Water360
Resources for Reuse

Recycled water for drinking: Orange County: world's largest for groundwater replenishment scheme

Orange County's groundwater replenishment system is the world's largest water recycling system of its kind. Treated water is purified to near-distilled quality then piped to a location where it naturally seeps into a groundwater basin that provides about 70 percent of the potable water needs of 2.4 million residents.

The drivers

Orange County in Southern California is a semi-arid region that receives on average 330 mm (13 inches) of rain a year. The population of more than 3 million is projected to grow by more than 10 per cent by 2035.

The Orange County Groundwater Basin provides about 70 percent of the potable water needs of 2.4 million residents in north and central Orange County.

The Santa Ana River was once the main source of water for replenishing the basin but increasingly unreliable flows meant that the Orange County Water District (OCWD) was forced to import water from Northern California — an expensive option.

In addition to fulfilling drinking water needs, water from the basin and imported water were injected into a barrier on the coast to prevent seawater from intruding into the groundwater.

By the mid-1990s, water demand had increased and there were continued problems with seawater intrusion. At the same time, the county's increasing volume of wastewater had become a disposal problem for the Sanitation District.

The two agencies saw the opportunity to extensively treat a large portion of the wastewater and use it to replenish the groundwater basin. This was the motivation to create the Groundwater Replenishment System (GWR).

The system at a glance

- Treated sewer water is purified to drinking-water quality standards using a three-step process consisting of microfiltration, reverse osmosis and ultraviolet light with hydrogen peroxide.
- The GWRS water is piped about 21 kilometres (13 miles) through the cities of Fountain Valley, Santa Ana, Orange, and Anaheim, to recharge basins where it seeps underground. The purified water is stored in the Orange County Groundwater Basin. 113 million litres (30 million gallons) per day of GWRS water is pumped into a string of wells to form a hydraulic barrier that prevents seawater from contaminating the county's groundwater supplies.
- The quality of the purified water meets or exceeds all state and federal drinking water standards.
- The GWRS began by purifying up to 265 million litres (70 million gallons) of water a day — enough to meet the needs of nearly 600,000 residents. After the completion of its initial expansion in June 2015, capacity increased to 378 ML (100 million gallons) a day.
- It will ultimately expand to 492 ML (130 million gallons) per day with its future final expansion. The system recycles more than half of the Sanitation District's wastewater and contributes about one-third of the water that refills the basin.
- The US$481 million project was jointly-funded by the Orange County Water District and the Orange County Sanitation District. The $142 million expansion was funded by the water district.
- OCWD manages and protects the Orange County Groundwater Basin, one of more than 500 basins in California. OCWD is a special district, unaffiliated with the County of Orange or any city government. It was created by the California State Legislature in 1933 to protect Orange County's rights to Santa Ana River water and to manage the local groundwater basin.
- The Orange County Sanitation District (OCSD) supplies OCWD with the secondary-treated wastewater at no charge. The Water District, in turn, manages and funds the operations.

The path taken

Holding back the sea with treated wastewater

Seawater intrusion is an ongoing challenge for freshwater basins located near an ocean. By the 1960s, so much water was being extracted from Orange County's underground basin that the resulting drop in water pressure allowed the Pacific Ocean to seep inland about 6.4 kilometres (four miles) through the sandy aquifer. The situation prompted the District to investigate whether it could use treated wastewater to replenish the basin and protect it from further seawater intrusion.

After a successful technology trial, in 1976 the Water District built the internationally known Water Factory 21, which treated wastewater, supplied by OCSD, using a state-of-the-art purification process that included reverse osmosis. The purified recycled water was injected into a string of 23 injection wells to form a hydraulic barrier to seawater and its associated saltwater contamination.

Win-win solution identified for waste disposal and water supply

By the 1990s, water demand was on the rise and there were continued seawater incursion problems. As more water was extracted from the basin, the barrier required more water than Water Factory 21 could produce.

At the same time, the volume of wastewater had increased so much that the Sanitation District was facing a US$200 million price tag to build a second pipe to convey it into the Pacific Ocean.

The two agencies agreed to collaborate and co-fund the construction of an advanced water treatment facility that would solve both problems—not only would it provide the additional purified water needed to keep the ocean at bay, but also enough water of drinking-water standard to help replenish the groundwater basin.

Pilot

The first step was to pilot test the treatment processes. In 1995, OCWD began pilot testing microfiltration, reverse osmosis and ultraviolet light with hydrogen peroxide to purify the Sanitation District's already highly treated wastewater. Testing results proved that this technology could purify the wastewater to near-distilled water quality.

In February 1997, the two agencies signed an agreement to plan and build the GWRS.

Design

In March 1999, the Environmental Impact Report received final certification. Preliminary design of the GWRS began in July 1999. OCWD Board approval to progress to final design was given in March 2001 and the final design was completed in November 2003.

In March 2004, the California Department of Public Health and the Santa Ana Regional Water Quality Control Board approved the system design.

Construction

The plan consisted of seven separate construction projects including an expanded seawater barrier and a 21-kilometre pipeline to carry purified water to recharge basins in Anaheim.

In April 2004, the contract to build the advanced water purification facility was awarded.

By June 2004, the Phase 1 (1.9 ML/day, 5 million gallons a day) Advanced Water Purification Facility was operational and Water Factory 21 ceased operation. This Phase 1 facility operated for two years while the Groundwater Replenishment System was being built. While continuing to prevent seawater intrusion, it also served as a training facility, enabling staff to become familiar with the treatment processes they would operate at the GWRS. New treatment processes were introduced, with the result of increased energy efficiency and more effective removal of contaminants.

The Phase 1 facility ceased operation in 2006 and potable water was imported for injecting into the seawater barrier until the Groundwater Replenishment System was completed and operational in January 2008.

Regulatory approval

The system was reviewed, approved and permitted by the California Department of Public Health and the Santa Ana Regional Water Quality Control Board, to ensure public health, water quality and environmental compliance. The permit establishes criteria for water treatment, total organic carbon limits, and travel time and blending requirements.

Engaging the community

A creative and proactive outreach campaign was designed to secure support for the project from:

- local, state and federal elected officials
- business and civic leaders
- health experts
- environmental advocates
- regulatory agencies
- media
- the general public

The campaign's primary objectives were to:

1. secure positive media impressions
2. be prepared to address significant opposition
3. educate people to overcome the negative "toilet-to-tap" perception of recycling wastewater
4. start the outreach campaign nearly 10 years prior to the project's start-up and continue it throughout the project's life to maintain support for future expansions
5. create a positive perception of recycling wastewater to increase support of indirect and direct potable reuse.

An extensive range of strategies was employed, including forming relationships with media, briefing elected officials, selecting respected community spokespeople, being transparent, offering facility tours, securing commitment from supporters, and reaching out specifically to minority groups, women, mothers and seniors.

Success factors

The system meets Orange County's water needs

The Groundwater Replenishment System gives the growing population of north and central Orange County a locally-controlled reliable source of safe, clean water which reduces the regions dependency on imported water.

Insistence on the highest water quality

OCWD's board of directors insisted that the purified water be of the highest quality. The purified water used to replenish the groundwater basin meets or exceeds all state and federal drinking water standards.

Engaging minority groups and health/medical experts

Proactive face-to-face engagement garnered the support of minority groups and experts in the medical field (health experts, doctors, hospitals, pharmacists, and scientists).

A history of successful water reuse

The Orange County Water District has been treating wastewater to drinking-water standards since 1976 when they built Water Factory 21, and has earned a worldwide reputation for supporting a culture of innovation. Its professionalism and increasingly sophisticated water analyses instilled confidence in the health and regulatory community and the general public in allowing the District to continually push the frontiers of water recycling.

The final destination is the basin, not the tap

The purified recycled water is piped to three recharge basins in nearby Anaheim where it percolates through the sand and gravel, and is naturally filtered, by the time it reaches the groundwater basin.

An outreach campaign that won over the public

From the project's outset, the boards of the water and sanitation districts recognised that public relations would be critical to the success of the Groundwater Replenishment System. They knew they had to overcome the negative public perception of recycling wastewater to "make" drinking water. Similar projects in Los Angeles and San Diego were defeated because of this issue.

The two agencies decided the 'clean water' agency, OCWD, would manage and be the face of an outreach campaign to earn and maintain support for the project. The campaign, which began 10 years before construction started, is recognised as the main reason the public accepted the project.

High-profile and credible speakers and tours of the facility were used to educate people from local colleges, water agencies, international organisations, and local residents.

The success of the campaign was demonstrated by the absence of any organised opposition. Strong support from policymakers and politicians allowed the project to move forward, and secured $92.8 million in state, federal and local grants. Letters of support were obtained from every city council and chamber of commerce in the OCWD's service area. The governor of California was an important supporter.

Ongoing independent scientific review

The permit to operate requires that an independent advisory panel provide an ongoing periodic scientific peer review of the Groundwater Replenishment System. The permit specifies minimum qualifications for the panel members and requires that the panel meet annually during the first five years, and then every two years thereafter. The panel is administered by the National Water Research Institute, and is made up of experts in toxicology, chemistry, microbiology, hydrogeology, environmental engineering, public health, and water treatment technology.

Lessons learnt

- Extensively communicate and engage with the community about the unknown or hard-to-understand project, the need for it and the potential problems it will solve.
- Key messages must address health and safety.
- Proactively reach out to the media. Use language that is easy to understand; jargon generates mistrust.
- Understand and use social media but don't discard traditional tactics.
- Have an open-door policy and tell the truth — have no secrets.
- Interact with people directly, face-to-face, including those who oppose the potable reuse.
- Understand that with social media the same things happen, only faster. Have a crisis management plan and a social media protocol.
- Tours of the pilot/facility and taste tests are important to build public confidence.
- Embrace "toilet to tap". Be creative and have fun with it, especially with young people.

The GWRS website: www.gwrsystem.com

Produced by the Australian Water Recycling Centre of Excellence, a national partnership of industry, research and government organisations working to develop water recycling solutions for Australia's future. www.australianwaterrecycling.com.au