A Second Use

An unsuccessful water supply well proves aquifer storage can be a key to success.

By Bob Mansfield

A brief look at aquifer storage and recovery (ASR) projects around the country reveal they are often large, complicated by source and receiving water quality issues, and involve a myriad of government, public, and private interests.

For those reasons alone, ASR has a reputation for being expensive and has been mostly used by large municipal water systems.

However, a small water utility district in Warren, Oregon, the McNulty Water People's Utility District (PUD), used a single well for ASR, and in so doing, increased its water system storage capacity by 600% for considerably less cost than the steel, above-ground reservoir it originally considered.

The PUD, which is about 30 miles north of Portland, provides water for domestic and light commercial purposes to more than 2000 customers. Officials there decided an additional one million gallons of reserve storage was needed to satisfy excess system demand during the dry season, provide backup in case one of its wells went out of service, and assure a ready reserve for emergencies such as fire suppression.

The PUD was ready to construct one or more above-ground reservoirs, but an interesting alternative seemed possible. It had drilled a routine water supply well into the regional aquifer a decade earlier that remained unusable. Testing showed the well could supply water at high transmissivity, but once drawn down, water levels took years to recover.

The interesting thought was if the well couldn't recharge efficiently, perhaps it might be ideal for aquifer storage.

Exploring the idea

The idea was certainly attractive. Other wells in the PUD's system draw water from the same aquifer. Water from those wells could be injected during periods of low demand and the resulting aquifer-to-aquifer transfer promises a minimum of chemical incompatibility.

The PUD had infrastructure already in place to use the well water. It seemed a minor task to add plumbing and monitoring for injection. The PUD also has a water right for the injection well since it was originally intended for use as a water supply well. As such, the Oregon ASR application process was an increment—something in addition to but not supplanting rights otherwise held by the PUD.

More than 6 million gallons of water can be stored under this 4-foot-high roof for a water utility in Warren, Oregon. Photo by John Borden.

But the PUD was worried about geological unknowns. Why does the well recharge so slowly? The nature of the barrier that restricts communication between the regional aquifer and the zone tapped by the well is a mystery. All the other wells in the regional aquifer recharge very quickly. How much water could be stored is an apparent anomaly.

The PUD's worries were not restricted to science. How rigorous would the state's regulatory requirements be? If the PUD was unable to afford additional geologic characterization, would the regulators allow the project to progress? How far into the project could the PUD allow itself to venture without full knowledge of all the downstream project costs? Having to resolve an unexpected issue halfway into the project could easily catapult expenses to unacceptable levels.

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The project commenced with the implicit understanding the unknowns had to be determined as early as possible. If at any point the projected costs exceeded those to construct an above-ground reservoir, then the ASR project would be abandoned.

My firm structured the project as a proof-of-concept test and priority was given to only those activities considered absolutely necessary to prove out the concept.

Careful management in four areas helped to ensure the success of the project.

The ASR well for McNulty Water People's Utility District in Warren, Oregon, holds 6 million gallons of water, six times the storage capacity of its three above-ground reservoirs, and does so without significantly impacting the scenery in the area. Photo by John Borden.

Identify regulatory 'fatal-flaw' intangibles early.

It was important to know early on if the regulatory agencies would approve a project with definite limitations, especially in scientific characterization. For example, if observation wells were required, the costs would have killed the project.

Before starting, we thoroughly discussed the project goals and the PUD's limitations with the regulatory staff assigned to the project. All parties agreed on a project scope limited to the single existing well with conservative maximums placed on the target storage volume and pumping rates.

We maintained close coordination with the regulators. We routinely kept them informed of all developments to make sure no surprises occurred and to let them know we were conducting the project as initially proposed. Fortunately, the regulators were enthusiastic about the venture and were instrumental in resolving issues in a way to keep the project moving forward.

Engineering and science were constrained to that only absolutely necessary.

We wanted to prove the usefulness of the concept in as economical a way as possible, so only the most necessary equipment was installed. It was understood engineering upgrades and improvements could be deferred until after the project had proved successful.

Every pumping event becomes an opportunity to quantitatively assess the efficiency of the well.

Hydrogeological assessment was similarly curtailed. The regional aquifer is in the Columbia River Basalt Group and our conceptual model suggests the portion of the aquifer tapped by our well is part of but somehow isolated from the regional aquifer. Our well intercepts a zone of limited areal extent, possibly as small as a few hundred yards radius.

The temptation to conduct an additional investigation to understand the local zone was powerful. There were many times during the project both the consultants and regulators yearned for additional information.

However, the question we had to keep asking ourselves was what actual value would knowing the geologic details of our unusual aquifer provide? The interesting answer is, regardless of how much geological information could have been compiled, the project would not have performed differently.

During the five-year period of a limited license, we conducted standard ASR testing. Water from other system wells was pumped into and out of the receiving water aquifer. Cycles of injection, storage, and discharge were conducted to assess the storage capacity of the aquifer and to develop operational guidelines.

Analyses of the water chemistry confirmed the receiving aquifer water quality mirrored that of the source aquifer water quality. Ultimately we never discovered any information to explain or further define the specific geologic conditions causing restricted communication between our ASR well and the surrounding regional aquifer.

Limit the number of consultants.

Two senior consultants performed all the engineering and geologic tasks. Where help in specialized technical matters were needed, additional professionals were hired on an ad hoc basis.

Utilize SCADA to the maximum.

The PUD had installed a supervisory control and data acquisition (SCADA) system a few years earlier, and additional telemetry and sensors specific to the ASR project were added. By using remote desktop software, the consultants were able to monitor the functions of the ASR project from afar—thereby reducing the frequency of site visits. More importantly, raw data files generated by SCADA could be downloaded for more sophisticated analyses.

The downloads were used to create an off-site database of SCADA files that could then be queried with custom-written programs.

One of the shortcomings of many SCADA systems is their reporting capabilities are limited. SCADA-supplied software focuses on visualization, trending, and alarms—and a common complaint is the reporting capabilities offer few, if any, of the types of analytical tools that engineers and geologists use.

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Being free from having to be logged on to the system, the trial and error associated with programming was done at leisure and resulted in the creation of a wide array of specialized analytical tools not available with SCADA or third-party reporting products.

For example, we discovered long periods of injection at 45 gallons per minute didn't allow efficient cleaning of the well screen environment. Discharge pumping at 250 gpm was required to clear the plugging, and in fact is needed periodically especially during a long injection cycle. Using the off-site database, we performed specific capacity (SC) calculations for years of historic data and determined the shortest pumping duration that could generate a reliable SC.

The result is almost every pumping event becomes an opportunity to quantitatively assess the efficiency of the well. SC calculations are performed on the fly and the injection/discharge pumping ratios changed to maintain well efficiency while maximizing injection.

Read Interview with ASR Experts

Make sure you read the article in the *WWJ* September issue which interviewed two industry experts on aquifer storage and recovery. The article is titled "Saving Water for a Drier Day."

Conclusions

This project is a success for all the stakeholders. In fact, on October 14, the PUD received only the second permanent ASR license to be awarded in Oregon.

Here are just some of the reasons why:

- The project results greatly exceeded the PUD's initial needs. More than 6 million gallons of water are capable of being stored in the sole ASR well—far in excess of the 1 million gallon storage capacity initially needed and six times the storage capacity of the PUD's three existing above-ground reservoirs.
- Water quality within the receiving aquifer is improved by the addition of the source water obtained from other system wells.
- The residents and users of the water have the aesthetic benefit of observing no change to the bucolic scenery outside their windows. Six million gallons of water stored invisibly underground is equivalent to a dozen half-million-gallon above-ground reservoirs—tanks that never had to be constructed.

The use of underground storage for drinking water is becoming more common in the United States, but small and medium water supply systems that may benefit from underground storage have traditionally avoided ASR due to cost concerns.

This project demonstrates the benefits of ASR can be an affordable alternative to above-ground storage tanks for small as well as for large water supply districts. WWJ

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