SJRRP Flow Bench Evaluation

December 22, 2017

A revised Restoration Administrator (RA) Recommendation was received on December 21, 2017. The RA recommendation calls for 240 cfs of Restoration Flow at Gravelly Ford effective upon approval. The recommendation also includes increasing flows and the target at Sack Dam throughout the remainder of the Restoration Year. Adjustments from Friant Dam are projected in the RA recommendation, and are summarized in Table 1 below. Reservoir releases will be increased to provide a sufficient Mendota Pool inflow credit that allows increases at Sack Dam in 10 cfs increments over the next two months pending continuous analysis of groundwater conditions. As of December 22, the Mendota Pool inflow credit is approximately 147 cfs. As the Mendota Pool inflow credit increases, the target at Sack Dam will subsequently increase as listed in Table 1. This Flow Bench Evaluation analyzes the anticipated flow changes and outlines monitoring to prevent material adverse impacts from groundwater seepage on adjacent lands.

As of December 22, 2017:

1. Channel conveyance: Flow rates are below known conveyance thresholds.

2. Operations Conference Call: An operations call was held on December 20, 2017. With the updated RA recommendation, flows are expected to increase throughout the Restoration Area.

3. Seepage Hotline Calls: The seepage hotline has received no calls regarding Restoration Flows in Water Year 2018.

4. Real-time wells: All telemetered groundwater monitoring well levels are below Seepage Management Plan (SMP) thresholds except for MW-09-49B. This well does not restrict releases since the projected groundwater elevation is below threshold when accounting for the lateral gradient.

5. Priority wells: Weekly groundwater measurements in priority wells, Table 3, indicate that most wells are below well thresholds. MW-09-47, MA-4, and MW-09-49B are projected to be below threshold due to the lateral gradient from the channel. MW-14-208 is near its well threshold, but a hand auger in field measurement from December 22, 2017 indicates the groundwater elevation is below the field threshold (see Analysis). A groundwater gradient map was also prepared to further characterize the site (Figure 1).

Table 1. The following plan is the proposed sequence to maximize Restoration Flow releases from Sack Dam while adhering to the Seepage Management Plan and protecting agricultural fields adjacent to the San Joaquin River from seepage impacts.

Planned Mendota Dam Flow Change Date (0900)	**Planned Sack Dam Flow (cfs)**	Estimated Minimum Friant Release to support Sack Dam Release (cfs)	Date Flow Reaches Sack Dam	Date Flow Reaches Washington Avenue	10 days of stabilization	Planned date of in-field boring (within 1 day of stabilization)	Planned next notification to Mendota Pool and Sack Dam operators (1500)
12/12/17	**140**	375	12/13/17	12/14/17	12/23/17	12/22/17	12/22/17
12/23/17	**150**	380	12/24/17	12/25/17	1/3/18	1/4/18	1/4/18
1/5/18	**160**	390	1/6/18	1/7/18	1/16/18	1/17/18	1/18/18
1/19/18	**170**	405	1/20/18	1/21/18	1/30/18	1/31/18	2/1/18
2/2/18	**180**	415	2/3/18	2/4/18	2/13/18	2/14/18	2/15/18
2/16/18	**190**	425	2/17/18	2/18/18	2/27/18	2/28/18	3/1/18
3/1/18	2018 Restoration Year						

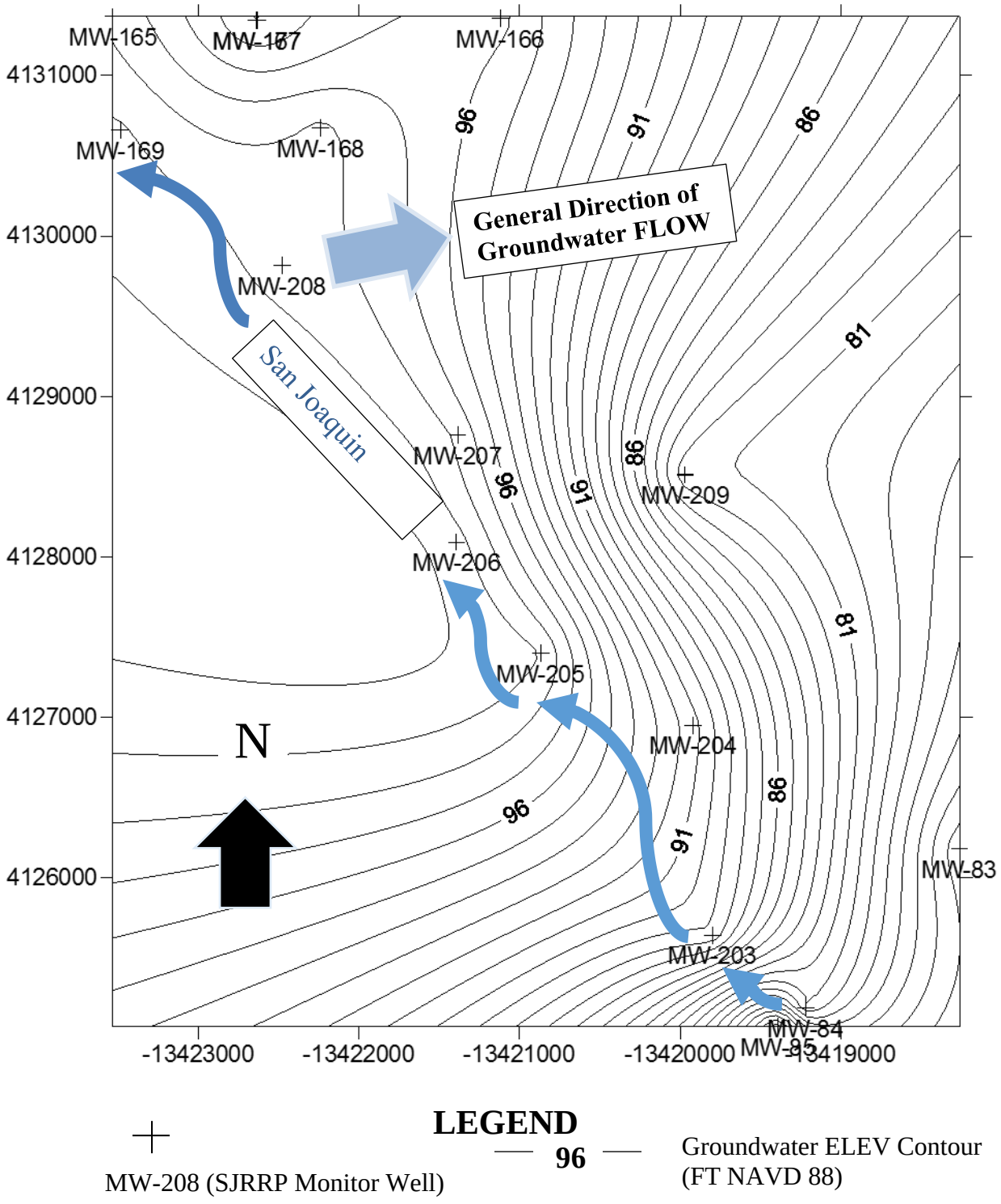

Figure 1. Contour Map showing groundwater gradient and general direction of groundwater flow on the property near SJRRP Monitor Well MW-14-208 during December 2017. The water-table slopes away from the San Joaquin River near MW-14-208 at a rate of over 4 feet per mile.

6. Flow Stabilization: Flows in the system have been stable with a constant release of 375 cfs from Friant Dam; however, flow changes are still subject to occur at the reservoir and downstream due to operations at Mendota Pool and Sack Dam, as evaluated here.

7. Projected Groundwater Level Changes: Groundwater levels are predicted to remain stable through Reach 3, potentially even decreasing with falling demand at Arroyo Canal. Reach 4A, below Sack Dam, is projected to have a minor increase in groundwater levels due to the recommendation of 150 cfs past Sack Dam. All groundwater well levels are still projected to be below threshold by the Observed Groundwater Level Method (Appendix J). The Observed Groundwater Level Method conservatively applies the change in stage observed in the river to the groundwater elevation.

8. Levees: LSJLD has not expressed concerns about the projected flow increases.

9. Water Districts: The SJRECWA has not identified any operational concerns.

Data

Table 2 shows the groundwater depth in five real-time wells and eight manual measurements from field staff as reported in the weekly groundwater report with a publish date for the week ending December 23, 2017. Reclamation publishes the weekly groundwater report with manual measurements via electronic well sounder and recent flow data on the SJRRP website HERE. To calculate field depths, Reclamation adds ground surface buffers and lateral gradient buffers to measured groundwater depths in the well (Figure 2, Equation 1).

$$Field\ Depth_{Current} = D_{well} - GS_{Buffer} + LG_{Buffer} \quad (1)$$

Where:

$Field\ Depth_{Current}$	Current groundwater level depth in the field
D_{Well}	Current groundwater level depth as measured in the monitoring well
GS_{Buffer}	Ground surface buffer, or the difference in elevation between the well and the field
LG_{Buffer}	Lateral gradient buffer, to account for losing reaches where the groundwater table slopes away from the river (if any)

Table 2. Current Well Data

Well	Reach	1 - Measured Groundwater Depth in Well (feet bgs)	2 - Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 - Field GW Depth (feet bgs)	5 - Field Threshold (feet bgs)	Comment
FA-9	2A	8.9	2.0	2.5	9.4	6.0	Acceptable
MW-09-47	2A	8.5	2.5	3.3	9.3	6.5	Acceptable
MA-4	2A	10.9	6.1	4.6	9.4	7.0	Acceptable
MW-09-49B	2A	5.9	1.7	2.4	6.6	5.5	Acceptable
MW-09-54B	2B	16.3	7.9	5.5	13.9	7.0	Acceptable
MW-09-55B	2B	9.4	3.7	3.0	8.8	5.5	Acceptable
PZ-09-R3-5	3	10.8	1.2	0.0	9.7	5.7	Acceptable
MW-12-191	3	12.1	1.0	0.0	11.1	6.5	Acceptable
PZ-09-R3-7	3	8.6	0.7	0.0	7.9	6.5	Acceptable
MW-10-75	3	17.4	0.5	0.2	17.1	8.0	Acceptable
MW-14-208	4A	6.5	1.0	0.0	5.5	5.5	Acceptable*
MW-10-89	4A	10.8	1.0	0.0	9.8	6.5	Acceptable
MW-10-92	4A	8.8	1.0	0.0	7.8	4.8	Acceptable

bgs = below ground surface; GW = groundwater
*See Analysis for discussion of MW-14-208

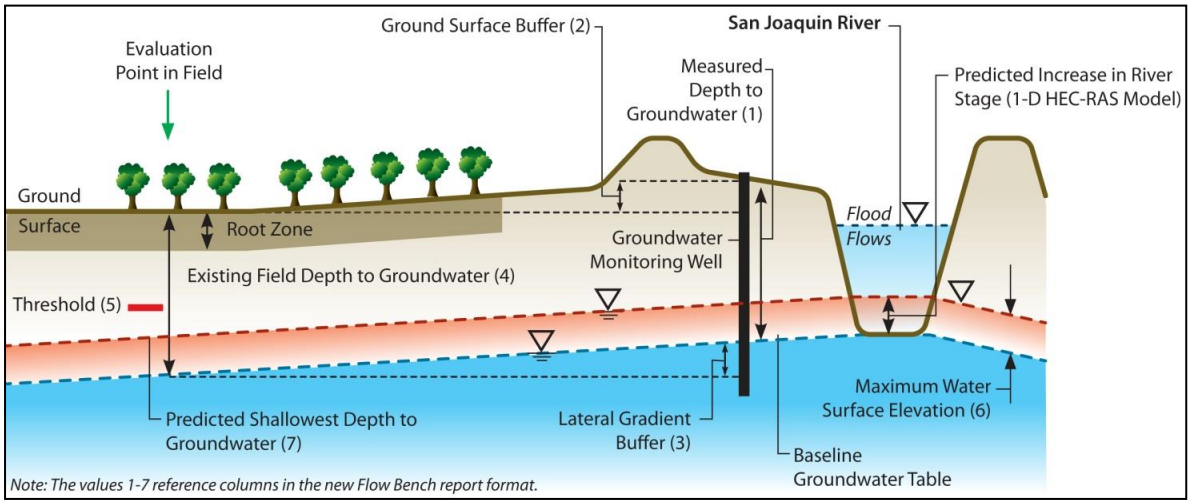

Figure 2. Conceptual Model for Observed Groundwater Level Method

Table 3 shows the anticipated flow rates used to evaluate future groundwater depths. Reclamation calculated losses from Friant Dam to Mendota Pool based on the long-term pattern established by Exhibit B. San Luis Canal Company demands were also accounted for in Reach 3 using the most recent operations report sent December 17. Pre-condition flows are based on December 22 data. The comparison of pre-condition and projected flows informs the estimated result of increasing the Sack Dam target by the first 10 cfs increment of the recommendation.

Table 3. Anticipated Change in Flows.

	Pre-condition Flows (cfs)	Projected Flows for Evaluation (cfs)
Reach 1	375	380
Reach 2A	260	265
Reach 2B	180	185
Reach 3	285	275
Reach 4A	140	150

Table 5 shows the rise in groundwater based on estimated changes in river stage and the conceptual model shown in Figures 2 and 4. Field depths are calculated by taking the most recent measurements from Table 2, adding the ground surface and the lateral gradient buffers, and subtracting the maximum predicted stage increase (Equation 2).

$$Field\ Depth_{Predicted} = Field\ Depth_{Current} - WSEL_{Max\ Increase} \quad (2)$$

Analysis

All thirteen priority groundwater monitoring wells are predicted to remain below seepage thresholds, with most currently below thresholds at present.

Groundwater levels below Sack Dam were analyzed, and found to remain below the thresholds identified in the Seepage Management Plan for flows of 150 cfs, as shown in Table 5. The Observed Groundwater Level Method (Figure 2) estimates the predicted water surface elevation in the river from the 1-D HEC-RAS model (Tetra Tech 2009).

Initial measurements at MW-14-208 indicated that the groundwater was near its well threshold of 6.5 ft. To inform whether or not an increase of 10 cfs at Sack Dam would impact this site, a field measurement was taken on December 22, 2017. The hand auger boring in field was drilled at the edge of the recently harvested tomato field, located approximately 150ft east of MW-14-208. The boring was terminated at a depth of 6ft below ground surface in a dense sandy clay strata that was dry. The field threshold at this location has been determined to be 5.5ft below ground surface. The boring confirms at least a 0.5ft buffer below the field threshold. The maximum predicted water surface elevation increase from Table 5 is 0.3ft, and therefore below the threshold.

The SJRRP will continue weekly monitoring of groundwater wells to track the influence of Restoration Flows, and will update this analysis if any changes to Restoration Flows are recommended. Follow-up monitoring is specifically scheduled at MW-14-208 to closely track the response of the proposed 10 cfs increases past Sack Dam. The attached RA recommendation includes monitoring dates at the MW-14-208 site. Monitoring will occur with each proposed increase after approximately 10 days to allow for stabilization, and will include a hand auger boring in field.

A stage and discharge relationship for the Washington Avenue gage (SWA) located downstream of MW-14-208, and based on 2016 and 2017 gage data, indicates that from a baseline of 140 cfs past Sack Dam (current conditions), the 0.5 ft buffer currently measured in field would not be exceeded until releases closer to 190 cfs past Sack Dam (Figure 3, Table 4). This supports the current RA recommendation and will be confirmed with field observations after each scheduled flow change.

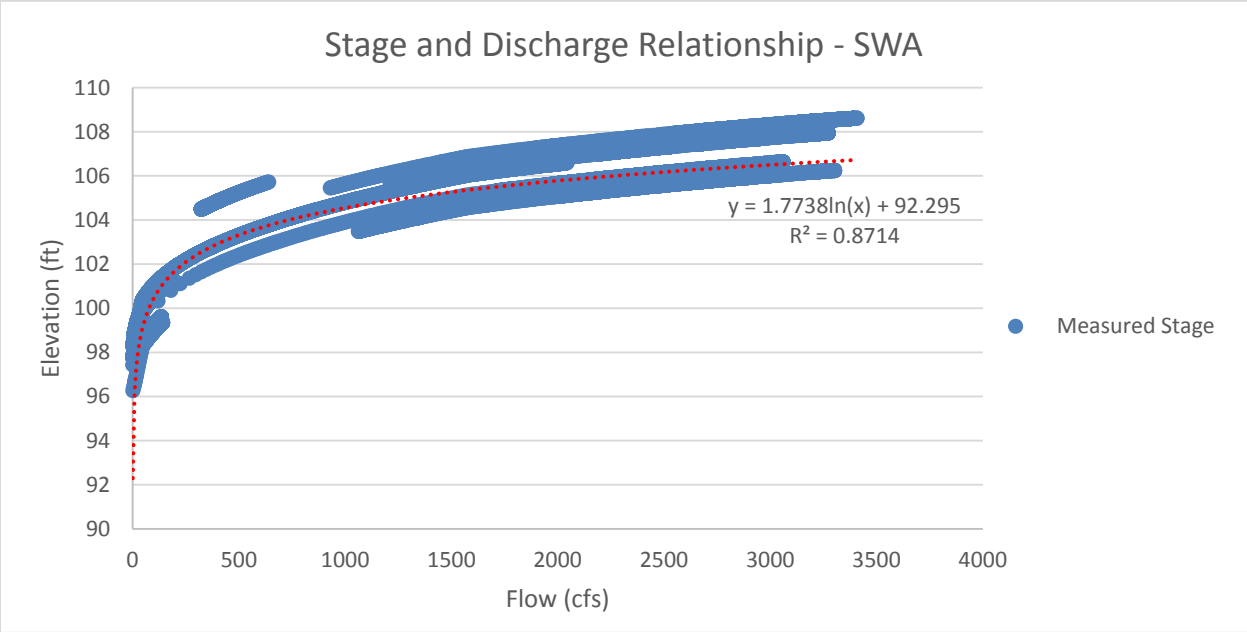

Figure 3. Stage and Discharge Relationship at SWA Gage

Table 4. Predicted Stage Increases with the Current RA Recommendation

Flow	Predicted stage difference (ft)
140	-
150	0.1
160	0.2
170	0.3
180	0.4
190	0.5

Summary

This analysis in combination with recent field measurements, indicates acceptable conditions for the target of 150 cfs past Sack Dam and potentially up to the recommendation of 190 cfs. The maximum allowable flow below Sack Dam is currently limited by conditions at MW-14-208. Therefore, conditions at this site will be closely monitored in response to the proposed flow changes so as not to exceed threshold. No additional flow bench evaluations will be posted unless either 1) the field borings near MW-14-208 reach, or are expected to reach, the field threshold, 2) other wells reach or are expected to reach a threshold with the planned increases, or 3) flow recommendations deviate from the incremental increases indicated in Table 1.

Table 5. Predicted Groundwater Levels for Priority Wells

Well	Reach	1 - Measured Groundwater Depth in Well (feet bgs)	2 - Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 - Field GW Depth (feet bgs)	6 - Maximum Predicted WSEL Increase (feet)	7 - Predicted Shallowest GW Depth (feet bgs)	5 - Field Threshold (feet bgs)	Comment
FA-9	2A	8.9	2.0	2.5	9.4	0.0	9.4	6.0	Acceptable
MW-09-47	2A	8.5	2.5	3.3	9.3	0.0	9.3	6.5	Acceptable
MA-4	2A	10.9	6.1	4.6	9.4	0.0	9.4	7.0	Acceptable
MW-09-49B	2A	5.9	1.7	2.4	6.6	0.0	6.6	5.5	Acceptable
MW-09-54B	2B	16.3	7.9	5.5	13.9	0.0	13.9	7.0	Acceptable
MW-09-55B	2B	9.4	3.7	3.0	8.8	0.0	8.7	5.5	Acceptable
PZ-09-R3-5	3	10.8	1.2	0.0	9.7	0.0	9.7	5.7	Acceptable
MW-12-191	3	12.1	1.0	0.0	11.1	-0.1	11.2	6.5	Acceptable
PZ-09-R3-7	3	8.6	0.7	0.0	7.9	0.0	7.9	6.5	Acceptable
MW-10-75	3	17.4	0.5	0.2	17.1	0.0	17.1	8.0	Acceptable
MW-14-208	4A	6.5	1.0	0.0	5.5	0.3	5.1	5.5	Acceptable*
MW-10-89	4A	10.8	1.0	0.0	9.8	0.3	9.5	6.5	Acceptable
MW-10-92	4A	8.8	1.0	0.0	7.8	0.2	7.6	4.8	Acceptable

bgs = below ground surface; GW = groundwater; WSEL = water surface elevation

*See Analysis for discussion of MW-14-208

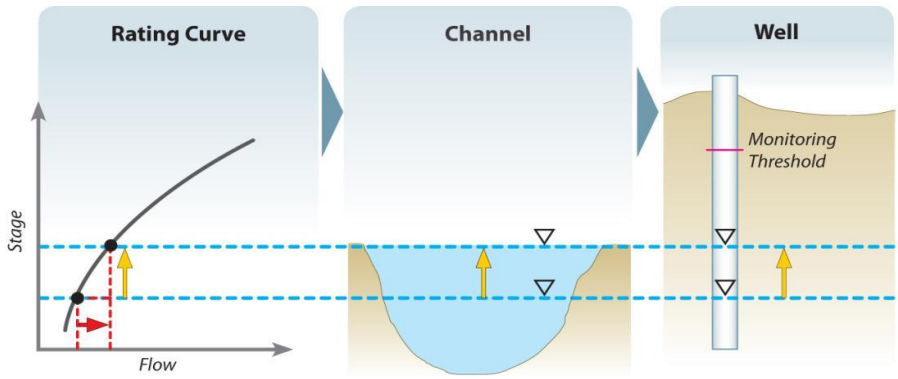

Figure 4. Conceptual Relationship between River Stage and Groundwater Levels

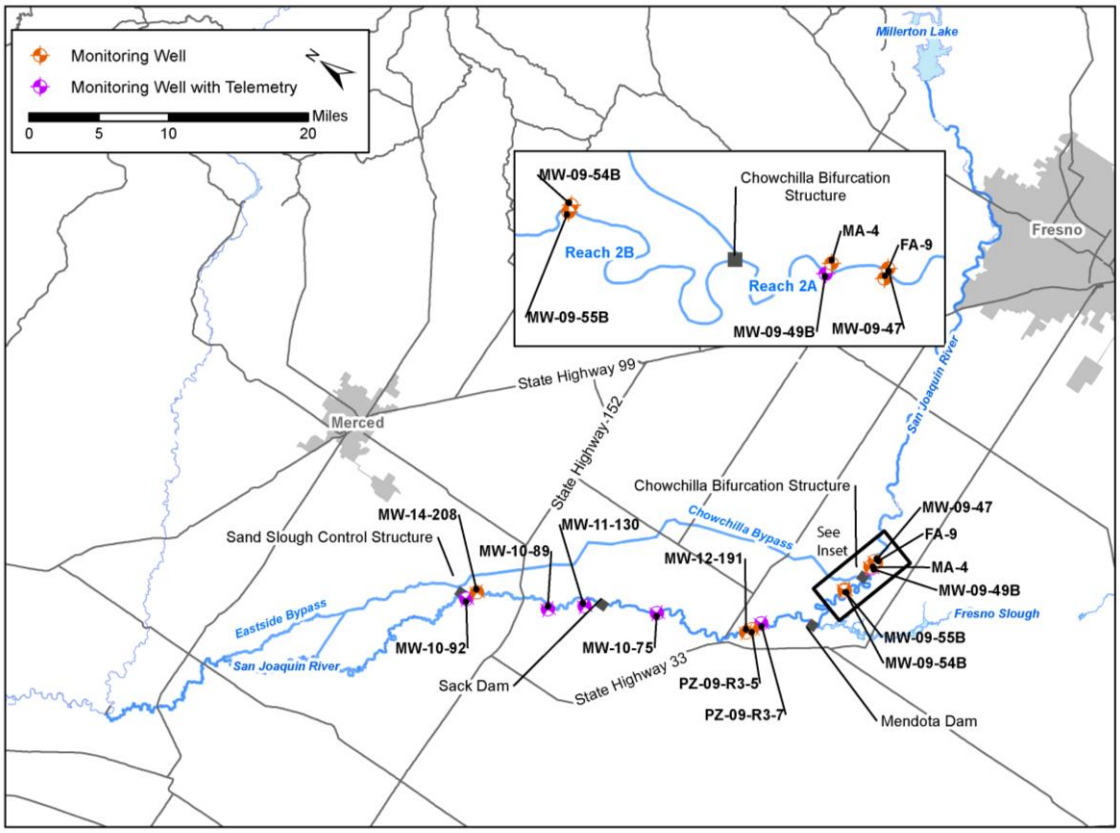

Figure 5. Priority Monitoring Well Locations