Topics

- Overview of KBH Desalination Plant
- Concentrate Disposal Alternatives
- Site Characterization
- Injection Well Construction
- Regulatory Compliance
- Project and Permitting Costs
- Future Plans
Concentrate Disposal Alternatives

- Passive Evaporation
- Enhanced Evaporation
- Deep Well Injection
Injection Well Timeline

- McGregor Range Geothermal Study (1997)
- Initial Disposal Site Studies (2002)
- Test holes, pilot well, and geophysical studies (2003-4)
- Class V – Authorization by Rule Application Submitted (3/2005)
- Class V-Authorization Approved (up to 5 wells) (7/2005)
- Desalination Plant start-up (9/2007)
- Aquifer Exemption -2012
Site Characterization

- Timeline of injection well activities.
- Identify suitable geologic conditions for deep well injection.
- Storage, containment, permeability, water quality
Groundwater in the injection zone is under artesian pressure. Static water level in the injection zone is 500 feet beneath ground surface.
EPA Injection Well Classification

- **Class I** – Inject hazardous waste below an Underground Source of Drinking Water (USDW)
- **Class II** – Dispose of fluids associated with the production of oil and natural gas. Inject fluids for enhanced oil recovery.
- **Class III** – Inject fluids for the extraction of minerals
- **Class IV** – Inject waste above a USDW and radioactive waste (banned)
- **Class V** – Wells not included in the other classes.
  - Includes wells that inject non-hazardous fluids into a USDW
  - TDS less than 10,000 mg/l
Injection Well Construction

- Class I Standards
- Well 3 (2006) – 4,030 ft deep
- Well 2 (2007) – 3,720 ft deep
Injection Well Construction

- Cementing technique
- Purpose
- Cement Bond Log
- Challenges
9-5/8" Casing

Seal Assembly and Packer

Open-Hole Interval to ~ 4,000 feet.

Injection Tubing 7"

13 3/8" Surface Casing
Injection Well Summary

- Depth to Water (Static) ~ 500 ft
- Injection Capacity 1,400 to 2,000 gpm
- Depth to Water (Injection) > 350 ft
- Formation Water TDS ~ 8,800 mg/l
- Bottom Hole Temperature ~ 160°F
Regulatory Concepts

- Injection Zone considered an Underground Source of Drinking Water (USDW) <10,000 mg/l total dissolved solids
- Safe Drinking Water Act (SDWA) prohibits injection which endangers an underground source of drinking water.
- Aquifer Exemption
Compliance Testing Of Injection Wells

- Mechanical Integrity Test (MIT) verifies the wells containment of the fluid being injected and that the injection provides no path for contamination of underground source of drinking water (USDW)
  - Annulus Pressure Test (APT)
  - Radioactive Tracer Survey (RTS)
  - Differential Temperature Survey (DTS)

- Pressure Fall-Off Test
Injection Well Repair

- Both wells failed their MITs and required extensive testing and analysis to locate leaks.
- A micro-vertilog was performed to ascertain the casing condition and the resulting data sent out for analysis and interpretation.
- Both wells suffered failure at generally the same geologic zone and from corrosion of the exterior of the casing that was exposed to the naturally occurring groundwater.
- A plan was submitted to the TCEQ Executive Director for approval and guidance.
Injection Well Liner

- TCEQ Executive Director approved the use of a liner for repair of the injection well.

- A liner was installed and cemented from just below the identified leak to a point inside the surface casing.

- A MIT was performed to verify adequacy of repair

- TCEQ Executive Director specified a series of annual MITs to verify adequacy of repair.
Original 9-5/8" Casing
with Leaks

13 3/8" Surface Casing

Injection Tubing 7" and 5"

7-5/8" Liner Cemented in Place

New Seal Assembly and Packer
Old Packer

Open-Hole Interval to ~ 4,000 feet.
## Project Costs

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Injection wells</td>
<td>$6.5 Million</td>
</tr>
<tr>
<td>Surface Injection Facilities</td>
<td>$4.9 Million</td>
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<tr>
<td>Downhole Equipping</td>
<td>$1.0 Million</td>
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<tr>
<td>Concentrate Pipeline</td>
<td>$7.0 Million</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>$18 Million</strong></td>
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Future Injection Wells

- Additional injection capacity needed for plant expansion.
- Injection well site selection will consider groundwater modeling, subsurface geology, and coordination with US Army.
- Evaluating options for well construction materials and construction techniques
Questions?
Surface Injection Facilities