# SJRRP Flow Bench Evaluation

August 4, 2017

The Restoration Administrator (RA), as of August 4, 2017, continues to recommend Restoration Flow releases of no less than 125 cfs past Gravelly Ford through August 31, 2017. The recommendation also includes a release of no less than 43 cfs past Sack Dam, specifying that any additional Restoration Flows that arrive at Mendota Pool in excess of the Sack Dam target also be released downstream. Groundwater levels continue to drain and decrease due to the end of flood operations. The combined release from Friant Dam, including Restoration Flows and holding contract releases, will remain at least 350 cfs. As of August 4, a 350 cfs release from Friant Dam is resulting in approximately 220 cfs at Gravely Ford, and a Mendota Pool inflow credit of approximately 150 cfs. This provides for Sack Dam releases to be higher than 43 cfs, potentially up to the Mendota Pool inflow credit. This Flow Bench Evaluation continues to evaluate the transition from flood flows to Restoration Flows, which took effect on July 21, 2017, per Section J.3 of the Seepage Management Plan.

As of August 4, 2017:

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

2. Operations Conference Call: An operations call was held on August 2, 2017. No issues were raised. Stakeholders have been notified of the switch to Restoration Flows.

3. Seepage Hotline Calls: The seepage hotline has received no calls regarding Restoration Flows in Water Year 2017. Groundwater well observations emailed to Reclamation on August 3, 2017 from a Reach 4A landowner will be responded to as a hotline call.

4. Real-time wells: All telemetered groundwater monitoring well levels are below thresholds except for MW-09-49B. This well does not restrict releases since the projected groundwater elevation will fall below threshold with the current RA Recommendation.

5. Priority wells: Weekly groundwater measurements in priority wells, Table 3, indicate that most wells are below thresholds. MW-09-47, MA-4, and MW-09-49B are projected to be below threshold with the decrease in river stage. PZ-09-R3-7 and MW-14-208 are projected to be below threshold by the drainage method (refer to Appendix J of the Seepage Management Plan).

6. Flow Stabilization: Flows in the system are not currently stable, and are decreasing from flood control releases. Since January 4, 2017, Friant Dam has been releasing flood flows. For the first week of July, flood flows were at 2,500 cfs. Flows ramped up to as high as 3,500 cfs in the second week of July and ramped back down to 2,150 cfs. For the third week, releases from Friant reduced to 500 cfs and fell to 350 cfs on July 20, 2017. On July 21, 2017, flood flows ceased and Restoration Flows resumed, continuing the 350 cfs Friant Release. Groundwater levels have been in flux due to the recent decrease in flow.

7. Projected Groundwater Level Changes: Groundwater levels are predicted to continue to fall as a result of transitioning to Restoration Flows, with flow rates lower than recent flood control releases. The Reach 3 and Reach 4A priority wells are projected to have a

minimal increase in elevation with Sack Dam releases ranging from 43 cfs to 129 cfs. All groundwater well levels are still projected to be below threshold by the Observed Groundwater Level Method or the Drainage Method (Appendix J). The Observed Groundwater Level Method applies the change in stage observed in the river to the well elevation. The Drainage Method accounts for sufficient drainage from the well to the river channel.

8. Levees: LSJLD has not expressed concerns about this flow increase.

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

# 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 up to 129 cfs, as shown in Tables 2 and 3 below. The Drainage Method uses the same type of relationships (i.e., rating curves) as in the Groundwater Level Method (Figure 1) to estimate the predicted water surface elevation in the river from the 1-D HEC-RAS model (Tetra Tech 2009). The Drainage Method (Figure 2) then uses the predicted water surface elevation and compares this to the elevation of the threshold. If the predicted water surface elevation is more than 0.3 feet below the threshold elevation it is assumed that drainage from the field to the river will still be able to occur given the change in flow in the river. If the predicted water surface elevation is above the threshold elevation or within 0.3 feet of the threshold elevation, then drainage cannot occur with certainty and the proposed Restoration Flows would need to be re-evaluated.

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. Real-time monitoring equipment that required removal during flood flows will also be restored. Staff gages will be monitored closely along with groundwater levels to ensure that water surface elevations in the river do not impede drainage of groundwater.

# Data

Table 1 shows the groundwater depth in three real-time wells and ten manual measurements from field staff as reported in the weekly groundwater report with a publish date for the week ending August 5, 2017. Reclamation publishes the weekly groundwater report with manual measurements via electronic well sounder and recent flow data on the SJRRP website at: http://www.restoresjr.net/monitoring-data/groundwater-monitoring/. To calculate field depths, Reclamation adds ground surface buffers and lateral gradient buffers to measured groundwater depths in the well (Figure 1, 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 1. 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 | 8.2 | 2.0 | 2.5 | 8.7 | 6.0 | Acceptable |
| MW-09-47 | 2A | 7.7 | 2.5 | 3.3 | 8.5 | 6.5 | Acceptable |
| MA-4 | 2A | 11.2 | 6.1 | 4.6 | 9.7 | 7.0 | Acceptable |
| MW-09-49B | 2A | 5.3 | 1.7 | 2.4 | 6.0 | 5.5 | Acceptable |
| MW-09-54B | 2B | 16.0 | 7.9 | 5.5 | 13.6 | 7.0 | Acceptable |
| MW-09-55B | 2B | 8.9 | 3.7 | 3.0 | 8.3 | 5.5 | Acceptable |
| PZ-09-R3-5 | 3 | 9.2 | 1.2 | 0.0 | 8.0 | 5.7 | Acceptable |
| MW-12-191 | 3 | 10.6 | 0.0 | 0.0 | 10.6 | 7.0 | Acceptable |
| PZ-09-R3-7 | 3 | 7.1 | 0.7 | 0.0 | 6.4 | 6.5 | Acceptable by Drainage |
| MW-10-75 | 3 | 18.4 | 0.5 | 0.2 | 18.1 | 8.0 | Acceptable |
| MW-14-208 | 4A | 6.1 | 0.0 | 0.0 | 6.1 | 7.0 | Acceptable by Drainage |
| MW-10-89 | 4A | 11.7 | 1.0 | 0.0 | 10.7 | 6.5 | Acceptable |
| MW-10-92 | 4A | 7.8 | 1.0 | 0.0 | 6.8 | 4.8 | Acceptable |

bgs = below ground surface; GW = groundwater

Table 2 shows the anticipated flow rates used to evaluate future groundwater depths. Reclamation calculated losses from Friant Dam to the Mendota Pool based on the long-term pattern established by Exhibit B. Actuals were used at gage locations in Reach 1, 2A, 2B as of 0000 (12:00 am) on July 20 to account for conditions prior to the transition of Restoration Flows. San Luis Canal Company demands were also accounted for in Reach 3 flows. Reaches 1, 2A and 2B currently represent higher flows than anticipated in steady-state conditions for a 350 cfs Friant release.

**Table 2. Anticipated Change in Flows**

| | Recent Flows (cfs) | Projected Flows for Evaluation (cfs) |
|---|---|---|
| Reach 1 | 496 | 350 |
| Reach 2A | 671 | 220 |
| Reach 2B | 625 | 150 |
| Reach 3 | 542 | 569 |
| Reach 4A | 42 | 129 |

Table 3 shows the current and maximum rise in groundwater based on estimated changes in river stage and the conceptual models shown in Figure 1 and Figure 2. Field depths are calculated by taking the most recent measurements from Table 1, adding the ground surface and the lateral gradient buffer, and subtracting the maximum predicted stage increase (Equation 2).

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

This analysis shows acceptable conditions for the maximum allowable flow below Sack Dam, 129 cfs. Actual Restoration Flow amounts below Sack Dam will depend on Restoration Flow inflow to Mendota Pool, and may vary between 129 cfs and 43 cfs as inflow recedes.

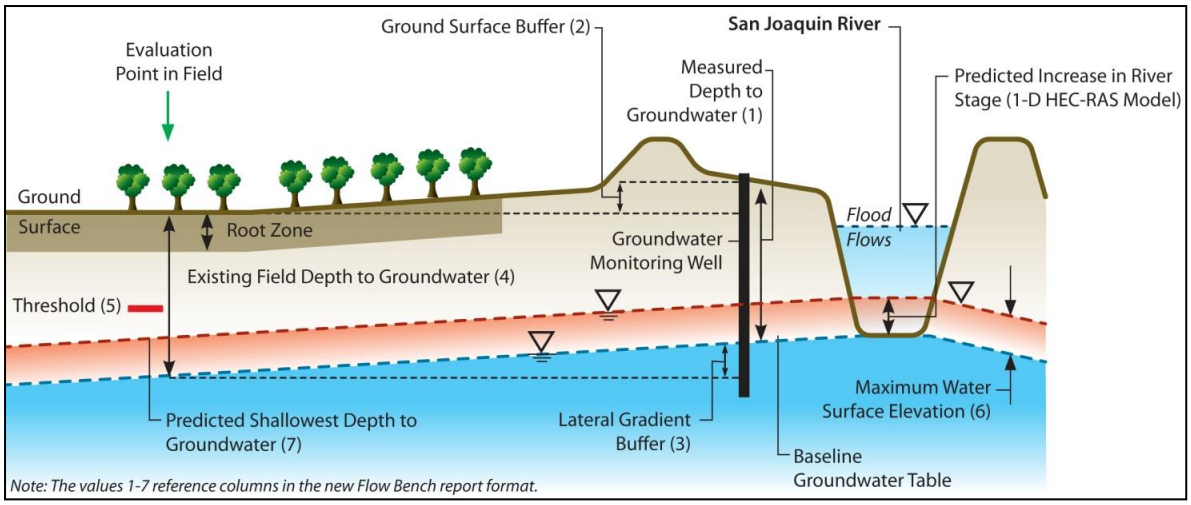



**Figure 1. Conceptual Model for Observed Groundwater Level Method**

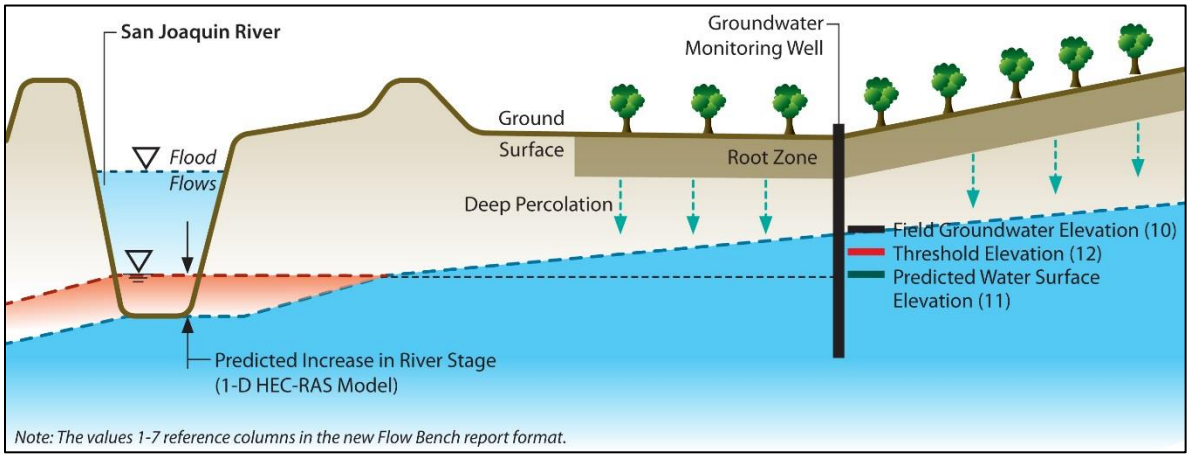



**Figure 2. Conceptual Model for Drainage Method**

**Table 3. 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 | 8.2 | 2.0 | 2.5 | 8.7 | -1.4 | 10.1 | 6.0 | Acceptable |
| MW-09-47 | 2A | 7.7 | 2.5 | 3.3 | 8.5 | -1.4 | 9.9 | 6.5 | Acceptable |
| MA-4 | 2A | 11.2 | 6.1 | 4.6 | 9.7 | -1.4 | 11.2 | 7.0 | Acceptable |
| MW-09-49B | 2A | 5.3 | 1.7 | 2.4 | 6.0 | -1.4 | 7.4 | 5.5 | Acceptable |
| MW-09-54B | 2B | 16.0 | 7.9 | 5.5 | 13.6 | -2.4 | 16.0 | 7.0 | Acceptable |
| MW-09-55B | 2B | 8.9 | 3.7 | 3.0 | 8.3 | -2.4 | 10.6 | 5.5 | Acceptable |
| PZ-09-R3-5 | 3 | 9.2 | 1.2 | 0.0 | 8.0 | 0.1 | 7.9 | 5.7 | Acceptable |
| MW-12-191 | 3 | 10.6 | 0.0 | 0.0 | 10.6 | 0.1 | 10.5 | 7.0 | Acceptable |
| PZ-09-R3-7 | 3 | 7.1 | 0.7 | 0.0 | 6.4 | 0.1 | 6.3 | 6.5 | Acceptable by Drainage |
| MW-10-75 | 3 | 18.4 | 0.5 | 0.2 | 18.1 | 0.1 | 18.0 | 8.0 | Acceptable |
| MW-14-208 | 4A | 6.1 | 0.0 | 0.0 | 6.1 | 2.8 | 3.2 | 7.0 | Acceptable by Drainage |
| MW-10-89 | 4A | 11.7 | 1.0 | 0.0 | 10.7 | 2.8 | 7.9 | 6.5 | Acceptable |
| MW-10-92 | 4A | 7.8 | 1.0 | 0.0 | 6.8 | 1.7 | 5.1 | 4.8 | Acceptable |

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

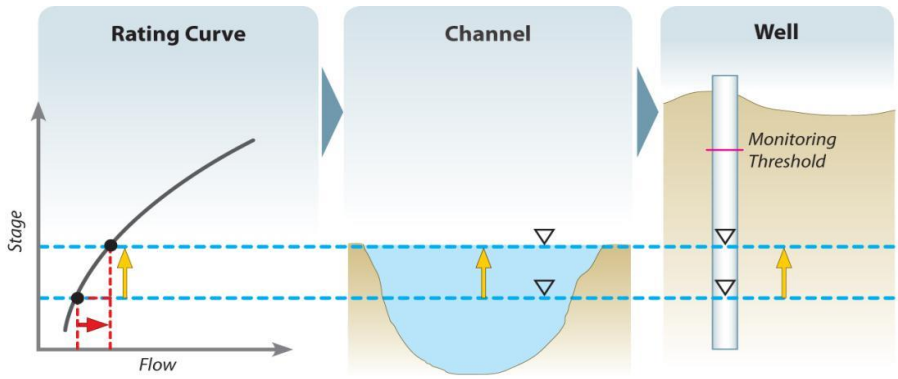



**Figure 3. Conceptual Relationship between River Stage and Groundwater Levels**

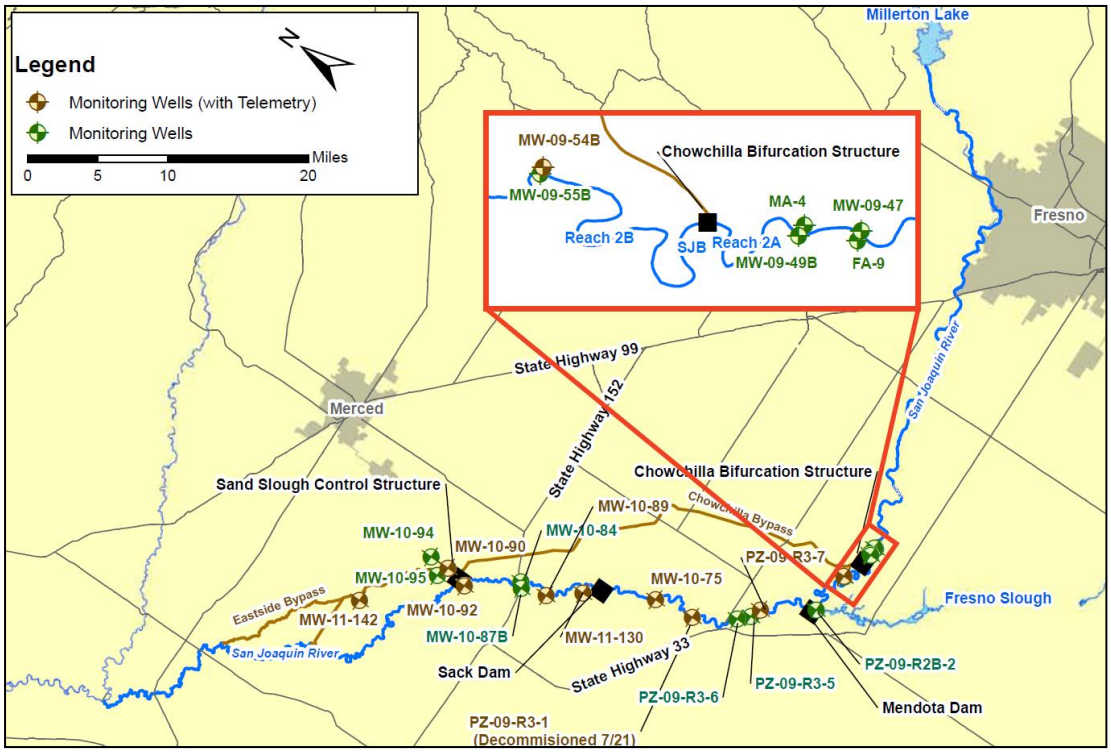
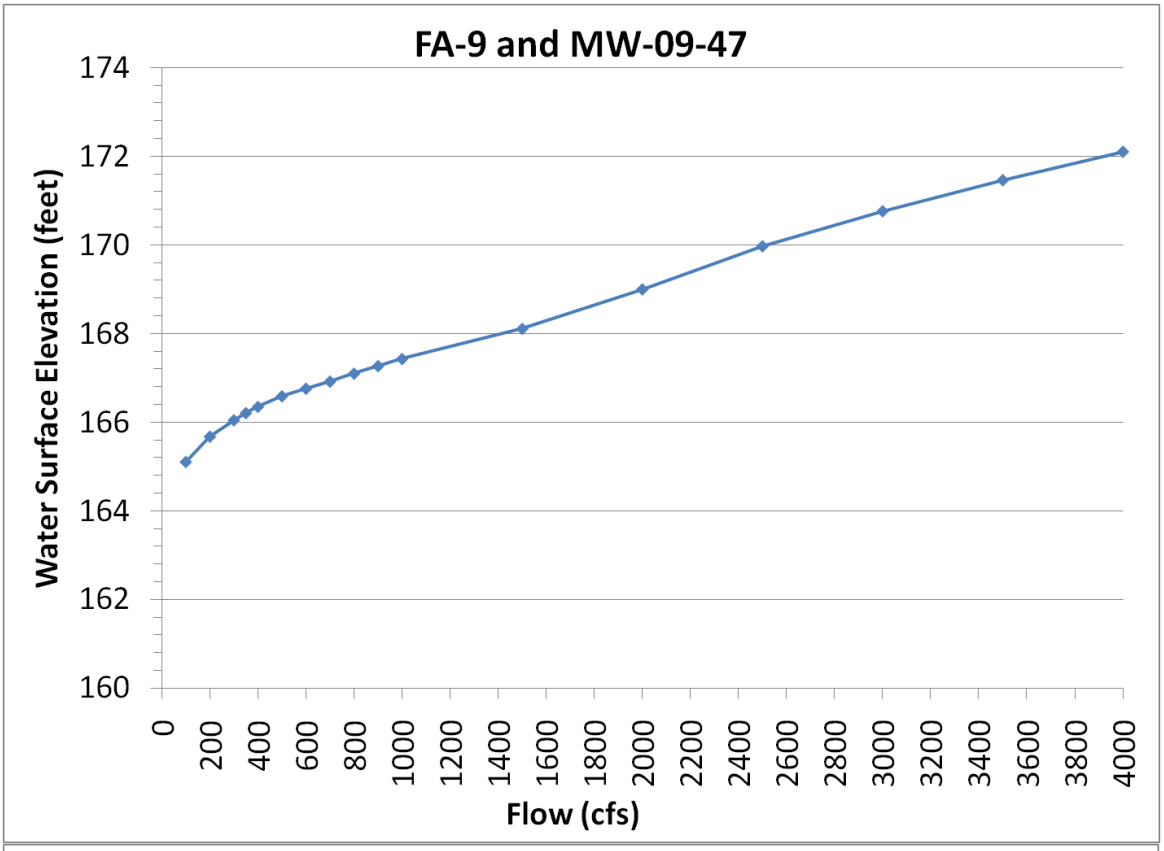
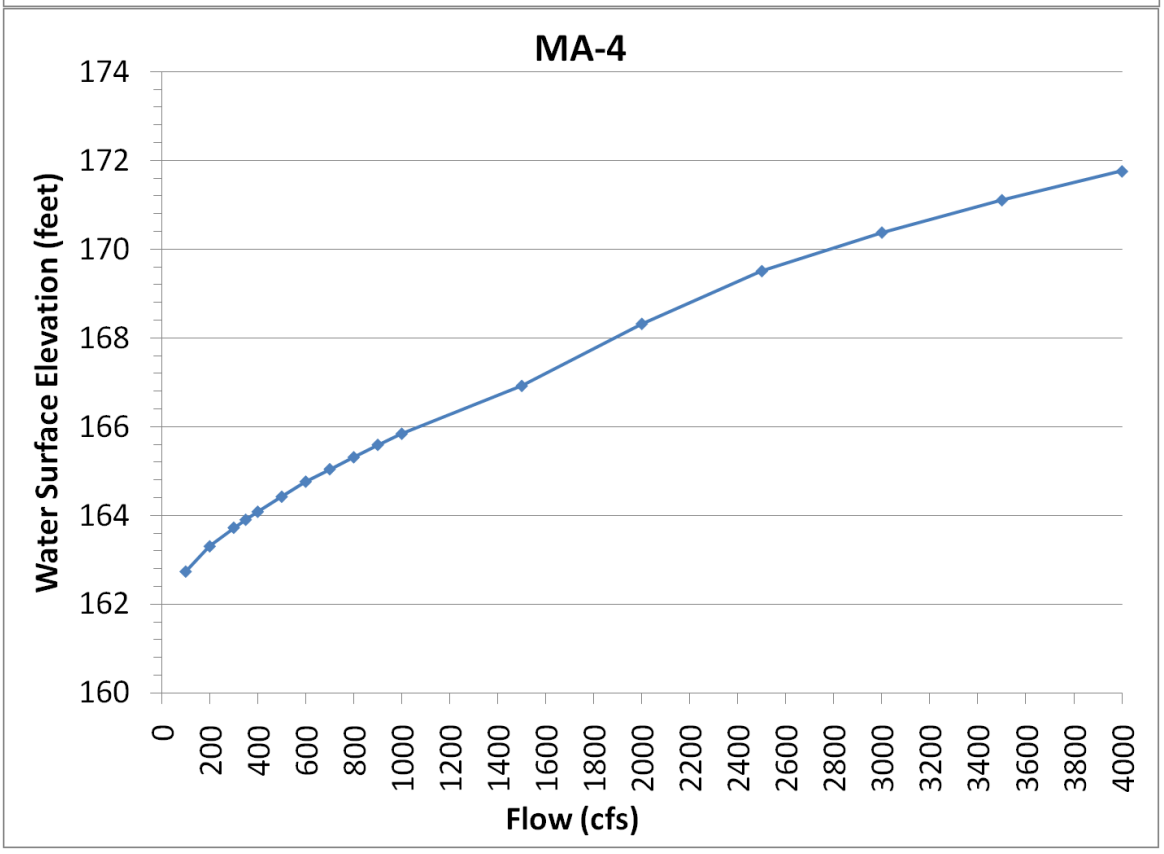
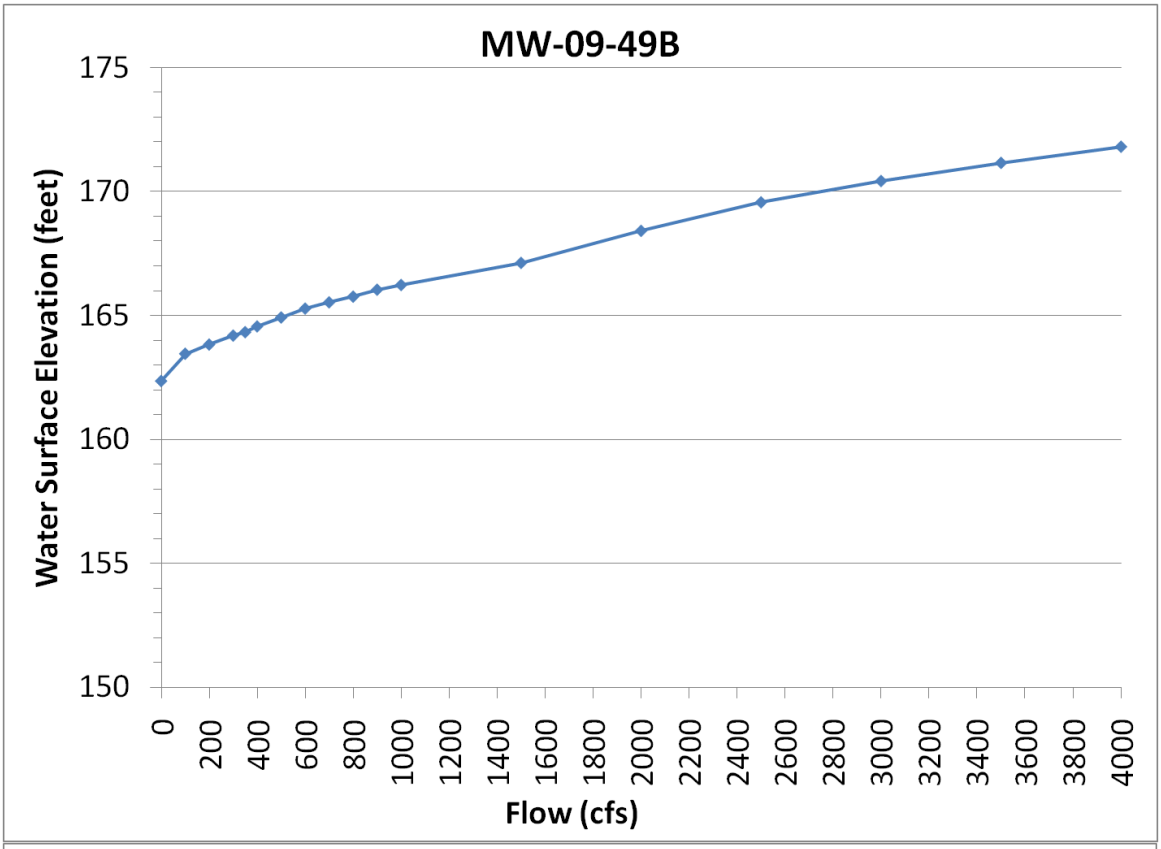
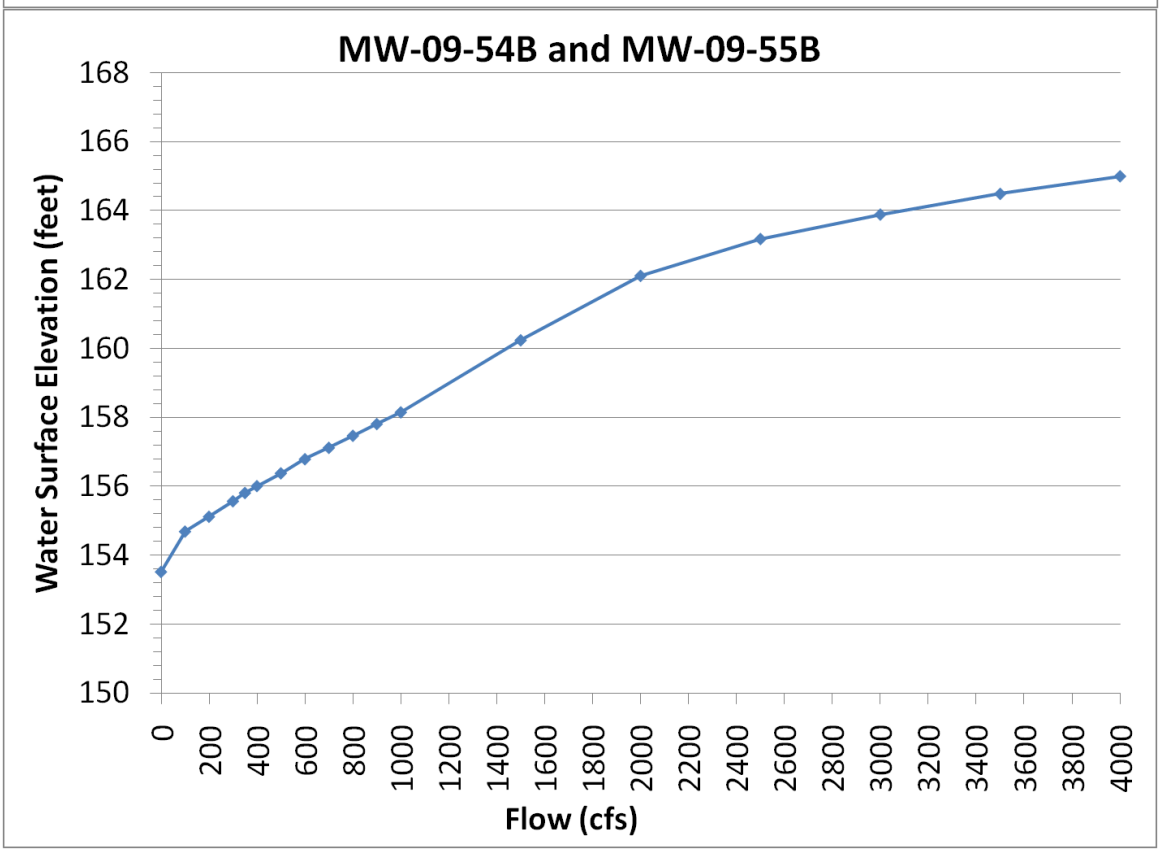


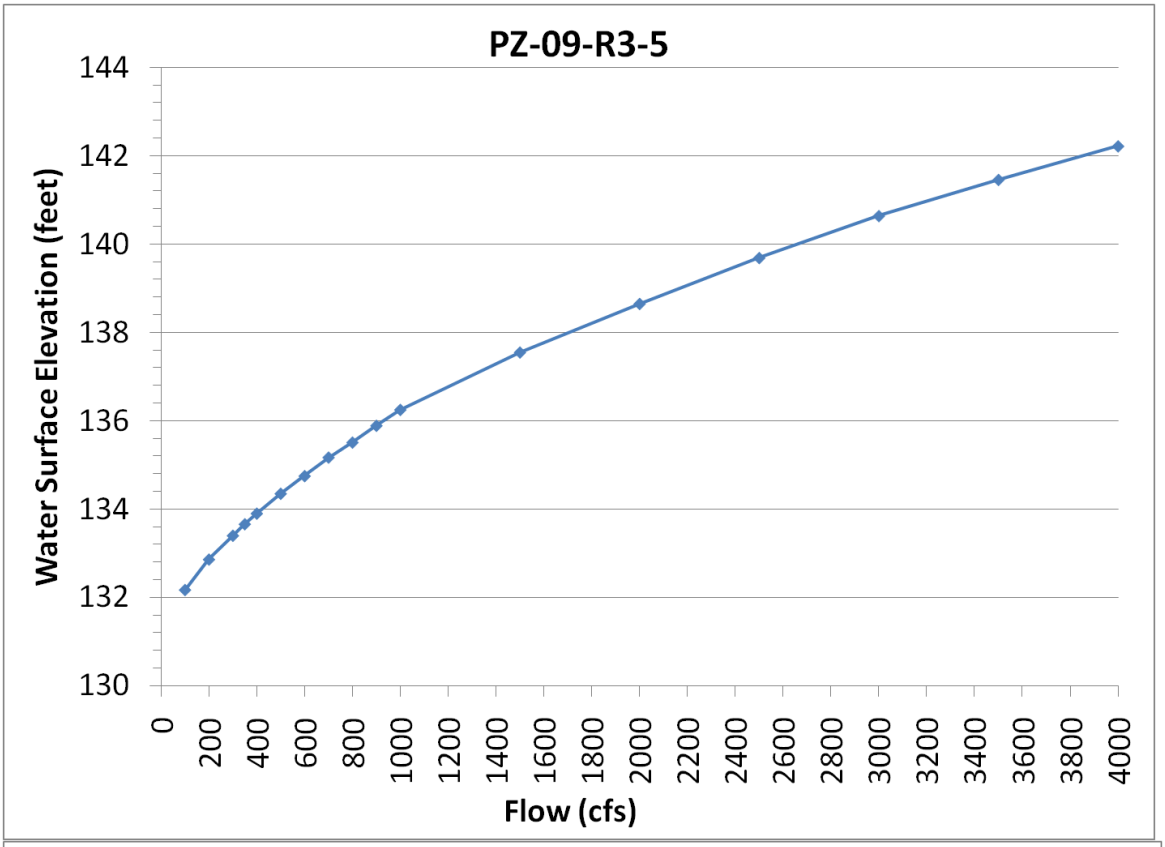

**Figure 4. Key Monitoring Well Locations**

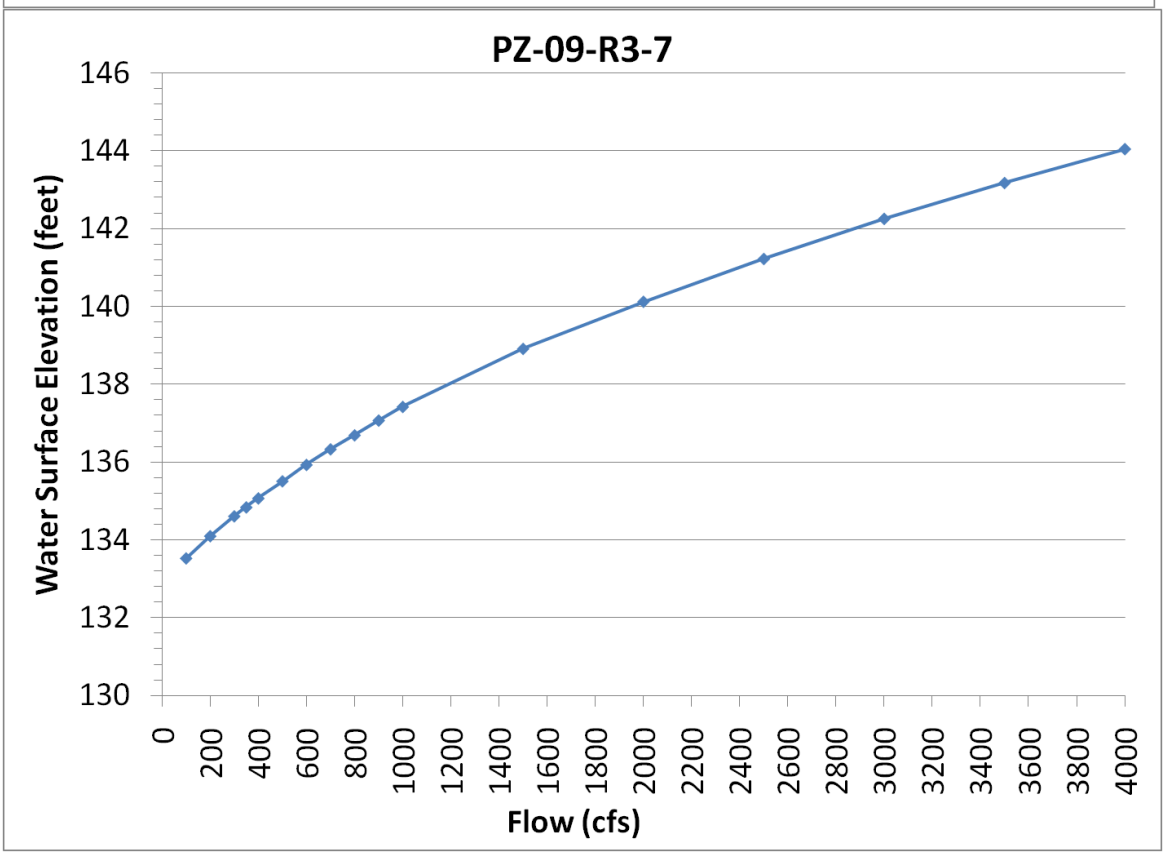

FA-9 and MW-09-47
Water Surface Elevation (feet)
174
172
170
168
166
164
162
160
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)

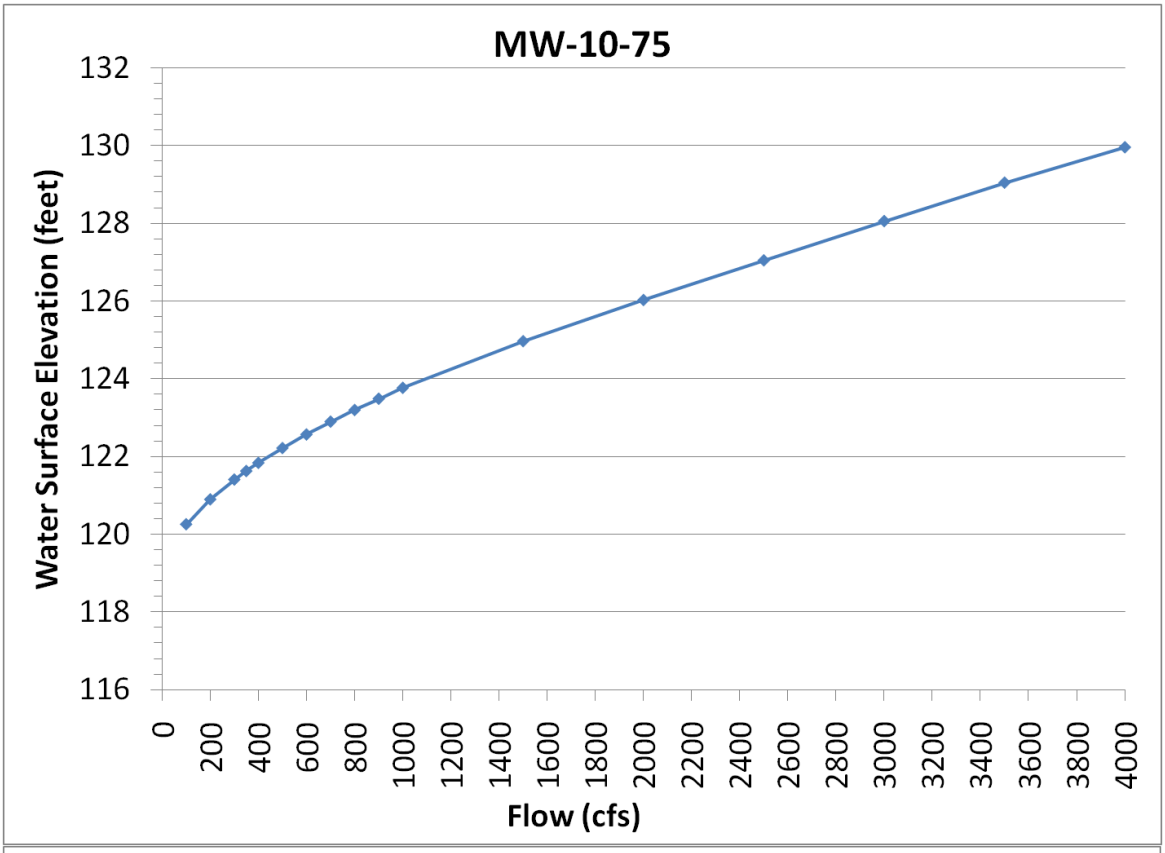

MA-4
Water Surface Elevation (feet)
174
172
170
168
166
164
162
160
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)

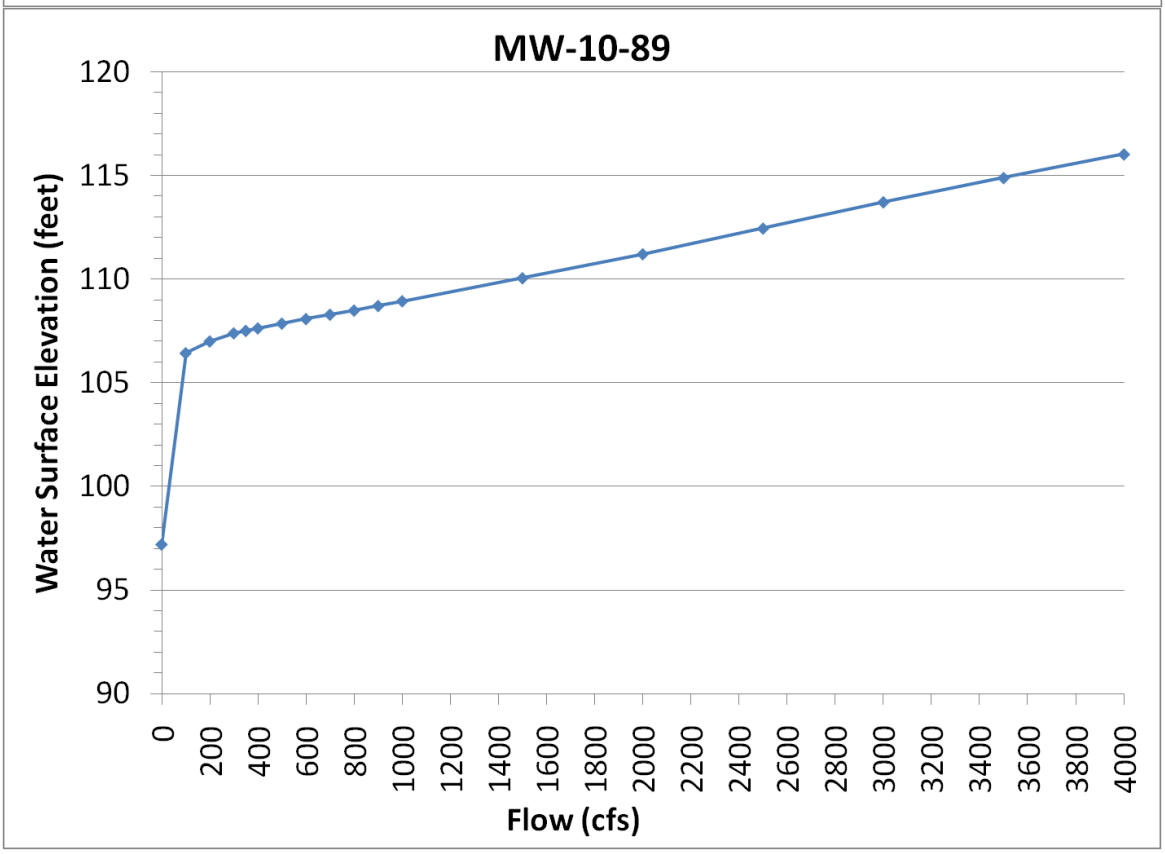

MW-09-49B
Water Surface Elevation (feet)
175
170
165
160
155
150
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)

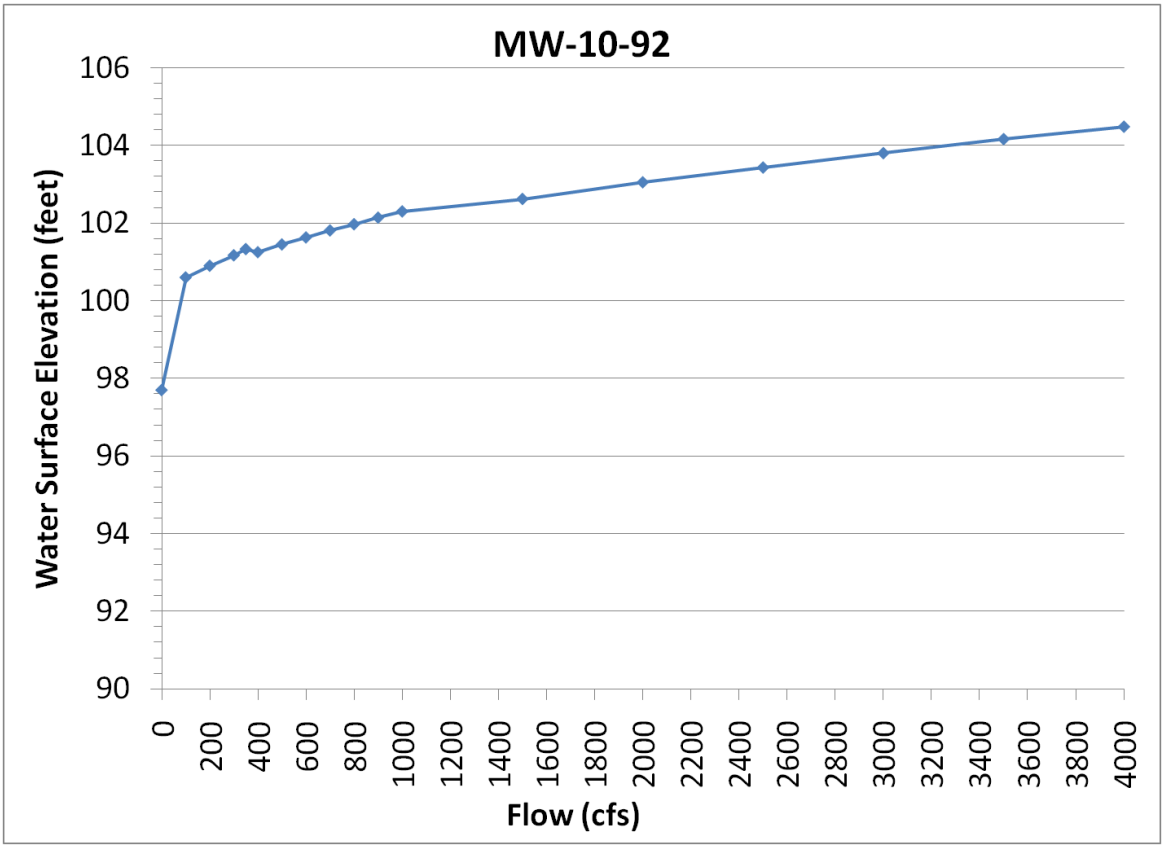

MW-09-54B and MW-09-55B
Water Surface Elevation (feet)
168
166
164
162
160
158
156
154
152
150
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)


PZ-09-R3-5
Water Surface Elevation (feet)
144
142
140
138
136
134
132
130
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)


PZ-09-R3-7
Water Surface Elevation (feet)
146
144
142
140
138
136
134
132
130
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)


MW-10-75
Water Surface Elevation (feet)
132
130
128
126
124
122
120
118
116
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)


MW-10-89
Water Surface Elevation (feet)
120
115
110
105
100
95
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)


MW-10-92
Water Surface Elevation (feet)
106
104
102
100
98
96
94
92
90
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Flow (cfs)