SALINAS VALLEY GROUNDWATER BASIN SETTING

INITIAL REVIEW FOR DEVELOPMENT OF GROUNDWATER SUSTAINABILITY PLAN

May 10, 2018

Prepared for Salinas Valley Basin Groundwater Sustainability Agency
Outline

- Purpose and Background
- Salinas Valley Basin Hydrogeology
- Water Budgets
- Sub-basins
Purpose of Presentation

- GSP Section 2.2 GSP: “Basin Setting” sets stage for the Plan
  - Hydrogeologic Conceptual Model
  - Current and Historical Groundwater Conditions
  - Water Budget Information
  - (Management Areas, if applicable)

- “The Long Valley”
  - Considerable local knowledge w/ many viewpoints
  - Basin-wide framework for discussion of projects/management actions
  - Distinguish between “uncertainty” and “controversy”
Background

- **DWR Bulletin 52 (jointly funded by State and County) - 1946**
  - Defined “Water Supply Areas” that are basis of DWR-defined “subbasins”
  - Overdraft, water quality, and recommended solution

- **Monterey County Water Resources Agency (MCWRA) - 1947**
  - Flood control, sustainable water supply
  - Groundwater level and water quality monitoring – 1940s
  - Nacimiento and San Antonio reservoirs for water conservation – 1957/1967
  - Collect groundwater extraction data from operators – 1992
  - Seawater intrusion control – CSIP and SVWP projects – 1998

- **Salinas Valley Basin Groundwater Sustainability Agency – 2017**
  - Plan for long-term sustainable management of groundwater resources
  - Incorporate actions of other agencies and plans into GSP
Background

- **Key Sources of Information**
  - “Salinas Basin Investigation - Bulletin 52” – 1946 California DWR
  - “Hydrogeology and Water Supply of Salinas Valley” 1995 – MCWRA
  - “Ground Water Extraction Summary Reports” annual since 1995 - MCWRA
  - “Hydrostratigraphic Analysis of the Northern Salinas Valley” 2004 – MCWRA
  - “State of the Salinas River Groundwater Basin” 2015 - MCWRA
  - “Water Quality Control Plan” 2016 –RWQCB, Central Coast Region
  - Recommendations to Address Expansion of SWI in the SV GB, 2017 - MCWRA
  - Various maps and publications - USGS
  - SVIHM (unpublished) USGS-MCWRA
  - [https://www.water.ca.gov/Programs/Groundwater-Management/Data-and-Tools](https://www.water.ca.gov/Programs/Groundwater-Management/Data-and-Tools)
  - Other SGMA-focused websites, e.g. TNC
Sub-basins defined by DWR (Bulletin 118)

Subareas used by MCWRA

Source: MCWRA 2005 GW Conditions Report
Outline

- Purpose and Background
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Salinas Valley Basin Groundwater

- Overview
- Conceptual Model
- Geologic Setting
- Hydrostratigraphy
- Groundwater Flow
- Water Quality
Unique: Large agriculture-based economy with no imported water
Conjunctive use water system: Salinas River – Groundwater

Water Sources:
- Salinas River and tributaries, including groundwater recharge
- Rainfall percolation to groundwater

Water Storage:
- Groundwater - critical storage reservoir 16 million acre-feet estimated in storage
- San Antonio and Nacimiento Reservoirs = 0.7 million acre-feet

Water Distribution System:
- Few canals/pipelines to move water w/in the basin
- Salinas River acts as the primary “trunk line”
- Surface water diversions
- Groundwater acts as distributed but very slow conveyance/delivery system

Challenges due to spatial and temporal variability in water availability and demand
Physiographic Setting
Conceptual Model
Alluvial basin fill bounded by relatively impermeable sedimentary rock or granitic basement.

Source: https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer
Conceptual Cross-Section

Adapted from Brown and Caldwell, 2015 (MCWRA); MCWRA, 2006.
Cross-Section: Hydrostatigraphy

Cross-Section Source: Brown and Caldwell, 2015 (MCWRA).

180 ft Aquifer
400 ft Aquifer
Depositional Transition from 180/400 to Eastside

Source: Brown and Caldwell, 2015, after Kennedy/Jenks 2004 (MCWRA)
Cross-Sections: Hydrostratigraphy

Cross-Section Source: Kennedy-Jenks, 2004 (MCWRA)
Cross-Sections: Hydrology

Cross-Section Source: Kennedy-Jenks, 2004 (MCWRA).
Soil Characteristics

- Soil Agricultural Groundwater Banking Index (SAGBI), UC Davis
- Feasibility of groundwater recharge on agricultural land

Source: DWR landuse viewer
https://gis.water.ca.gov/app/CADWRLandUseViewer/
Groundwater Flow

- Inferred from water level measurements in wells
- GW flow is generally down the valley
- Inward flow from the ocean at the coastal margin where GW elevations are below sea level due to pumping
- Based on Fall measurements

Groundwater Flow

180-400 Foot (Pressure)/East Side

Forebay

Upper Valley

Source: Fall 2015. Brown and Caldwell 2015 (MCWRA)
Groundwater Elevation and Flow (180-foot Aquifer)

- August 2015 water levels

Adapted from MCWRA, 2017
Groundwater Elevations and Flow (400-foot Aquifer)

- August 2015 water levels

Adapted from MCWRA, 2017
Groundwater Quality

- Elevated salinity due to seawater intrusion
- Nitrates from agriculture
- Organic compounds from industry
- High TDS associated with sulfate and boron

Sources: DWR Bull 118, USGS, 1983
Boyle et al., UC Davis, 2012
Seawater Intrusion

Maps show estimated extent of groundwater with chloride > 500 mg/L

Source: MCWRA, 2017
Seawater Intrusion

180-ft Aquifer

400-ft Aquifer

Aug 2015 water levels

Adapted from MCWRA, 2017
Seawater Intrusion Conceptual Model
180- and 400-foot Aquifers

Figure 9B. With regional seawater intrusion, seawater moves inland because there are submarine outcrops of the geologic formations and a landward groundwater gradient.

Source: MCWRA, 2017
SWI Conceptual Model
180- and 400-foot Aquifers

Figure 9B. With regional seawater intrusion, seawater moves inland because there are submarine outcrops of the geologic formations and a landward groundwater gradient.

Source: MCWRA, 2017
Groundwater-Surface Water Interaction and Groundwater Dependent Ecosystems

Source: https://gis.water.ca.gov/app/NCDatasetViewer/
Outline

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- Water Budgets
- Sub-basins
Water Budgets – “Think Inside the Box”

- Define spatial boundaries on all sides
- Define time period
- Water inflow and outflow
  - Regional horizontal flow
  - Recharge and vertical flow
  - Sources and sinks (e.g., wells)
- Change in storage during the period

Inflow – Outflow = Change in Storage
Water Budgets – “Think Inside (which) Box(?)”

- What spatial boundaries?
  - Sub-basins or management areas
  - Surface water
  - Crop use, return flow, excess irrigation
  - Flow between layers/zones

- What time period?
  - Long-term average
  - Climatic cycles (e.g. droughts)
  - Seasonal
  - Future scenarios for planning

Inflow – Outflow = Change in Storage

Source: Brown & Caldwell, 2015 (MCWRA)

Note: The annual precipitation surplus represents the difference between the annual precipitation and the long-term mean.
Change in Groundwater Storage

- Cumulative storage change by subarea (1994 – 2015)
- Does not include loss of fresh water storage due to seawater intrusion

Source: Brown and Caldwell, 2015 (MCWRA)
Example Published Water Budgets

- 1946 Bulletin 52 (DWR)
- 1995 White Paper Summary of Basin Groundwater (for MCWRA)
- Differences reflect both uncertainties and choice of boundaries/periods
# Annual Water Budget Estimates (acre-feet/year)

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Water Inflow to Basin</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Salinas River and Tributaries</td>
<td>701,000</td>
<td>547,000</td>
<td>-</td>
</tr>
<tr>
<td>Valley Floor Percolation</td>
<td>239,000</td>
<td>66,000</td>
<td>-</td>
</tr>
<tr>
<td>Groundwater Flow</td>
<td>-</td>
<td>44,000</td>
<td>-</td>
</tr>
<tr>
<td>Recycled water / desalination water</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Inflow</strong></td>
<td>940,000</td>
<td>657,000</td>
<td>508,000</td>
</tr>
<tr>
<td><strong>Water Consumption in Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriculture Demand</td>
<td>400,000</td>
<td>-</td>
<td>464,000</td>
</tr>
<tr>
<td>Municipal, Industrial, Domestic Demand</td>
<td>15,000</td>
<td>-</td>
<td>59,000</td>
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<tr>
<td>Native Vegetation ET</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total Water Consumption</strong></td>
<td>415,000</td>
<td>391,000</td>
<td>523,000</td>
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<tr>
<td><strong>Water Outflow and Storage</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Discharge to Ocean</td>
<td>503,000</td>
<td>303,000</td>
<td>-</td>
</tr>
<tr>
<td>Net Groundwater Flow (Intrusion) to Ocean</td>
<td>24,000</td>
<td>(17,000)</td>
<td>(11,000-18,000)</td>
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<tr>
<td>Annual Change in Storage</td>
<td>(2,000)</td>
<td>(20,000)</td>
<td>(6,000)</td>
</tr>
</tbody>
</table>
Estimated Water Budget (1995)

- Precipitation Infiltration: 66,000
- Stream Infiltration: 244,000
- Recirculated Pumpage: 144,000
- Stream Flow: 547,000
- Subsurface Inflow: 44,000
- Seawater Intrusion: 17,000

- M & I
- Ag.

Stream Flow: 303,000

Pumpage: 535,000
Outline

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Sub-basins – Geology

Alluvial basin fill bounded by relatively impermeable sedimentary rock or granitic basement

https://sgma.water.ca.gov/webgis/?appid=SGMADataViewer
Sub-Basins – Pumping

Average Annual Pumping (ac-ft/yr) by Section

Source: Brown and Caldwell 2015 (MCWRA)
Subareas - Historical Production
1949 to 2012

Source: Brown and Caldwell 2015 (MCWRA)
Subsurface Flow

Arrows are preliminary schematic representation of subsurface flow at basin boundaries.

### Table 4-3. Water Budget Components by Subarea

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Average of WY 1958-1994 (from MW, 1998)</th>
<th>2013 Groundwater Pumping (reported by MCWRA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inflow</td>
<td>Outflow</td>
</tr>
<tr>
<td></td>
<td>Natural Recharge</td>
<td>Subsurface Inflow</td>
</tr>
<tr>
<td>Pressure</td>
<td>117,000</td>
<td>17,000</td>
</tr>
<tr>
<td>East Side</td>
<td>41,000</td>
<td>17,000</td>
</tr>
<tr>
<td>Forebay</td>
<td>154,000</td>
<td>31,000</td>
</tr>
<tr>
<td>Upper Valley</td>
<td>165,000</td>
<td>7,000</td>
</tr>
</tbody>
</table>

Note: All estimates in acre-feet per year (afy).

- Includes agricultural return flow, stream recharge, and precipitation.
- Groundwater pumping as reported by MW (1996) is presented to provide a complete water budget.
- The 2013 groundwater pumping totals are provided for comparison.

Adapted from: Brown & Caldwell 2015 (MCWRA)
Groundwater Levels with Time (Hydrographs) with Chloride

Upper Valley Subarea

- Groundwater levels stable and above sea level
- Small difference between peak irrigation and end of irrigation

Source: Brown and Caldwell 2015 (MCWRA)
Groundwater Levels with Time (Hydrographs) with Chloride

Forebay Subarea

• Groundwater levels generally stable or declining but more than 100 ft above sea level
• Small difference between peak irrigation and end of irrigation
Groundwater Levels with Time (Hydrographs) with Chloride

Eastside Subarea

- Groundwater levels below sea level except in SE
- Declining groundwater levels but low salinity
- Large difference between peak irrigation and end of irrigation (~ 40 ft)

Source: Brown and Caldwell 2015 (MCWRA)
Groundwater Levels with Time (Hydrographs) with Chloride

Pressure Subarea

- Groundwater levels below sea level NW of Salinas
- Declining groundwater levels and increasing salinity
- Moderate difference between peak irrigation and end of irrigation

Source: Brown and Caldwell 2015 (MCWRA)
CSIP deliveries:
- Decreased pumping
- Water levels in portions of the deep aquifer recovered

Source: MCWRA, 2017
Groundwater-Surface Water Interaction and Groundwater Dependent Ecosystems

Example from Upper Valley:

Source: https://gis.water.ca.gov/app/NCDatasetViewer/
Questions / Comments?

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