Seepage and Conveyance Technical Feedback Group Meeting

January 23, 2017
Agenda

• Introductions, Meeting Agenda
• SJRRP Updates
• Thresholds Overview
• Capillary Fringe Buffer, Almond Root Zone
• Lateral Gradient Buffers
• Historical Groundwater Method Thresholds
• Questions, Wrap-Up, Action Items
Katrina Harrison

RESTORATION PROGRAM UPDATE
• WY 2016: Normal Dry Year Type
• Water Year 2017: Wet Year Type
  – Flood control releases
  – Longer Restoration Flows after flood releases stop
Restoration Flows

- Flood flows released from Millerton starting January 4, 2017 – no Restoration Flows
- Restoration Flows will begin again targeting 150 cfs of flow at Sack Dam when flood flows are complete
- Restoration Administrator anticipated to request increase in flows to ~300 cfs below Sack Dam in March 2017
Seepage Projects Update

• Reclamation completed a seepage easement on land adjacent to the Eastside Bypass on October 25, 2016
  – Anticipated to allow approximately 300 cfs below Sack Dam depending on groundwater levels
• Two additional seepage easements are in progress in Reach 4A
Seepage Environmental Assessment

• Draft EA posted for public comment on December 22, 2016
  – Environmental compliance coverage of seepage easements
  – Environmental compliance coverage of the Seepage Management Plan changes we will discuss today

• Comments due January 30, 2017
Other Project Updates

• Record of Decision signed for the Mendota Pool Bypass and Reach 2B Project
  – Construction to start late 2017

• Construction underway
  – Hatchery Water Supply Line
  – Madera Low-Flow Valve

• Construction completed
  – Sand Removal in the Eastside Bypass
## Schedule of Key Construction Actions in Framework

<table>
<thead>
<tr>
<th>2015-2019</th>
<th>2020-2024</th>
<th>2025-2029</th>
<th>2030+</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goal:</strong> 1,300 cfs Capacity in all Reaches</td>
<td><strong>Goal:</strong> Increased Capacity</td>
<td><strong>Goal:</strong> Phase I Projects Complete</td>
<td><strong>Goal:</strong> All Remaining Projects Complete</td>
</tr>
<tr>
<td>• Friant-Kern Capacity Restoration</td>
<td>• Financial Assistance for Groundwater Banks</td>
<td>• Reach 4B</td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>• Friant-Kern Canal Reverse Pumps</td>
<td>• Reach 2B</td>
<td>• Salt and Mud Sloughs</td>
<td></td>
</tr>
<tr>
<td>• Madera Canal Capacity Restoration</td>
<td>• Arroyo Canal and Sack Dam</td>
<td>• Chowchilla Bifurcation Structure Improvements (DWR)</td>
<td></td>
</tr>
<tr>
<td>• Mendota Pool Bypass</td>
<td>• Reach 4B Land Acquisition</td>
<td>• Gravel Pit Isolation (DWR)</td>
<td></td>
</tr>
<tr>
<td>• Temporary Arroyo Canal Screen</td>
<td>• Seepage Projects to 2,500 cfs</td>
<td>• Seepage Projects to 4,500 cfs</td>
<td></td>
</tr>
<tr>
<td>• Conservation Facility / Hatchery</td>
<td>• Levee Stability to 2,500 cfs</td>
<td>• Levee Stability to 4,500 cfs</td>
<td></td>
</tr>
<tr>
<td>• Seepage Projects to 1,300 cfs</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preliminary draft – subject to change
Purpose of Today

• Receive input on proposed groundwater seepage threshold changes

• Almond Root Zone

• Capillary Fringe

• Lateral Gradient Buffers

• Historical Groundwater Method
Restoration Flow Schedule

- Flexible flow periods
- Restoration Administrator
- Interim Flow monitoring program
- All flows released up to “then existing’ channel capacity
Seepage Management Plan (SMP)

• “Then existing” channel capacity includes seepage

• The SMP influences flows, one of the 3 pieces of the Restoration Goal

• SMP was developed in collaboration with landowners and other members of the SCTFG

• Peer review to independently check

• Revisions to SMP in late 2012 based on peer review recommendations

Preliminary draft – subject to change
Purpose and Objective

• The SMP describes
  – Monitoring and operating guidelines to reduce Restoration Flows to address adverse material impacts (per our PEIS/R)
  – Identify projects to increase flows while avoiding seepage impacts
• Meant to be dynamic and adaptive
• Objective: convey Restoration/Interim Flows while avoiding seepage impacts
Thresholds

• Thresholds identify potential problems so that Reclamation can establish operating criteria to manage flows

• Two thresholds methods
  – Agricultural conditions
  – Historical data

• Two calculation methods
  – 1:1 stage relationship
  – Drainage direction
Thresholds - Agricultural Method

• Root Zone
• Capillary Fringe
• Ground Surface

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Root Zone (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Crop</td>
<td>4-5</td>
</tr>
<tr>
<td>Vines, etc.</td>
<td>6</td>
</tr>
<tr>
<td>Almond</td>
<td>9 (currently)</td>
</tr>
</tbody>
</table>
Thresholds – Historical Method

- CCID Well Database
- DWR Well Database
- 75th percentile or CCID average

CCID 191, GS elevation 110.9

Spring threshold of 101.9 ft calculated as the 75th percentile of spring WLS prior to SJRRP flows

Fall threshold of 99.9 ft calculated as the 75th percentile of Fall WLS prior to SJRRP flows

Preliminary draft – subject to change
1:1 Stage Relationship

a) Determine increase in river stage from proposed flow increase
b) Assume increase in river = increase in groundwater
c) Add increase in groundwater to most recent observed groundwater level
Figure J-2 from SMP Appendix J

Note: The values 1-7 reference columns in the new Flow Bench report format.
Drainage Direction

- Gaining reaches
- Groundwater threshold elevation
- River water surface elevation

Note: The values 1-7 reference columns in the new Flow Bench report format.
Triggers, Site Visit, and Response

• Monitoring Data
• Triggers
  – Flow Bench Evaluations
  – Hotline Intake
• Site Visit
• Response

Seepage Hotline
916-978-4398
Iterative Approach to Increase Flows while Avoiding Impacts

- Flow Bench Evaluation
- Seepage Hotline
Proposed Changes

- Almond Root Zone
- Capillary Fringe
- Lateral Gradient Buffers
- Historical Groundwater Method
ALMOND ROOT ZONE AND CAPILLARY FRINGE STUDY
Outline

• Phase 1 - Root zone study conclusions
• Phase 2 - Capillary fringe study
  – Literature review
  – Expert input
  – Data review
  – Outcomes and recommendations
Root Zone Threshold Terms

- **Active Root Zone**: 2–3 ft bgs, 80% of roots, Where most uptake occurs
- **Effective Root Zone**: 3–5 ft bgs, Over 90% of roots
- **Maximum Root Zone**: 6–13 ft bgs, Not necessarily typical

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**Root Zone Depth:** 6 ft

**Seepage Threshold**

**Aerated Root Zone**

**Capillary Fringe**

**CF**

**Water Table**

Preliminary draft – subject to change
Threshold Calculation: Agricultural Practices Method

Threshold Calculation:

Agricultural Practices Method

Root Zone + Capillary Fringe = Seepage Depth Fringe Threshold

1 2 3

Preliminary draft – subject to change
March 2016 SCTFG – Conclusions

• Discussed 6-foot root zone for almonds
• Should be combined with appropriate capillary fringe depending on site-specific factors
• Capillary Fringe
  – Current SMP: capillary fringe is 6 inches or 1 foot
  – Need: Further refine the understanding of site specific capillary fringe
March 2016 SCTFG – Path Forward

- Capillary fringe arose out of Phase 1 efforts as an important topic
- Objectives:
  - Evaluate existing data and literature and identify data gaps that need to be addressed.
  - Develop specific guidelines for the range of capillary fringe in various soils and site conditions, to be used in conjunction with root depth estimates to protect almond roots from seepage in the project area.
Phase 2 Capillary Fringe Study

• Evaluate capillary fringe information
  – Literature
  – Regional expert input
  – Site specific data review

• Engage subcommittee to review information

• Propose refined capillary fringe values

Preliminary draft – subject to change
Literature Review – Purpose

• Define capillary rise and capillary fringe
• Summarize findings
  – Characteristics of capillary fringe
  – Influences on capillary fringe
  – Typical heights of capillary fringe in fine soil types
  – Spatial and temporal variability of capillary fringe
  – Methods used to measure capillary fringe in the field
• Determine applicability of existing data to interpretations in current literature
• Recommend potential approaches to refine SMP capillary fringe values
Literature Review – Key Findings

• In general, capillary rise is defined as the movement of pore water against the flow of gravity

• Depends on
  – Soil type
  – Soil moisture depletion
  – Depth to the water table
  – Recharge
The definition of capillary fringe has differed among experts. Definitions for this study:

**Capillary Rise**
- The full range of capillary moisture above the water table
- A large portion of the capillary rise contains air and is not detrimental to root growth

**Capillary Fringe**
- The tension saturated, anoxic portion of the capillary rise
- Used in the SMP to determine seepage thresholds
Capillary Fringe

- Soil Surface
- Water Table
- Capillary Fringe
- Soil Moisture Gradient %
- Capillary Rise
- Soil Volumetric Water Content %

Preliminary draft – subject to change
The tension saturated capillary fringe is “compact,” meaning that soil moisture decreases abruptly above its upper limit.

Literature values for coarse soils generally agreed with the SMP, but literature values for fine soils are generally higher than in the SMP.

Modeled or laboratory capillary fringe in fine soils can reach multiple yards, however, field values for similar soils are typically lower.

Data for field studies are less prevalent because they are difficult to obtain.
Literature Review – Key Findings

• Capillary fringe varies temporally and spatially (within a few feet)
• Can be measured in the field using portable soil moisture instruments in situ or on extracted cores, however
  – Methods performance varies by soil type
  – Field study results can be variable
  – Experts indicate field measurement may only nominally improve literature capillary fringe estimates
Expert Consultation – Purpose

- Provide regional perspective
- Provide hands-on knowledge
- Comment on literature review findings
- Contribute to subject knowledge based on local and/or regional experience
Expert Consultation – Experts

• Dr. Jan Hopmans
  – Associate Dean International Programs Office Soil Physicist Professor of Vadose Zone Hydrology, UC Davis

• Dr. Robert Hutmacher
  – UCCE Specialist and Center Director West Side Research and Extension Center.

• Dr. Charles Burt
  – Retired Professor, Bioresource and Agricultural Engineering, Cal Poly San Luis Obispo; Chairman of Irrigation Training and Research Center

• Dr. Mark Grismer
  – Professor of Hydrology and Biological and Agricultural Engineering, UC Davis

• Dr. James Ayars
  – Agricultural Engineer, USDA ARS Parlier
Expert Consultation – Protocol

1. Phone conversation
2. Notes were sent to expert for review
3. Experts responded with any clarifications

Documentation of discussions with experts in October 2016 Phase 2 report on website
Expert Input – Recommendations

• The problem of determining capillary fringe is difficult
  – There is no simple solution

• There is no published literature on the exact level of oxygen that almond roots require
  – In this situation, the tension saturated zone (capillary fringe) is the only practical measurement that affects roots.
  – This can be observed in the field or in the lab
Expert Input – Recommendations

• Capillary fringe measurements will always be approximations because of variability
  – Difficult to find specific thresholds to apply generally because of site-specific conditions
Expert Input – Recommendations

• Published values of capillary rise
  – In various soil types are applicable to the SMP purpose
  – Are a good starting point
  – Should definitely be used to inform field investigations
  – Are likely accurate for coarse soils
  – May not be as accurate for fine soils
  – Are a good approximation and field investigation data may only improve these estimates incrementally
Data Review

- USBR data from well borings and soil logs

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of Observations</th>
<th>Average Thickness (Inches)</th>
<th>95% Confidence Range (Inches)</th>
<th>Anoxic Zone Thickness (Inches)</th>
<th>Anoxic Zone Adjustment (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sands, loamy sands</td>
<td>39</td>
<td>8.6</td>
<td>7.2 - 10.0</td>
<td>4.3</td>
<td>6</td>
</tr>
<tr>
<td>All other soils</td>
<td>160</td>
<td>17.0</td>
<td>15.5 - 18.5</td>
<td>8.5</td>
<td>12</td>
</tr>
</tbody>
</table>

Mica, please fill this in just to demonstrate that we did data review and it informed our adaptation of the cap fringe values table.
Capillary Fringe – Published Values

- Most widely cited values in Handbook of Soil Science (Sumner 1999)
  - Values derived from the work of Rawls and Brakensieck (1982, 1992)
  - Represent 1,320 soils in 32 states
  - Consulted 400 soil scientists
  - Various types of data
- Categorized into 11 texture-types from sand to clay
- Simplified/adapted for SMP
Proposed CF Values

• Values adapted from Handbook of Soil Science (Sumner 1999)
• Soil physical characteristics of fine and very fine sands result in greater CF
• Texture classes with very similar CF were grouped
Proposed CF Values

• Estimates focus on the tension saturated capillary fringe
• When an actively growing crop is present and is consuming water from the upper portion of the capillary fringe, the thickness of the capillary fringe would likely be less than tabular values
Current vs. Proposed SMP

• Currently, SMP provides two Capillary Fringe (CF) values
  – Coarse soils (0.5 ft)
  – Finer soils (1.0 ft)

• Capillary fringe information indicates more soil textural categories and CF depths are appropriate

Preliminary draft – subject to change
## Capillary Fringe – Proposed Values

<table>
<thead>
<tr>
<th>Soil Texture</th>
<th>Capillary Fringe (inches)</th>
<th>Capillary Fringe (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>Loamy sand; very fine sand; fine sand</td>
<td>8</td>
<td>0.7</td>
</tr>
<tr>
<td>Sandy loam; loamy very fine sand; loamy fine sand</td>
<td>12</td>
<td>1.0</td>
</tr>
<tr>
<td>Very fine or fine sandy loam; silt loam; loam</td>
<td>20</td>
<td>1.7</td>
</tr>
<tr>
<td>Sandy clay loam; clay loam</td>
<td>24</td>
<td>2.0</td>
</tr>
<tr>
<td>Silty clay loam</td>
<td>28</td>
<td>2.3</td>
</tr>
<tr>
<td>Sandy clay; silty clay</td>
<td>32</td>
<td>2.7</td>
</tr>
<tr>
<td>Clay</td>
<td>36</td>
<td>3.0</td>
</tr>
</tbody>
</table>

• Capillary fringe assignment:
  1. Identify USCS soil classifications from well logs at deep and shallow crop root zones
  2. Convert USCS to USDA soil textures
     • Using logs and soil gradation curves
  3. Assign capillary fringe value from proposed table of capillary fringe by soil texture
## GEOLOGIC LOG OF DRILL HOLE NO. MW-10-98

### NOTES

All measurements are in feet from the ground surface.

**Purposes of Hole:**
To recover core, collect data to determine geologic and hydrologic site conditions, and install a groundwater monitoring well.

**Location:**
Reach 481, RM 167, river left, about 160 feet south from the center of the SR, about one mile west of the intersection of Indian Road and the SR.

**Drilled By:**
PN-Regional Drill Crew
Kerry L. Kaiser, Inspector
Ken Kretz, Helper

**Drill Rig:**
Central Mining Equipment 75 drill rig (GME-75)

**Drilling & Sampling Methods:**
Drill hole MW-10-98 was advanced using hollow stem flight augers with a continuous dry core sampling system (FADC) from the ground surface to a total depth of 31.2 feet. FADC uses 7-5/8-inch O.D. 4-1/4-inch I.D. hollow stem augers, with a 5-foot-long, 3-inch I.D. split sample bar.

**Interval Method:**
0.0 to 31.2 feet - FADC

**Drilling Conditions and Driller's Comments:**
None

### LABORATORY DATA

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>% Core Recovery</th>
<th>% Silt</th>
<th>% Clay</th>
<th>% Silt</th>
<th>% Sand</th>
<th>% Gravel</th>
<th>Plasticity Index</th>
<th>Moisture Content</th>
<th>Laboratory Classification</th>
<th>Visual Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 to 3.4 feet</td>
<td>FILL (FI)</td>
<td>30.0</td>
<td>12.4</td>
<td>52.3</td>
<td>47.7</td>
<td>0.0</td>
<td>0.0</td>
<td>21.5</td>
<td>s(CL)</td>
<td>s(CL)</td>
</tr>
<tr>
<td>3.4 to 31.2 feet</td>
<td>QUATERNARY ALLUVIUM (Qcl)</td>
<td>30.0</td>
<td>12.4</td>
<td>52.3</td>
<td>47.7</td>
<td>0.0</td>
<td>0.0</td>
<td>21.5</td>
<td>s(CL)</td>
<td>s(CL)</td>
</tr>
</tbody>
</table>

### CLASSIFICATION AND PHYSICAL CONDITION

- **0.0 to 3.4 feet:** Sandy lean clay, s(CL): About 60% fine sand; about 40% fill with medium plasticity, toughness and dry strength, slow dewatering; maximum size: fine sand; dry, medium brown; no reaction to HCl; soft consistency; organic; fill embankment material.
- **3.4 to 31.2 feet:** Quaternary alluvium (Qcl): About 90% fine sand; about 10% fine sand; maximum size: fine sand; dry, dark brown; no reaction to HCl; soft consistency.

### Laboratory Data Interval

- **4.3 to 6.5 feet:**
  - 6.0 to 7.4 feet: Lean clay, CL: About 90% fill with medium plasticity, toughness and dry strength; no dilatancy; about 10% fine sand; maximum size: fine sand; dry, dark brown; no reaction to HCl; firm consistency.

- **7.4 to 13.2 feet:** Sandy silty clay, s(CL/ML): About 60% fines with medium plasticity, low toughness, medium dry strength, rapid dewatering, about 40% fine sand; maximum size: fine sand; moist, brown; no reaction to HCl; soft consistency.

**Preliminary draft – subject to change**
2017 SMP Revisions – Ag. Thresholds

USDA Soil Textures

Preliminary draft – subject to change
2017 SMP Revisions – Ag. Thresholds

• In most wells, the capillary fringe value is the same for both crop root zone categories. If different, use the largest value.

• Example: MWV-10-98

<table>
<thead>
<tr>
<th>Depth Interval (ft)</th>
<th>USCS texture</th>
<th>USDA texture</th>
<th>Capillary Fringe (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.6 – 7.4</td>
<td>Lean clay, CL</td>
<td>Clay loam</td>
<td>2.0</td>
</tr>
<tr>
<td>7.4 – 13.2</td>
<td>Sandy silty clay, s(CL/ML)</td>
<td>Loam</td>
<td>1.7</td>
</tr>
</tbody>
</table>

– Capillary fringe assignment: 2.0 ft
## 2017 SMP Revisions

### Current 2016 Restoration Flows

<table>
<thead>
<tr>
<th>Zone</th>
<th>Current Flows</th>
<th>Proposed Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Almond Root Zone</strong></td>
<td>9 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td><strong>Capillary Fringe</strong></td>
<td>0.5 or 1 ft</td>
<td>0.5 to 3.0 ft (soil dependent)</td>
</tr>
<tr>
<td><strong>Net Almond Agricultural</strong></td>
<td>9 to 10 ft</td>
<td>6 to 9 ft</td>
</tr>
<tr>
<td><strong>Threshold Change</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net Row Crop Agricultural</strong></td>
<td>4 to 6 ft</td>
<td>4 to 8 ft</td>
</tr>
<tr>
<td><strong>Threshold Change</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preliminary draft – subject to change
Comments?

• We would like to hear your thoughts on these changes
• We have incorporated input from the subcommittee
Purpose

- Account for slope of groundwater table away from the river

Note: The values 1-7 reference columns in the new Flow Bench report format.

Figure J-2 from SMP Appendix J

Preliminary draft – subject to change
Threshold – Historical Method

- Monitoring Well
- Ground Surface Buffer
- Well Threshold
- Well Threshold - GS Buffer
- Lateral Gradient Buffer
- Field Threshold
- Ground Surface
- Low Point in Field
- Within 750 ft of well
- Groundwater Table

Preliminary draft – subject to change
Threshold – Agricultural Method

Low Point in Field Within 750 ft of well

Ground Surface

Root Zone

Capillary Fringe

Field Threshold

Groundwater Table

Edge of Field

Monitoring Well

Ground Surface Buffer

Field Threshold + GS Buffer

Lateral Gradient Buffer

750 ft

Preliminary draft – subject to change
Lateral Gradient Calculation

1. Identified well transects
2. Calculated the river water surface elevation
3. Calculated groundwater table elevation
4. Calculated slope of the groundwater table from the edge of the river to the well
5. Assumed the same slope from well to field
6. Multiplied slope by distance from well to field
Selecting wells

1. Identifying well transects

   - For key groundwater wells evaluated in flow bench evaluations
Calculating elevations

2. Calculated the river water surface elevation
   – Staff gage data

3. Calculated groundwater table elevation
   – Groundwater monitoring data
Calculating groundwater table slope

4. Calculated slope of the groundwater table from the edge of the river to the well

San Mateo Ave - Reach 2B

Distance from SJR (feet)

Preliminary draft – subject to change
Calculating drop to field

5. Assumed the same slope from well to field
6. Multiplied slope by distance from well to field
### Table H-1. Difference Between Well and Field Groundwater Elevations

<table>
<thead>
<tr>
<th>Well</th>
<th>Reach</th>
<th>Bank</th>
<th>Minimum Difference (feet)</th>
<th>Maximum Difference (feet)</th>
<th>Average Difference (feet)</th>
<th>Lateral Gradient Buffer (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA-9</td>
<td>2A</td>
<td>Left</td>
<td>-2.1</td>
<td>4.5</td>
<td>-1.1</td>
<td>0.0</td>
</tr>
<tr>
<td>MA-4</td>
<td>2A</td>
<td>Right</td>
<td>-1.2</td>
<td>7.1</td>
<td>1.6</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-09-47</td>
<td>2A</td>
<td>Right</td>
<td>-15.0</td>
<td>18.3</td>
<td>-7.7</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-09-49B</td>
<td>2A</td>
<td>Left</td>
<td>-7.3</td>
<td>-0.1</td>
<td>-1.7</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-09-54B</td>
<td>2B</td>
<td>Right</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-09-55B</td>
<td>2B</td>
<td>Left</td>
<td>6.5</td>
<td>9.6</td>
<td>7.2</td>
<td>6.5</td>
</tr>
<tr>
<td>MW-09-87B</td>
<td>4A</td>
<td>Left</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-10-75</td>
<td>3</td>
<td>Left</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-10-89</td>
<td>4A</td>
<td>Right</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-10-92</td>
<td>4A</td>
<td>Left</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-10-94</td>
<td>4B1</td>
<td>Right</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-11-130</td>
<td>4A</td>
<td>Left</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-11-142</td>
<td>4B1</td>
<td>Right</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-12-191</td>
<td>3</td>
<td>Right</td>
<td>-0.5</td>
<td>0.6</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>MW-14-208</td>
<td>4A</td>
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</tr>
</tbody>
</table>

**Notes:**
1. Difference is calculated as the slope of (1) the river stage adjacent to the monitoring well to the groundwater level in the well (if there is flow in the river) or (2) the assumed water table under the river and the groundwater level in the well (no flow in the river), times the distance between the monitoring well and the adjacent field.

Preliminary draft – subject to change
Threshold Calculation

• Relates the threshold in the well to the threshold in the field.

\[
\text{Threshold}_{\text{field}} = \text{Threshold}_{\text{well}} - GS_{\text{Buffer}} + LG_{\text{Buffer}}
\]

\[
\text{Threshold}_{\text{well}} = \text{Threshold}_{\text{field}} + GS_{\text{Buffer}} - LG_{\text{Buffer}}
\]

• \(GS_{\text{Buffer}}\): Difference in elevation between well and field
  – Positive when the well is above the field elevation

• \(LG_{\text{Buffer}}\): Accounts for GW table slope
  – Positive when the section of the river is a losing reach (groundwater table slopes away from the river)
• MW-09-55B is the only well with a proposed lateral gradient buffer
• Lateral gradients were previously in the SMP in Appendix J, now updated with more recent data and in Appendix H

• We would like to hear your thoughts on these changes
• Are there better ways to present this concept?
HISTORICAL GROUNDWATER METHOD
Purpose

• Account for pre-existing shallow groundwater conditions adjacent to some parts of the river
Explanation

• Restoration Program is not responsible for improving groundwater conditions that existed prior to the SJRRP

• Periods without Restoration or flood flow provide a reasonable estimate of historical conditions where pre-SJRRP data is unavailable

• Utilize best available information and update as we get more data
  – Include 4 years of data with no Restoration or flood flow in the San Joaquin River
Historical Groundwater Method

- 4 methods:
  1) Long-term record  
     • No change proposed
  2) Nearby long-term record  
     • No change proposed
  3) Depth to water interpolations  
     • No change proposed
  4) January / February 2012  
     • Proposed change: December 2011 – January 2016  
     • For wells in Reach 3 and downstream
4-year period

• Flood flows damage crops, and while part of the pre-SJRRP hydrology, are not what controls farming
  – No floods from December 2011 – January 2016
• San Luis Canal Company deliveries are included
  – Part of historical condition
• During drought – low groundwater levels
  – Low groundwater levels = deeper thresholds, more protective of crops
No Restoration Flows or Flood Flows
Average Groundwater Level?

- This results in the SJRRP keeping groundwater levels lower than without the SJRRP
- This improves the groundwater condition, not the
Shallowest groundwater level?

This may result in picking an outlier point that could have had measurement error, nearby flood irrigation or some other issue.
Shallowest of 3-point moving average

- Avoids potential outlier issue

Preliminary draft – subject to change

MW-10-92
Shallowest Measurement

December 2011 through January 2016

Manual Measurements
3-Point Moving Average of Measurements

Shallowest Value

December 2011 through January 2016

Depth to Water from Ground Surface (ft.)

Manual Measurements

Calculated 3-Point Average

Preliminary draft – subject to change
Historical Threshold Method C4

Table H-9 in the SMP shows all the historical threshold method values

December 2011 through January 2016
Number of Wells Affected

- Most thresholds calculated based on agricultural practices (root zone + capillary fringe)
- Second most thresholds calculated by this method

<table>
<thead>
<tr>
<th>Threshold Method</th>
<th>Number of Wells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Practices</td>
<td>137</td>
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<tr>
<td>Historical Groundwater Method A</td>
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<tr>
<td>Historical Groundwater Method B</td>
<td>0</td>
</tr>
<tr>
<td>Historical Groundwater Method C</td>
<td>109</td>
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<tr>
<td>Method C1, CCID Well</td>
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</tr>
<tr>
<td>Method C2, 1999</td>
<td>1</td>
</tr>
<tr>
<td>Method C3, 2009</td>
<td>5</td>
</tr>
<tr>
<td>Method C4 (Dec/2011 – Jan/2016)</td>
<td>95</td>
</tr>
</tbody>
</table>
Comments?

• We would like to hear your thoughts on this method

• Are there factors we did not take into consideration?
• Is there other information we should consider?
## Agricultural Threshold Changes

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Almond Root Zone</strong></td>
<td>9 ft</td>
<td>6 ft</td>
</tr>
<tr>
<td><strong>Capillary Fringe</strong></td>
<td>0.5 or 1 ft</td>
<td>0.5 to 3.0 ft (soil dependent)</td>
</tr>
<tr>
<td><strong>Net Almond Agricultural Threshold Change</strong></td>
<td>9 to 10 ft</td>
<td>6 to 9 ft</td>
</tr>
<tr>
<td><strong>Net Row Crop Agricultural Threshold Change</strong></td>
<td>4 to 6 ft</td>
<td>4 to 8 ft</td>
</tr>
</tbody>
</table>

Preliminary draft – subject to change
Historical Groundwater Threshold Changes

– Shallowest of 3-point moving average
Comments?

• We would like to hear your thoughts on the changes

• Are there factors we did not take into consideration?

• Is there other information we should consider?
WRAP-UP, ACTION ITEMS
Contact

- Technical Feedback Group: Katrina Harrison
  - 916-978-5465
  - KHarrison@usbr.gov

- Seepage Concerns: Seepage Hotline
  - 916-978-4398
  - RestorationFlows@restoresjr.net