



## Managed Aquifer Recharge (MAR): Case Studies in the Western U.S.

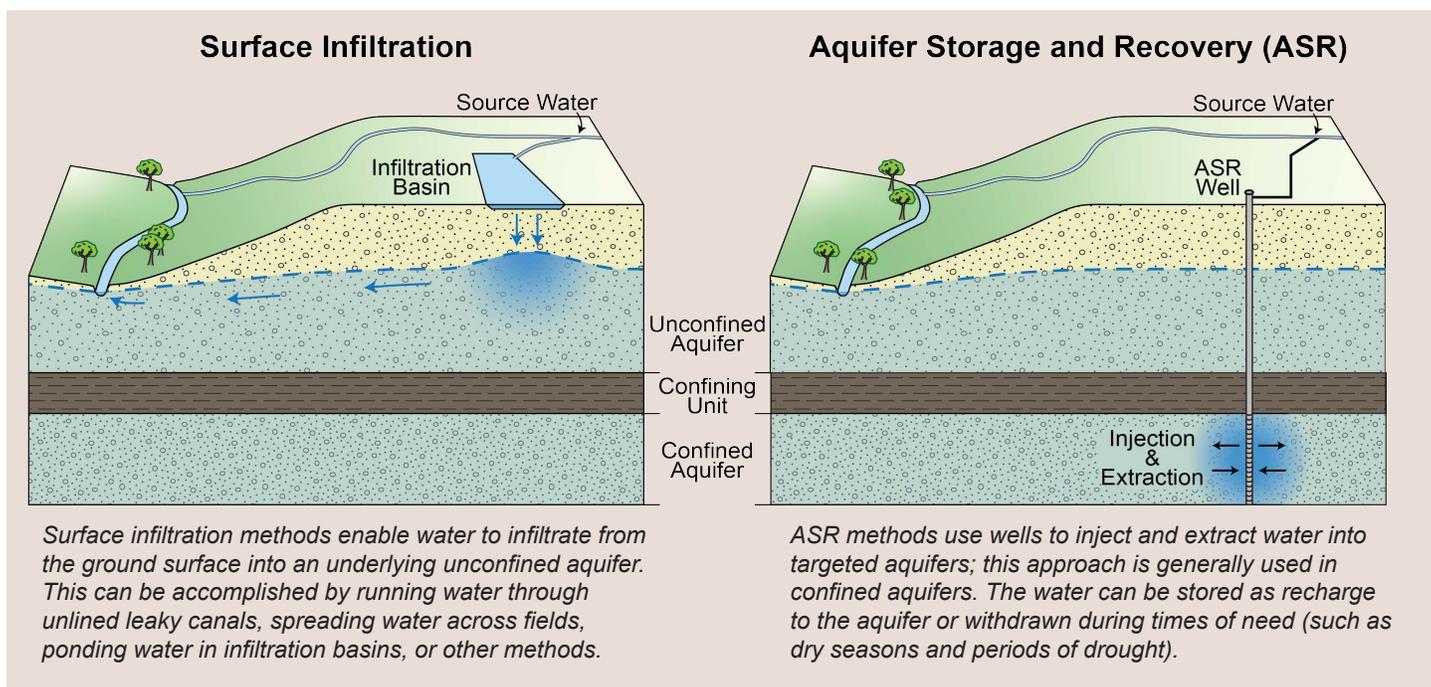
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### Introduction

Managed aquifer recharge (MAR) provides a means to supplement water supplies by intentionally recharging aquifers; it is a method to “slow water down” or store water with the intent of recovering it later during times of need or to achieve ecological benefit (NGWA, 2024; Parker and others, 2022). Globally and in more than half of the states, MAR projects help build drought resilience, offset declining water levels from over-pumping, supply municipal uses, stabilize stream flows, and improve water quality. The two primary approaches to MAR are surface infiltration and aquifer storage and recovery (ASR).



### Need for MAR in Montana

Much of Montana has a semi-arid climate, and drought is a recurring pattern. Montana has experienced drought in 20 of the past 21 years (Montana DNRC, 2023), underscoring its water-limited status. Declining snowpack and shifting climate patterns are reducing water supplies, while water demand continues to grow. Since 2000, Montana’s population has increased by approximately 26%, adding to the need for reliable water to support communities, agriculture, and local economies. At the same time, many surface-water sources are fully or over-appropriated, directly affecting groundwater levels because they are closely interconnected.

### Purpose

This fact sheet includes several examples of MAR projects from western states to show how MAR could be applied in Montana. These projects demonstrate practical, real-world ways communities have stored water underground during wet periods to recharge aquifers or for later use during dry times. By highlighting successful efforts in places with comparable climates and water challenges, we can better understand what options might fit Montana’s needs and help guide future planning and local decision-making.

## Agricultural MAR—Central Valley, California

California has experienced chronic groundwater declines due to agricultural over-pumping and drought. Although MAR began in the mid-20th century, it was not formally addressed until the 2014 passage of the Sustainable Groundwater Management Act. The Kings River MAR project is one of hundreds in the Central Valley, where groundwater levels have dropped by more than 3 feet per year (Jasechko and others, 2024).



During 2012 floods, surplus Kings River water was diverted at 2–22 cfs onto 1,000 acres of cropland growing tomatoes, wine grapes, pistachios, and alfalfa (Bachand and others, 2016).

### Successes:

- Over 3,000 acre-feet was diverted for groundwater recharge.
- Infiltration rates for the alfalfa field averaged 8 in/day.

### Challenges:

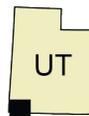
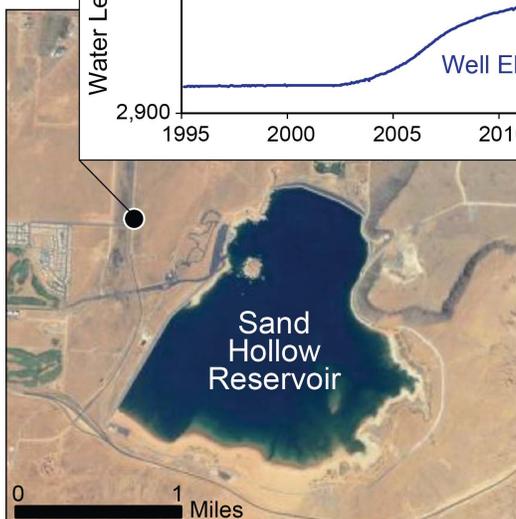
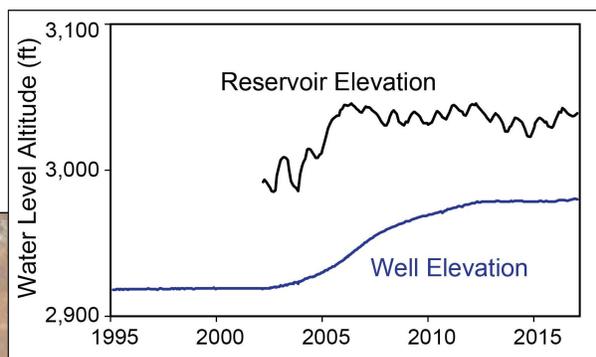
- Infiltrated water carried salts and nitrate into the groundwater.
- Application rate was limited by conveyance structure (diversion, pumps, pipe capacities).



Surplus surface water was diverted onto a tomato field for an Ag-MAR project. Photo by Bachand and others (2016; CC BY-NC-ND 4.0).

Costs to capture and apply water (covering labor, land preparation, fuel, and infrastructure) were \$36/acre-feet.

## Basin Infiltration for Municipal Water—Sand Hollow Reservoir, Utah



Utah, the second-driest state, is facing rapid population growth, drought, and irrigation demands—82% of its aquifers are currently in decline; MAR is being used to combat declining groundwater levels (Elbein, 2024).

The Sand Hollow Reservoir is one of over 20 MAR projects in Utah (Utah Division of Water Rights, 2026). Surface water from the Virgin River is piped to Sand Hollow Reservoir, a MAR facility that has operated since 2002 and infiltrates water into the underlying sandstone aquifer. Nearby municipal wells have withdrawn 37,000 acre-feet of native and recharged water (Marston and Nelson, 2018).

### Successes:

- Over 141,000 acre-feet has infiltrated the sandstone aquifer from 2002 to 2016.
- Wells near the reservoir show groundwater rises up to 80 feet.

### Challenges:

- Downgradient areas were saturated after dam construction, requiring drains.
- Evaporation losses can be 20 to 1,500 acre-feet per month.

Water has infiltrated from Sand Hollow Reservoir into the sandstone aquifer since 2002, increasing nearby groundwater elevations (adapted from Marston and Nelson, 2018).

## Aquifer Recharge with Multiple MAR Methods—Eastern Snake Plain, Idaho

One of the most productive groundwater sources in Idaho, the Eastern Snake Plain Aquifer, has seen steady declines of about 200,000 acre-feet per year since the 1950s due to groundwater use for irrigation, canal lining, conversion to more efficient irrigation methods (pivot versus flood), and recent droughts. MAR in the Eastern Snake Plain began in the 1970s. The Idaho Water Resources Board (IWRB) holds three water rights with the stated beneficial use of recharge. Recharge methods include spreading basins, infiltration through unlined canals, and injection wells. The IWRB pays a conveyance fee to canal owners for delivery of the water (Stewart-Maddox and others, 2018; Miller and others, 2021).



One 16.5-inch injection well can recharge 10.5 cfs to the aquifer (IWRB, 2024). Screenshot from IWRB outreach video (IWRB, 2018).

### Successes:

- Total MAR averages ~\$250,000 acre-feet per year since 2014.
- High degree of collaboration between the Idaho State Legislature, the IWRB, state departments, canal owners, and other stakeholders.

### Challenges:

- For some canals, the delivery capacity matches total irrigation rights, so water delivery to recharge locations cannot be guaranteed during the irrigation season.
- A contaminant survey found that Coliform and *E. coli* are present in canal water, but these bacteria attenuate quickly once underground.

Current cost of recharge (including all methods) is about \$20-40 per acre-feet (Idaho Water Resources Board, 2018, 2024).

## Aquifer Storage and Recovery—Las Vegas, Nevada

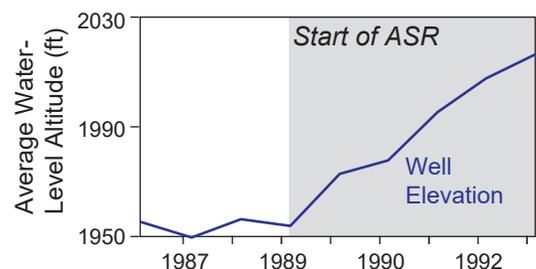
Nevada is the driest state, and 39% of its wells show declining water levels (Saito and others, 2025). Groundwater declines have triggered greater than 5 feet of subsidence in the Las Vegas valley sand and gravel aquifer system since 1912. Surface water from the Colorado River has been injected into the aquifer since 1987 as part of an aquifer storage and recovery system run by the Las Vegas Valley Water District (LVVWD; Pavelko and others, 1999; Pyne, 2005).

### Successes:

- Between 1987 and 2005, the water levels in the aquifer had recovered almost 100 feet in some areas.
- The LVVWD has expanded to 52 dedicated dual-purpose recharge and recovery wells, with additional injection- or extraction-only wells
- The LVVWD has the capacity to inject over 300 acre-feet per day.

### Challenges:

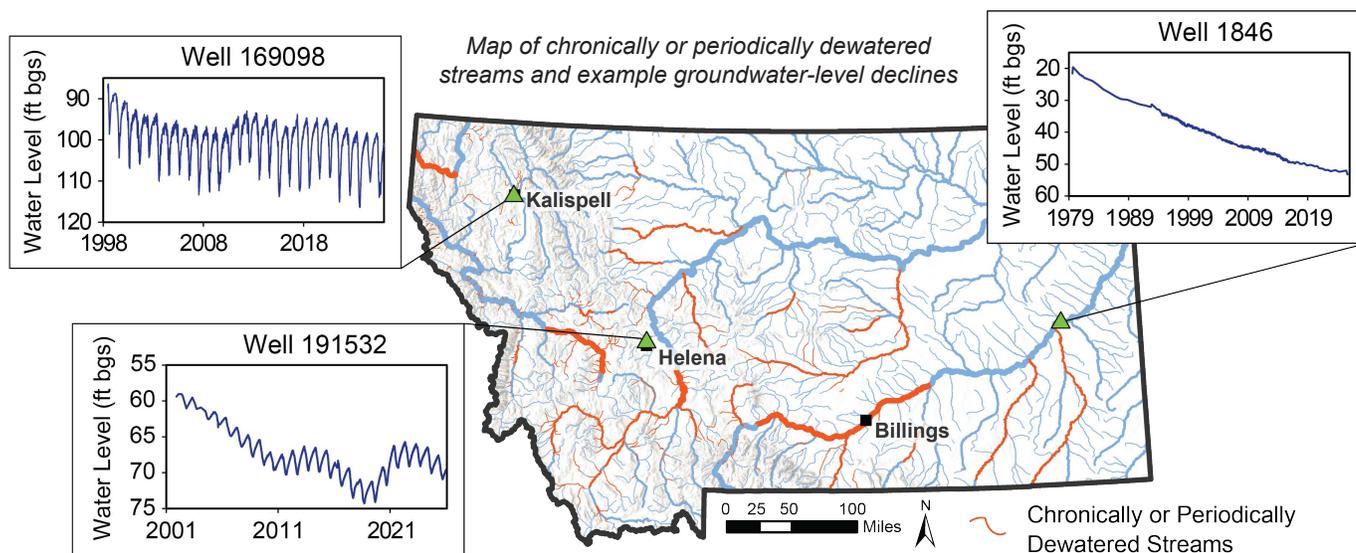
- Water must be disinfected before injection, causing disinfection byproducts that become diluted in the aquifer but still can require post-treatment when extracted.



Water levels pre- and post-ASR near the LVVWD main well field (top) and dual-purpose recharge and recovery well. Adapted from Pavelko and others (1999).

## MAR Potential in Montana

Groundwater declines are not widespread in Montana, but are occurring in localized areas. Montana also has streams that are chronically or periodically dewatered (Montana FWP, 2015). MAR could help augment water supplies in areas experiencing groundwater declines or rivers with diminished flow due to drought and stream withdrawals.



### Check out our recently published MAR suitability analyses for Montana:

- Managed Aquifer Recharge (MAR): An initial hydrogeologic screening for surface infiltration suitability in Montana: <https://doi.org/10.59691/SXSP1714>
- Evaluating the hydrogeologic potential for aquifer storage and recovery (ASR) in the deep aquifer of the Flathead Valley, northwest Montana: <https://doi.org/10.59691/YJBP7613>

### References\*

- Bachand, P., Roy, S., Stern, N., Choperena, J., Cameron, D., and Horwath, W., 2016, On-farm flood capture could reduce groundwater overdraft in Kings River Basin: *California Agriculture*, v. 70, no. 4, p. 200–207, <https://doi.org/10.3733/ca.2016a0018>
- Elbein, S., 2024, The 6 states facing the most serious groundwater crises: The Hill, Jan 26, 2024, available at <https://thehill.com/policy/equilibrium-sustainability/4429352-states-facing-most-serious-groundwater-crisis/>
- Idaho Water Resource Board (IWRB), 2018, Idaho's Managed Recharge Program works to restore the ESPA [Video]: YouTube, posted Jan 16, 2018, available at [https://www.youtube.com/watch?v=nEq\\_tKc5H58](https://www.youtube.com/watch?v=nEq_tKc5H58)
- Idaho Water Resource Board (IWRB), 2024, Aquifer Stabilization Committee meeting no. 1–24 materials: Idaho Department of Water Resources, Jan 18, 2024, available at <https://idwr.idaho.gov/wp-content/uploads/sites/2/iwr-b/2024/AquiferStabilizationCommitteeMeeting1-24MATERIALS.pdf>
- Jasechko, S., Seybold, H., Perrone, D., Fan, Y., Shamsudduha, M., Taylor, R.G., Fallatah, O., and Kirchner, J.W., 2024, Rapid groundwater decline and some cases of recovery in aquifers globally: *Nature*, v. 625, no. 7996, p. 715–721, <https://doi.org/10.1038/s41586-023-06879-8>
- Marston, T.M., and Nelson, N.C., 2018, Assessment of managed aquifer recharge at Sand Hollow Reservoir, Washington County, Utah, updated to conditions through 2016: U.S. Geological Survey Open-File Report 2018–1140, 38 p., <https://doi.org/10.3133/ofr20181140>
- Montana Department of Natural Resources and Conservation (Montana DNRC), 2023, Montana Drought Management Plan, available at <https://drought.mt.gov/montana-drought-management-plan>
- Montana Fish, Wildlife & Parks, 2015, Dewatered streams—Montana: GIS dataset, Montana FWP GIS Hub, available at [https://gis-mtftp.hub.arcgis.com/datasets/e0849312c41b415992a075f8696164c8\\_0](https://gis-mtftp.hub.arcgis.com/datasets/e0849312c41b415992a075f8696164c8_0)
- Miller, K., Goulden, P., Fritz, K., Kiparsky, M., Tracy, J., & Milman, A., 2021, Groundwater recharge to address integrated groundwater and surface waters: The ESPA recharge program, Eastern Snake Plain, Idaho: *Case Studies in the Environment*, v. 5, no. 1, 1223981, <https://doi.org/10.1525/cse.2020.1223981>
- National Ground Water Association (NGWA), 2024, Managed aquifer recharge (MAR) terminology, available at <https://www.ngwa.org/whatis-groundwater/groundwater-issues/managed-aquifer-recharge/mar-terminology> [Accessed May 2024].
- Parker, T.K., Alley, W.M., and Job, C.A., 2022, Managed Aquifer Recharge: A proven technology for water supply resilience: *Groundwater*, v. 60, no. 5, p. 577–578, <https://doi.org/10.1111/gwat.13222>
- Pavelko, M.T., Wood, D.B., and Laczniak, R.J., 1999, Las Vegas, Nevada, in Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., eds., *Land subsidence in the United States*: U.S. Geological Survey Circular 1182, p. 49–64, <https://doi.org/10.3133/cir1182>
- Pyne, R.D.G., 2005, *Aquifer storage recovery: A guide to groundwater recharge through wells*: Gainesville, Fla., ASR Systems LLC, 608 p.
- Saito, L., Byer, S., Munn, L., Badik, K., Provencher, L., McEvoy, D.J., and Rohde, M.M., 2025, Strategies to address risks to groundwater dependent ecosystems: *Hydrological Processes*, v. 39, no. 8, e70229, <https://doi.org/10.1002/hyp.70229>
- Stewart-Maddox, N., Thomas, P., Parham, W., and Wesley H., 2018, Restoring a world class aquifer: A brief history behind managed recharge and conjunctive management: *The Water Report*, July 15, 2018.
- Utah Division of Water Rights, 2026, Recharge and recovery (managed aquifer recharge) projects: Utah Department of Natural Resources, available at <https://www.waterrights.utah.gov/groundwater/asr/ASRlist.asp> [Accessed February 2026].

\*All online references accessed in March 2026 unless otherwise noted.

### About the MBMG

Established in 1919, the Montana Bureau of Mines and Geology (MBMG) continues to fulfill its mandate to collect and publish information on Montana's geology to promote orderly and responsible development of the energy, groundwater, and mineral resources of the State. A non-regulatory state agency, the MBMG provides extensive advisory, technical, and informational services on the State's geologic, mineral, energy, and water resources. The MBMG is increasingly involved in studies of the environmental impacts to land and water caused either by past practices in hard-rock mining or by current activities in agriculture and industry. The Montana Bureau of Mines and Geology is the principal source of Earth science information for the citizens of Montana. More information is available at [mbmg.mtech.edu](http://mbmg.mtech.edu).