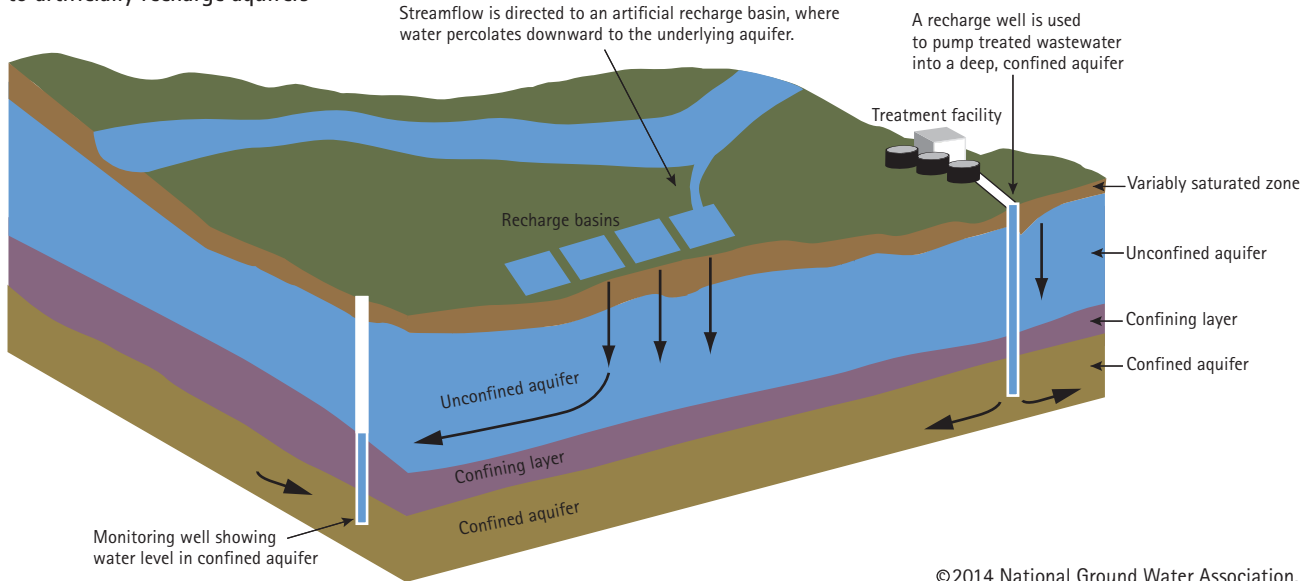


Several techniques are employed to artificially recharge aquifers



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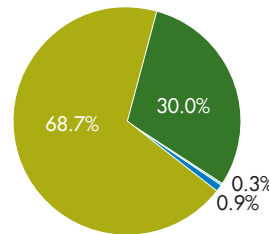
Managed Aquifer Recharge: A Water Supply Management Tool

Introduction

Groundwater is a critical component of this nation's water resources. Approximately 78 percent of community water systems and nearly all rural water supplies use groundwater. Groundwater is the source for 42 percent of the nation's agricultural irrigation water. Additionally, groundwater also feeds streams and rivers, especially during periods of drought or low flow, providing environmental benefits and sustaining ecosystem services.

Of all freshwater on Earth:

- 68.7%** is icecaps and glaciers
- 30.0%** is groundwater
- 0.3%** is surface water
- 0.9%** is other



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Water Shortages and Managed Aquifer Recharge

Water supply shortages are occurring now and are expected to occur more widely in the future. Managed aquifer recharge (MAR) will become an increasingly important tool for mitigating the economic, environmental, and public health impacts of these shortages. MAR captures available water (during wet periods, during periods of low demand, or water that would be lost otherwise) and moves this water under controlled conditions into underground reservoirs called aquifers.

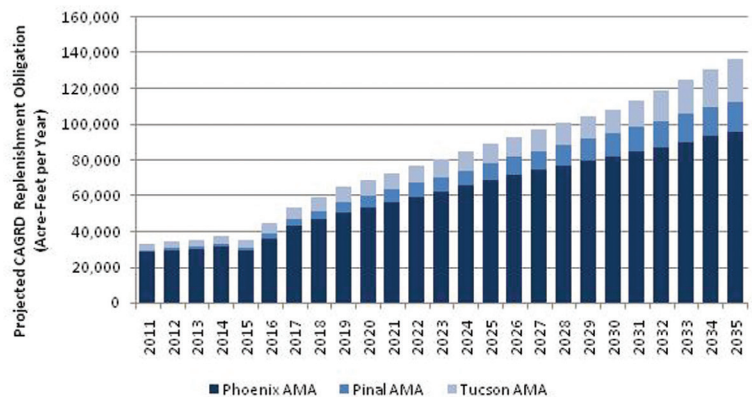
MAR projects are used to:

- Provide more stable water supplies during drought
- Supplement the quantity of groundwater available
- Conserve and dispose of runoff and floodwaters
- Reduce or eliminate declines in the water level of groundwater reservoirs
- Reduce or halt saltwater intrusion
- Improve groundwater quality
- Store water in off-seasons for use during the growing seasons
- Allow stored water to be released during dry periods to augment minimum stream flows and maintain lake levels, thereby benefiting ecosystems
- Mitigate land subsidence.

MAR projects are occurring in every region of the country, although some states have more experience than others do. Properly sited, designed, constructed, operated, and maintained MAR projects are a key component for addressing the nation's water supply challenges. While there are many successful MAR projects as noted below, additional research is needed on the long-term physical and chemical impacts on aquifers, optimal management in different environments, uses of stormwater and reclaimed water, and institutional considerations.¹

Examples of Current Managed Aquifer Recharge Projects

- The Central Arizona Groundwater Replenishment District (CAGR) is statutorily obligated to replenish excess groundwater withdrawn by its members in the Phoenix, Pinal, and Tucson Active Management Areas (AMAs). Replenishment may be accomplished through the operation of underground storage facilities or groundwater savings facilities, or through the purchase of long-term underground storage credits held by third parties. As of early 2014, the CAGR has developed a diverse portfolio of short-, mid-, and long-term water supplies yielding in excess of 43,500 acre-feet per year over the next 30 years. The CAGR's current replenishment obligation is approximately 35,000 acre-feet per year, but the obligation is projected to reach 136,500 acre-feet per year by 2035. The CAGR Water Supply Program plans to continue developing a diverse portfolio of water supplies to address this shortfall between current and projected needs.²



Graph courtesy of CAGR

¹National Research Council (2008). Prospects for managed underground storage of recoverable water. Washington, D.C.: National Academies Press.

²"Report on CAGR Water Supply Program," presented to the CAGR and Underground Storage Committee of the Central Arizona Water Conservation District Board of Directors, February 20, 2014.

- The Orange County Water District (OCWD) in California started using MAR in 1936 to refill the basin aquifer. Today OCWD has one of the largest MAR systems in the world that has more than doubled the yield of the groundwater basin. One of the keys to its successful MAR program is the district's Groundwater Replenishment System, which has produced 100 billion gallons of ultra-pure water over the past five years to recharge groundwater. The recharged water has helped the basin to weather multi-year droughts by stabilizing local supplies and has a smaller energy footprint than alternative sources of water.
- Florida uses MAR extensively. For example, the Peace River Manasota Regional Water Supply Authority serves members in a four-county area of Florida. The authority supplies an average of 25 million gallons of water to its members daily. The water, skimmed during higher flow periods from the Peace River, is treated and then injected in an aquifer, for later recovery. The process allows water to be withdrawn from the river during "wet" periods, stored underground, and then used during "dry" periods when river levels are low.³
- In Boise, Idaho, United Water Resources uses MAR to inject and store seasonally available high-quality groundwater and treated surface water into aquifers of poorer quality water for use during peak demand season using municipal wells.
- New Jersey has what is believed to be the oldest U.S. aquifer storage and recovery (ASR) project, a type of MAR. Operational since 1967, treated drinking water is injected using ASR wells and stored underground during most of the year. During summer when tourists from New York, Philadelphia, and other areas flock to the beach at Wildwood, local water demand increases dramatically. A significant portion of this short-term demand increase is met by withdrawing water from the underground aquifer using the same ASR wells.
- Rio Rancho, New Mexico: Water reuse and MAR programs are under development to meet the city's long-term water demands. The city has demonstrated that surface infiltration and direct injection methods can be used to safely replenish the underlying aquifer with a purified, reclaimed water source when the proper level of treatment is employed. The surface infiltration system has the capacity to recharge the underlying aquifer, present at a depth of nearly 500 feet below ground surface, at a rate of 650,000 gallon per day. The direct injection facility is capable of replenishing the same groundwater system at a rate of one million gallons per day. The city is currently constructing an advanced water treatment facility that uses an ozone-based advanced oxidation process, followed by a biologically activated carbon step to reduce remaining wastewater-derived organics in the reclaimed water prior to direct injection. This process has been used extensively for drinking water treatment and has shown great potential for reclaimed waters when coupled with membrane bioreactor water reclamation systems.



Photo courtesy of Peace River Manasota Regional Water Supply Authority.

The city has demonstrated that surface infiltration and direct injection methods can be used to safely replenish the underlying aquifer.

³Peace River Manasota Water Supply Authority. Retrieved January 28, 2014 at <http://regionalwater.org/>

- The Dayton, Ohio Water Department provides drinking water to approximately 440,000 people. The infiltration lagoons and ponds throughout the wellfield property enhance natural ground-water recharge. The MAR project provides the community robust water supplies even during hot, dry summer days.⁴
- In Oregon, Madison Farms uses artificial recharge as a way to collect high turbidity winter flood-water. The water is then cleaned to potable standards, injected into the aquifer, and withdrawn in the summertime for irrigation use.⁵

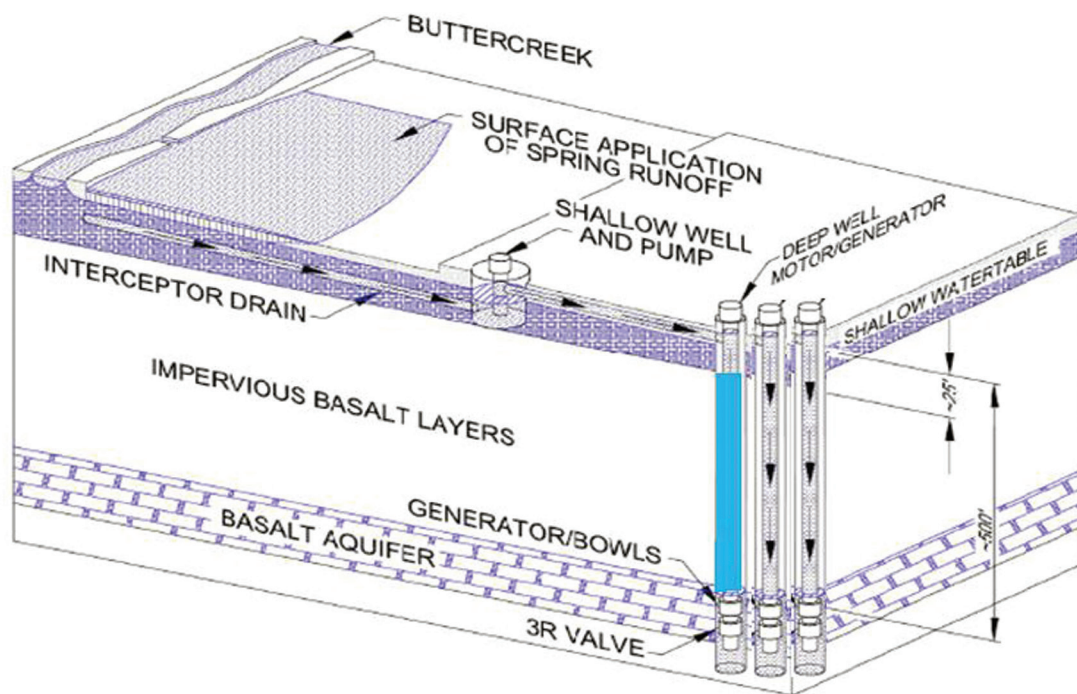


Diagram courtesy of Madison Farms

⁴City of Dayton. City of Dayton Water One Source. Retrieved January 28, 2014 at http://m.boonshoftmuseum.org/images/stories/News%20Releases/City%20of%20Dayton%20031210_aquifer-well%20field.pdf.

⁵Madison Farms, AR and ASR. Retrieved January 29, 2014 at <http://www.madisonfarms.com/index.php?page=24>

The National Ground Water Association and Its Members: A Tool for Policymakers

For additional information about groundwater and MARs, contact the National Ground Water Association (NGWA). NGWA is the largest association of groundwater professionals in the world. Our members include leading public and private sector groundwater scientists, engineers, water well contractors, manufacturers, and suppliers of groundwater-related products and services. NGWA provides guidance to members, government representatives, and the public regarding sound scientific, economic, and beneficial development, protection, and management of the world's groundwater resources.

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