Effects of experimental passive artificial recharge of treated surface water on water quality in the *Equus* Beds aquifer, 2009-2010

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Report available at:
Wichita Aquifer Storage and Recovery (ASR) Project, Phase 1

Recharge through 4 injection wells and 2 recharge basins

- To replenish the water in the Equus Beds aquifer
- To establish a hydraulic barrier to a known brine plume upgradient of public water supply wells

Role of the USGS

- Monitor water quality in the Equus Beds aquifer and assess changes that may occur as a result of ASR.
Recharge Basin 1 History

- Originally designed as a recharge basin.
- Unexpected slow water infiltration rate during testing in 2007 and 2008 prompted Wichita to install an experimental passive gravity recharge well for testing.
- One passive gravity recharge well was tested in Recharge Basin 1 (RB1)
Passive artificial recharge well and trench system installed at RB1.
Questions

- Did the passive recharge well increase recharge so that the migration of a chloride-brine plume was slowed?
- Did the passive recharge system effectively remove atrazine and microbes from the surface water before it entered the aquifer?
- Is there potential for changes in the aquifer’s geochemistry and microbial population resulting from the introduction of oxygenated surface water?
RB1 test sampling locations

EXPLANATION
- U.S. Geological Survey monitoring well and site identifier
Measurements

- Collected at river, after treatment, after flow through the trench (TR), at recharge well (P well), and at four pairs of monitoring wells.
  - Discrete samples collected at sites before, during and after artificial recharge
  - Continuous monitors at 8 locations

- Data collected include:
  - Water level altitude
  - Physical properties: specific conductance, pH, water temperature, dissolved oxygen
  - Water chemistry: major ions, trace elements, atrazine
  - Bacterial and viral indicator organisms
## Data Collection Sites

<table>
<thead>
<tr>
<th>Data-collection site</th>
<th>Measurement type</th>
<th>Approximate well depth (feet)</th>
<th>Depth of screened interval (feet)</th>
<th>Approximate depth of continuous measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>07143672, Little Arkansas River at Highway 50 near Halstead, Kansas</td>
<td>C, D</td>
<td>NA</td>
<td>NA</td>
<td>-</td>
</tr>
<tr>
<td>RB1 Source Water</td>
<td>D</td>
<td>NA</td>
<td>NA</td>
<td>-</td>
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<tr>
<td>Trench</td>
<td>C, D</td>
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<td>NA</td>
<td>2</td>
</tr>
<tr>
<td>P Shallow</td>
<td>C, D</td>
<td>253</td>
<td>20-233</td>
<td>50</td>
</tr>
<tr>
<td>P Deep</td>
<td>C, D</td>
<td>253</td>
<td>20-233</td>
<td>170</td>
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<tr>
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<td>C, D</td>
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<td>20-80</td>
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<td>247</td>
<td>20-243</td>
<td>170</td>
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<tr>
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<td>240-260</td>
<td>170</td>
</tr>
<tr>
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<td>50-60</td>
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<tr>
<td>MN Deep</td>
<td>D</td>
<td>253</td>
<td>233-253</td>
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<tr>
<td>IW-09A</td>
<td>D</td>
<td>53</td>
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<tr>
<td>IW-09C</td>
<td>D</td>
<td>255</td>
<td>233-253</td>
<td>-</td>
</tr>
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</table>
Passive recharge well test at RB1.

Overview--Water from the Little Arkansas River is treated and then recharged at RB1 through a passive recharge well and trench to increase recharge rate.

- The passive well and trench system and two monitoring wells were installed December 2008.
- Passive artificial recharge occurred in April 2009. 576,000 gallons (~1.77 acre-ft) were recharged.
- Artificial recharge was halted on April 30, 2009 because of increased detections of coliform bacteria in the aquifer.
- The trench was disconnected from the passive recharge well on July 9, 2009.
Water was continuously pumped out of the aquifer at RB1 from 7/7/09 to 7/21/09 and again from 8/11/09 to 8/14/2009.

A total of about 1,825,000 gallons (5.6 acre-ft) were extracted.

There were detections of bacteria and viral indicators in RB1 wells during water withdrawal.

Additional groundwater samples were collected from RB1 monitoring wells in November 2009 and March 2010.

Final samples collected had no detections of bacteria or viral indicators.
Total Coliform Detections
Total Coliform Detections

Artificial recharge

Water withdrawal

RB1-TR
RB1-P shallow
RB1-P deep
RB1-PMS shallow
RB1-PMS deep
RB1-MS shallow
RB1-MS deep
RB1-MN deep
IW-09 shallow
IW-09 deep
Quantity of water recharged

- RB1 Original Basin Configuration
  - Recharge was slow, less than 10.8 gallons per day per square foot.
- RB1 with Passive Recharge Well Installed
  - Recharge was approximately 19.2 gallons per day per square foot
  - Recharge was increased approximately 78 percent (per unit area) by the installation of the passive recharge well.
Water level altitudes from continuous monitors
Atrazine detections

![Graph showing atrazine concentrations over time, with annotations for artificial recharge and water withdrawal. The graph includes a line indicating the U.S. Environmental Protection Agency's Maximum Contaminant Level for atrazine (3 µg/L).]
Turbidity increase in wells signals the possibility of bacterial contamination.
Conclusions

- The passive recharge well and trench system increased artificial recharge by about 78 percent per unit area.
- Populations of viral and bacterial indicator organisms increased in RB1 wells during and immediately after artificial recharge through the passive well and trench system.
- After water withdrawal, bacterial and viral indicator densities returned to pre-recharge values.
- Continuous monitors (turbidity) may provide early warning that undesirable bacteria are present.
- Continuous monitors (water level) can provide information about the hydraulic barrier to the brine plume.