TWO DECADES OF ARTIFICIAL RECHARGE IN LAS VEGAS VALLEY: HOW FAR HAVE WE COME?

Las Vegas Valley Water District
and
Southern Nevada Water Authority
David J. Donovan
2010 Arizona Hydrological Society Symposium
Acknowledgments

- Current and previous staff of LVVWD and SNWA especially:
  - Bruce Wert
  - Joe Leising
  - Gavin Kistinger
  - Terry Katzer
  - Kay Brothers

*note typo in abstract*
Purpose and Scope

• Examples of wells effected by climate variability inside Las Vegas Valley

• Summary of Las Vegas Valley Hydrology

• Examples of wells effected operational changes inside of Las Vegas Valley

• Monitoring, management, and planning
Artificial Recharge in Las Vegas Valley

• Artificial recharge (AR) is the process of designed (as opposed to natural) replenishment of groundwater storage through saturated or unsaturated geologic materials

• The Las Vegas Valley Water District has operated an AR aquifer recharge, storage, and recovery (production) program since 1987
  – Over 90 % was recharged though District Facilities
Nevada’s Colorado River rights

- Nevada’s consumptive use water right is 2% of all water rights on Colorado River
- All rights = 16.5 Mafy
- Nevada = 0.3 Mafy (3.7×10^8 m³)
History (Late 20th Century and 2000’s)

- Initial Investigations for Cooperative Water Project
- 1987 - SNWS provides source water for Artificial Recharge (AR) in Las Vegas Valley
- Formation of SNWA
- Conservation Goals and Tiered Water Rate Structure
- Formation of Ground Water Management Program Survey
- Valley-wide Groundwater Level Monitoring
- Periodic and Ongoing Geochemical Studies
Water in the Las Vegas Valley

- Nevada is the driest state in the U. S. The L.V. Valley floor receives 10 cm average annual precipitation; mountain areas may receive 66 cm per year (snow)

- There are no natural rivers in the Las Vegas Valley

- Approx. 90% of water supply comes from Colorado River via Lake Mead
  - The Colorado River is shared by 7 States, 10 Native American Tribes and the Republic of Mexico
  - Nevada uses all of its 300,000 acre-feet consumptive use Colorado River water allocation

- Approx. 10% of water supply comes from groundwater
Water Resources Planning

- Described in SNWA Resource Plan Along With A History of Past Resources and Future Probable Resources

Historic Water Resources for Las Vegas Valley

Note: Available water resources are legally defined and determined annually.

- Imports From Lake Mead
- Well Production
- Spring flow

Start of GW Production
BMI Diversion
SNWS Stage I and Revocation of temporary GW Permits
SNWS Stage II

Date

Water resources, in acre feet
0 100,000 200,000 300,000 400,000 500,000 600,000
Las Vegas Valley Groundwater Hydrology

- A small percentage of total supply
- In the central part of the valley, water level changes are large and strongly associated with anthropogenic activities
- Water level changes, however, are ultimately controlled by long term natural recharge volumes and permeability differences
- Water level rises were observed prior to the initiation of artificial recharge activities
Las Vegas Hydrographic Basin

- 1500 miles$^2$ (3,885 km$^2$)
- Altitudes range from approximately 12,000 feet (3,650 m) to 1,500 feet (450 m) above sea level
- Structurally formed alluvial-filled basin
- Alluvium thick ranges from approximately 1,000 feet (300 m) to greater than 5,000 feet (1,525 m) thick
- Natural recharge to basin estimated to be at least 35,000 acre-feet ($43 \times 10^6$ m$^3$) per year. Could be as much as 57,000 acre-feet ($70 \times 10^6$ m$^3$) per year
Las Vegas Hydrographic Basin

LVVWD (2004)
Generalized Geologic Map
Operational Changes / Observations

- Long term shift in production (South)
- Long term reduction in production (N-Central)
- Intentional shift west (West-Central)
- New production areas and identification of production vs climate variation effects (North-West)
- Water level rises, in all cases, are better described as a response to natural recharge
Additional Observations

• Historical subsidence occurred offset of major production center
  – Partly controlled by geologic variations

• Current water level rise is largest at major production / AR center, however, more areally extensive
  – Combination of reduced pumping stresses and natural recharge
Key Points

• Aquifer response (water levels changes) are primarily determined by the natural plumbing of the hydrogeological system (sources, sinks and flow paths).

• The most accurate way to determine these factors is by careful analysis of the operational changes
Implications

- AR has nearly the same effect as reduced production and In-Lieu recharge has been legally recognized, under specified conditions, since 2004
Las Vegas Hydrographic Basin

- 1500 miles$^2$ (3,885 km$^2$)
- Elevations range from 12,000 feet (3,658 m) to 1,500 feet (457 m) above sea level
- Structurally formed alluvial-filled basin
- Alluvial thickness from 0 feet (0 m) to ~15,000 feet (5,000 m) thick
- Natural recharge to the aquifer is estimated to be at least 35,000 acre-feet per year. The best estimate is about 50,000 acre-feet per year
Las Vegas Hydrographic Basin
Las Vegas Valley Geologic Cross-Section

- Spring Mts.
- Water flow
- Water table
- Sands and gravel
- Springs
- Faults (arrow indicates direction of relative movement)
- Las Vegas Wash
- Silt and clay
- Bedrock
Generalized Surface Geologic Map of the Las Vegas Hydrographic Basin
Location of LVVWD wells used for artificial recharge and groundwater production

Dedicated AR Wells
Dual Use Wells
Production Wells
Very simplified diagram of the ground-water system in the central part of Las Vegas Valley.
Primary Alluvial Aquifer

- Semi-consolidated interbedded sands and gravels
- Transmissivity between 6,000 to 300,000 gallons per day per foot
- Storativity between $10^{-4}$ to $10^{-8}$
- Porosity between 10 to 20 percent
- Ground-water gradient from the northwest to the southeast
- Most productive zone from 200 to 750 feet (68 to 255 m) below land surface
Artesian wells in the Las Vegas Valley

1912

1998
Historical Water Level Changes

• Generally declining water levels prior to 1990
• Resulted in a large decline west of main well field (Location of Wells 1-17)
• Water levels after 1990 are rising in the same area as the historic decline
• Maps and hydrographs provided
Change in Water Levels 1912-1990

Donovan (1997)

Contour Interval=10 ft
Blue=rise
Red=decline
Change in water levels
October 1990 to October 1995

1990 - 1995

Generalized bedrock geology of Las Vegas Valley, from Plume (1984)
1990 - 2000

Figure 4. -- Water level change Fall 1990 to Fall 2000, in feet (water level decline, negative: water level rise, positive).
Figure 3. Change in potentiometric surface of the principal aquifer, Fall 1990 to Fall 2004

Figure 3: Change in potentiometric surface of the principal aquifer, Fall 1990 to Fall 2005
1990 - 2007

Contour Interval = 10 ft
Green = rise
Red = decline

Figure 3: Change in Potentiometric Surface of the Principal Aquifer, Fall 1990 to Fall 2007
Change in Potentiometric Surface of the Las Vegas Valley Aquifer Fall 1990 – Fall 2009

Contour Interval=10 ft.
Generalized Surface Geologic Map of the Las Vegas Hydrographic Basin
Kyle Hydrograph

ECHO 3 Well (2000 to 2009) Transducer (1 Hour) Water Level and Precipitation Data

- Transducer Water Level Data
- Physical WL
- LV-Ave-Monthly Precipitation Data
- Kyle RAWS Monthly Precipitation Data
- Kyle RAWS Daily Precipitation

Depth to water level, in feet

Date

Precipitation, in inches

Land Surface
Location of Index Wells

Green Dots

10 ft Contour Interval
Water Levels in Las Vegas Valley at Selected Wells (1940-2010)

Minimum Altitude in Las Vegas Valley is ~ 1,500 feet above mean sea level
Water Levels in Las Vegas Valley at Selected Wells (1990-2010)
Operation Change Since 2000
Production and AR through Time (District)
Production (Brown) AR (Lt Blue)
Production and AR through Time (District)
Main or North WF
Other District Wells

Production (Pink)
AR (Blue)
Location / Volume of AR though Time

AR
1987-1995 (Blue)
2005-2009 (Tan)
Water Levels in Las Vegas Valley at Selected Wells (1990-2010)
Location of Index Wells

Green Dots

10 ft Contour Interval
Water Levels in Las Vegas Valley at Selected Wells (1940-2010)

Minimum Altitude in Las Vegas Valley is ~ 1,500 feet above mean sea level
Non District Operations
Location of LVVWD wells used for artificial recharge and groundwater production

Dedicated AR Wells
Dual Use Wells
Production Wells
Groundwater Production in Las Vegas Valley (1900 to 2009)
Figure 2. Total ground-water pumpage in Las Vegas Valley, by type of pumper, 1956 to 2009.
Groundwater Production by North Las Vegas since 1956

Year

Production, in acre-feet per year


Page 1
District wells and water level rise
District wells and water level rise

Other Areas (preliminary boundaries)
Water Levels in Las Vegas Valley at Selected Wells (1940-2010)

Minimum Altitude in Las Vegas Valley is ~1,500 feet above mean sea level.
Water Levels in Las Vegas Valley at Selected Wells (1940-2010)

Minimum Altitude in Las Vegas Valley is ~ 1,500 feet above mean sea level

Month-Year
Subsidence
Subsidence indicated from interferograms: April 1992 to December 1997 (Amelung et al, 1999)
Subsidence at Well 5 in the Main Well Field

4 to 5 feet of land surface depression

LVVWD Well #5

Circ. 1990
PInSar
1996-2000
2000-2005
Bell and others, 2008
Subsidence
2002 - 2004
Bell and Arai (2009)

Figure 3b. Interferogram for northwest portion of Las Vegas Valley covering the time period 10/25/2002 to 12/3/2004. The Northwest and North Las Vegas subsidence bowls each show one full fringe (2.5 cm) of subsidence. An area of water level rise near the intersection of SR 157 and US 95 shows a possible partial up fringes signal (blue area), but this may be an atmospheric artifact. Monitoring wells shown by green circles.
Subsidence 2006 - 2007
Bell and Arai (2009)

Figure 3d. Interferogram for northwest portion of Las Vegas Valley covering the time period 3/8/2006 to 4/27/2007. Subsidence rate has significantly decreased compared to earlier years. The Northwest subsidence bowl shows only a partial fringe (1-2 cm), and the North Las Vegas bowl shows a partial up fringe. The area of water level rise shows no visible signal. Monitoring wells shown by green circles.
Las Vegas Valley Subsidence

• Historic Changes Described by:
  – Bell (1981)
  – Bell et al. (1991)
  – Amelung et al. (1999)
  – Bell et al. (2008)
  – Donovan et al. (2008)

• Recent publications show strong links with the underlying geologic variations, introduction of new remote sensing techniques, and general slowing and reversal of historic trends
Additional Quantitative Analysis

- Snow Mountain Agreement
  - Beginning 2001
- “In-Lieu”
  - Beginning 2004
Monthly Volumes of Artificial Recharge Water 1987 - 2009

Annual Totals
Artificial Recharge Volume (through December 31, 2009) = 353,004 acre-feet
Table of LVVWD Groundwater Production and Artificial Recharge 1987 - 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>LVVWD Colorado River Water Recharged</th>
<th>LVVWD In-Lieu Recharge Recoverable</th>
<th>LVVWD In-Lieu Recharge Unrecoverable</th>
<th>LVVWD In-Lieu Recharge Total</th>
<th>LVVWD Well Production</th>
<th>LVVWD Groundwater Rights</th>
<th>LVVWD Groundwater Recovery</th>
<th>LVVPT Groundwater Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>37,145</td>
<td>39,682</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1988</td>
<td>1,153</td>
<td>0</td>
<td>0</td>
<td>1,153</td>
<td>37,096</td>
<td>39,772</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1989</td>
<td>3,676</td>
<td>0</td>
<td>0</td>
<td>3,676</td>
<td>34,025</td>
<td>39,890</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1990</td>
<td>10,389</td>
<td>0</td>
<td>0</td>
<td>10,389</td>
<td>33,925</td>
<td>39,920</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1991</td>
<td>14,621</td>
<td>0</td>
<td>0</td>
<td>14,621</td>
<td>36,653</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1992</td>
<td>15,616</td>
<td>0</td>
<td>0</td>
<td>15,616</td>
<td>39,937</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>23,868</td>
<td>0</td>
<td>0</td>
<td>23,868</td>
<td>35,647</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1994</td>
<td>20,120</td>
<td>0</td>
<td>0</td>
<td>20,120</td>
<td>37,907</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>16,661</td>
<td>0</td>
<td>0</td>
<td>16,661</td>
<td>42,720</td>
<td>40,247</td>
<td>2,473</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>12,005</td>
<td>0</td>
<td>0</td>
<td>12,005</td>
<td>41,543</td>
<td>39,947</td>
<td>1,596</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>17,791</td>
<td>0</td>
<td>0</td>
<td>17,791</td>
<td>40,316</td>
<td>40,152</td>
<td>164</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>27,146</td>
<td>0</td>
<td>0</td>
<td>27,146</td>
<td>39,857</td>
<td>40,126</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>32,061</td>
<td>0</td>
<td>0</td>
<td>32,061</td>
<td>39,028</td>
<td>40,126</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>29,721</td>
<td>0</td>
<td>0</td>
<td>29,721</td>
<td>38,255</td>
<td>40,126</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>21,269</td>
<td>0</td>
<td>0</td>
<td>21,269</td>
<td>40,620</td>
<td>40,126</td>
<td>494</td>
<td>1,205</td>
</tr>
<tr>
<td>2002</td>
<td>2,255</td>
<td>0</td>
<td>0</td>
<td>2,255</td>
<td>41,218</td>
<td>40,126</td>
<td>1,092</td>
<td>1,178</td>
</tr>
<tr>
<td>2003</td>
<td>28,540</td>
<td>0</td>
<td>0</td>
<td>28,540</td>
<td>40,127</td>
<td>40,126</td>
<td>1</td>
<td>985</td>
</tr>
<tr>
<td>2004</td>
<td>17,116</td>
<td>0</td>
<td>0</td>
<td>17,116</td>
<td>40,877</td>
<td>40,612</td>
<td>265</td>
<td>664</td>
</tr>
<tr>
<td>2005</td>
<td>15,867</td>
<td>7,621</td>
<td>1,345</td>
<td>8,966</td>
<td>31,661</td>
<td>40,626</td>
<td>0</td>
<td>572</td>
</tr>
<tr>
<td>2006</td>
<td>19,976</td>
<td>4,064</td>
<td>717</td>
<td>4,781</td>
<td>35,845</td>
<td>40,626</td>
<td>0</td>
<td>815</td>
</tr>
<tr>
<td>2007</td>
<td>18,015</td>
<td>0</td>
<td>0</td>
<td>18,015</td>
<td>40,932</td>
<td>40,629</td>
<td>303</td>
<td>923</td>
</tr>
<tr>
<td>2008</td>
<td>5,045</td>
<td>0</td>
<td>0</td>
<td>5,045</td>
<td>40,671</td>
<td>40,629</td>
<td>42</td>
<td>809</td>
</tr>
<tr>
<td>2009</td>
<td>91</td>
<td>0</td>
<td>0</td>
<td>91</td>
<td>40,640</td>
<td>40,629</td>
<td>11</td>
<td>614</td>
</tr>
</tbody>
</table>

Total Artificial Recharge: 353,004

Totals: 886,645

Net Recoverable AR Storage: 350,483

Groundwater Recovery: 7,765
<table>
<thead>
<tr>
<th>Year</th>
<th>LVWD Colorado River Water是最好的</th>
<th>LVWD In-Lieu Recharge Recoverable</th>
<th>LVWD In-Lieu Recharge Unrecoverable</th>
<th>LVWD Total</th>
<th>NLV Colorado River Water Recharged</th>
<th>NLV In-Lieu Recharge Total</th>
<th>NLV Well Production</th>
<th>LVWD Well Production</th>
<th>LVWD Groundwater Rights</th>
<th>LVWD Groundwater Recovery</th>
<th>LVWD Groundwater Recovery</th>
<th>NVPT Groundwater Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>37,145</td>
<td>36,882</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1988</td>
<td>1,153</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>37,095</td>
<td>39,772</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1989</td>
<td>3,876</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>34,025</td>
<td>38,890</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1990</td>
<td>10,389</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33,925</td>
<td>39,920</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1991</td>
<td>14,621</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>43,124</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1992</td>
<td>15,616</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>43,937</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>23,868</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>35,647</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1994</td>
<td>20,120</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>37,907</td>
<td>40,314</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1995</td>
<td>16,681</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33,457</td>
<td>40,247</td>
<td>0</td>
<td>2,473</td>
<td>0</td>
</tr>
<tr>
<td>1996</td>
<td>12,005</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>39,947</td>
<td>39,947</td>
<td>0</td>
<td>1,596</td>
<td>0</td>
</tr>
<tr>
<td>1997</td>
<td>17,791</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,152</td>
<td>40,152</td>
<td>0</td>
<td>164</td>
<td>0</td>
</tr>
<tr>
<td>1998</td>
<td>23,416</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,126</td>
<td>40,126</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1999</td>
<td>32,061</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,028</td>
<td>40,028</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2000</td>
<td>29,721</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,126</td>
<td>40,126</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2001</td>
<td>21,269</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,620</td>
<td>40,620</td>
<td>0</td>
<td>494</td>
<td>1,205</td>
</tr>
<tr>
<td>2002</td>
<td>2,256</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>41,218</td>
<td>40,126</td>
<td>1,092</td>
<td>1,178</td>
<td>0</td>
</tr>
<tr>
<td>2003</td>
<td>28,540</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,126</td>
<td>40,126</td>
<td>0</td>
<td>985</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>17,116</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,877</td>
<td>40,612</td>
<td>0</td>
<td>265</td>
<td>664</td>
</tr>
<tr>
<td>2005</td>
<td>15,867</td>
<td>7,621</td>
<td>1,345</td>
<td>8,966</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>31,661</td>
<td>40,626</td>
<td>0</td>
<td>0</td>
<td>572</td>
</tr>
<tr>
<td>2006</td>
<td>19,976</td>
<td>4,064</td>
<td>717</td>
<td>4,781</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>35,845</td>
<td>40,626</td>
<td>0</td>
<td>0</td>
<td>815</td>
</tr>
<tr>
<td>2007</td>
<td>18,015</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,932</td>
<td>40,629</td>
<td>303</td>
<td>923</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>5,045</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,671</td>
<td>40,629</td>
<td>42</td>
<td>809</td>
<td>0</td>
</tr>
<tr>
<td>2009</td>
<td>91</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40,640</td>
<td>40,629</td>
<td>11</td>
<td>614</td>
<td>0</td>
</tr>
</tbody>
</table>

Total Artificial Recharge:

Totals: 353,004, 11,685, 2,062, 13,747, 11,843, 21,109, 73,983, 886,645, 6,441, 7,785

Net Recoverable AR Storage: 350,483

NOTES:
All volumes in acre-feet (af), +/- 1 af due to rounding
Yearly groundwater rights reflect revisions per Las Vegas Basin Adjudication (1999)
Las Vegas Paiute Tribe's temporary recovery of LVWD-recharged water began in 2001
LVWD Total Colorado River Water Artificial Recharge
Net Recoverable AR Storage = Total LVWD CRW Recharged + LVWD In-Lieu Recharge Recoverable - LVWD Recovery - LVPT Recovery
Location of LVVWD wells used for artificial recharge and groundwater production

Dedicated AR Wells
Dual Use Wells
Production Wells
Effects of Artificial Recharge in the Las Vegas Valley

- Static Water Levels rising in the primary aquifer
  - Observed 10 to 100 feet rise in vicinity of AR
- Water Levels have been influenced throughout most of the Las Vegas Springs Aquifer
- Injected approx. 12,000 to 32,000 acre feet per recharge season since 1991, lesser amounts in recent years
- Banked 353,004 acre feet Net Volume of water through December 31, 2009
Change in Potentiometric Surface of the Las Vegas Valley Aquifer
Fall 1990 – Fall 2009

Contour Interval=10 ft.
Benefits of Artificial Recharge

- Provide an emergency supply in case of drought or a water facility failure
- Help meet summer peak demands and “bridge the gap” until future water resources become available
- Reduced pumping (electrical) cost
- Reverse declining water level trends (approximately 1/3 recovered)
- Minimize land subsidence and fissuring
Geochemical Considerations For Artificial Recharge

- Suspended solids in injectate
- Microorganisms and biofouling
- Ion exchange and adsorption – clay mineralogy
- Reduction/oxidation processes
- Carbonate precipitation/dissolution
- Disinfection by-products
  - Leising, 2004
Geochemical Influences of AR
Leising (2004)
Well Construction Considerations

- Age of Well
- Method Of Construction
- Dual Use
- Paired Wells
- Single Purpose
- Currently 78 (District) Wells Permitted for AR
How Far Have We Come?
Katzer and Brothers, 1989

Principal Aquifer

Shallow Aquifer

Southern Nevada Water System

Stage I

Stage II

Figure 4. Hydrographs of Monitoring Wells.

Figure 5. Nitrate Concentrations in Water from Selected Las Vegas Valley Water District Wells Pumping from the Principal Aquifer.
Key Points

• Aquifer response (water levels changes) are primarily determined by the natural plumbing of the hydrogeological system (sources, sinks and flow paths).

• The most accurate way to determine these factors is by careful analysis of the operational changes.