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Overview

• What motivated the Middle Carson River study?
• Introduce the Middle Carson River groundwater flow model
• Identification and testing of potential alternative management scenarios
• Show the simulated impacts of the proposed alternative management scenarios
Motivating Concerns:

- Increased demand for water resources
  - Municipal
  - Agricultural
- Long-term groundwater drawdown within Middle Carson study area
- Altered future runoff patterns
Increased pressure on water resources: Population Trends

County population

Carson City
Lyon County
Churchill County
Increased pressure on water resources: Crop water demand

Carson Valley

# Days > 90° F

Widening “Warm Season”
Increased pressure on water resources: Crop water demand

Widening “Warm Season”
Temperatures ≥ 90°F

Narrowing “Cool Season”
Temperatures ≤ 32°F
Long-term groundwater drawdown within Middle Carson study area

Water-level decline greater than 10 feet, spring 1964 to spring 2009

Water-level decline greater than 40 feet, spring 1964 to spring 2009

From Maurer (2011)
Long-term groundwater drawdown within Middle Carson study area

Water-level decline about 10 feet, 1995 to 2009

From Maurer (2011)
Long-term groundwater drawdown within Middle Carson study area

Water-level decline about 5 feet, spring 1982 to spring 2009

Water-level decline about 10 feet, spring 1982 to spring 2009

From Maurer (2011)
Altered future runoff patterns

Carson City stream gage

Annual Mean Daily Flow

May/June 7-day Minimum Flow
Concerns...

- Increased pressure on available water resources
- Long-term groundwater drawdown within Middle Carson study area
- Altered future runoff patterns

...Explore alternative management scenarios

1. 40-40-20
2. Reclaim Effluent
3. Exercise existing groundwater permits
Middle Carson River Model: Eagle Valley

Simulated Processes:

- **Pumping:**
  - ✔ Supply wells (yellow circles)
  - ✔ Induction wells (green circles)
- **Irrigation**
- **Crop & riparian evapotranspiration (ET)**
- **Streamflow routing with diversions**
- **Groundwater/surface-water interaction**
- **Mountain front recharge**
Middle Carson River Model: Carson Plains subbasin

Simulated Processes:

- Pumping:
  - ✔ Supply wells (yellow circles)
  - ✔ Induction wells (green circles)
- Irrigation
- Crop & riparian evapotranspiration (ET)
- Streamflow routing with diversions
- Groundwater/surface-water interaction
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Middle Carson River Model: Stagecoach subbasin

Simulated Processes:

- **Pumping:**
  - ✔ Supply wells (yellow circles)
  - ✔ Induction wells (green circles)
- Irrigation
- Crop & riparian evapotranspiration (ET)
- Streamflow routing with diversions
- Groundwater/surface-water interaction
- Mountain front recharge
Middle Carson River Model: Churchill Valley

Simulated Processes:

- **Pumping:**
  - Supply wells (yellow circles)
  - Induction wells (green circles)

- **Irrigation**

- **Crop & riparian evapotranspiration** (ET)

- **Streamflow routing with diversions**

- **Groundwater/surface-water interaction**

- **Mountain front recharge**

- **Reservoir storage**

- **Groundwater/reservoir interaction**
Evaluation of alternative management scenarios

1. “40-40-20”
2. Reclaimed Effluent Trade
3. Exercise existing groundwater permits
Scenario developed during a Middle Carson River water purveyor’s meeting
“40-40-20” Scenario

Expanded Residential Area

Induction well

Production well

Diversion for Agriculture

Carson River

Transferred amount = 2.5 ft * acreage dried-up
“40-40-20” Scenario: April, May, & June
“40-40-20” Scenario: July - March
Scenario evaluation

Review of model results includes:

- Change in Groundwater Levels
- Change in groundwater/surface-water exchange patterns
- Change in Flows at Fort Churchill
“40-40-20” Scenario: Groundwater levels show an increase in Eagle Valley.

Change in groundwater level (ft)

- **Decline**: 10.001 to 14.475, 1.001 to 5.000, 0.501 to 1.000, 0.101 to 0.500
- **Rebound**: -0.100 to 0.100, -0.500 to -0.101, -1.000 to -0.501, -5.000 to -1.001, -10.000 to -5.001, -46.206 to -10.001
“40-40-20” Scenario: Increased seepage loss from the Carson River in Eagle Valley

Increase in Loss (cfs)

Additional Loss

- > 0.10
- 0.06 to 0.10
- 0.04 to 0.05
- 0.01 to 0.03
- 0.00

0.00
“40-40-20” Scenario: Groundwater levels decline in Carson Plains subbasin

Decrease in GW Levels (ft)

Decline

<table>
<thead>
<tr>
<th>Decline Range</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.001 to 5.000</td>
<td>Dark</td>
</tr>
<tr>
<td>0.501 to 1.000</td>
<td>Medium</td>
</tr>
<tr>
<td>0.101 to 0.500</td>
<td>Light</td>
</tr>
<tr>
<td>-0.100 to 0.100</td>
<td>Very light</td>
</tr>
</tbody>
</table>
“40-40-20” Scenario: Increased seepage loss from the Carson River in the Carson Plains subbasin

Increase in Loss and Gains (cfs)

- Additional Loss
  - > 0.10
  - 0.06 to 0.10
  - 0.04 to 0.05
  - 0.01 to 0.03
  - 0.00
- Decreased Loss
  - -0.01
“40-40-20” Scenario: Decrease in flows @ Fort Churchill are small
“40-40-20” Things to Remember

• Transfers consumptive use
• 100% of the previously diverted water stays in the river
  • Would expect diminished groundwater return flow owing to reduced recharge from irrigation and ditch seepage
  • Scenario does not account for adjustments in downstream diversion amounts resulting from water left in the river
What questions do you have regarding the “40-40-20” scenario?
Evaluation of alternative management scenarios

1. “40-40-20”
2. Reclaimed Effluent Trade
3. Exercise existing groundwater permits
Reclaimed Effluent Trade Scenario: Explanation

• An estimated 600,000 gpd (1 cfs) of treated effluent
• Contracted to be delivered to the golf course Apr. to Oct.
• Nov. to March, reclaim water released to Rapid Infiltration Basin (RIB)
• Relax supply well pumping by an amount equivalent to the augmented induction well pumping
Reclaimed Effluent Trade Scenario: Change in groundwater levels is negligible.
Reclaimed Effluent Trade Scenario: Groundwater Levels

Change in groundwater level (ft)

Carson Plains Subbasin

Area with long-term drawdown
Reclaimed Effluent Trade Scenario: Change in Flows @ Fort Churchill are negligible to neutral
What questions do you have regarding the reclaimed effluent trade scenario?
Evaluation of alternative management scenarios

1. “40-40-20”
2. Reclaimed Effluent Trade
3. Exercise existing groundwater permits
Exercise of existing groundwater permits: Explanation
Exercise of existing groundwater permits: Significant groundwater level declines in Eagle Valley

25% Pumping Increase

100% Pumping Increase

GW Level Change (ft)

Decline
Exercise of existing groundwater permits: Increased seepage loss from the Carson River

Eagle Valley, 100% pumping scenario

Increased Loss (cfs)

- > 0.10
- 0.06 to 0.10
- 0.04 to 0.05
- 0.01 to 0.03
- 0.00

Additional Loss
Exercise of existing groundwater permits: Significant decline in groundwater levels in Carson Plains subbasin

25% Pumping Increase

100% Pumping Increase

GW Level Change (ft)
Exercise of existing groundwater permits: Increased seepage loss from Carson River

Carson Plains Subbasin, 100% pumping scenario

Increased Loss or Gain (cfs)

- Seepage Loss
  - > 0.10
  - 0.06 to 0.10
  - 0.04 to 0.05
  - 0.01 to 0.03
  - 0.00
  - -0.03 to -0.01

- Seepage gain (or reduced seepage loss)
Exercise of existing groundwater permits: Significant groundwater level declines in Stagecoach subbasin

25% Pumping Increase

100% Pumping Increase

GW Level Change (ft)

Decline
Exercise of existing groundwater permits: Mixed changes in seepage loss/gain along the Carson River in Stagecoach subbasin

Stagecoach Subbasin, 100% pumping scenario

Seepage Loss or Gain (cfs)

- Additional Loss
- Reduced Loss
Exercise of existing groundwater permits: Significant groundwater level declines in Churchill Valley

25% Pumping Increase

100% Pumping Increase

GW Level Change (ft)

Decline
Exercise permitted groundwater rights scenario: Decrease in flows @ Fort Churchill
Parting thoughts:

• Increasing population, longer growing seasons, long-term groundwater drawdown, and changing runoff patterns combine to apply increased demand on available water resources

• Alternative management scenarios developed by local stakeholders demonstrate use of Middle Carson Model for evaluating changes to the system that may result from management decisions.

• All scenarios impact groundwater heads, groundwater/surface-water exchanges, and flows in Carson River - but impacts from '40-40-20' and 'Effluent Trade' are small to negligible.

• Full development of existing groundwater rights (i.e., increased groundwater pumping) significantly lowered groundwater levels and reduced river flows.

• Reclaiming of wastewater effluent had very little impact on Carson River flows relative to the baseline conditions.
What questions do you have regarding the exercise of permitted groundwater rights scenario?
Thank you