Sacramento Valley Conjunctive Water Management Program

A Collaborative Planning Effort by GCID and NHI
Funded by the Bureau of Reclamation and DWR

August 8, 2012
Two Sites Selected for Modeling

Glenn-Colusa ID connected to CVP/Shasta

Butte Basin connected to SWP/Oroville

August 8, 2012
Reoperate Reservoirs with Backstopping by Groundwater Integration

- Capture the fraction of the runoff hydrograph not now controlled for beneficial use by increasing flood reservation
- Dedicate this “surplus” water to environmental flows and improved water supply
- Payback reservoir in dry years with groundwater substitution (also looked at crop idling)
- Incidental flood control benefits
- Incidental climate resilience benefits
Project Design Principles

• Honor all existing CVP and SWP water supply obligations operational constraints

• Achieve net environmental benefit
  – Tradeoffs among alternative environmental water uses
  – Account for impacts of additional pumping on fish-critical streams

• Hold other GW users harmless: avoid, minimize, or mitigate impacts

• Generate net economic benefits
STORAGE RESERVOIRS IMPAIR NATURAL FLOWS IN TWO WAYS

1. FLOW DEPLETION

2. FLOW ALTERATION

COMBINED EFFECTS: FRESHWATER ECOSYSTEMS ARE THE MOST IMPAIRED ON THE PLANET

= EXTINCTION CRISIS
**ENVIRONMENTAL FLOWS**

<table>
<thead>
<tr>
<th>OLD PARADIGM:</th>
<th>“MINIMUM INSTREAM FLOWS”</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW PARADIGM:</td>
<td>MORE VARIABLE FLOWS – MIMIC NATURAL PATTERNS RECONNECT RIVERS TO THEIR HISTORIC FLOODPLAINS</td>
</tr>
</tbody>
</table>
SPECIFYING ENVIRONMENTAL FLOW REQUIREMENTS

- MAGNITUDE
- DURATION
- FREQUENCY
- TIMING
- REACH [SEQUENTIAL USE?]
Environmental Flow Objectives

• Geomorphic
  – Single day large event
  – February or March

• Riparian establishment
  – Five day large flow with 60 day recession
  – April start

• Flood plain inundation
  – Single day large event with 45 day recession
  – Between February and April

• Spring pulse flow
  – Simulate more natural spring runoff period

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Improve In-Valley Water Supply

- Historical unmet agricultural surface water demands used as surrogates for additional in-Valley water needs
  - Central Valley Project (CVP) water supply contractors along Tehama-Colusa Canal
  - Feather River water rights holders subject to shortages in dry years
  - Minimize crop idling and groundwater pumping

Additional water supplies could be used for any purpose.
# Options Considered for Paying Back the Reservoirs

<table>
<thead>
<tr>
<th>Options</th>
<th>Limiting Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Active groundwater recharge</td>
<td>• Lack of persistent cones of depression</td>
</tr>
<tr>
<td>2. Pumping groundwater within cooperating districts</td>
<td>• Costs of mitigation of groundwater impact</td>
</tr>
<tr>
<td></td>
<td>• Keswick minimum release requirements for temp control</td>
</tr>
<tr>
<td>3. Crop idling in cooperating districts</td>
<td>• Timing for decisions make this inefficient</td>
</tr>
<tr>
<td></td>
<td>• Keswick minimum release requirements for temp control</td>
</tr>
</tbody>
</table>
Early Finding: Traditional water banking generally not viable in the Sacramento Valley due to lack of aquifer storage space.

August 8, 2012
## Project Scenarios Evaluated

<table>
<thead>
<tr>
<th>Scenario</th>
<th>GCID (CVP)</th>
<th>Butte Basin (SWP)</th>
<th>Total</th>
<th>Pumping Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>50</td>
<td>150</td>
<td>summer</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>100</td>
<td>300</td>
<td>summer</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>50</td>
<td>150</td>
<td>fall</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>50</td>
<td>150</td>
<td>summer &amp; fall</td>
</tr>
</tbody>
</table>

All scenarios modeled with an existing (shallow) and new (deep) well field to reveal range of potential impacts to streams and existing pumpers.
**Scenario 1—CVP/Shasta**

100 TAF Pumping Capacity in GCID

Environmental Flow Releases
Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Sac River Agricultural Deliveries

Add. Ag Release
Unmet Contract
Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Refill from Surplus Surface Water
Scenario 1—CVP/Shasta
100 TAF Pumping Capacity in GCID
Refill from Groundwater Pumping
## Scenario Performance 1922-2003

*(Table ES-3 from Draft Final Report)*

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Project/System</th>
<th>Payback Pumping Capacity (TAF)</th>
<th>Environmental Benefits</th>
<th>Agricultural Benefits</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number of Years</td>
<td>Avg in Yrs of Occurrence (TAF)</td>
<td>Avg Over All Yrs (TAF)</td>
</tr>
<tr>
<td>1, 3 and 4</td>
<td>GCID/CVP Lake Shasta-Sac R</td>
<td>100</td>
<td>23</td>
<td>46</td>
<td>13</td>
</tr>
<tr>
<td>1, 3 and 4</td>
<td>Butte Basin/SWP Lake Oroville-Feather R</td>
<td>50</td>
<td>28</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>GCID/CVP Lake Shasta-Sac R</td>
<td>200</td>
<td>40</td>
<td>96</td>
<td>47</td>
</tr>
<tr>
<td>2</td>
<td>Butte Basin/SWP Lake Oroville-Feather R</td>
<td>100</td>
<td>44</td>
<td>43</td>
<td>23</td>
</tr>
</tbody>
</table>
Findings & Conclusions

• Core concept of reservoir reoperation is feasible:
  – Refill is mostly from surplus surface flows
  – Reservoir payback required in some years

• Project generates appreciable new water
  – Shasta: 27 TAF to 69 TAF annually
  – Oroville: 17 TAF to 43 TAF annually
  (Neglecting effects of minimum reservoir releases for temperature control)
Findings & Conclusions

• Reservoir payback strategies
  – Groundwater banking in Sacramento Valley not feasible at this time
  – Pumping in GCID for Shasta payback and in Butte Basin for Oroville payback is feasible and impacts to existing pumpers and streams are manageable
  – Crop idling (as evaluated) is not feasible due to timing of decisionmaking
  – Groundwater banking south of Delta not evaluated
Findings & Conclusions

• Effectiveness of all payback mechanisms is constrained during periods when temperature releases exceed releases for downstream demands

• Conservative operation of Shasta and Oroville to minimize risk of temperature stresses on fish reduce opportunities to make other environmental releases, also for fish benefits
Further Investigation
Further Investigation:
Technical

- Reconcile tradeoffs among environmental project functions
- Refine reservoir operation rules based on temperature modeling
- Explore south of Delta groundwater banking as a reservoir payback mechanism and costs
Reoperate Shasta and/or Oroville Reservoirs to capture additional flood waters—dedicate to e-flows and water supply

<table>
<thead>
<tr>
<th>Payback Options (~15% of years when refill inadequate)</th>
<th>Without Isolated Delta Conveyance</th>
<th>With Isolated Delta Conveyance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Already Assessed</strong></td>
<td>• Sac Valley GW Banking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• GW substitution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Crop Idling</td>
<td>X</td>
</tr>
<tr>
<td><strong>Not Yet Assessed</strong></td>
<td>• Sites reservoir</td>
<td>• South of delta GW banking</td>
</tr>
<tr>
<td></td>
<td>• Delta island storage</td>
<td>• South of delta surface</td>
</tr>
<tr>
<td></td>
<td></td>
<td>banking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• MWD svc area storage</td>
</tr>
</tbody>
</table>
Linkage to System Reoperations Program
Legislation: Senate Bill X2 1
(Water Quality, Flood Control, Water Storage, and Wildlife Preservation - Perata, 2008)

- Authorized DWR to conduct planning and feasibility studies to identify potential options for the reoperation of the state's flood protection and water supply systems that will optimize the use of existing facilities and groundwater storage capacity.

- The studies shall incorporate appropriate climate change scenarios and be designed to determine the potential to achieve the following objectives…
Simultaneous Objectives:
- Water supply reliability
- Flood hazard reduction
- Ecosystem protection and restoration

By
- **Integrating** flood protection and water supply systems
- **Reoperating** existing system in conjunction with effective groundwater management
- **Improving** existing water conveyance systems
Reoperation Building Blocks

• Re-operate reservoirs
• Integrate groundwater and surface water
• Water transfers
• Change points, timing and/or volume of diversions
• Change flow regimes (stream flow patterns)
• Reactivate floodplains
• Retrofit dams
• Inter-connect conveyance
• Augment storage at existing reservoirs
• Fish passage facilities
• Desalinization
Why South of Delta GW Banking is Promising

- Avoid impacts on Sac Valley GW Users
- Extract and use banked water at times of greatest need and economic value
- No increase in Sac Valley exports
- Avoid operational losses for IDC by-pass flows by “riding on the back” of PRE exports
Big Question

This option converts Delta outflow to Delta exports:

• Is the value of improved flows in Sacramento and Feather Tributaries larger than the value of Delta outflows during the flood season?
Modes of Groundwater Banking

NHI Approach

![Graph showing modes of groundwater banking with measurements and calculations.](image-url)
Average Annual Yield Estimates for Eleven Regulated Tributaries of the Central Valley

<table>
<thead>
<tr>
<th>River</th>
<th>Reservoir</th>
<th>NHI Estimates</th>
<th>USACE Estimates</th>
<th>Increase in Flood Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sacramento</td>
<td>Shasta</td>
<td>196.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feather</td>
<td>Oroville</td>
<td>126.9</td>
<td>148</td>
<td>29%</td>
</tr>
<tr>
<td>Yuba</td>
<td>New Bullards Bar</td>
<td>144.5</td>
<td>120</td>
<td>71%</td>
</tr>
<tr>
<td>American</td>
<td>Folsom</td>
<td>80.4</td>
<td>211</td>
<td>31%</td>
</tr>
<tr>
<td>Mokelumne</td>
<td>Camanche</td>
<td>69.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calaveras</td>
<td>New Don Hogan</td>
<td>25.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanislaus</td>
<td>New Melones</td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuolumne</td>
<td>Don Pedro</td>
<td>77.9</td>
<td>160</td>
<td>36%</td>
</tr>
<tr>
<td>Merced</td>
<td>McClure/New Exchequer</td>
<td>108.1</td>
<td>92</td>
<td>28%</td>
</tr>
<tr>
<td>Upper San Joaquin</td>
<td>Millerton/Friant</td>
<td>100</td>
<td>322?</td>
<td>71%?</td>
</tr>
<tr>
<td>King's River</td>
<td>Pine Flat</td>
<td>108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL:</td>
<td></td>
<td></td>
<td>1102.4</td>
<td></td>
</tr>
</tbody>
</table>
Factors Taken Into Account

- Pre-existing rights & entitlements
- Prescribed environmental flows
- Temperature regulation

Factors **NOT** Taken Into Account

- Delta transfer constraints
Potential Groundwater Banking Sites

Sacramento Valley

San Joaquin Valley

Map of potential groundwater banking sites in California, showing sites and basins in the Sacramento and San Joaquin valleys.
Feasibility Requirements for In Lieu Storage

• Extend water district to encompass groundwater use area

  OR

• Develop groundwater in surface water irrigation district

  AND

• Adequate aquifer storage space
Promising Central Valley DAUs