Enhanced Aquifer Recharge Demonstration Project

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Aquifer Recharge
Aquifer Storage and Recovery

• *Artificial recharge* (AR) and *aquifer storage and recovery* (ASR) are processes that convey water underground. These processes replenish ground water stored in aquifers for beneficial purposes.

• Although the terms are often used interchangeably, they are separate processes with distinct objectives.
  
  – AR is used to replenish water in aquifers to achieve system management outcomes
  
  – ASR is used to store water which is later recovered for reuse, usually through the same injection/introduction point

https://www.epa.gov/uic/aquifer-recharge-and-aquifer-storage-and-recovery
Oklahoma Land Use Patterns

Surface Area, by Land Cover/Use, 2012

<table>
<thead>
<tr>
<th>Land Cover/Use</th>
<th>Area (acres)</th>
<th>Area (mi²)</th>
<th>% Total Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed</td>
<td>2,187,300</td>
<td>3,400</td>
<td>5%</td>
</tr>
<tr>
<td>Rural</td>
<td>40,267,800</td>
<td>63,000</td>
<td>95%</td>
</tr>
<tr>
<td>Total*</td>
<td>42,455,100</td>
<td>66,000</td>
<td>100%</td>
</tr>
</tbody>
</table>

*total non-Federal

U.S. Department of Agriculture.
2012 National Resources Inventory.
Enhanced Aquifer Recharge

• EAR is a rural landscape application of aquifer storage and recovery.

• However the main objective is not to store drinking water but to *enhance spring and base flow*, by capturing diffuse flow from the lands surface *during significant rainfall* events, and creating conditions that facilitate infiltration.

• This approach allow for water to be shifted from time of excess to increase availability during times of scarcity
Enhanced Aquifer Recharge (EAR) Concept

Figure 3: Comparison of discharge curves in native and EAR implemented system.

Conditions of excess:
Low value water

Conditions of scarcity:
High value water
Arbuckle-Simpson Aquifer
Pilot Study

Arbuckle-Simpson aquifer is the primary water supply for 100,000 people in southeastern Oklahoma.
Arbuckle-Simpson Aquifer
Pilot Study Area

- GWERD assisted the City of Ada with design and installation of a monitoring well network

- Purpose to *determine amount and impact of recharged water on groundwater quality*

- Collaborators: City of Ada, The Chickasaw Nation, East Central University and Oklahoma State University
Arbuckle-Simpson Aquifer

Pilot Study Area

Result: *Recharge Rate* ~ 1,400 gallons per minute
Impact: > 8 million gallons added to aquifer
Aquifer Storage & Recovery

Project Research Topics

Water Quality

• Geochemical changes in aquifer
• Fate and transport of pathogens or contaminants

Water Quantity

• Recharge rate and volume
Figure 12: Distribution of significant rainfall events in project region.
Figure 9: Potential locations for series recharge structures in run-off basin around EAR demonstration site.
Figure 10: Basic weir design for series recharge structures.
**Benefit/Cost**

Serial retention/recharge structure approach

<table>
<thead>
<tr>
<th>Valuation Source</th>
<th>High estimate(^3)</th>
<th>Low estimate(^4)</th>
<th>Const. Estimate High(^5)</th>
<th>Const. Estimate Low(^6)</th>
<th>Ratio Worst Case(^7)</th>
<th>Ratio Best Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Rights</td>
<td>$2,250,000</td>
<td>$1,125,000</td>
<td>$320,000</td>
<td>$160,000</td>
<td>3.52</td>
<td>14.06</td>
</tr>
<tr>
<td>Raw water(^1)</td>
<td>$963,330/ year</td>
<td>$481,665/ year</td>
<td>$320,000</td>
<td>$160,000</td>
<td>30.1</td>
<td>120.4</td>
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<tr>
<td>Raw Water(^2)</td>
<td>$93,594/y year</td>
<td>$46,797/y year</td>
<td>$320,000</td>
<td>$160,000</td>
<td>2.96</td>
<td>11.7</td>
</tr>
</tbody>
</table>

\(^*\) 20 Recharge Structures, 5 or 2.5 ac-ft per event, 15 (1” to 4”) events per year

\(^1\) Based on highest published raw water rates

\(^2\) Based on lowest publish raw water rate

\(^3\) 100% infiltration efficiency of captured water

\(^4\) 50% capture efficiency of captured water

\(^5\) 20 Units, $16,000/each, construction cost

\(^6\) 20 Units, $8,000/each, construction cost

\(^7\) 20 year lifetime, assumes no increase in water rates/price, and available substitutable resources
Current Status

• LS-ASR permit application in preparation
• Working with partners to secure additional EAR/flood control project funding
• EAR demonstration project underway
  – Geochemical monitoring
  – Chemical and biological fate and transport studies
  – Recharge rates and volumes
• Multi-agency ASA II project underway
Project Technical Team

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