evaluated with Watermaster’s groundwater models in a manner identical to the baseline scenarios, and these model results were then compared to the most probable baseline scenario model results and each other to estimate the impacts from increasing amounts of storage. Table 1 (next page) summarizes the impacts of these scenarios relative to the most probable baseline scenario.

Based on the work conducted in the Storage Framework investigation for the storage and recovery program scenarios, we concluded:

- There would be no new land subsidence. This is due primarily to focusing the storage and recovery facilities and their operations in the northeast part of the basin.
- Pumping sustainability challenges are expected to occur in the eastern half of the basin, where pumping sustainability challenges have historically occurred. There are several ways to mitigate these impacts: modifying pumping at the affected wells, improving pumping equipment at or replacing affected wells, optimizing the location of and pumping at the wells used for the take, or some combination of the above.
- Recharge to the basin will decline as storage is increased above baseline levels. Unless mitigated, this will reduce the safe yield of the basin. At the percentages shown in Table 1, the reductions in recharge over a 10-year put-hold-take cycle range from about 16,000 AF to 29,000 AF and the impact on safe yield would be 1,600 AFY to 2,900 AFY. There are several ways to mitigate the loss in recharge that include a reduction in the take amounts to offset the reduction in recharge, increasing groundwater pumping near the Santa Ana River in the lower southern part of the basin to generate more recharge, or a combination of two.
- The projected movements of two contaminant plumes are projected to change in all storage and recovery scenarios evaluated in the Storage Framework. The leading edge of plumes appear to travel further than would occur under the most probable baseline scenario. It is unclear if this is a significant impact that will require mitigation.

This work was completed in a fully transparent process with the full engagement of the Judgment parties and other stakeholders. As of this writing, the Judgment parties are engaged in a similar process to update Chino Basin OBMP, which includes the update of the storage management plan. This work will be completed in early 2020. The new storage management plan will describe parameters for operating storage and recovery programs (e.g., assignment of storage space, operating cycles, mitigation of storage-induced recharge reductions and other undesirable results), transfers of stored water among parties and mitigation of undesirable results from the storage or recovery of Judgment parties stored water.

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### TABLE 1

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Operating band</th>
<th>Range in storage used for storage and recovery Programs</th>
<th>New Land Subsidence</th>
<th>Pumping sustainability</th>
<th>Average annual reduction in safe yield as a percentage of average annual storage space used</th>
<th>Contaminant plumes</th>
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<tr>
<td></td>
<td>2</td>
<td>700,000 to 800,000 AF</td>
<td>None</td>
<td>No new pumping sustainability challenges</td>
<td>2.41%</td>
<td>Potential MPI related to GE Flat Iron and GE Test Cell plumes</td>
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<tr>
<td></td>
<td>2 and 3</td>
<td>700,000 to 900,000 AF</td>
<td></td>
<td>Poetential new pumping sustainability challenges</td>
<td>1.50%</td>
<td></td>
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<tr>
<td></td>
<td>2,3 and 4</td>
<td>700,000 to 1,000,000 AF</td>
<td></td>
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Summary of expected storage and recovery program impacts.