APPENDIX 6C

Future Conditions Scenario 2

Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

Lower Charlotte Harbor Flatwoods Strategic Hydrologic Restoration Plan

6C – Future Conditions Scenario 2

PREPARED FOR:

Coastal & Heartland National Estuary Partnership
1050 Loveland Boulevard
Port Charlotte, Florida 33980

PREPARED BY:

Water Science Associates
Coastal & Heartland National Estuary Partnership

IN CONJUNCTION WITH:

South Florida Water Management District
Florida Fish and Wildlife Conservation Commission
Southwest Florida Water Management District

LOWER CHARLOTTE HARBOR FLATWOODS HYDROLOGIC MODELING AND PLANNING PROJECT

TECHNICAL MEMORANDUM – TASK 6C – SCENARIO 2

To:	Ms. Jennifer Hecker, Ms. Nicole Iadevaia, Ms. Sarina Weiss
From:	Roger Copp and Kirk Martin, P.G. Water Science Associates
Date	June 12, 2023
Re:	Task 6C – Scenario 2

INTRODUCTION

Water Science Associates (Water Science) was contracted by the Coastal & Heartland National Estuary Partnership (CHNEP) to develop a hydrologic restoration plan for the Lower Charlotte Harbor Flatwoods that will promote sheet flow enhancement, restore wetland hydroperiods in the Babcock Webb and the Yucca Pens Wildlife Management Areas (WMA), and improve the timing and magnitude of flows to tidal creeks west of Yucca Pens WMA.

Project tasks include:

1. Compilation of existing hydrologic data,
2. Installation of new surface and groundwater monitoring stations and rain gages,
3. Evaluation of vegetative indicators of wetland health,
4. Maintenance of the monitoring stations and management of manual and electronic data,
5. Development of an existing conditions hydrologic model of the study area,
6. Evaluation of alternative management scenarios, and
7. Development of a Lower Charlotte Harbor Flatwoods Strategic Hydrological Restoration Planning Tool and Report.

Tasks 1 through 5 have been completed. Task 6 includes modeling natural pre-development and three future conditions scenarios. The Task 6A NSM and the Task 6B Scenario 1 memoranda have been completed. This TM describes the work associated with Task 6C, the development and results of Scenario 2 of the three planned Scenario evaluations. The Scope of Work stipulates that this memorandum describe the predicted water levels, flows, and hydroperiods for Scenario 2.

Future conditions scenarios include restoration projects that are set to be completed in the near future including the Bond Farm Hydrological Enhancement Impoundment (HEI) which is a permitted project (FDEP ERP No. 0375475-001 EI & State 404 Program Individual Permit No. 0375475-004 SFI). Funding is not available for this proposed project. The scenarios also include potential feasible projects that can be completed to address additional concerns. However, implementation of the modeled projects is contingent upon a number of key factors including funding and stakeholder agreement to secure property easements or publicly acquire land and/or permits.

The three future conditions scenarios include the following assumptions:

1. Scenario 1 interventions include ATV channel blocks, low-water fords, and constructed weirs in Yucca Pens to slow drainage from eroded all-terrain vehicle (ATV) trails, inflow pumps to move excess standing water during the wet season from Babcock Webb to the Bond Farm Hydrologic Environmental Impoundment (HEI), an outflow gate to move water from the Bond Farm HEI south toward Prairie Pines Preserve (PPP) during the dry season, and a groundwater seepage barrier at the southern boundary of Yucca Pens to limit loss to the Gator Slough Canal.
2. Scenario 2 includes Scenario 1 improvements plus additional features to increase hydrological restoration and ecosystem benefits. Additional features included in Scenario 2 are 1) a flow-way from Bond Farm HEI to Yucca Pens to direct Bond Farm HEI outflows west to Yucca Pens during the dry season, 2) more storage for flooded areas of Babcock Webb in the Southwest Aggregates

reservoir during the wet season, 3) water deliveries from the Southwest Aggregates Reservoir via existing US-41 ditches to deliver freshwater flows to Gator Slough just west of US-41 in the late dry season only when freshwater flows are needed, and 4) modification of one weir in Yucca Pens.

3. Scenario 3 includes Scenario 2 improvements along with future evapotranspiration (ET) and sea level rise assumptions associated with climate change.

SCENARIO 2 ASSUMPTIONS

As management needs for Babcock Webb and Yucca Pens were not met in Scenario 1, Scenario 2 modeled Scenario 1 improvements plus additional features to increase restoration performance. Additional features added in Scenario 2 include:

1. A flow-way from Bond Farm HEI to Yucca Pens to direct Bond Farm HEI outflows west during the dry season,
2. More wet season storage for flooded areas of Babcock Webb in the Southwest Aggregates reservoir,
3. Water deliveries from the Southwest Aggregates Reservoir via existing US-41 ditches to deliver freshwater flows to Gator Slough just west of US-41 in the late dry season only when freshwater flows are needed, and
4. Modification of one weir in Yucca Pens.

Implementation of modeling assumptions made in Scenario 2 are contingent upon a number of key factors: first this scenario can only be implemented if private and public landowners in the region of the proposed flow-way are willing to work with regional partners to secure property easements, publicly acquire land and/or permits in order to allow water to move from Bond Farm HEI to Yucca Pens through the SLD property south of the SLD Construction and Demolition (C&D) Landfill, second stakeholder agreements are needed to conveyance water from the Southwest Aggregates Reservoir to Gator Slough. Finally, stakeholders will need to formally acquire use of the Southwest Aggregates Reservoir to potentially store additional freshwater in the wet season. The new features of Scenario 2 are described below:

- In the model, the Bond Farm HEI outflow was directed west towards Yucca Pens at a constant flow of 20 cfs during December and January. The Bond Farm HEI will have a maximum storage depth of 4 feet, which translates to a storage volume of 2,400 acre-feet. The Bond Farm HEI inflow pump station will be located on the east side of Bond Farm HEI approximately 1,300 feet south of the northern property line of Bond Farm HEI (locations shown in ***Figure 1***). The Bond Farm HEI inflow pump station operation will gradually increase from no flow to 20 cfs between upstream stages of 24.5 and 25.0 ft-NAVD. Stages to turn on the pump were based on observed wet season water levels at monitoring station STA-6 located just east of the proposed pump. As stated in the Bond Farm HEI design report (HDR, 2020), no flow will be permitted if water levels within the impoundment are above 28.0 ft-NAVD. The pump will only operate during the wet season between June and November. Note that a western discharge from the Bond Farm HEI is not part of the approved engineering plans. No outflow will be permitted during the wet season. The flow-way from Bond Farm HEI to Yucca Pens was modeled along the southern border of the Southwest Aggregates Reservoir property, passed under US-41, and was routed west through a new flow-way south of the SLD C&D Landfill. A new 7-ft x 3-ft box culvert was assumed under US-41. Dimensions of this culvert were approximated using best engineering judgment and it may be appropriate to modify the dimensions during the design phase.
- In the model, the Southwest Aggregates mine was used as a 'reservoir' to store additional water from Babcock Webb (shown in ***Figure 1***). A proposed flow-way was modeled along the southern border of that property and used to convey water from Bond Farm HEI to Yucca Pens as well as used as an inflow canal for water that could potentially be routed around Bond Farm HEI into the existing pits on the Southwest Aggregates property in the wet season. The depth range modeled was 15.0 to 25.0 ft-NAVD. The modeled inflow rate to the Southwest Aggregates Reservoir was limited to 35 cfs between June and November, and the outflow rate between March and May was

limited to 26 cfs. Inflow rate was determined by iteratively testing inflow rates in the model to maximize storage in both Bond Farm HEI and the Southwest Aggregates Reservoir (by running pumps simultaneously it allows water to continuously be removed from Babcock Webb during the wet season to achieve desired restoration goals). The outflow rate of 26 cfs was selected based upon prior water deliveries from Southwest Aggregates Reservoir to US-41 ditches during 2017, 2020, 2021, and 2022.

  - In the model, the outflow was directed from the Southwest Aggregates Reservoir via existing US-41 ditches to Gator Slough just west of US-41.
  - Gated culverts in a proposed seepage control ditch on the west side of Bond Farm HEI will open during the wet season to allow water from Babcock Webb to flow west into the Southwest Aggregates Reservoir using the above-mentioned flow-way. The dimensions of the culverts associated with this structure were taken from the Bond Farm HEI design plans (HDR, 2020), however gates on the culverts were not part of the Bond Farm HEI design plans. Filling of Bond Farm HEI will have priority over filling of the Southwest Aggregates Reservoir. The western discharge is conceptually discussed and design, modeling and permitting would be required to construct it.
  - A proposed gate on the east side of the Southwest Aggregates south ditch will open during wet season flow deliveries to the Reservoir or during flow routing from Bond Farm HEI to Yucca Pens in the early dry season. The following specifications were used in the model and may be changed or reduced in the design phase. It was assumed that this gate will be 24.0 feet wide with a sill elevation of 22.0 ft-NAVD, and a maximum elevation of 26.0 ft-NAVD.
  - Gated weirs will be needed in the US-41 ditches north and south of the flow-way to direct the Bond HEI outflows to Yucca Pens. These gates will be closed blocking flow north and south to these US-41 ditches, instead directing water west via the proposed flow-way during the time period that the flows would be directed to Yucca Pens (typically December and January). Gates would be at an added 6'x4' box culvert. Sensitivity tests would be needed to confirm dimensions. A schematic of the flow routing from Babcock Webb to Bond Farm HEI and Southwest Aggregates Reservoir is provided in ***Figure 1***.

- A number of proposed weirs representing either low-water fords or constructed weirs were modeled in Future Conditions Scenario 1 to minimize excess drainage from eroded ATV trail in Yucca Pens (see TM 6B for details). The proposed weirs for Scenario 2 are identical to those included in Scenario 1 with the exception of Yucca Pens New Weir 3. Yucca Pens New Weir 3 was moved 1,325 meters (4,347 feet) upstream (east) from the location used in Scenario 1 for two reasons: a) the Scenario 1 location was too close to private lands, and b) the new Scenario 2 location is along an existing firebreak that is already disturbed and would be easier to access, so the construction of the New Weir 3 will result in significantly reduced wetland disturbance. The location of this weir is #7 in ***Figure 3***. It should be noted that there will still be some potential direct and secondary wetland disturbance with any weir installation in Yucca Pens. The dimensions of the proposed weirs are presented in ***Table 1***, and the locations are presented in ***Figures 3*** and ***4.*** Details of the proposed weirs are presented in ***Appendix A***.

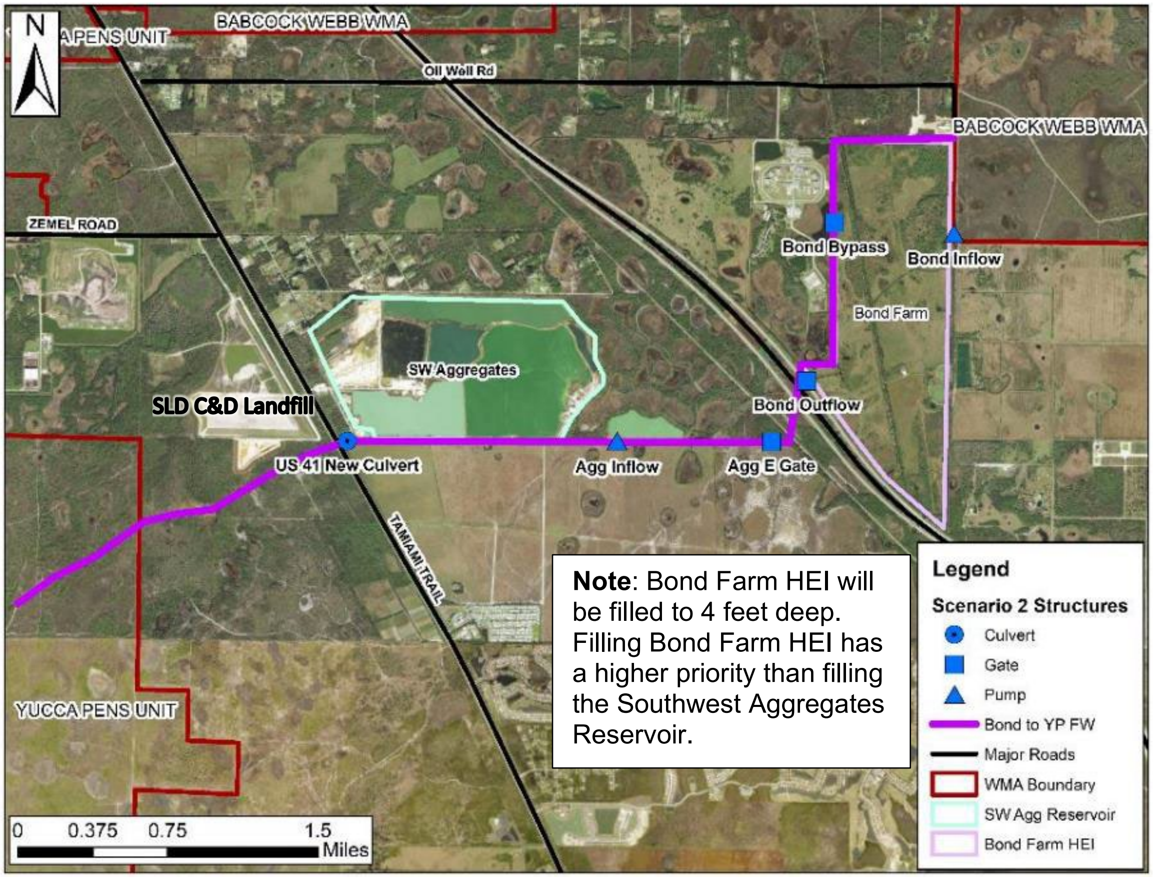

Figure 1. Scenario 2 Modeled Storage Facilities and Flow-ways

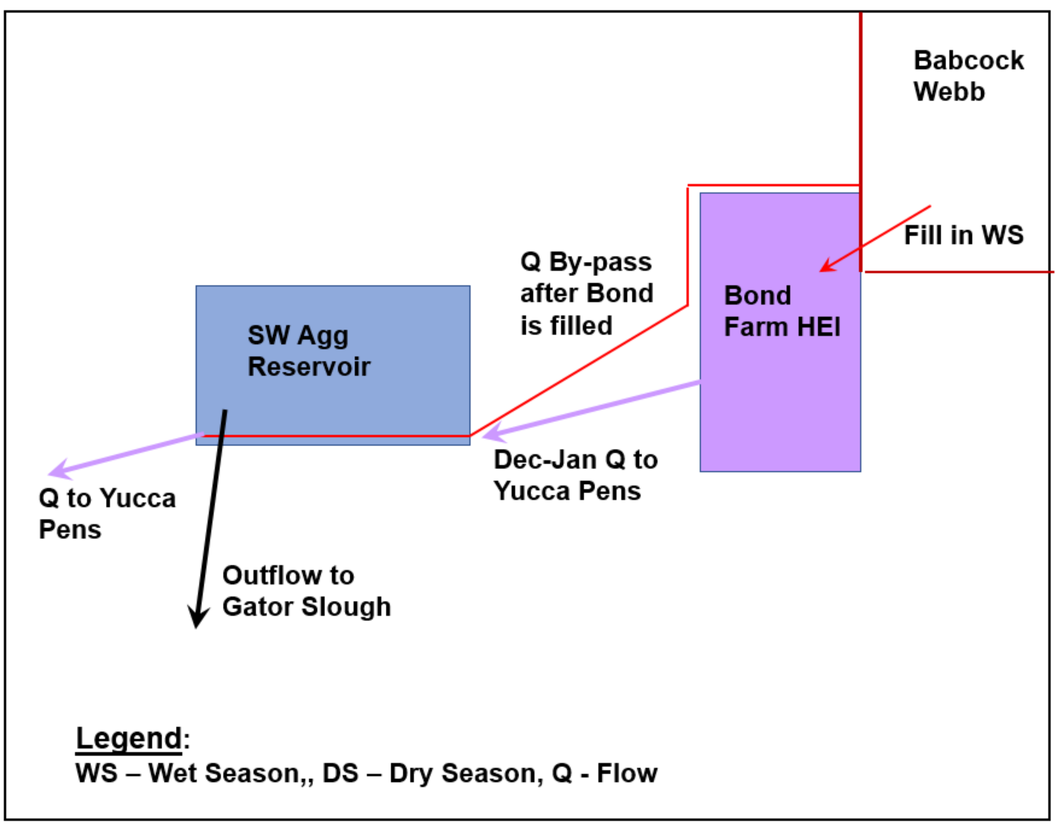

Figure 2. Schematic of Flow Routing, Babcock Webb to Bond Farm HEI and Southwest Aggregates Reservoir

Table 1. Scenario 2 Weir Dimensions, Chainage in meters, elevations in ft-NAVD

Map #	Weir	MIKE 11 Branch	Chainage, m.	Lowest Control Elevation	U/S XS Invert
1	Zemel_New_Weir	Zemel	6700	10.0 ft wide at 15.0 ft	13.4 ft
2	Bear_HW_New_Weir	Bear_Branch	360	10.0 ft wide at 16.0 ft	14.2 ft
3	Hog_New_Weir	Hog_Branch	430	20.0 ft wide at 14.4 ft	13.7 ft
4	New_Weir_YPensN	YuccaPensN	790	10.0 ft wide at 11 ft	10.3 ft
5	New_Weir_YuccaPensCk	YuccaPensCreek	10000	10.0 ft wide at 10.5 ft	8.8 ft
6	Yucca_New_Weir2	YuccaPensCreek	9090	10.0 ft wide at 12.6 ft	12.0 ft
7	Yucca_New_Weir3	YuccaPensCreek	6525	5.0 ft wide at 15 ft	14.9 ft
8	YuccaP_4_NewWeir	YuccaPensCreek	5270	10.0 ft wide at 15.9 ft	15.1 ft
9	Durden_4_NewWeir2	SR-7_Branch	1440	10.0 ft wide at 16.25 ft	14.7 ft
10	New_Weir_DurdenN	Durden_N	100	7.0 ft wide at 13.0 ft	11.0 ft
11	New_Weir2_DurdenN	Durden_N	770	5.0 ft wide at 12.0 ft	10.5 ft
12	New_Weir_DurdenCk	DurdenCreek	4700	10.0 ft wide at 13.0 ft	11.8 ft
13	Durden_New_Weir2	DurdenCreek	3720	10.0 ft wide at 14.3 ft	13.5 ft
14	Durden_4_NewWeir	DurdenCreek	330	10.0 ft wide at 16.25 ft	13.8 ft
15	New_Weir_DurdenCreek1	DurdenCreek1	100	10.0 ft wide at 12.5 ft	11.0 ft
16	YP-6_W_New_Weir	SR10-YPN-1	380	10.0 ft wide at 12.0 ft	11.0 ft
17	New_Weir_YP-6	SR10-YPPN	2200	10.0 ft wide at 12.7 ft	11.9 ft
18	New_Weir_YPPS	SR10-YPPS	2800	10.0 ft wide at 14.35 ft	13.6 ft
19	YP_Jak_NewWeir	YP_Jacaranda	740	10.0 ft wide at 13.7 ft	12.2 ft
20	SY_YP_NewWeir	ATV3	400	10.0 ft wide at 15.0 ft	12.4 ft
21	ATV_New_Weir	ATV2	500	7.0 ft wide at 14.8 ft	14.7 ft
22	SYP2_New_Weir	SYP2_Weir	170	5.0 ft wide at 14.5 ft	12.8 ft
23	TrapConc (Ex conc weir)	ATV2	1065	5.0 ft wide at 11.8 ft	8.2 ft
24	CMP_Riser	ATV1	540	Raise riser 1.0 ft	13.2 ft
25	SR-7_S_NewWeir	SR-7_South	1050	10.0 ft wide at 17.5 ft	15.8 ft
26	Durden_3_NewWeir	DurdenCreek	2850	10.0 ft wide at 15.7 ft	14.6 ft

Note: yellow-highlighted text indicates a change in the location of Yucca New Weir 3 for this scenario

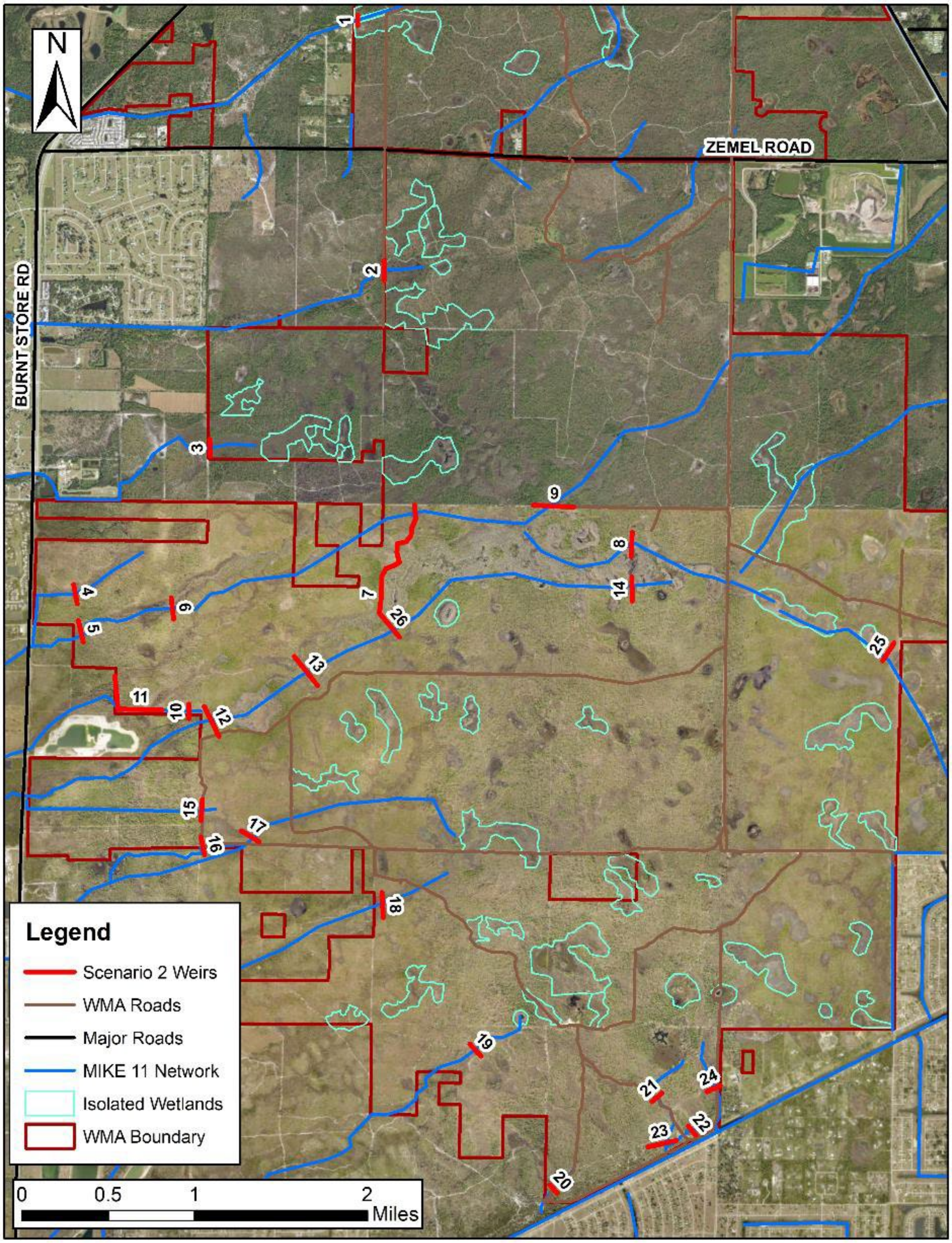

Figure 3. Map of Proposed Weirs/Low Water Fords in Yucca Pens WMA

The design details for each of the proposed weir locations will be determined during subsequent design studies. It is recommended that in future work the weirs be prioritized for available funding so that if, for example, funding is only available for 10-15 weirs, then a plan would be in place already for implementing staged construction of weirs. Similarly, consideration should be given to model results if all 26 proposed weirs are not completed.

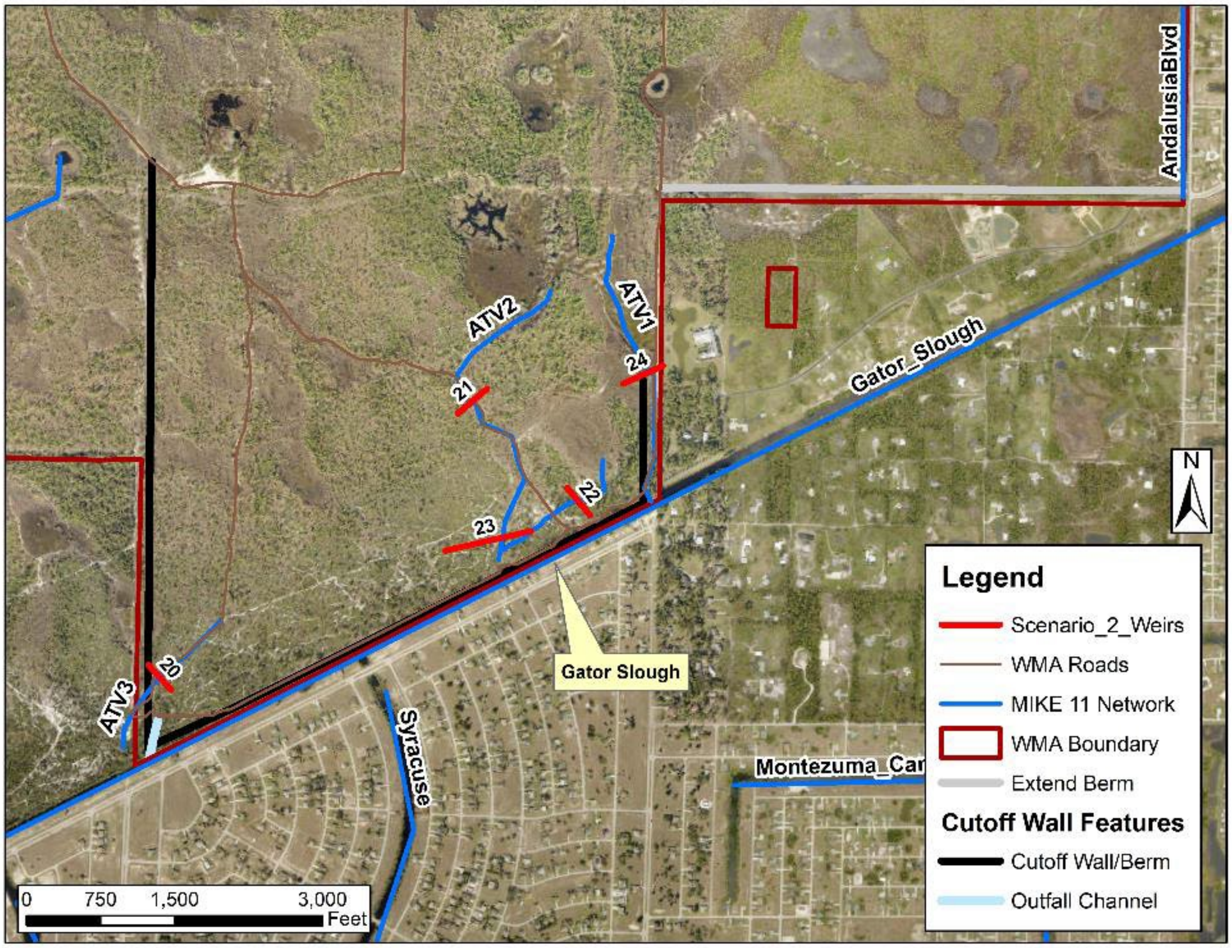

Figure 4. Restoration Measures in South Yucca Pens

SCENARIO 2 HYDROPERIODS AND WET SEASON WATER DEPTHS

Scenario 2 and baseline existing conditions were simulated for 2012 – 2021, and the results were analyzed to determine the hydrologic response of the Scenario 2 restoration measures. The difference between simulated hydroperiods in Yucca Pens for Scenario 2 and existing conditions is presented in ***Figure 5***. Significant improvements in hydroperiods are predicted for the southern and western areas of Yucca Pens. Hydroperiod increases in Yucca Pens generally range from 0.5 to 4 months with a few small areas with hydroperiod increases of 5 months. Wetland hydroperiods are predicted to decrease in the South Walk-In Area of Babcock Webb, northeast of Bond Farm HEI, by 0.5 to more than 2 months.

Figure 7 compares the simulated hydroperiods for Babcock Webb and Yucca Pens for Scenario 1 and 2. Hydroperiod increases of greater than one month are predicted for 3,465 acres of Yucca Pens in Scenario 2 model results (compared to improvements seen in 2,553 acres for Scenario 1). In Scenario 2, water levels in March and April (end of dry season) are predicted to increase by greater than 1 foot for 431 acres in Yucca Pens, and water levels are predicted to increase by 0.25 to 0.5 feet for 5,440 acres in Yucca Pens. This means that the hydroperiod range and water levels in Yucca Pens are now closer to optimum conditions for these areas. Reduced wetland hydroperiods and decreased water levels (see ***Figure 6)*** are predicted in a portion of the Babcock Webb SWIA because of water deliveries to both the Bond Farm HEI and the proposed Southwest Aggregates Reservoir. The Scenario 2 results suggest that additional off-line storage will be needed to achieve more substantial hydrologic restoration of the Babcock-Webb SWIA.

Figure 8 compares the simulated hydroperiods in a portion of Yucca Pens south of Zemel Road for Scenario 1 and Scenario 2. Wetland hydroperiods for Scenario 2 are shorter than hydroperiods for Scenario 1 in private lands (identified in ***Figure 8***). This change in hydroperiods was due to the change in location of

Yucca Pens Weir 3, which was moved approximately 4,300 feet upstream from the Weir 3 location simulated in Scenario 1. This change is beneficial for a number of reasons. This weir was moved upstream to minimize hydroperiod impacts to the private lands identified in ***Figure 8*** and because cypress in the vicinity the location used in Scenario 1 was undisturbed, thereby resulting in permitting challenges. The revised upstream location is co-located with an existing fire break, which will permit construction of a low-water ford that will facilitate access during prescribed burns. An additional benefit of Scenario 2 is that the area of increased wetland hydroperiods is concentrated more in cypress areas for Scenario 2 than for Scenario 1.

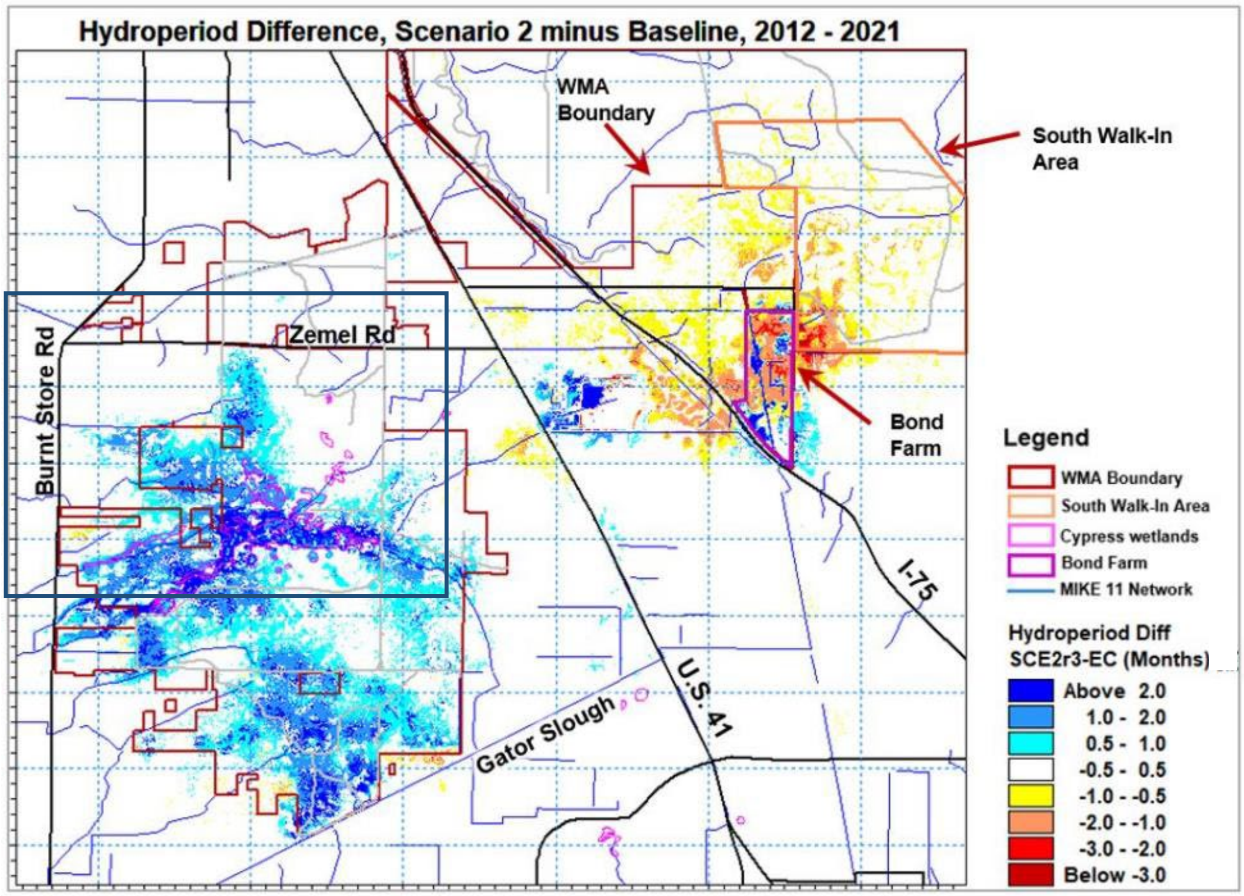

Figure 5. Scenario 2 minus Baseline average annual hydroperiod difference at a 50-ft resolution during the period 2012-2021

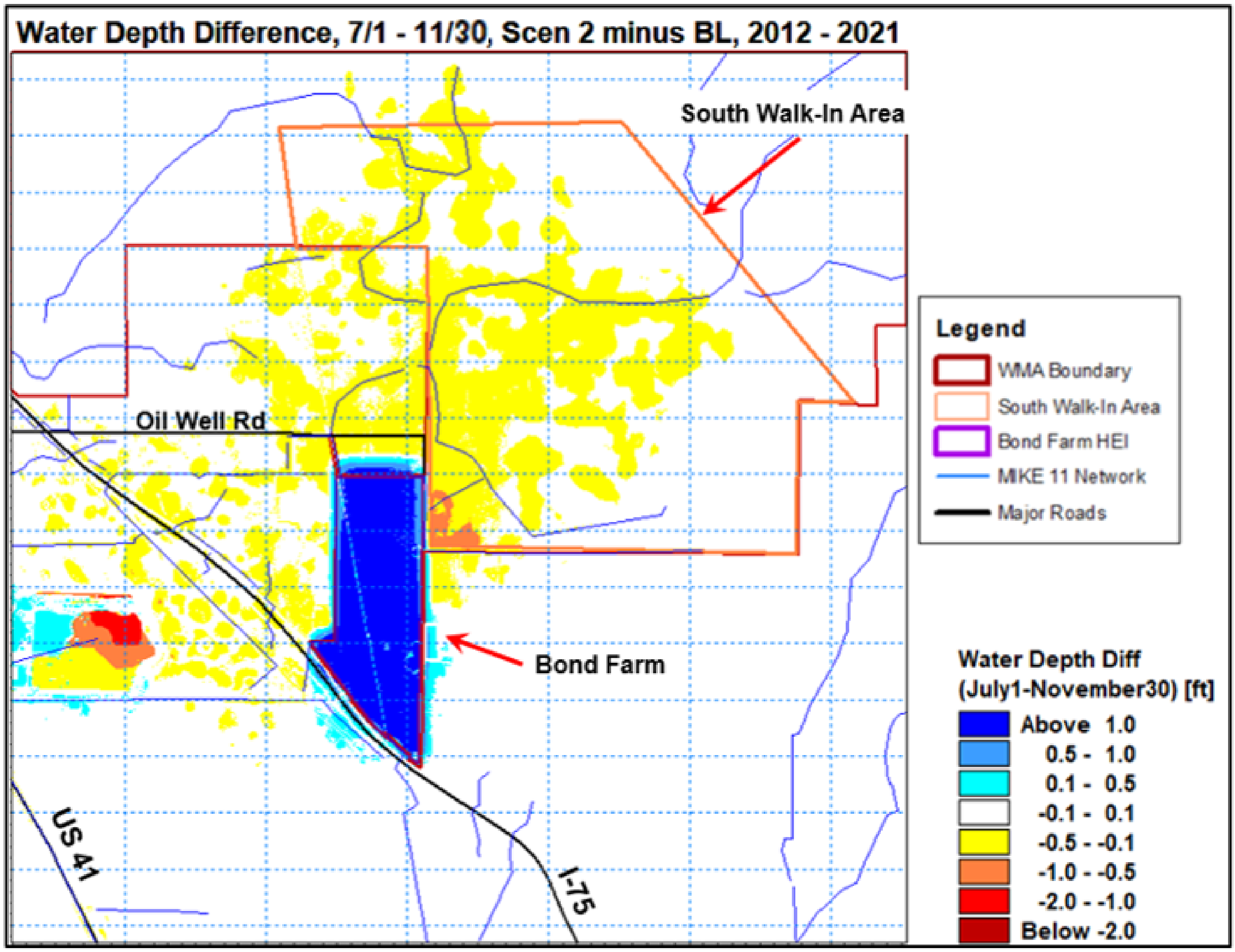

Figure 6. Water Depth Difference, July 1 - November 30, Scenario 2 minus Baseline, 2012 - 2021

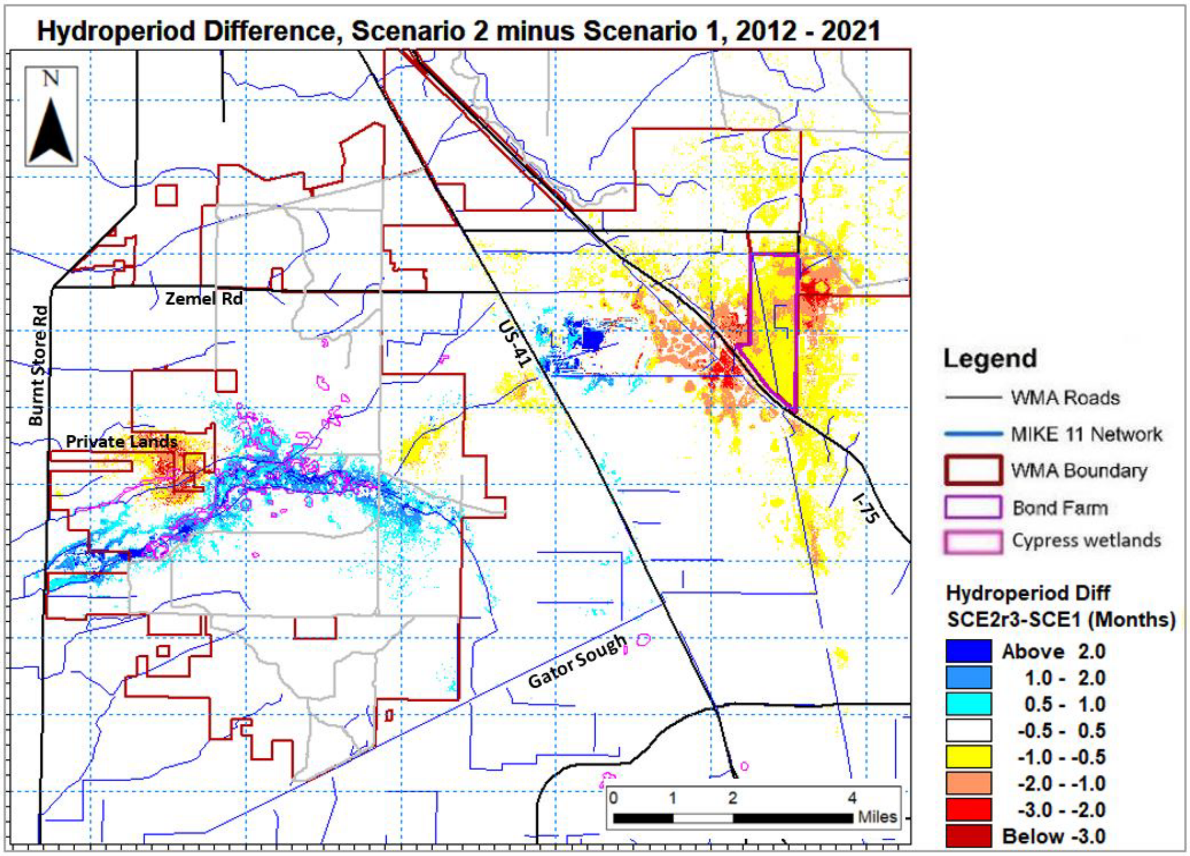

Figure 7. Scenario 2 minus Scenario 1 Hydroperiod Difference at a 50-ft resolution during the period 2012 – 2021

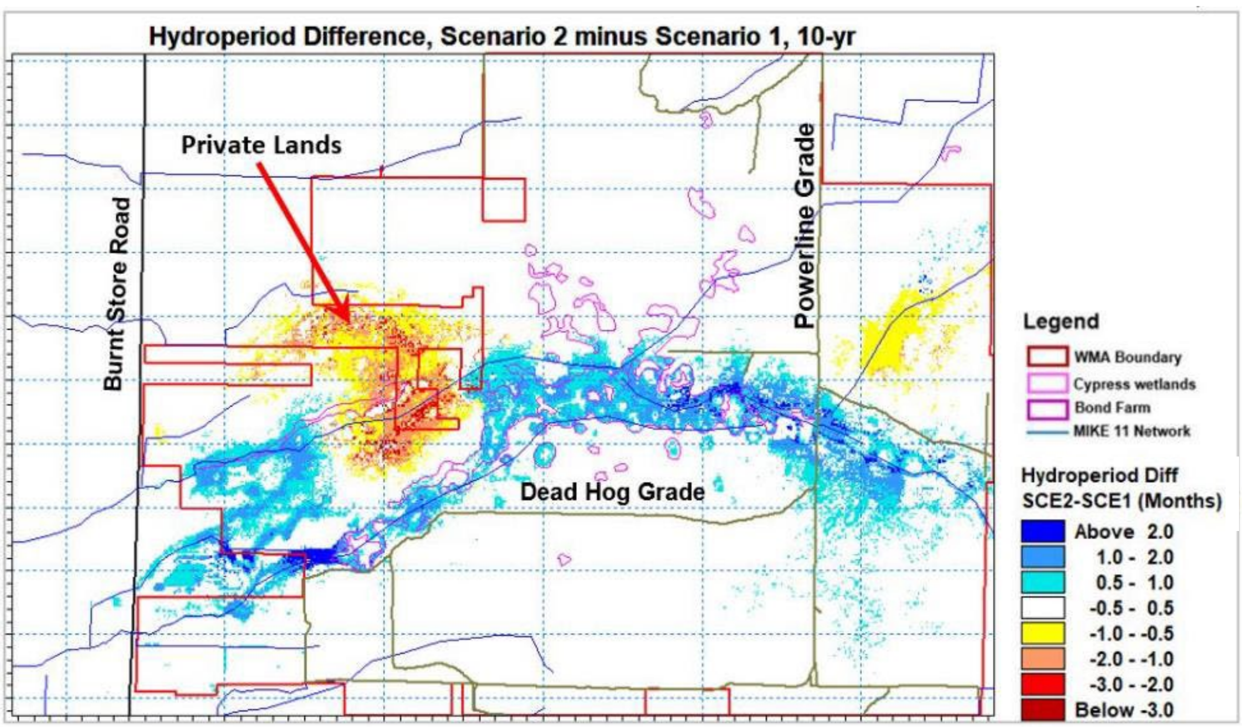

Figure 8. Zoomed-in Scenario 2 minus Scenario 1 hydroperiod difference at a 50-ft resolution during the period 2012 - 2021

Simulated wetland hydroperiods for the area of Yucca Pens south of Zemel Road for Scenario 2 are presented in ***Figure 9***. Hydroperiods in Yucca Pens cypress wetlands increased due to the additional Scenario 2 restoration measures, including the additional dry season flows into Yucca Pens from Bond Farm HEI and the location change of Yucca Pens Weir 3. Yucca Pens New Weir 3 was moved 1,325 meters (4,347 feet) upstream (east) from the location used in Scenario 1 for two reasons: a) the Scenario 1 location was too close to private lands, and b) the new Scenario 2 location is along an existing firebreak that is already disturbed and would be easier to access, so the construction of the new weir 3 will result in significantly reduced wetland disturbance. It should be noted that there will still be some potential direct and secondary wetland disturbance with any weir installation in Yucca Pens. The location of this weir is #7 in ***Figure 3***.

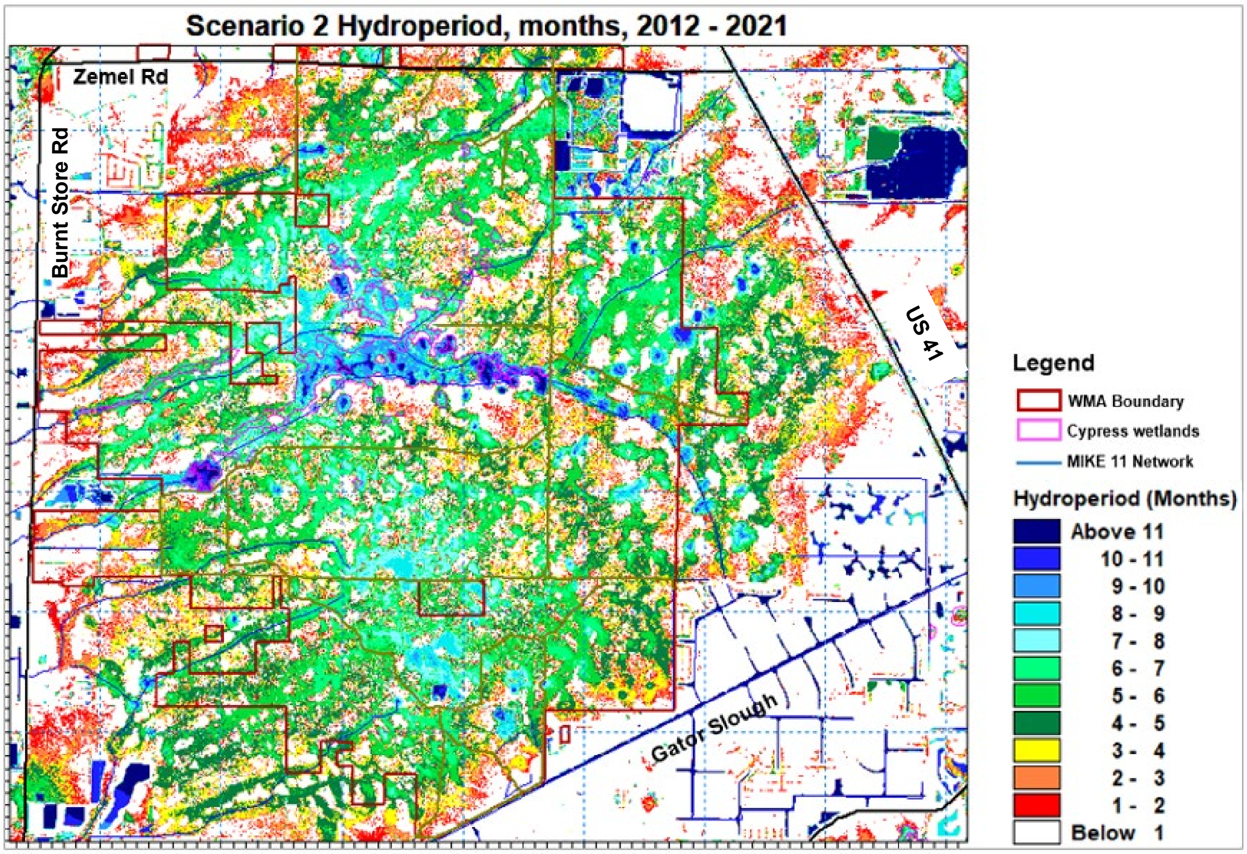

Figure 9. Simulated Scenario 2 hydroperiods in Yucca Pens south of Zemel Road

Wet season water depth differences associated with Scenario 2 are presented in ***Figure 10***. The most significant difference between Scenario 2 and Scenario 1 is the decreased water depths predicted in the South Walk-In Area of Babcock Webb. Water depths are predicted to decrease by 0.5 to 1.0 feet in an area just east of Bond Farm HEI in the South Walk-In Area, and water depth decreases of 0.1 to 0.25 feet are predicted for more than half of the South Walk-In Area. Lowered water depths in Scenario 2 in the South Walk-In Area of Babcock Webb are desirable and closer to optimum conditions for the area as determined in prior memoranda (WSA & CHNEP, 2022b). Previous wet season vegetation indicator surveys documented suboptimcal hydroperiods and extensive inundation of the South Walk-In Area due to the blocked historic flow-ways west of the South Walk-In Area.

Figure 11 presents a comparison of wet season water elevations between the baseline existing conditions and Scenario 2 for a location in the Yucca Pens cypress (see location **1** shown in ***Figure 10***). The average difference in water elevation is 0.28 ft, which is 0.06 ft higher than predicted for Scenario 1. Increased water depths bring the cypress wetlands closer to optimal conditions as explained in Technical Memorandum 6A (WSA & CHNEP, 2022c).

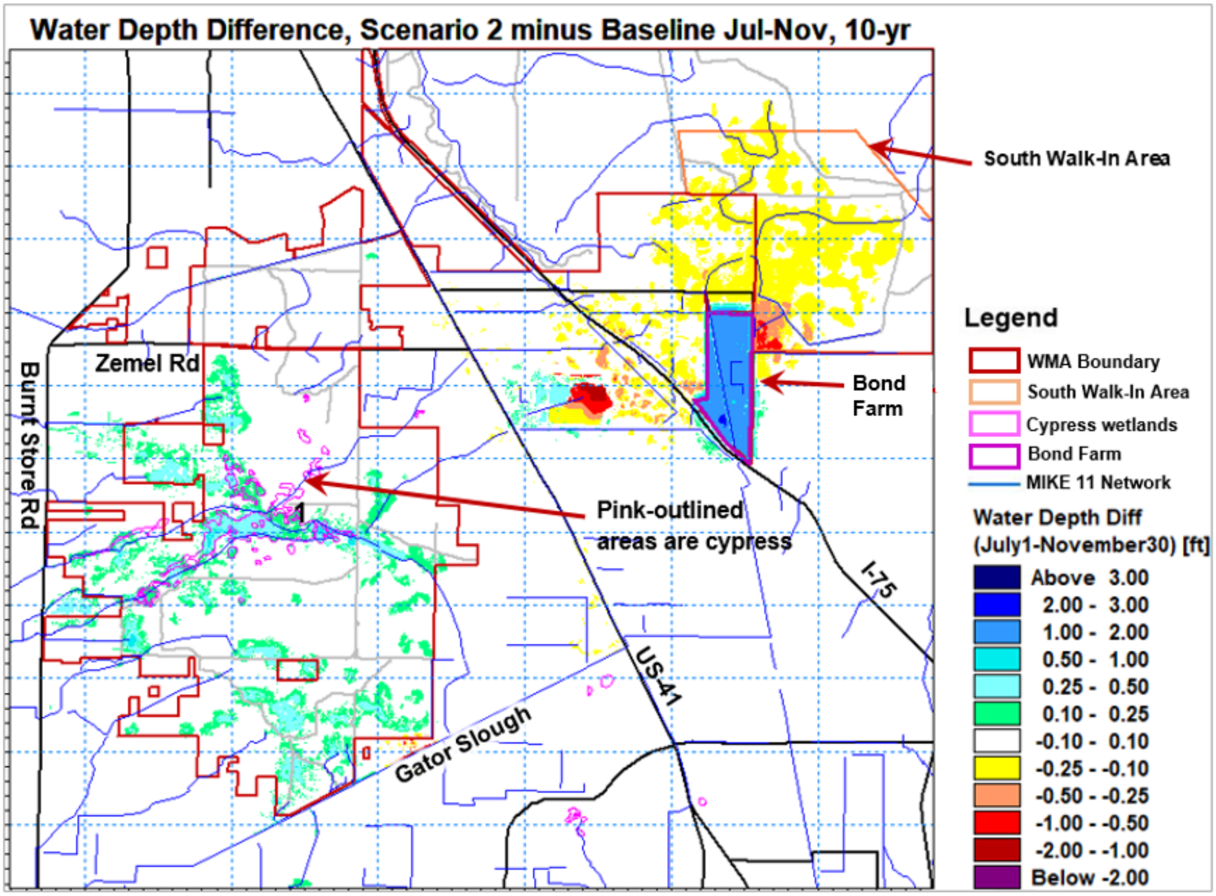

Figure 10. Scenario 2 minus Baseline average water depth differences for July 1 – November 30 during the period 2012-2020

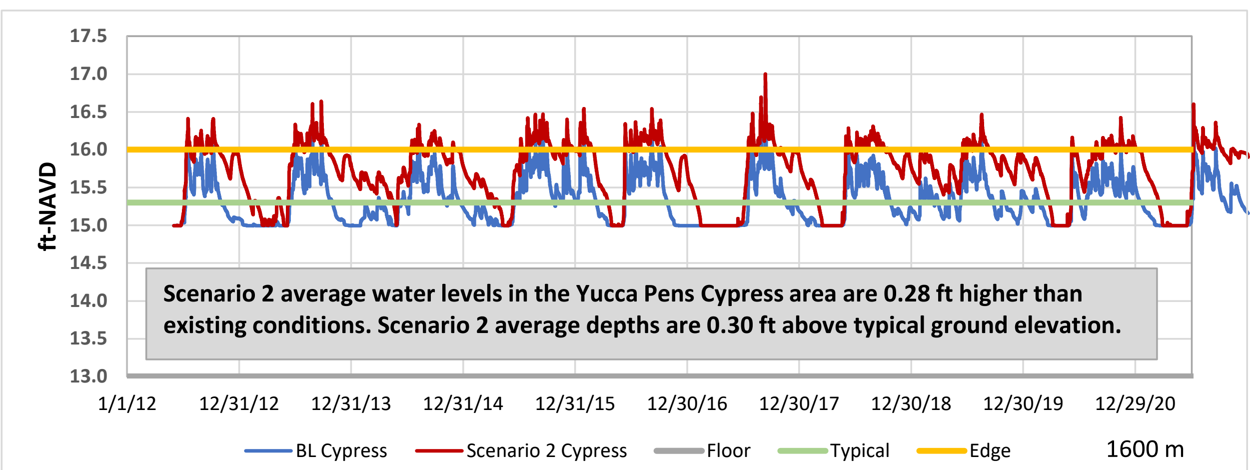

Figure 11. Simulated water levels for Scenario 2 and Baseline Existing Conditions (point 1 in Figure 10, floor elevation is 13.0 ft-NAVD)

A comparison of dry season water levels between the baseline existing conditions and Scenario 2 are presented below in ***Figure 12***. The greatest changes in water levels are predicted in the southern portion of Yucca Pens, with groundwater levels increasing by an average of 1-2 feet during the months of March and April for the 2012 – 2021 period. Dry season decreases in water levels are predicted for the South Walk-In Area of Babcock Webb, which is consistent with the observed wet season changes. Please note that this figure also shows increased water levels around US-41 drainage ditches in the late dry season March – April when it is anticipated that these drainage ditches can handle this amount of added water.

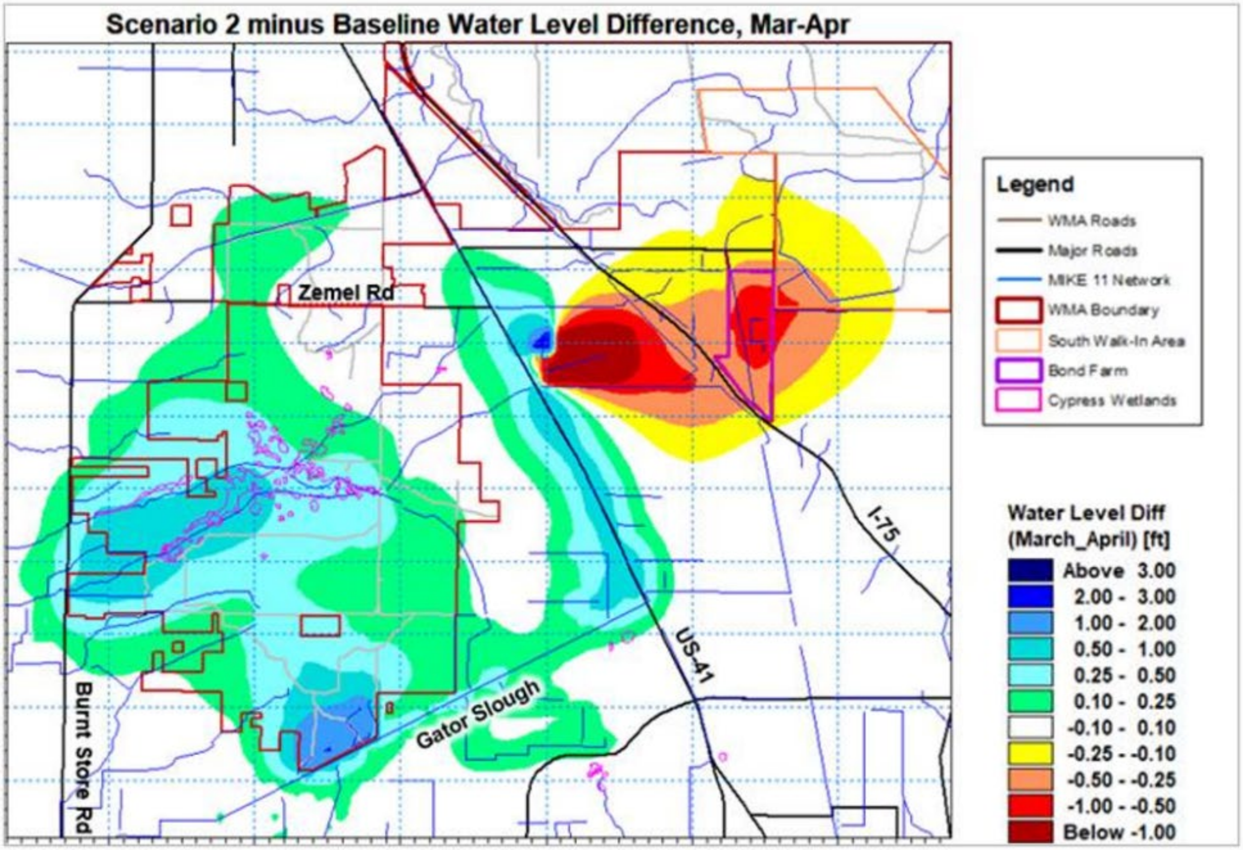

Figure 12. Scenario 2 minus Baseline water level differences during March - April during the period 2012 – 2021

Quantitative summaries of the Scenario 2 changes in Yucca Pens are presented below in **Table 2**. Although specific quantitative acreage targets were not identified as a project goal, acreage totals are presented below in order to further demonstrate hydrologic restoration. Hydroperiod increases of greater than one month are predicted for 3,465 acres of Yucca Pens as compared to the Baseline existing conditions hydroperiods, an increase of 907 acres from Scenario 1. Scenario 2 hydroperiods are closer to optimum conditions and therefore a greater level of restoration is predicted than for Scenario 1.

The location of Yucca Pens Weir 3 in Scenario 1 was in undisturbed cypress wetlands, and therefore implementation would likely be a challenge. The Scenario 2 location is along an existing fire-break that is already disturbed and would be easier to access, so the construction of the New Weir 3 will result in significantly reduced wetland disturbance. It should be noted that there will still be some potential direct and secondary wetland disturbance with any weir installation in Yucca Pens.

Water levels in March and April are predicted to increase for more than 15,000 acres (78%) of the 20,000-acre Yucca Pens WMA. The improvement area includes 431 acres with more than one foot of improved water level, and 5,440 acres where water levels increased by 0.25 to 0.5 feet. This means that the hydroperiod range and water levels in Yucca Pens are now closer to optimum conditions for these areas.

Table 2. Summary of Scenario 2 Hydroperiod and March – April Water Level Improvements in Yucca Pens

Hydroperiod Difference	Area, ac. (S2-Baseline)	+/- from S1, ac.	Avg Hydroperiod Change, months
> 2 months	+1,081	+355	+2.89
1 - 2 months	+2,385	+557	+1.4
0.5 - 1 months	+2,799	+198	+0.72
0.25 - 0.5 months	+2,435	+102	+0.37
> 0.25 months	+8,700	+1,212	+1.08
Water Elevation Difference, March - April	**Area, ac. (S2-Baseline)**	**+/- from S1, ac.**	**Avg Elevation Change, ft**
> 2.0 ft	+2	+1	+2.04
1.0 – 2.0 ft	+429	+20	+1.38
0.5 – 1.0 ft	+2,210	+1,549	+0.65
0.25 - 0.5 ft	+5,440	+2,016	+0.34
0.1 - 0.25 ft	+7,550	-872	+0.17
> 0.1 ft	+15,631	+2,714	+0.33

Quantitative summaries of Babcock Webb hydroperiod and water level changes due to the modeled Scenario 2 restoration measures are presented below in ***Table 3***. Although specific quantitative acreage targets were not identified as a project goal, acreage totals are presented below in order to further demonstrate hydrologic restoration. Reduced wetland hydroperiods and decreased water levels are predicted in a portion of the Babcock Webb South Walk-In Area because of water deliveries to both the Bond Farm HEI and the proposed Southwest Aggregates Reservoir. Hydroperiod and water depth changes were limited to the SWIA. The Scenario 2 results suggest that additional off-line storage will be needed to achieve more substantial hydrologic restoration of the Babcock-Webb South Walk-In Area.

Table 3. Babcock Webb hydroperiod and water level changes

Hydroperiod Decrease	Area, ac. (S2-Baseline)	+/- from S1, ac.	Average Hydroperiod Change, months
> 2 months	89	+89	-2.5
1 - 2 months	208	+208	-1.4
0.5 - 1 months	440	+398	-0.7
0.25 - 0.5 months	935	+766	-0.36
Water Elevation Difference, July 1 – Nov 30	**Area, ac. (S2-Baseline)**	**+/- from S1, ac.**	**Average Elevation Change, ft**
0.5 – 1.0 ft	40	+40	-0.61
0.25 - 0.5 ft	123	+123	-0.36
0.1 - 0.25 ft	1,674	+1,580	-0.18

Note: Hydroperiod and water depth differences were only observed in the South Walk-In Area

Water levels in Yucca Pens Creek (SR-8) and Durden Creek (SR-9) are predicted to increase from Baseline existing conditions (BL) water levels as a result of the Scenario 2 restoration measures, as shown below in ***Figure 13*** and ***Figure 14***, respectively. In Scenario 2, water levels exceed the edge of wetlands in Yucca Pens Creek (SR-8) during the wet season. Field investigations indicated the presence of habitat that appears to be wet prairie habitat that did not exhibit typical wetland vegetation, due to alternations caused by the incised channel of Yucca Pens Creek. The higher water levels will allow for restoration of the wetland habitat typically found on the edge of cypress wetlands. SR-8 and SR-9 are locations 5 and 12 in ***Figure 3***, respectively.

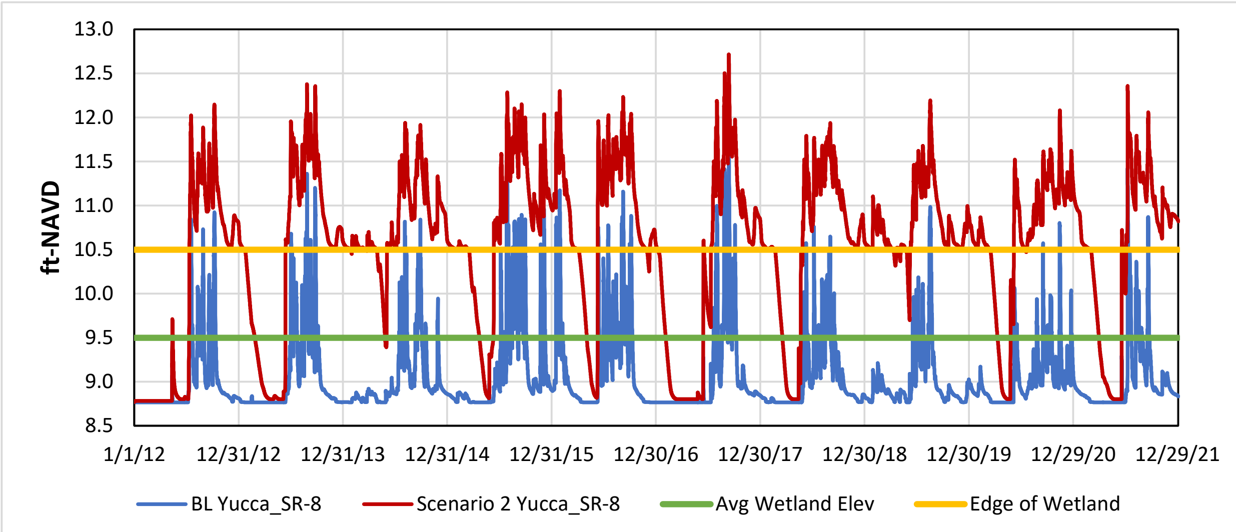

Figure 13. Simulated water levels in Yucca Pens Creek at SR-8 for Scenario 2 and Existing Conditions

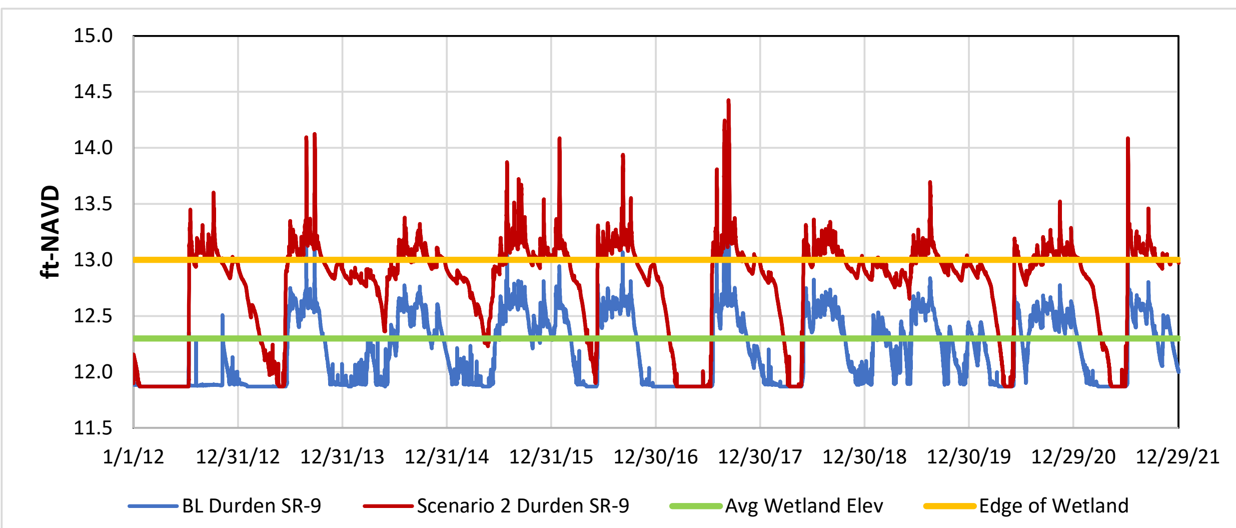

Figure 14. Simulated water levels in Durden Creek at SR-9 for Scenario 2 and Existing Conditions

Scenario 2 combined simulated flows at Burnt Store Road (BSR) for Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch were compared to Baseline existing conditions simulated flows for these same creeks and are presented in ***Figure 16***. A statistical comparison of the changes in peak flows for both Scenarios 1 and 2 is presented in ***Table 4***. The comparison indicates that, on average, peak flows were reduced by 15% in Scenario 1 as compared to the Baseline existing conditions model. While there is less reduction of peak flows in Scenario 2 as compared to Scenario 1, which is related to more water being delivered to Yucca Pens, the recession limb of the flow after each storm or rain event has been extended in Scenario 2 due to the restoration measures. One example of this is the ATV ditch blocks which slow flow out of Yucca Pens wetland areas and help retain water. This demonstrates that flashiness in streams is attenuated or reduced so that there is more moderate flow in these streams rather than extreme high and low flow events. The reductions in peak flow and the changes to the recession limb are shown more clearly in expanded graphs comparing Scenario 1, Scenario 2 and Baseline existing conditions simulated flows for 2017 and 2018 in ***Figure 7*** and ***Figure 8***, respectively. Locations of the Burnt Store Road stations are presented in ***Figure 15***. Additional plots of Scenario 2 results are provided in ***Appendix B***.

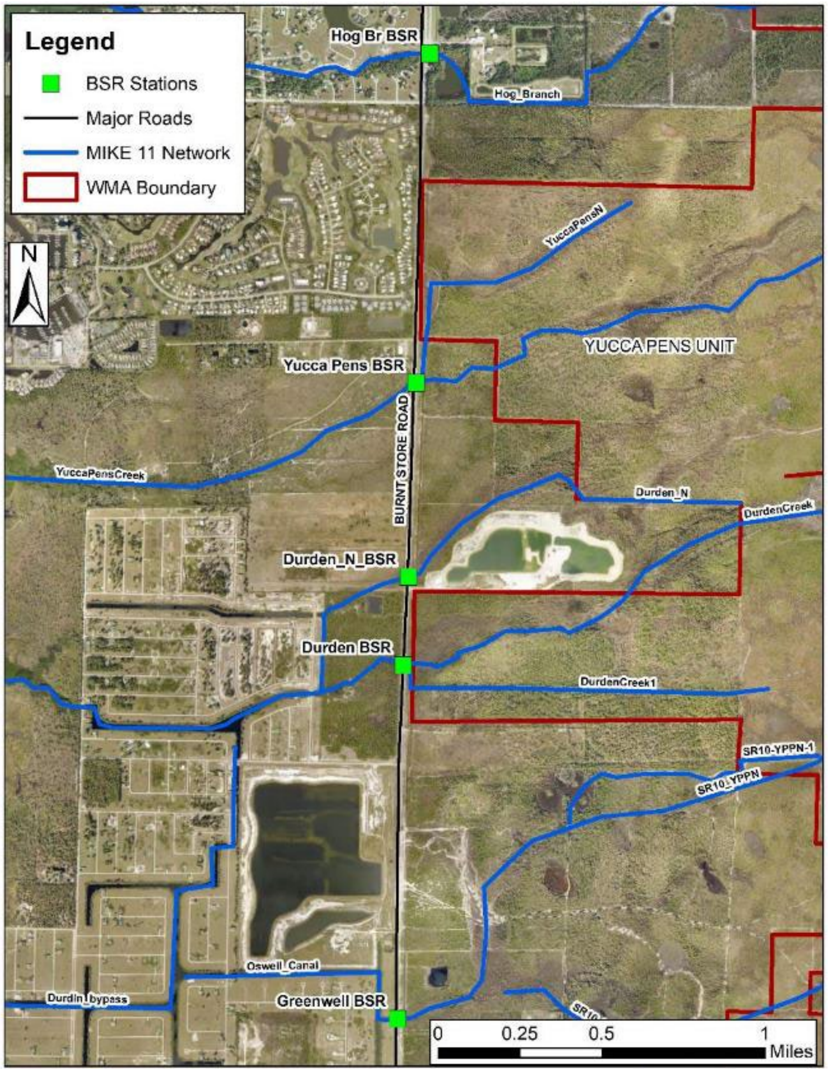

Figure 15. Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch at Burnt Store Road

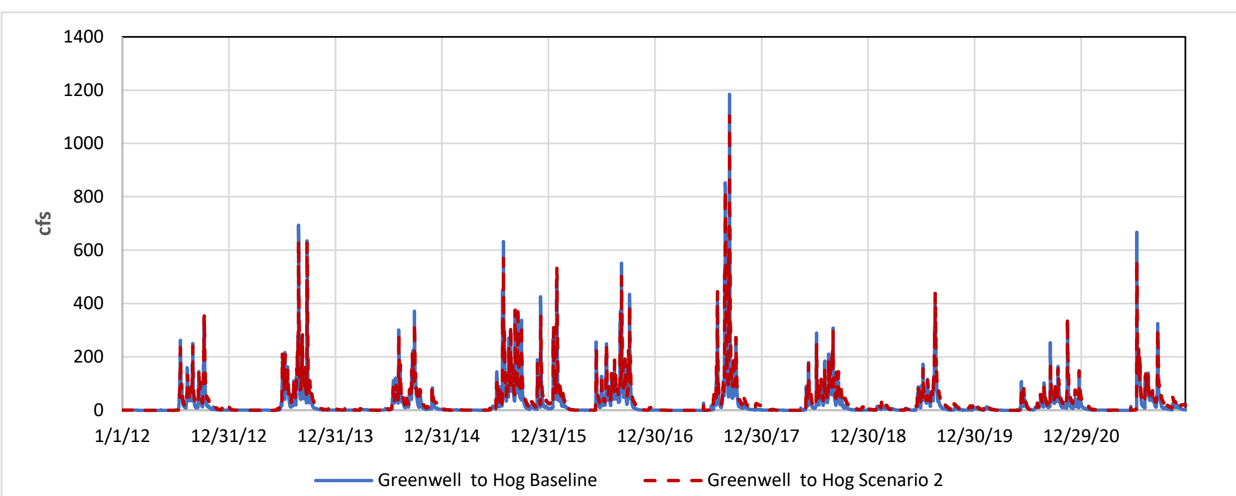

Figure 16. Simulated flows under Burnt Store Road for Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch for Scenario 2 and Baseline Existing Conditions

Table 4. Comparison of Changes in Peak Flows between Scenario 1 and Scenario 2, 2012 - 2021

Statistic	Scenario 1	Scenario 2
Average Change in Peak Flow, %	-15%	-1%
25th Percentile Change in Peak Flow, %	-8%	+8%
75th Percentile Change in Peak Flow, %	-22%	-10%

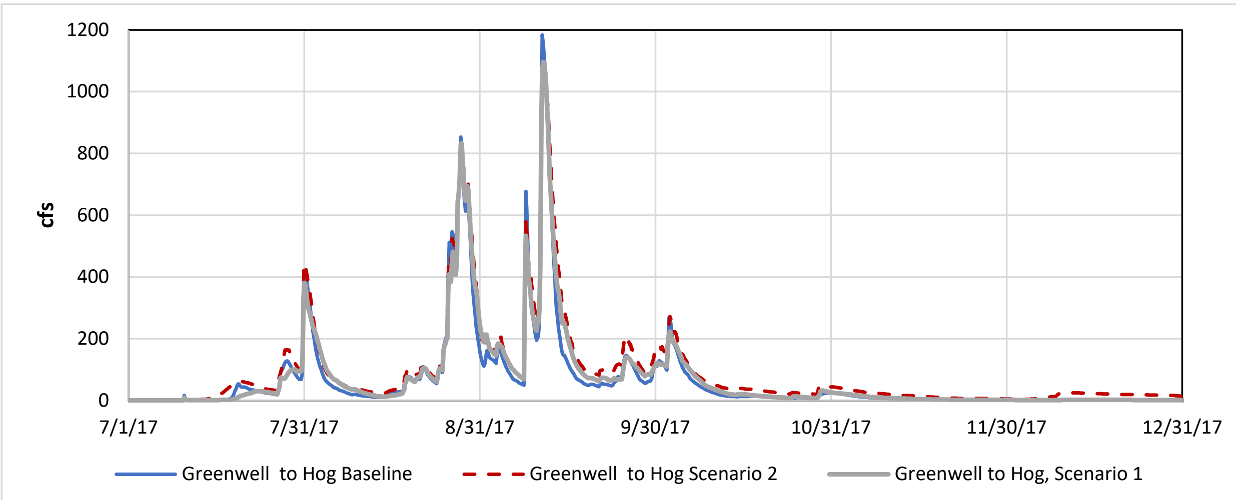

Figure 17. Simulated late 2017 flows at Burnt Store Road for Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch for Scenarios 1 and 2 and Baseline Existing Conditions

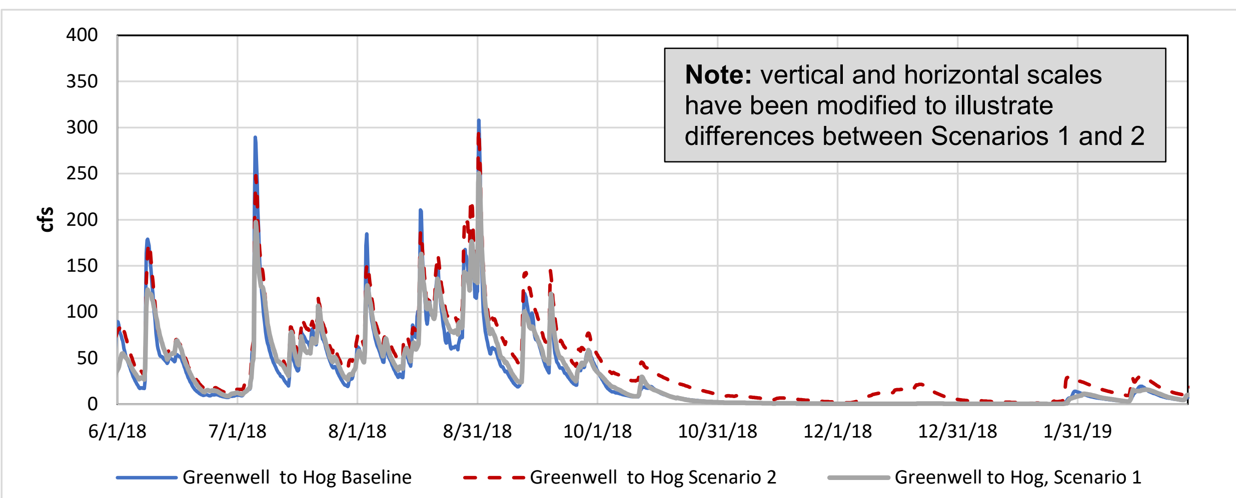

Figure 18. Simulated flows (6/1/18 to 2/28-19) at Burnt Store Road for Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch for Scenarios 1 and 2 and Baseline Existing Conditions

A detailed evaluation of simulated flows during the late wet/early dry seasons (November 1 through January 31) was conducted to highlight the differences between Scenarios 1 and 2. Flows for November 1 through January 31 for each simulation year under Burnt Store Road from Greenwell Branch, Durden Creek, Yucca Pens Creek, and Hog Branch for Scenarios 1 and 2 are compared in ***Table 5***. Scenario 2 provides, on average, 87% more flow to tidal creeks during the late wet season and early dry season than Scenario 1. While Scenario 1 conditions result in higher water levels in Yucca Pens wetlands, the additional conditions in Scenario 2 (added storage, additional delivery of water via flow-way to Yucca Pens, modified Weir 3 location) provide further restoration benefit by extending the duration of positive discharges from Yucca Pens to tidal creeks during the early dry season.

Table 5. Simulated flows under Burnt Store Road for Scenarios 1 and 2, Greenwell Branch to Hog Branch

Flows November 1 to January 31, acre feet			
Year	**Scenario 1**	**Scenario 2**	**Scenario 2 – Scenario 1**
2012	199	1,538	+1,339
2013	138	1,041	+903
2014	1,450	2,905	+1,455
2015	10,018	13,590	+3,572
2016	84	678	+594
2017	563	2,155	+1,592
2018	173	1,373	+1,200
2019	469	1,552	+1,083
2020	4,947	8,925	+3,978
Averages	**2,005**	**3,751**	**+1,746**

All graphs presented below in ***Figure 19*** represent flows under Burnt Store Road. Overall combined response for Hog Branch, Yucca Pens Creek, Durden Creek North, Durden Creek, and Greenwell Branch are presented in the top left graph. Graphs of Scenario 1 versus baseline existing conditions for each of the creeks is presented in the remaining graphs in the figure. Hog Branch (top right graph) flows do not change significantly due to the proposed weirs. This is expected since most of the Hog Branch watershed is outside the boundaries of Yucca Pens WMA. Yucca Pens Creek peak flows in the early part of the wet season (June through September) are less for Scenario 1 than for the baseline existing condition scenario. Scenario 1 flow reductions are most effective in the North Branch of Durden Creek. Performance in Durden Creek was similar to Yucca Pens Creek with reductions during peak flow periods and higher flows during the recession limb of hydrographs. Peak flow reductions in Greenwell Branch were minimal due to the urban nature of the watershed east and west of Burnt Store Road.

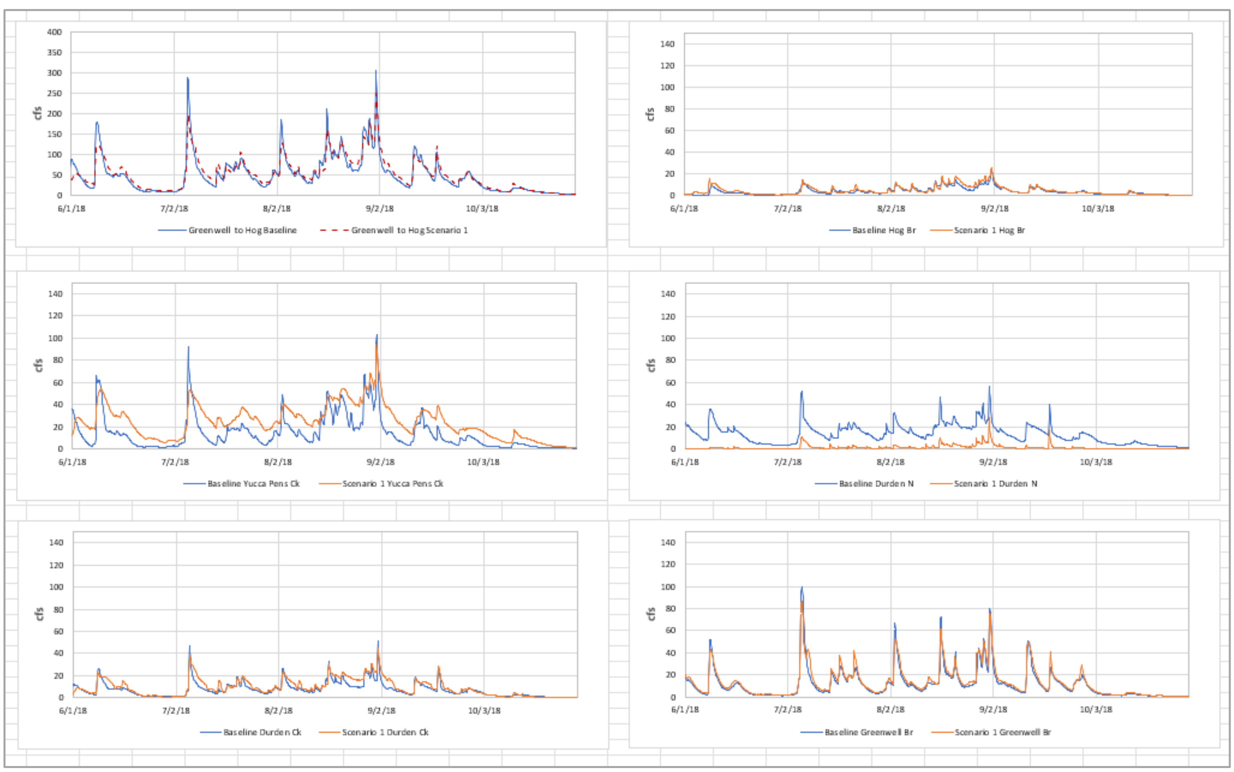

Figure 19. 2018 Flows for Scenario 1 and Baseline Existing Conditions for Burnt Store Road Creeks

HISTOGRAM ANALYSIS OF SCENARIO 2 HYDROPERIODS

The Natural Systems analysis presented in Technical Memorandum 6A provided a comparison of the Baseline existing conditions simulated hydroperiods and average wet season water depths to optimum hydroperiods and depths expected under pre-development conditions. The Natural Systems analysis results were presented as a series of histograms for Areas of Interest (AOIs) within Babcock Webb and Yucca Pens.

In order to evaluate the performance of Scenario 2, simulated Scenario 2 results were compared to the Scenario 1 and Baseline existing condition results for Hydro Ranks 3 and 4 (wetter conditions). Comparisons are presented for Babcock Webb South Walk-In (Reduced) for Hydro Ranks 3 and 4 in

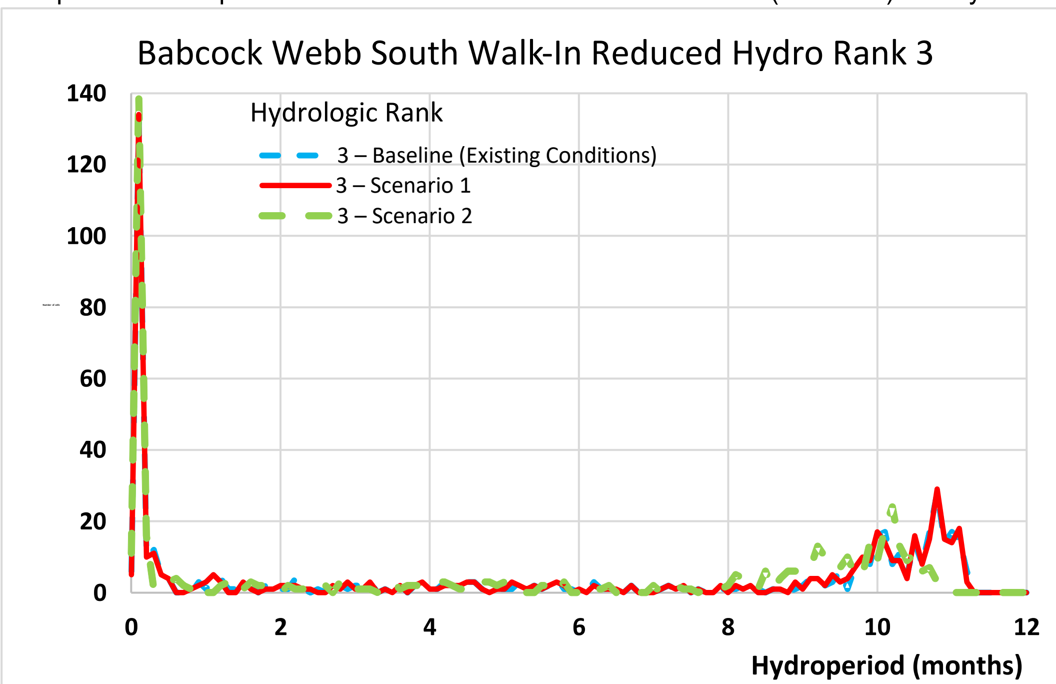

Figure ***20*** and ***Figure 21***. Results for Yucca Pens Cypress for Hydro Rank 3 and 4 are presented in ***Figure 22*** and ***Figure 23***. The Yucca Pens Cypress area is the pink-outlined area shown in ***Figure 10***. Comparisons are presented for the Yucca Pens ATV AOI for Hydro Rank 3 and 4 in ***Figure 24*** and ***Figure 25***.

Babcock Webb South Walk-In Area Reduced AOI. Scenario 2 simulated hydroperiods in the Babcock Webb South Walk-In Area (Reduced) decreased for both Hydro Ranks 3 and 4. This is an improved result compared to Scenario 1 outcomes, which did not yield substantial decreases in wetland hydroperiods for the excessively inundated South Walk-In Area (Reduced). The most common hydroperiod for the Baseline existing conditions scenario for Hydro Rank 3 was 10.8 months, which was decreased to 10.1 months in Scenario 2. The most common hydroperiod for the Baseline existing conditions and Scenario 1 results for Hydro Rank 4 was 11.5 months, and the Scenario 2 hydroperiods were more broadly distributed with two peaks at 9.5 and 11.4 months. South Walk-In Area hydroperiods have dropped below 10.5 months for a larger percentage of the Hydro Rank 4 wetlands and the percentage of Hydro Rank 3 wetlands with hydroperiods above 10.5 months has decreased significantly. These results suggest that some of the wetlands in the South Walk-In Area (Reduced) experienced reduced hydroperiods while the remaining wetlands throughout the remainder of Babcock Webb did not change substantially. This is consistent with the hydroperiod difference map shown above in ***Figure 5*** and the wet season water depth difference map shown above in ***Figure 10***.

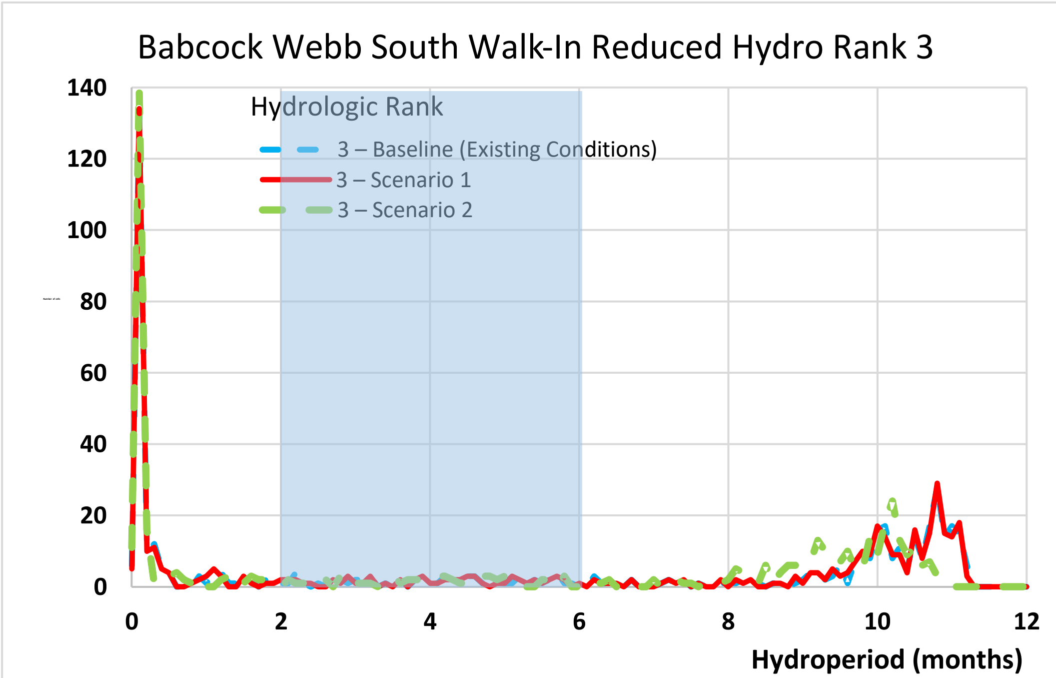

Figure 20. Hydroperiods for Babcock Webb South Walk-In Reduced Hydro Rank 3

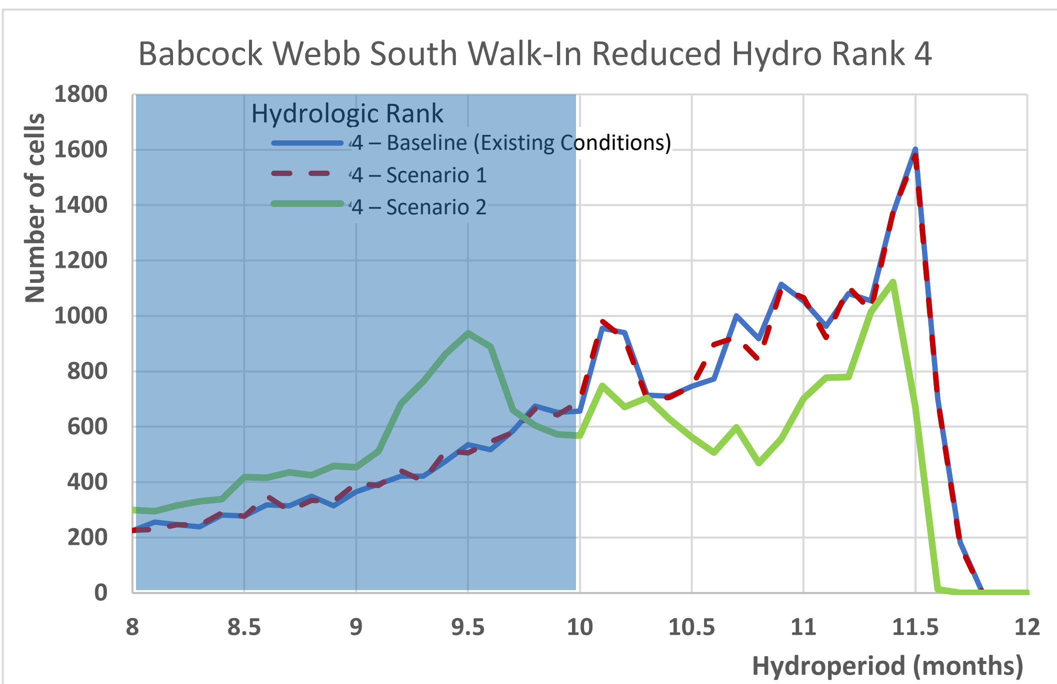

Figure 21. Hydroperiods for Babcock Webb South Walk-In Reduced Hydro Rank 4

Yucca Pens Cypress AOI. The most common hydroperiod for the Baseline existing conditions scenario for Hydro Rank 3 was approximately 5.5 months in the Yucca Pens Cypress area, and Scenario 2 hydroperiods were more broadly distributed with two peaks at 5.4 months and 8.5 months. The most common hydroperiod for the Baseline existing conditions scenario for Hydro Rank 4 was 5.9 months in

Yucca Pens Cypress, and Scenario 2 hydroperiods increased and were more broadly distributed with peaks at 9.1 and 10.9 months. Scenario 2 simulated hydroperiods were longer than Scenario 1 simulated hydroperiods for Yucca Pens Cypress. This means that the hydroperiod ranges in Yucca Pens Cypress are now closer to optimum conditions for these areas. Most of the simulated Hydro Rank 3 and 4 wetlands now have hydroperiods greater than five months, which is a significant improvement relative to baseline existing conditions.

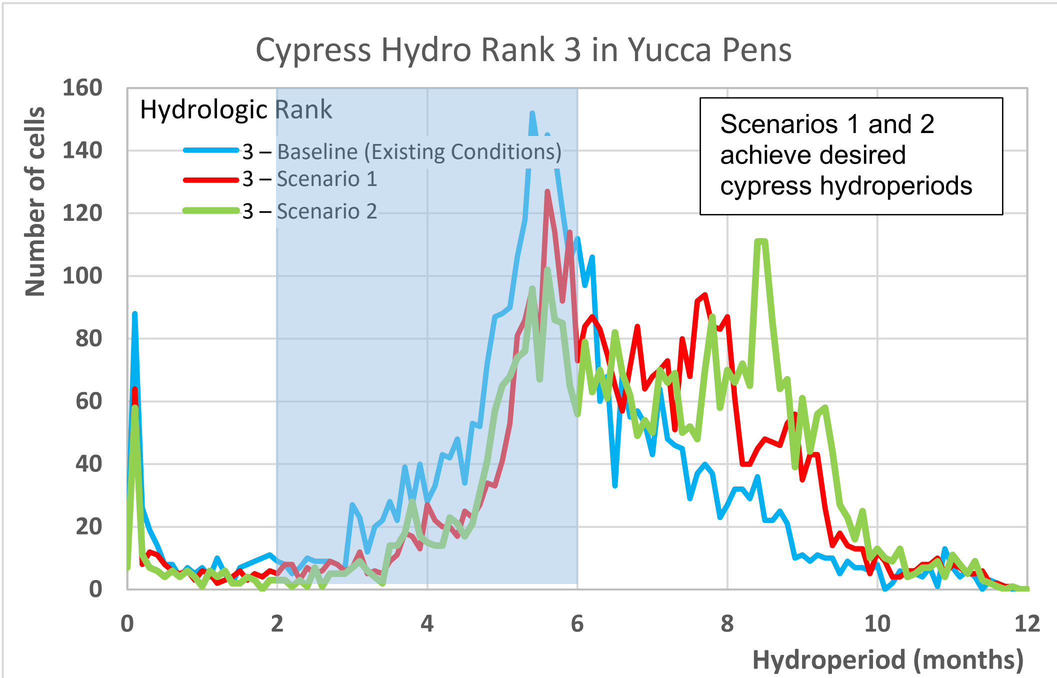

Figure 22. Hydroperiods for Yucca Pens Cypress Hydro Rank 3

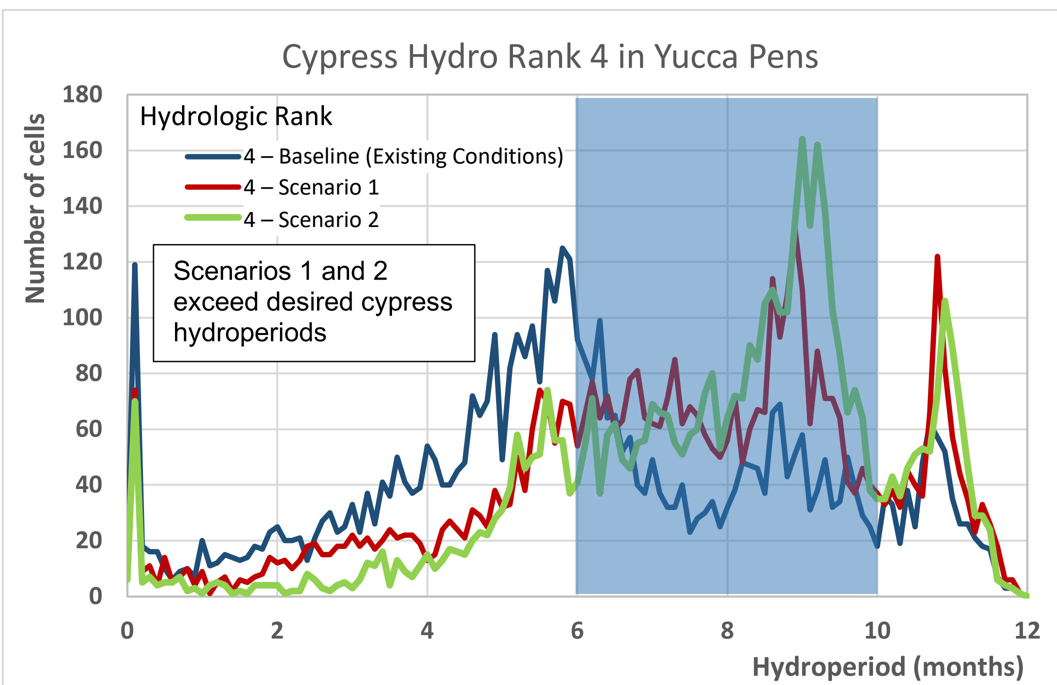

Figure 23. Hydroperiods for Yucca Pens Cypress Hydro Rank 4

Yucca Pens ATV AOI. The most common hydroperiod for the Baseline existing condition scenario for Hydro Rank 3 was approximately 4.5 months in the Yucca Pens ATV areas, while the most common hydroperiod for Scenario 2 increased to 5.6 months. The most common hydroperiods for the Baseline existing conditions scenario for Hydro Rank 4 were 3.9 and 5.7 months in the Yucca Pens ATV area, while the most common hydroperiod for Scenario 1 for Hydro Rank 4 was 4.7 months with more broadly distributed peaks between 4.7 and 7.7 months. The Yucca Pens ATV AOI performed relatively similar in both Scenarios 1 and 2, with a slight improvement for Scenario 2 as evidenced by the difference map presented in ***Figure 15****.* This means that the hydroperiod ranges in Yucca Pens ATV AOI are now closer to optimum conditions for these areas. The differences between Scenario 1 and Scenario 2 for the ATV AOI using either the histogram analysis (***Figures 24*** and ***25***) or the hydroperiod comparison (***Figure 15***) were relatively minor, suggesting that both Scenarios 1 and 2 achieved positive restoration of wetland hydroperiods and water levels. It also suggests, along with the Cypress results, that the hydrologic benefits of moving water from Bond Farm are concentrated in the Durden Creek area.

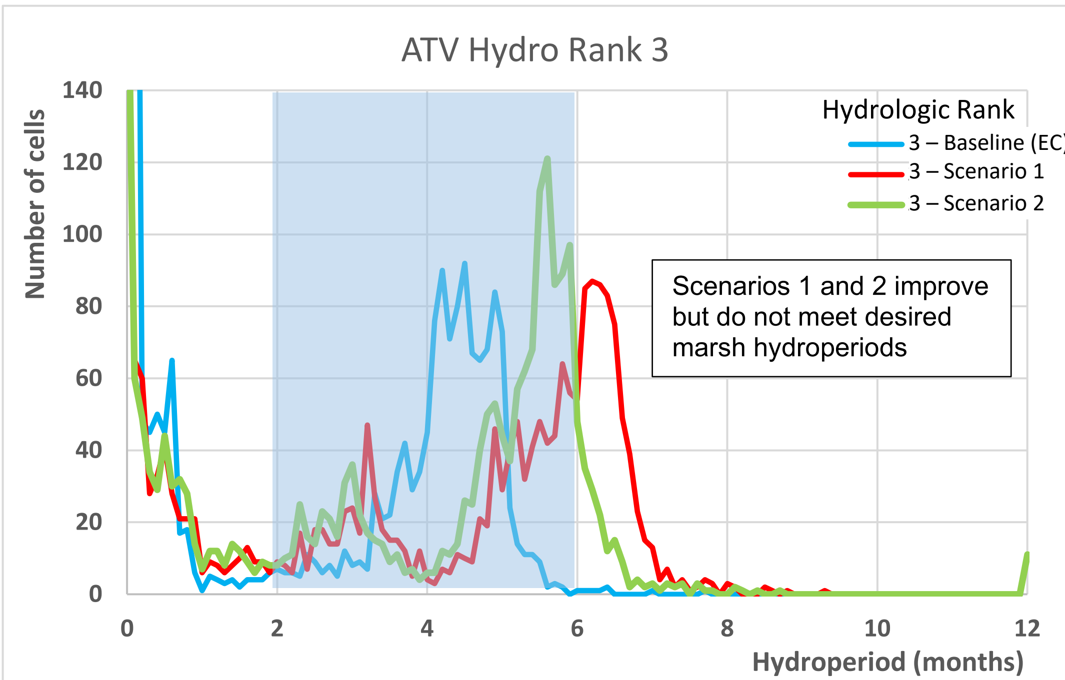

Figure 24. Hydroperiods for Yucca Pens ATV Area, Hydro Rank 3

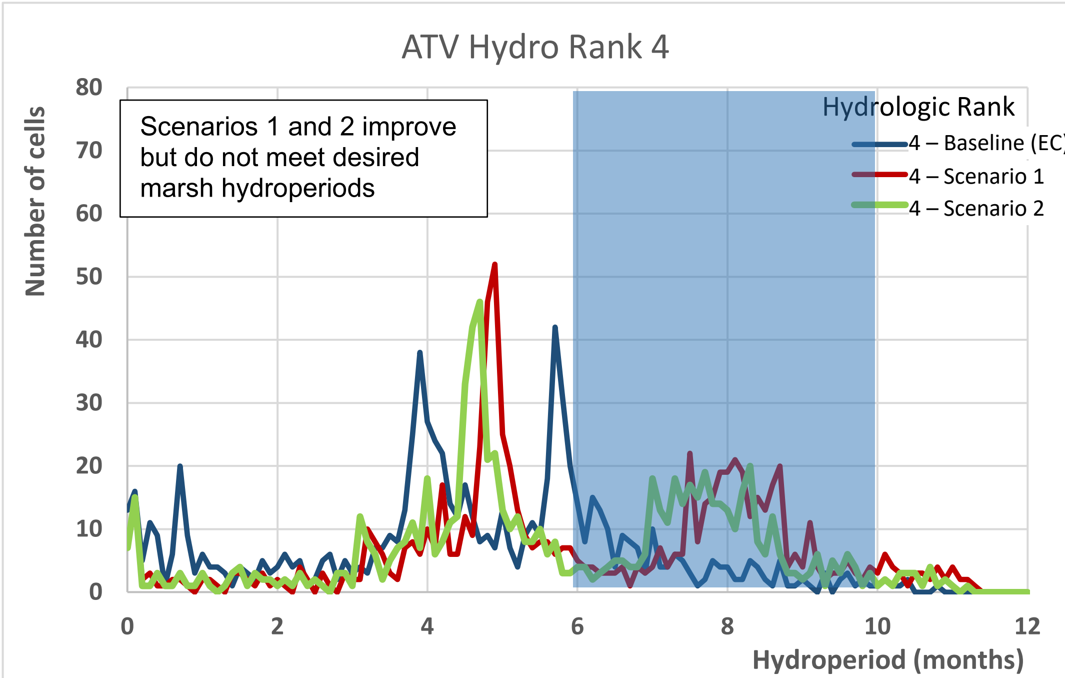

Figure 25. Hydroperiods for Yucca Pens ATV Area, Hydro Rank 4

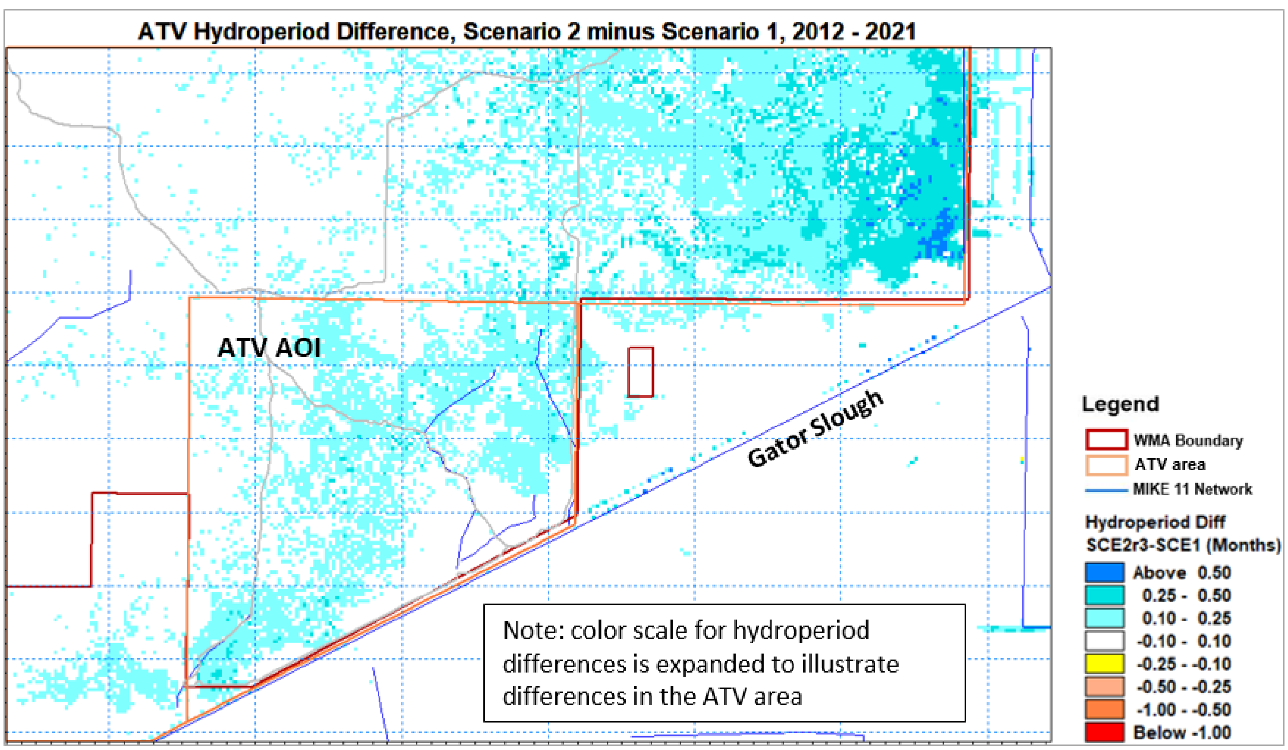

Figure 15. Scenario 2 minus Scenario 1 Yucca Pens ATV hydroperiod differences during the period 2012-2021 (note different color scale than prior figures)

SIMULATED PERFORMANCE FOR THE BOND FARM HEI AND THE SOUTHWEST AGGREGATES RESERVOIR

The Bond Farm HEI was programmed to store water pumped from the southwestern portion of Babcock Webb WMA with water depths up to 4 feet during the wet season and to release water during the dry season. The initial conceptual restoration plan developed in 2014 (ADA, 2014) included a proposed flow-way from Bond Farm HEI west to Yucca Pens with the intention that outflows would be released during the early part of the dry season (December and January) to extend hydroperiods in Yucca Pens. As described above in the Introduction section, Scenario 2 includes a flow-way west from Bond Farm HEI to Yucca Pens.

The Scenario 2 simulated inflows and outflows for Bond Farm HEI during the period of 2012 – 2021 are summarized below in ***Table 6***, ***Figure 16,*** and ***Figure 17***. Outflows are less than 50% of inflows for the final calibrated model (assumed lower water table hydraulic conductivity in Bond Farm HEI only). The majority of the difference between inflows and outflows is due to groundwater seepage. ***Table 7*** presents results for a sensitivity analysis with hydraulic conductivities capped at 297 ft/day (except in Bond Farm where capped at 35 ft/day, see ***Appendix C*** for description).

Table 6. Simulated inflows and outflows for Bond Farm HEI and Southwest Aggregates Reservoir, Final Calibration (units in acre-feet)

Year	Bond In	Bond Out		SW Agg In	SW Agg Out
2012	2,829	986		5,581	See note
2013	3,893	868		8,688	4,744
2014	1,157	742		4,522	4,744
2015	3,230	1,874		6,556	4,744
2016	4,559	855		9,335	4,744
2017	2,443	978		5,818	4,744
2018	4,128	714		8,007	4,744
2019	2,995	505		6,218	4,744
2020	3,603	1,858		5,885	4,744
2021	4,156	See note		7,386	4,744
Averages:	3,299	1,042		6,800	4,744

Note: Outflows not calculated in 2012 for SW Agg and 2021 for Bond.

Table 7. Simulated inflows and outflows for Bond Farm HEI and Southwest Aggregates Reservoir, Lower Hydraulic Conductivity (units in acre-feet)

Year	Bond In	Bond Out		SW Agg In	SW Agg Out
2012	2,323	1,478		5,002	See note
2013	2,627	1,357		8,428	4,744
2014	1,198	1,121		4,144	4,744
2015	2,465	2,382		6,172	4,744
2016	2,919	1,318		8,951	4,744
2017	1,848	1,434		5,643	4,744
2018	2,874	1,289		7,469	4,744
2019	2,448	1,190		5,616	4,744
2020	2,746	2,144		6,008	4,744
2021	3,034	See note		6,696	4,744
Averages:	2,448	1,524		6,413	4,744

Note: Outflows not calculated in 2012 for SW Agg and 2021 for Bond. Final calibration model described in TM 5c (WSA & CHNEP, 2022b). Reduced Hydraulic conductivity sensitivity analysis assumptions described in Appendix C.

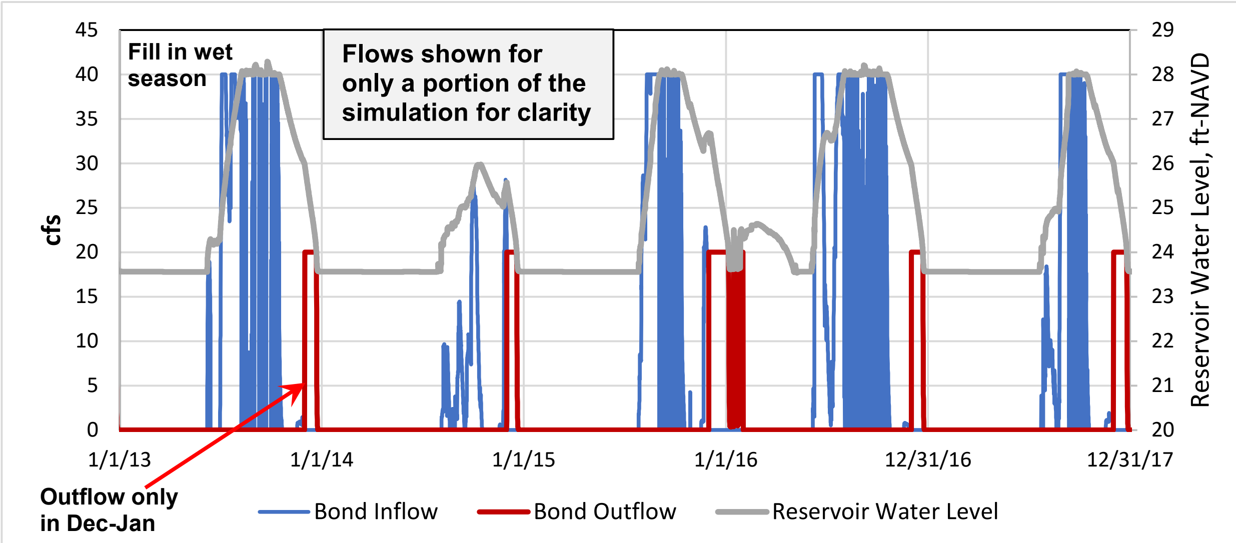

Figure 16. Simulated inflows, outflows and water levels in Bond Farm HEI (Final Calibration)

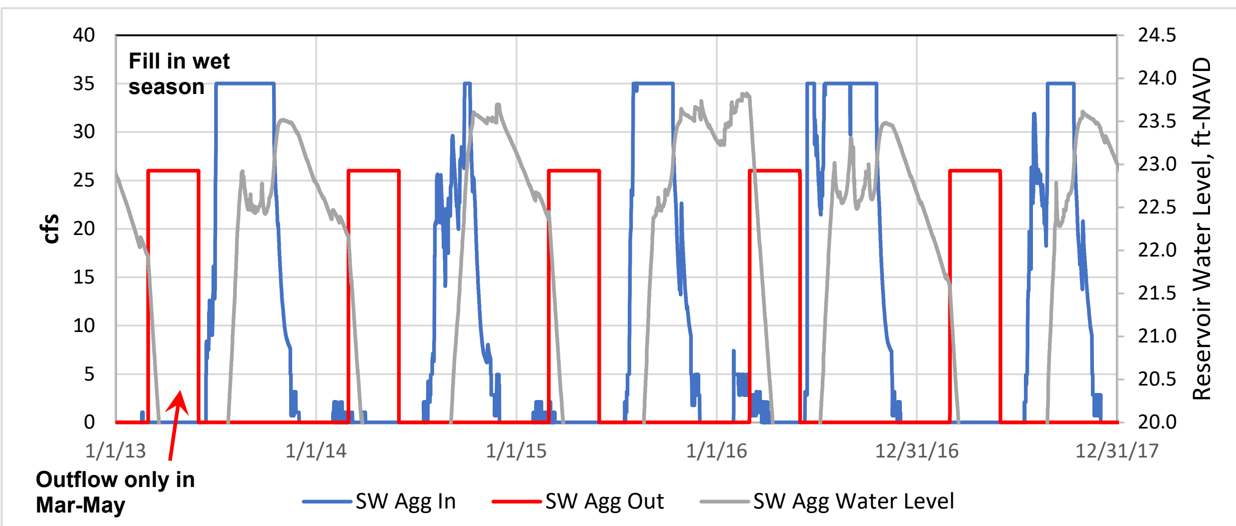

Figure 17. Simulated inflows, outflows and water levels in Southwest Aggregates Reservoir (Final Calibration)

The sensitivity analysis simulation with capped conductivities indicates lower overall losses to groundwater seepage. On average, simulated Bond Farm HEI outflows were 62% of simulated inflows for the reduced hydraulic conductivity sensitivity analysis simulation.

Tables 6 and **7** both show that the Bond Farm HEI inflow in 2014 is less than the capacity of that storage facility. It is recommended to consider modification of operating protocols, based on modeling, for inflow pumps for Bond Farm HEI and Southwest Aggregates so that the priorities for turning on both pumps may be varied through a series of sensitivity tests to obtain simulation results where Bond Farm HEI is filled to full capacity before the Southwest Aggregates Reservoir is filled during all simulation years. One possible approach is to have different operating rules for dry years where the Southwest Aggregates Reservoir inflow pump turns on at a higher trigger elevation, which will maximize inflows to the Bond Farm HEI.

SUMMARY OF SCENARIO 2

Scenario 2 includes storage of excess water from Babcock Webb in both the Bond Farm HEI (also included in Scenario 1) that would be used to store water up to a depth of 4 feet with water discharged west to Yucca Pens during the dry season and in the Southwest Aggregates mine property which is planned to be converted to a reservoir in the near future. While Scenario 1 did not result in significant measurable decreases in water depths or wetland hydroperiods in the South Walk-In Area of Babcock Webb, the analysis of Scenario 2 simulation results indicated that hydroperiod decreases greater than 0.5 months are predicted for 737 acres in the South Walk-In Area of Babcock Webb. This brings hydroperiods closer to optimum conditions due to increased removal of water from Babcock Webb. However, hydroperiods in this area are still not optimal, and additional storage may be needed to provide greater restoration of the Babcock Webb South Walk-In Area.

In Yucca Pens, hydroperiods and water depths will increase as a result of the proposed restoration measures described above in Scenario 2. Hydroperiod increases of greater than one month are predicted for 3,465 acres of Yucca Pens, which closer to optimum conditions and therefore a greater level of restoration than predicted for Scenario 1. Water table levels in March and April (dry season) are predicted to be greater than one foot for 431 acres, and water levels are predicted to increase by more than 0.25 feet for 8,082 acres in Yucca Pens.

A comparison of discharges to tidal creeks during the late wet/early dry season was conducted for Scenarios 1 and 2. That analysis suggests that Scenario 2 provides an 87% increase in freshwater flow to tidal creeks during the late wet season and early dry season as compared to Scenario 1. While Scenario 1 conditions result in higher water levels in Yucca Pens wetlands, the additional conditions in Scenario 2 (added storage, additional delivery of water via flow-way to Yucca Pens, modified Weir 3 location) provide further restoration benefit by extending the duration of positive discharges from Yucca Pens to tidal Durden and Yucca Pens creeks during the early dry season. Increasing freshwater flows to tidal creeks in the dry season is important for meeting fish habitat needs for salinity.

Scenario 2 provides additional hydrologic restoration benefits to those benefits provided by Scenario 1:

- Improved restoration of hydroperiods and water depths in the South Walk-In Area of Babcock Webb
- Greater restoration of wetland hydroperiods and water depths in Yucca Pens
- Increased discharges from Yucca Pens to tide during the late wet/early dry season

Based on the analysis described herein, Scenario 2 is recommended for implementation due to hydrologic improvements in both Babcock Webb and Yucca Pens. Further model refinements of Scenario 2 are recommended during subsequent restoration planning and design efforts. Additional calibration is recommended to decrease uncertainties regarding groundwater hydraulic conductivities, and this effort may indicate that greater restoration can be achieved by Scenario 2. Recalibration may indicate more substantial Yucca Pens peak flow reductions at Burnt Store Road. The priorities for turning on both Bond Farm HEI and the Southwest Aggregates Reservoir pump should be varied through a series of sensitivity tests to obtain simulation results where Bond Farm is filled to full capacity before the Southwest Aggregates Reservoir is filled during all simulation years. One possible approach is to have different operating rules for dry years such as 2014 where the Southwest Aggregates Reservoir inflow pump turns on at a higher trigger elevation, which will maximize inflows to the Bond Farm HEI.

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Water Science Associates & CHNEP (2022b) Lower Charlotte Harbor Flatwoods Hydrologic Modeling, Task 5c – Existing Conditions Model 100% Calibration. Prepared for the Coastal & Heartland National Estuary Partnership, Charlotte County, Florida, May 2022.

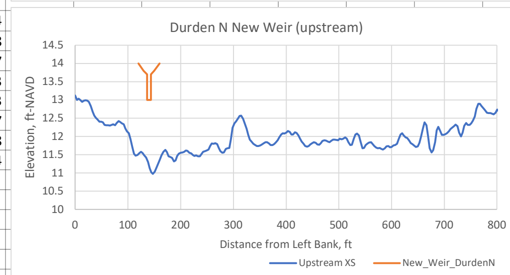
Water Science Associates & CHNEP (2022c) Lower Charlotte Harbor Flatwoods Hydrologic Modeling, Task 6a – Natural Systems Model. Prepared for the Coastal & Heartland National Estuary Partnership, Charlotte County, Florida, draft submitted to CHNEP, April 2022.

Appendix A

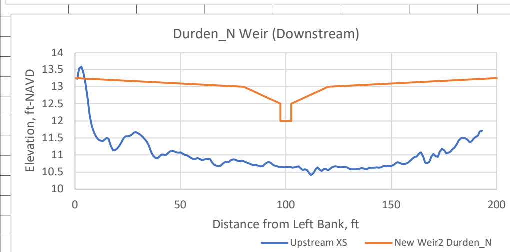
Additional Information of Proposed Weirs

CH-NCRB_20220320_BL_scenario_1						Separated_Overland_Areas_20211117r_ATV_alt1.dfs2		
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
SR-7_South	SR-7_S_NewWeir	1050		0	10	450	0	18.2
	Invert		17.5	0.5	10	500	50	18.1
				0.6	100	570	120	18
				0.7	250	570	120	17.5
						580	130	17.5
						580	130	18
						600	150	18.1
						700	250	18.2

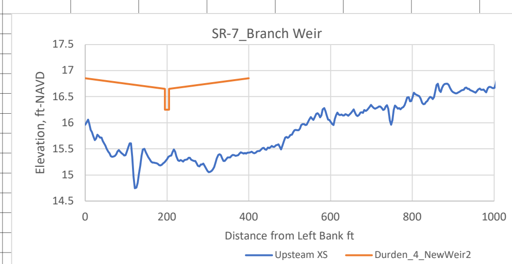
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
Durden_N	New_Weir_DurdenN	100		Level	Width	120	0	14
				13	7	130	10	13.8
				13.7	7	136.5	16.5	13.7
				13.8	20	136.5	16.5	13
				14	40	143.5	23.5	13
						143.5	23.5	13.7
						150	30	13.8
						160	40	14



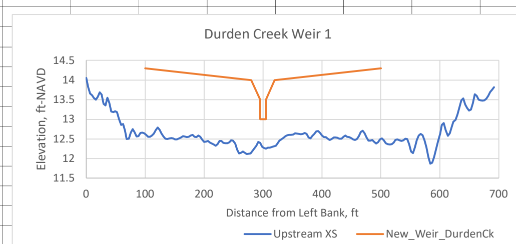
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
Durden_N	New Weir2 Durden_N			Level	Width		0	13.25
			12	0	5		80	13
				0.5	5		97.5	12.5
				1	40		97.5	12
				1.25	200		102.5	12
							102.5	12.5
							120	13
							200	13.25



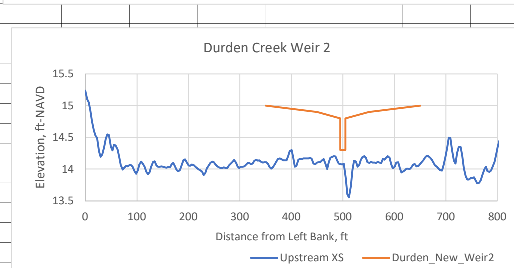
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
SR-7_Branch	Durden_4_NewWeir2	1440		Level	Width		Station	Elevation
			16.25	0	10		0	16.85
				0.4	10		100	16.75
				0.5	100		195	16.65
				0.6	400		195	16.25
							205	16.25
							205	16.65
							300	16.75
							400	16.85



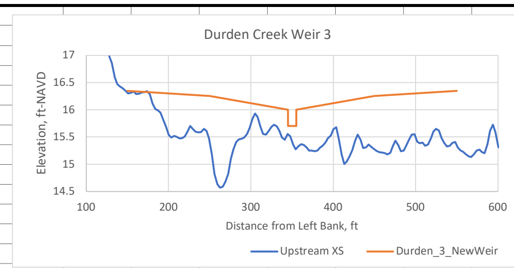
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
DurdenCreek	New_Weir_DurdenCk	4700		Level	Width	Adj Station	Station	Elevation
	Invert			13	10	100	0	14.3
				13.5	10	280	180	14
				14	40	295	195	13.5
				14.3	400	295	195	13
						305	205	13
						305	205	13.5
						320	220	14
						500	400	14.3



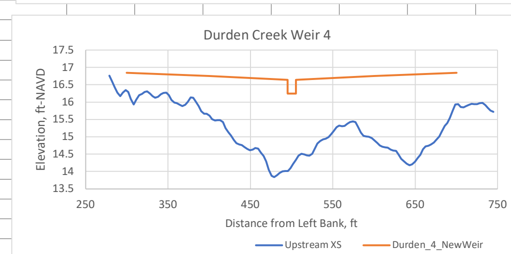
Branch	Name	chainage	Notes	Level	Width	Adj Station	Station	Elevation
DurdenCreek	Durden_New_Weir2	3720		Level	Width	Adj Station	Station	Elevation
	Invert		14.3	0	10	350	0	15
				0.5	10	450	100	14.9
				0.6	100	495	145	14.8
				0.7	300	495	145	14.3
						505	155	14.3
						505	155	14.8
						550	200	14.9
						650	300	15



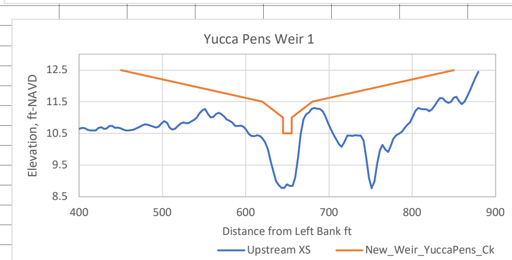
DurdenCreek	Durden_3_NewWeir	2850							
			15.7	Level	Width		Adj Statior	Station	Elevation
				0	10		150	0	16.35
				0.3	10.1		250	100	16.25
				0.55	100		345	195	16
				0.65	400		345	195	15.7
							355	205	15.7
							355	205	16
							450	300	16.25
							550	400	16.35



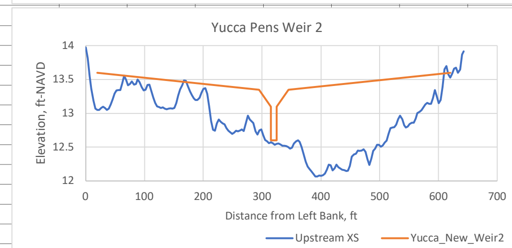
DurdenCreek	Durden_4_NewWeir	330	16.25	Level	Width		300	0	16.85
				0	10		400	100	16.75
				0.4	10.1		495	195	16.65
				0.5	100		495	195	16.25
				0.6	400		505	205	16.25
							505	205	16.65
							600	300	16.75
							700	400	16.85



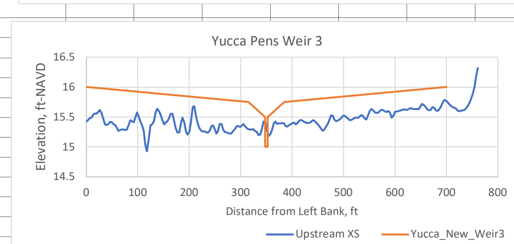
YuccaPensCreek	New_Weir_YuccaPens_	10000		Level	Width		Adj Statior	Station	Elevation
				10.5	10		450	0	12.5
				11	10		620	170	11.5
				11.5	60		645	195	11
				12.5	400		645	195	10.5
							655	205	10.5
							655	205	11
							680	230	11.5
							850	400	12.5



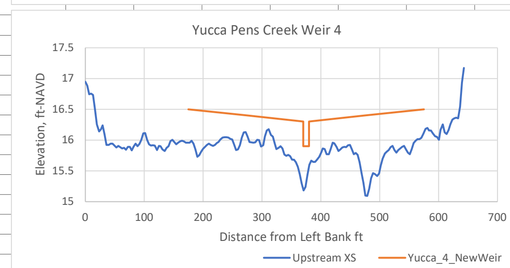
YuccaPensCreek	Yucca_New_Weir2	9090		Level	Width		Adj Statior	Station	Elevation
	Invert		12.6	0	10		20	0	13.6
				0.5	10.1		295	275	13.35
				0.75	50		315	295	13.1
				1	600		315	295	12.6
							325	305	12.6
							325	305	13.1
							345	325	13.35
							620	600	13.6



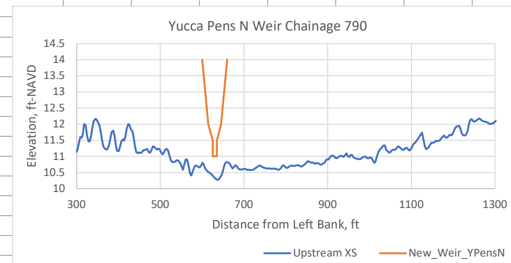
YuccaPensCreek	Yucca_New_Weir3	6525		Level	Width		Adj Statior	Station	Elevation
	Invert		15	0	5		128	0	16
				0.5	5		443	315	15.75
				0.75	70		475.5	347.5	15.5
				1	700		475.5	347.5	15
							480.5	352.5	15
							480.5	352.5	15.5
					5		513	385	15.75
							828	700	16



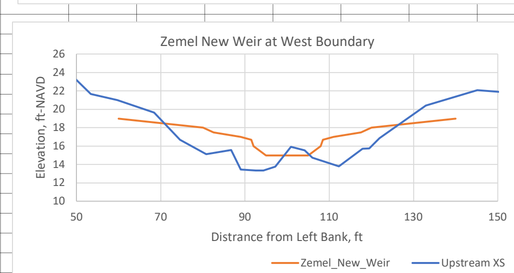
YuccaPensCreek	Yucca_4_NewWeir	5270		Level	Width		Adj Statior	Station	Elevation
			15.9	0	10		175	0	16.5
				0.4	10.1		275	100	16.4
				0.5	100		370	195	16.3
				0.6	400		370	195	15.9
							380	205	15.9
							380	205	16.3
							475	300	16.4
							575	400	16.5



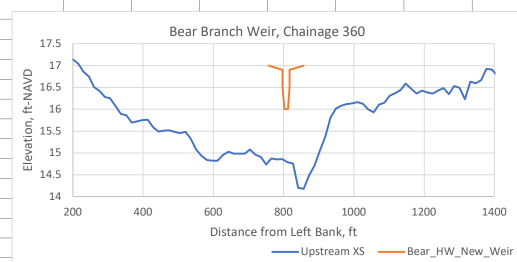
						Adj Statior	Station	Elevation
YuccaPensN	New_Weir_YPensN	790		Level	Width	600	0	14
				11	10	615	15	12
				11.5	10	625	25	11.5
				12	20	625	25	11
				14	30	635	35	11
				14.5	60	635	35	11.5
						645	45	12
						660	60	14



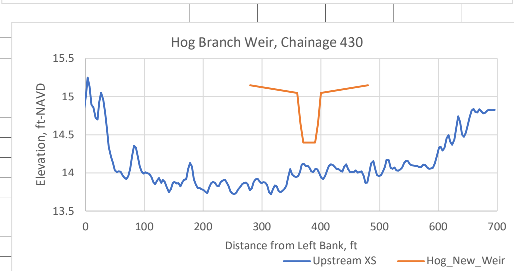
						offset	Station	Elevation
Zemel	Zemel_New_Weir	6700		Level	Width	60	0	19
			15	0	10	80	20	18
				1	16	82.5	22.5	17.5
				1.7	17	89	29	17
				2	22	91.5	31.5	16.7
				2.5	35	92	32	16
				3	40	95	35	15
				4	80	105	45	15
						108	48	16
						108.5	48.5	16.7
						111	51	17
						117.5	57.5	17.5
						120	60	18
						140	80	19



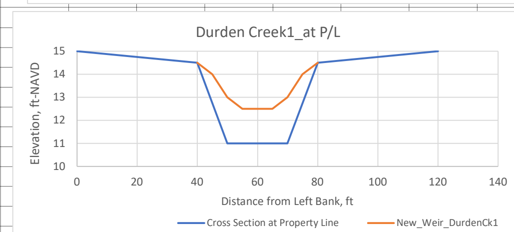
						Offset	Station	Elevation
Bear Branch	Bear_HW_New_Weir	360		Level	Width	757	0	17
			16	0	10	797	40	16.9
				0.5	20	797	40	16.5
				0.9	20	802	45	16
				1	100	812	55	16
						817	60	16.5
						817	60	16.9
						857	100	17



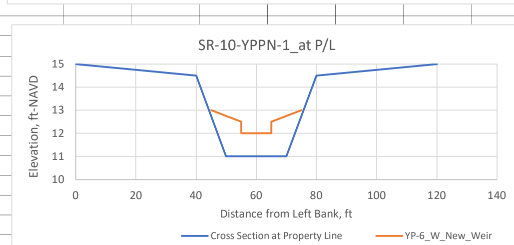
						Offset	Station	Elevation
Hog Branch	Hog_New_Weir	430		Level	Width	280	0	15.15
			14.4	0	20	360	80	15.05
				0.25	30	365	85	14.65
				0.65	40	370	90	14.4
				0.75	200	390	110	14.4
						395	115	14.65
						400	120	15.05
						480	200	15.15



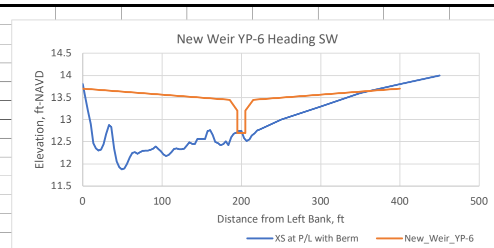
						Offset	Station	Elevation
DurdenCreek1	New_Weir_DurdenCk1	100		Level	Width	40	0	14.5
				12.5	10	45	5	14
				13	20	50	10	13
				14	30	55	15	12.5
				14.5	40	65	25	12.5
						70	30	13
						75	35	14
						80	40	14.5



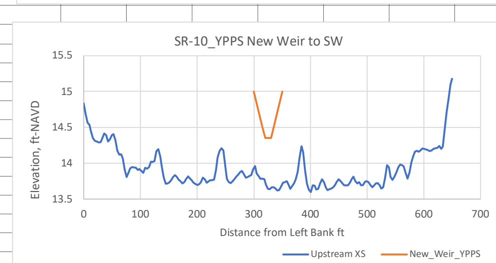
						Offset	Station	Elevation
SR10-YPPN-1	YP-6_W_New_Weir	380		Level	Width	45	0	13
			12	0	10	50	5	12.75
				0.5	10	55	10	12.5
				0.75	20	55	10	12
				1	30	65	20	12
						65	20	12.5
						70	25	12.75
						75	30	13



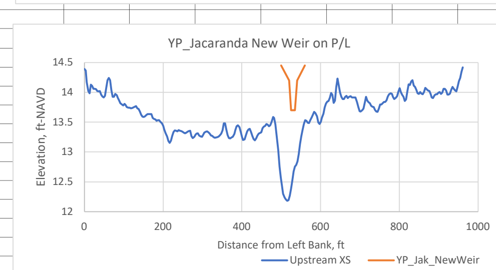
								Station	Elevation
SR10-YPPN	New_Weir_YP-6	2200		Level	Width			0	13.7
			12.7	0	10			185	13.45
				0.5	10			195	13.2
				0.75	60			195	12.7
				1	400			205	12.7
								205	13.2
								215	13.45
								400	13.7



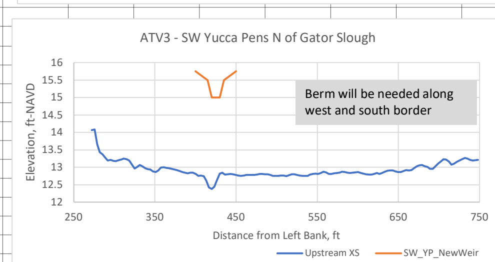
							Station	Elevation
SR10_YPPS	New_Weir_YPPS	2800		Level	Width			
				14.35	10	300	0	15
				14.5	20	315	15	14.5
				15	50	320	20	14.35
						330	30	14.35
						335	35	14.5
						350	50	15



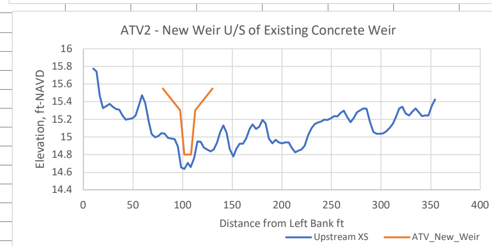
YP_Jacaranda	YP_Jak_NewWeir	740		Level	Width	Adj Sta	Station	Elevation
			13.7	0	10	500	0	14.45
				0.5	20	520	20	14.2
				0.75	60	525	25	13.7
						535	35	13.7
						540	40	14.2
						560	60	14.45



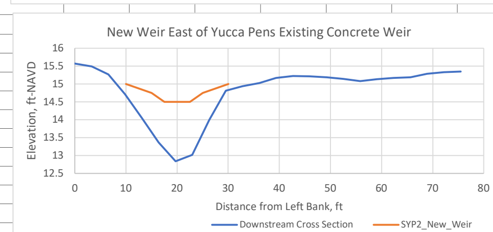
ATV3	SW_YP_NewWeir	400		Level	Width	Adj Sta	Station	Elevation
			15	0	10	400	0	15.75
				0.5	20	415	15	15.5
				0.75	50	420	20	15
						430	30	15
						435	35	15.5
						450	50	15.75



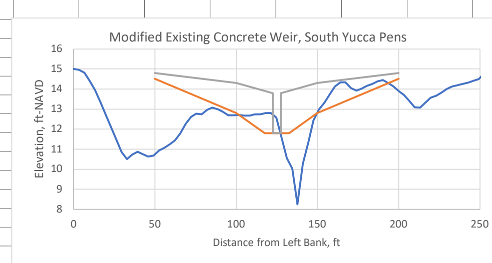
ATV2	ATV_New_Weir	500		Level	Width		Station	Elevation
			14.8	0	7	80	0	15.55
				0.5	15	97.5	17.5	15.3
				0.75	50	101.5	21.5	14.8
						108.5	28.5	14.8
						112.5	32.5	15.3
						130	50	15.55



SYP2_Weir	SYP2_New_Weir	170		Level	Width	10	0	15
			14.5	0	5	15	5	14.75
				0.25	10	17.5	7.5	14.5
				0.5	20	22.5	12.5	14.5
						25	15	14.75
						30	20	15



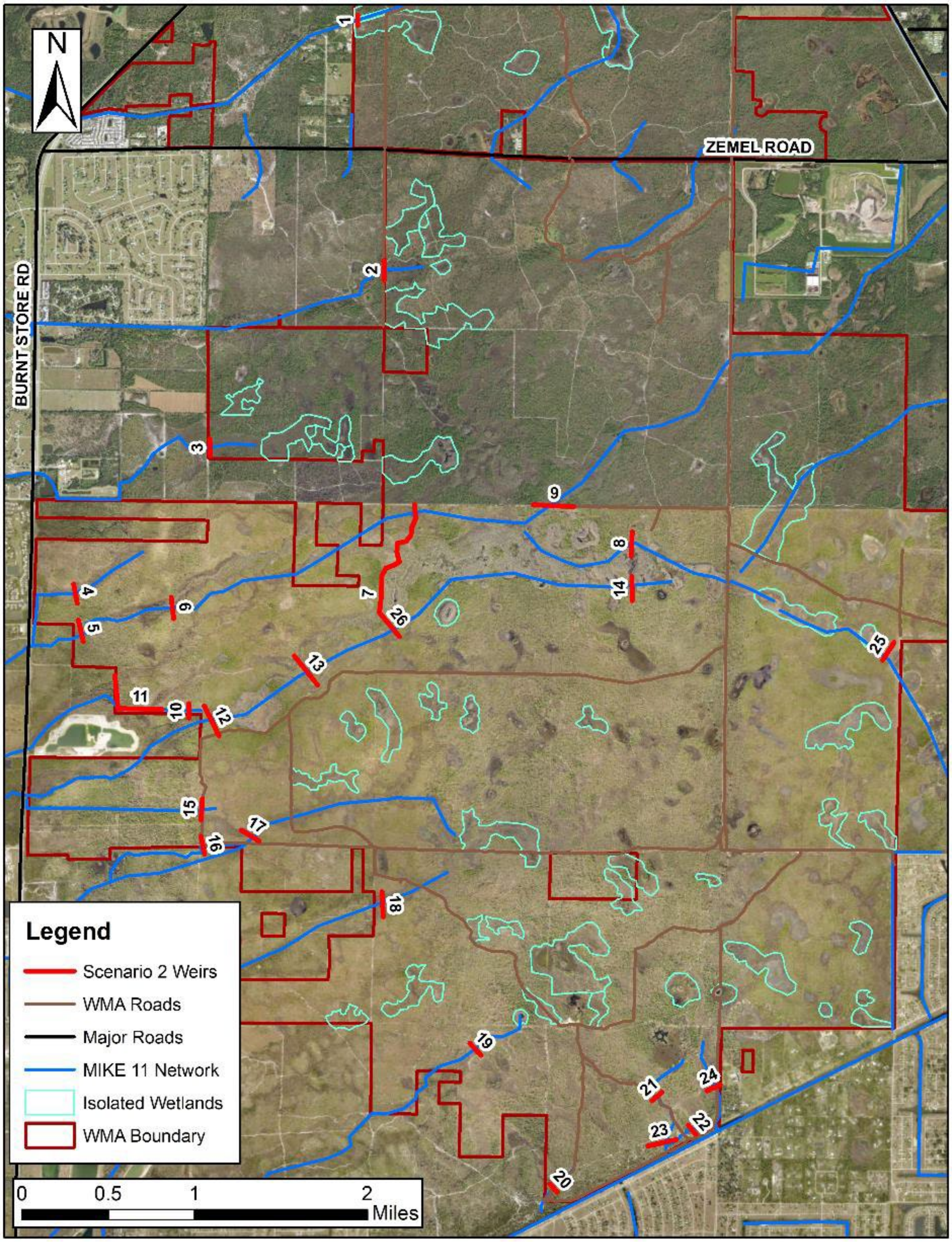
			Proposed Weir			Existing Weir	
ATV2	TrapConc	1065	Level	Width		Level	Width
		11.8	0	5	11.8	0	15
			2	5		1	50
			2.5	50		2.7	150
			3	150			
		Adj Sta	Station	Elevation	Adj Sta	Station	Elevation
		50	0	14.8	50	0	14.5
		100	50	14.3	100	50	12.8
		122.5	72.5	13.8	117.5	67.5	11.8
		122.5	72.5	11.8	132.5	82.5	11.8
		127.5	77.5	11.8	150	100	12.8
		127.5	77.5	13.8	200	150	14.5
		150	100	14.3			
		200	150	14.8			



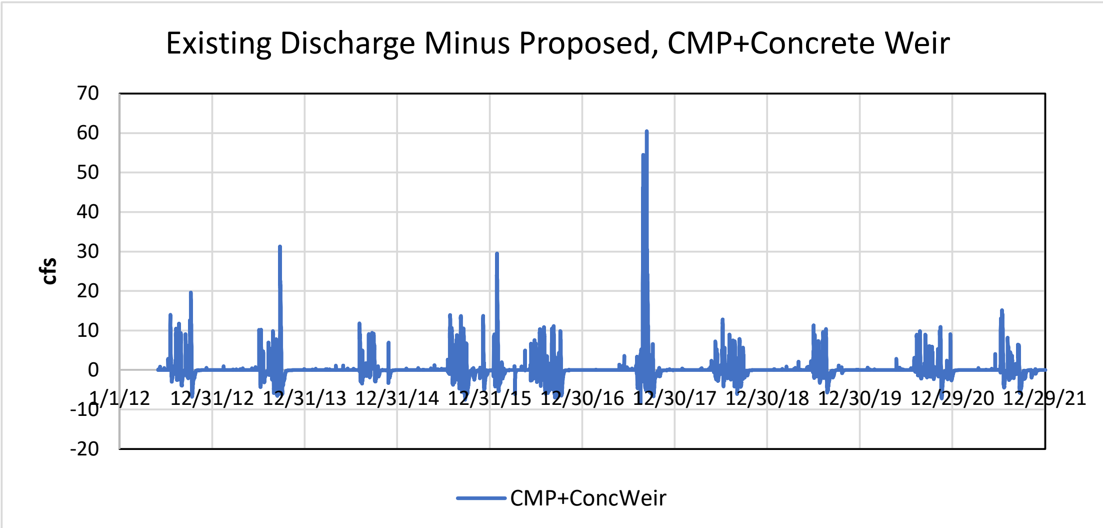
Appendix B

Additional Graphs of Scenario 2 Simulation Results

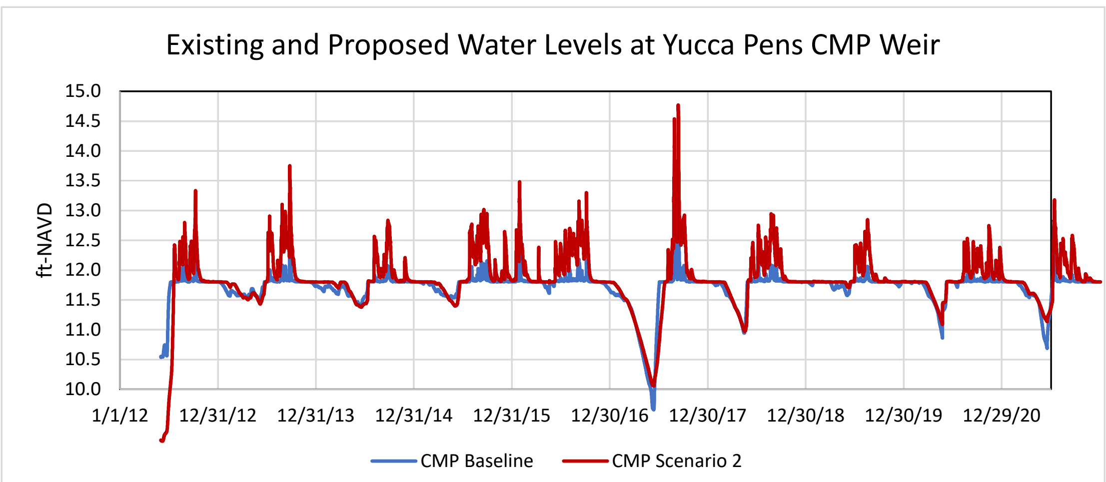
Refer to this figure when reviewing Scenario 2 plots shown below.



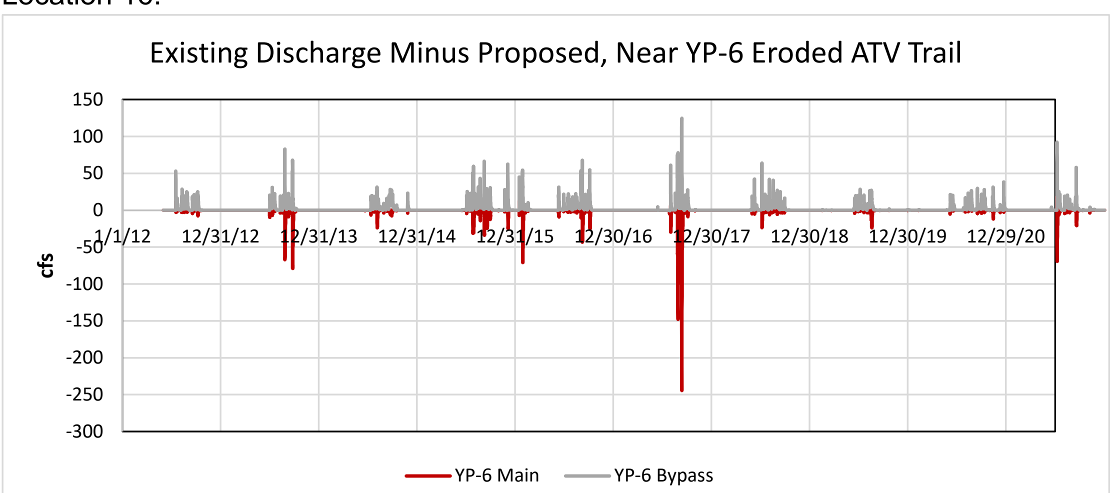
Location 24:



Location 23:



Location 16:



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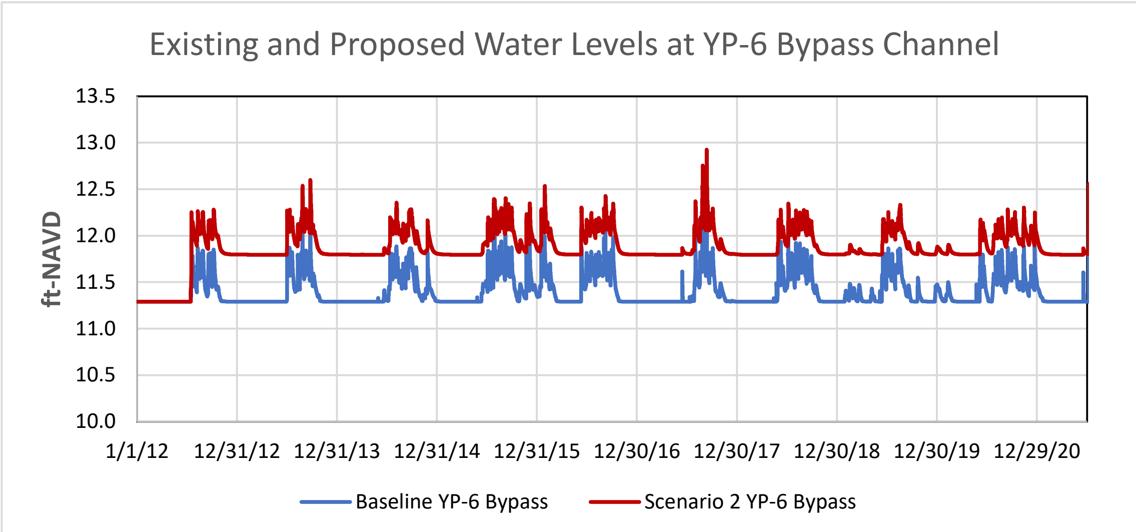
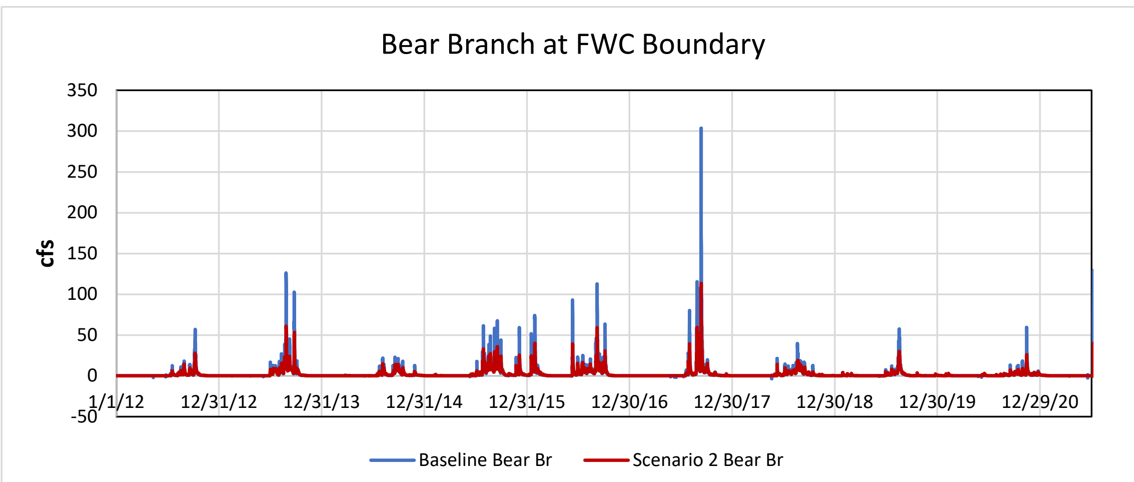
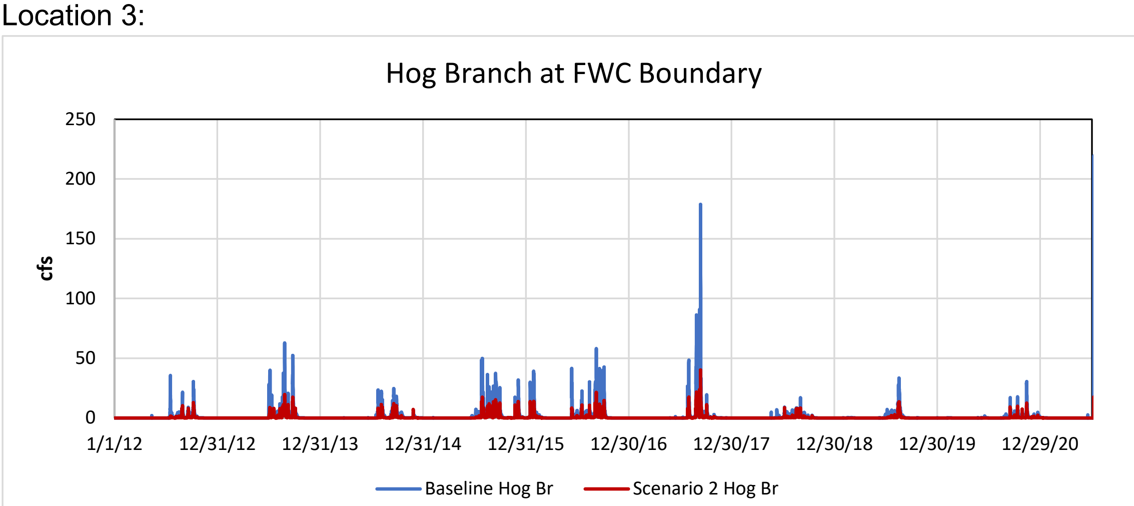


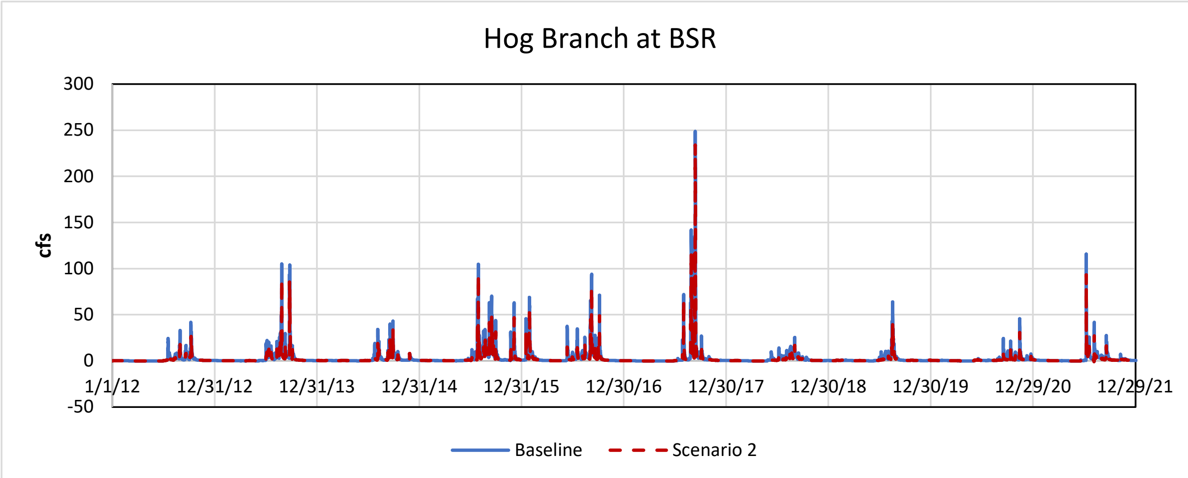
Location 2:



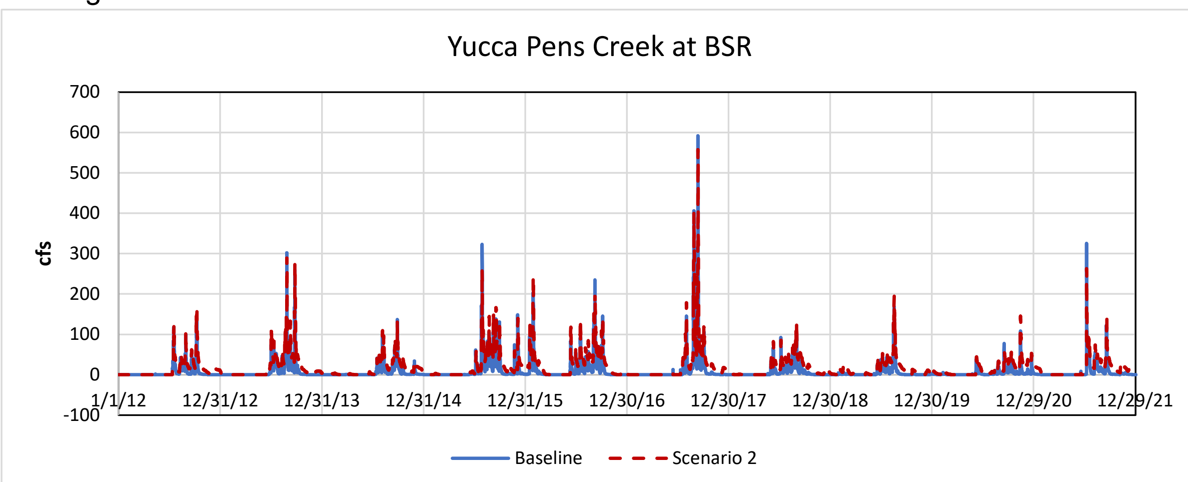
Location 3:



See Figure 12 for location:



See Figure 12 for Location:



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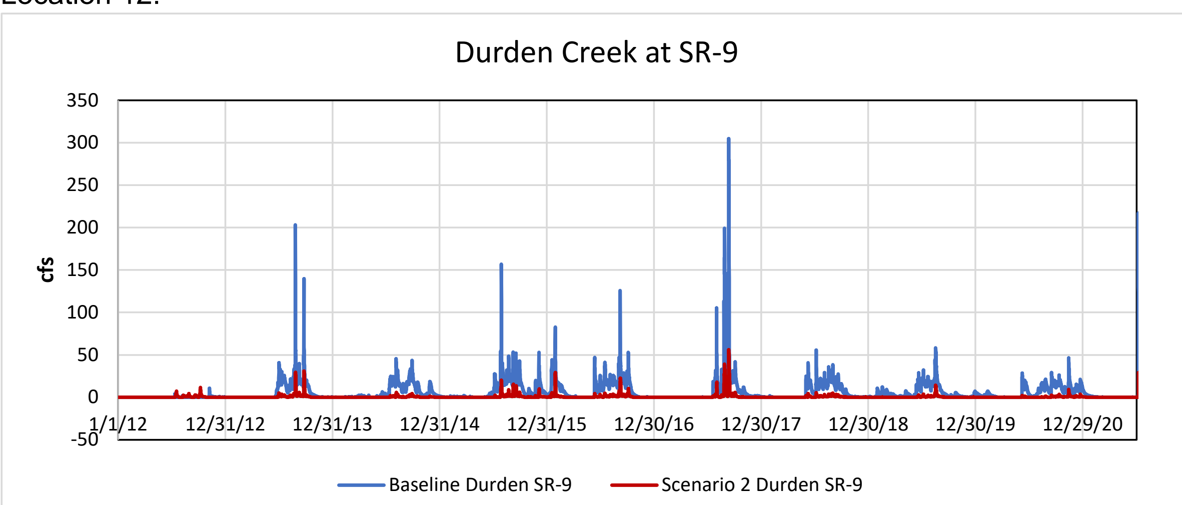
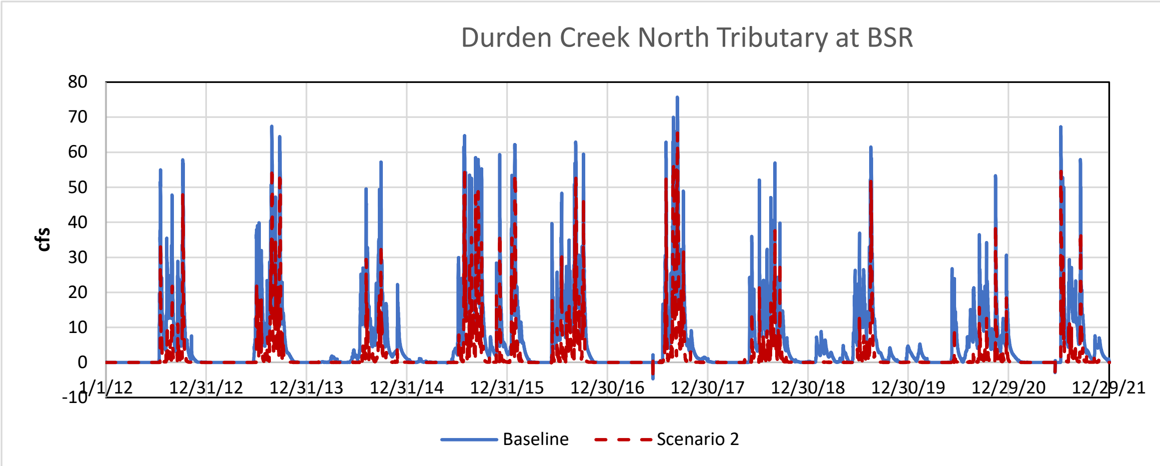
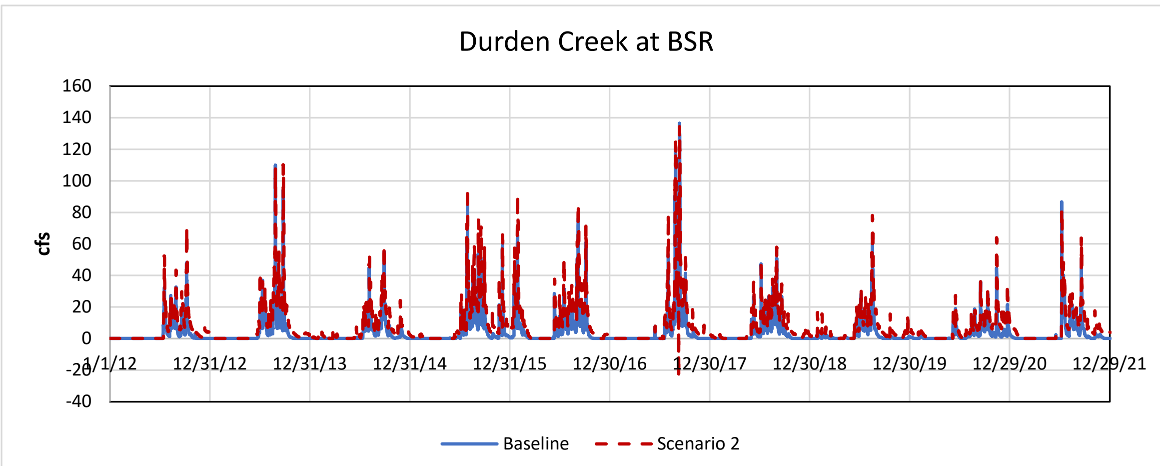


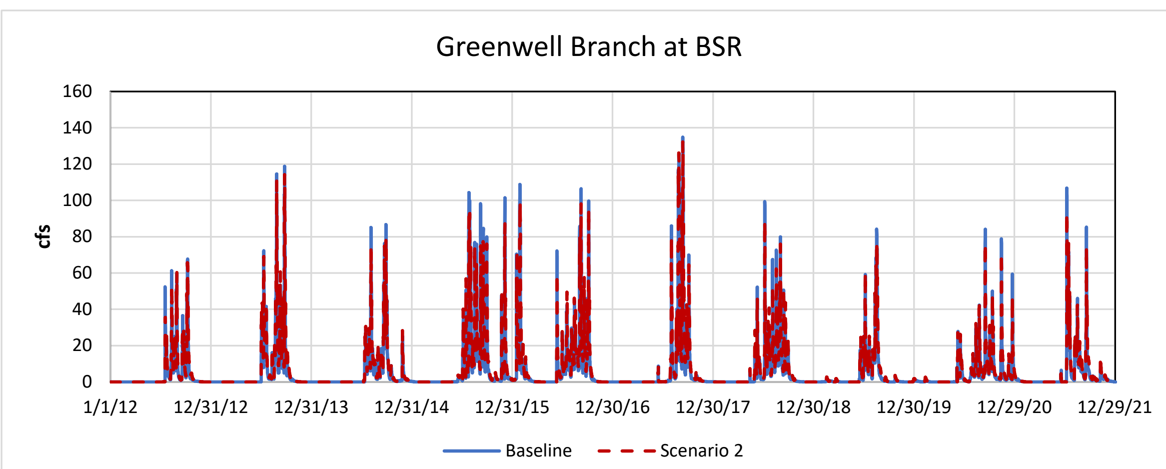
See Figure 12 for location:



See Figure 12 for location:



See Figure 12 for location:



Appendix C

Calibration Comparison – Original Calibration vs. Model with Lower Hydraulic Conductivity

Explanation of Modified Hydraulic Conductivities Referenced in Tables 6 and 7 Bond Farm HEI and Southwest Aggregates Reservoir Inflows/Outflows

All results in the scenario analysis memoranda use the final calibration with horizontal hydraulic conductivity capped only under Bond Farm HEI at 35 ft/day. Results from the sensitity test with reduced hydraulic conductivities were only presented for Bond Farm HEI and Southwest Aggregates Reservoir water balance results presented in Table 3 as a comparison.

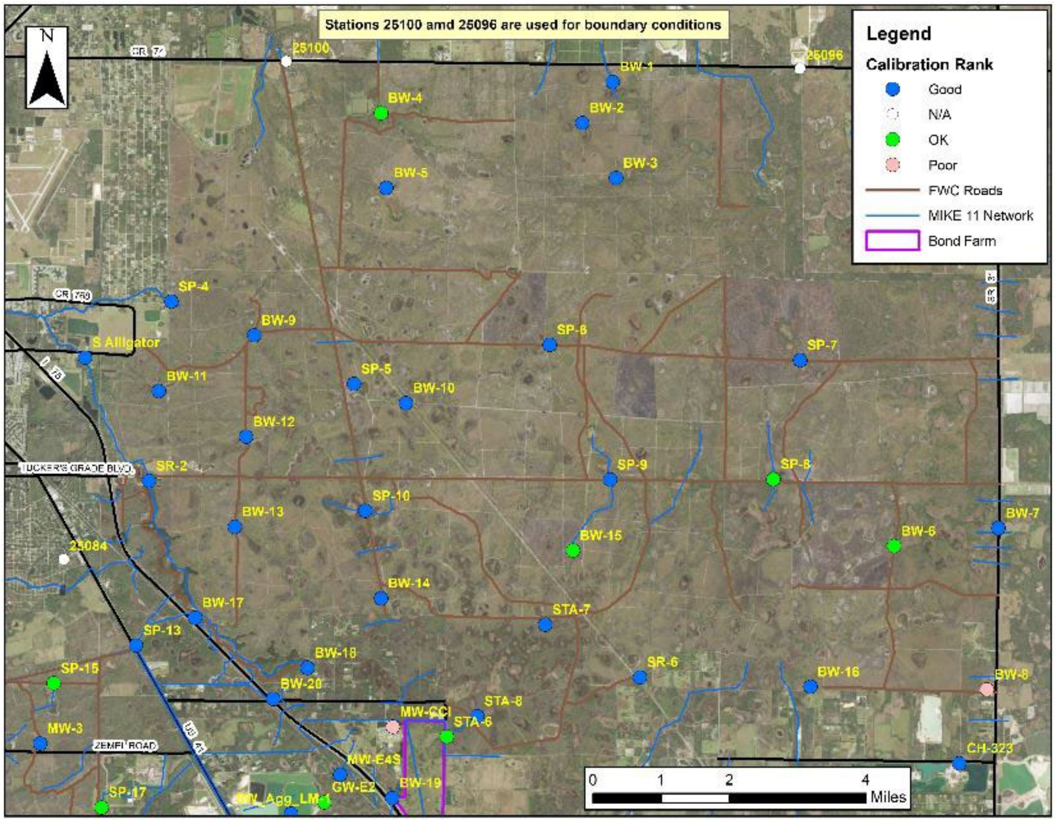
During scenario analysis of Bond Farm HEI, seepage rates from Bond Farm HEI were significantly greater than expected. The project area and larger Charlotte County is known to have porous shell layers. Hydrogeologic studies of the Bond Farm HEI area included lithologic descriptions of multiple borings around the perimeter of the proposed impoundment as well as field permeability measurements. Field permeability testing in Bond Farm HEI estimated a permeability rate of 40 ft/day for the limestone layer (HDR, 2020), however there have not been any full scale studies looking at seepage throughout Bond Farm HEI. These additional studies will provide insight on varied hydraulic conducitivity throughout Bond Farm HEI. A zone of lower water table horizontal hydraulic conductivity (35 ft/day) was used for only the area of Bond Farm HEI based on the Bond Farm HEI hydrologic investigation, along with findings from a previous study in the nearby Southwest Aggregates mining cells which calculated horizontal hydraulic conductivities of 35 ft/day (WSA, 2017). Therefore, these conservative hydraulic conductivities were used to avoid over-estimating the capacity of Bond Farm HEI to hold water. Additional studies are recommended to quantify groundwater seepage rates throughout Bond Farm HEI and the project area (see RECOMMENDATIONS section for more information).

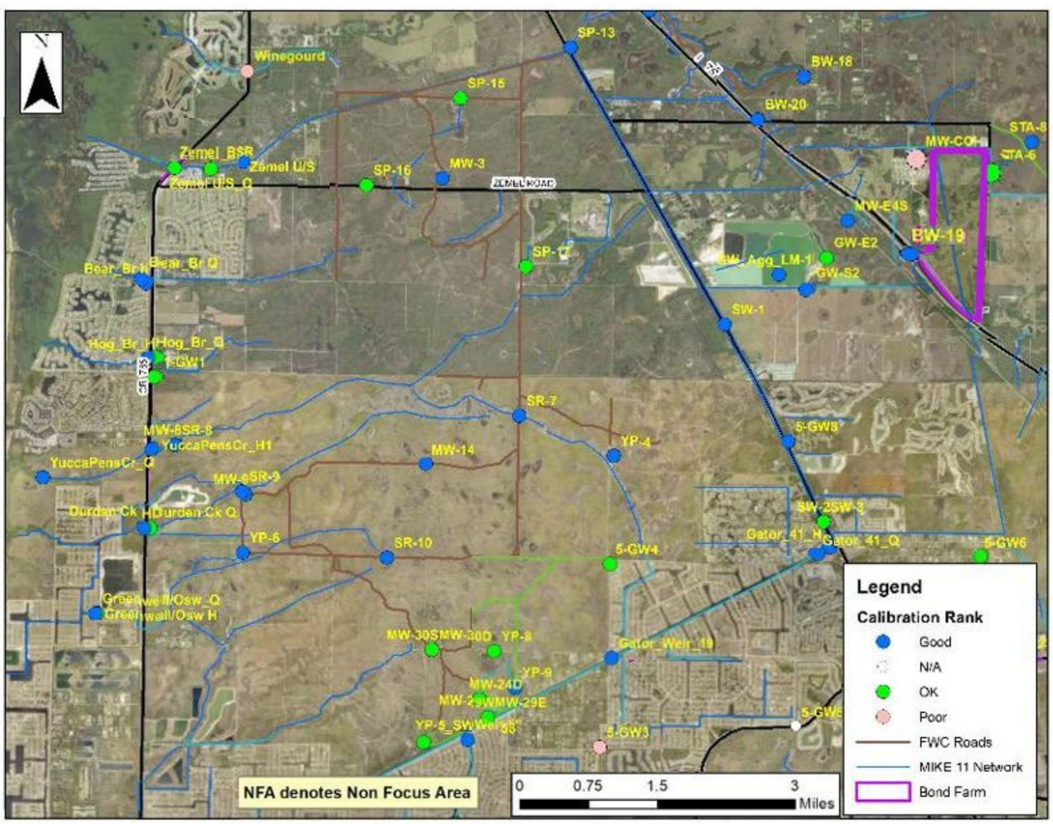
The initial analysis of Scenario 1 used the final calibrated model (see TM 5c, WSA & CHNEP, 2022b). Maps of calibration stations are shown below, and tables comparing the final calibrated model to a sensitivity test with lower hydraulic conductivities follow the maps of calibration station locations. The final calibrated model had upper water table horizontal hydraulic conductivities ranging from 456 to 1,500 ft/day with vertical conductivity values 10 times less than horizontal values. Lower water table horizontal hydraulic conductivity values ranged from 123 to 543 ft/day. Model calibration was best with these lower water table hydraulic conductivities, and resulted from an effort to match measured dry season water levels at numerous stations, most notably at stations STA-6, -7, and -8 northeast of Bond Farm HEI. The adjustment of hydraulic conductivity values was performed after all surface water conveyance details had been added to the model and all other model input files had been vetted and sensitivity testing had been completed.

Seepage losses from Bond Farm HEI were higher than what was deemed to be appropriate in additional testing of Scenario 1, therefore it was decided to perform a sensitivity test on Scenario 1 with lower hydraulic conductivities. Two iterations of the entire model domain were conducted, one with a maximum horizontal hydraulic conductivity of 35 ft/day and another with the maximum set to 300 ft/day. Then, two iterations were simulated that varied horizontal hydraulic conductivity between 35 and 300 ft/day, and the resulting best calibration was for a simulation with the maximum horizontal hydraulic conductivity value of 297 ft/day for the upper water table. The resulting lower water table aquifer horizontal hydraulic conductivities ranged from 70 to 292 ft/day.

Comparison of the final calibration and the sensitivity test is presented in the tables shown below. Calibration improved at 14 stations. Slight reductions in calibration performance were observed at stations SP-4, BW-19, and 20-GW3 in the sensitivity test. Performance changed from either Good to OK or OK to Poor in the sensitivity test at the following stations: MW-29W, SP-17, SP-17, STA-6, 5-GW4, L-721, MW-29E, SW_Agg_GW-E2 and SW_Agg_GW-S2. (NOTE: Performance deteriorated at Gator Slough at Weir 19 because the revised model used program logic (gates open according to prescribed rules) rather than known gate operations. Therefore, the drop in performance at this station is not considered valid. Gator Slough at US 41 was also affected because it is upstream of Weir 19).

Additional model calibration is proposed once additional hydrologic surveys are performed for this area and that information is available (see RECOMMENDATIONS section for more information).





	Final	Test	Final	Test	Final	Test		
Name	MAE	MAE	R_Corr	R_Corr	R2 NS	R2 NS	Overall	Change
Bear Branch H	0.36	0.37	0.82	0.84	0.11	0.11	Good	Same
Durden Creek H	0.84	0.95	0.87	0.88	0.61	0.57	OK	Same
Gator_Weir11_H	0.53	0.62	0.61	0.50	-5.11	-6.05	Poor	Same
Gator_41_H	0.46	0.60	0.95	0.94	0.37	-0.08	Good	Worse
Gator_Weir_19	0.17	0.63	0.96	-0.10	0.87	-1.04	Good	See note
Greenwell/Osw H	0.47	0.57	0.80	0.75	-0.62	-1.37	OK	Same
Hog Branch H	0.40	0.38	0.72	0.71	-0.36	-0.28	OK	Same
S Alligator	0.67	0.57	0.88	0.91	0.61	0.71	Good	Same
SP-4	0.45	0.82	0.93	0.87	0.85	0.71	Good	Worse
SP-8, BigWaterFor	0.97	0.65	0.88	0.88	0.54	0.75	OK	Better
SP-13, Zemel at 41	0.63	0.61	0.81	0.88	0.44	0.50	Good	Same
SR-2, WebbLake	0.46	0.58	0.94	0.92	0.83	0.72	Good	Same
SW-1, US_41	0.51	0.40	0.92	0.93	0.14	0.45	Good	Better
SW-2, US_41 E	0.62	0.62	0.88	0.86	-1.03	-1.19	OK	Same
SW-3, US_41 W	0.42	0.45	0.85	0.84	-0.04	-0.39	OK	Same
YuccaPensCr_H1	0.71	0.67	0.77	0.89	0.48	0.52	Good	Same
Weir 58	0.18	0.26	0.86	0.83	0.68	0.39	Good	Same
Winegourd	1.33	1.11	0.03	0.00	-5.43	-3.75	Poor	Same
Zemel U/S	0.43	0.41	0.86	0.90	0.67	0.72	Good	Same
Zemel_BSR	0.58	0.48	0.63	0.70	-1.25	-0.74	OK	Same
17-GW4	0.80	0.91	0.76	0.74	0.48	0.39	OK	Same
BW-1	0.47	0.55	0.94	0.93	0.84	0.81	Good	Same
BW-2	0.65	0.61	0.90	0.91	0.67	0.74	Good	Same
BW-3	0.50	0.33	0.94	0.96	0.73	0.91	Good	Better
BW-4	0.91	0.66	0.88	0.89	0.49	0.79	OK	Better
BW-5	0.67	0.66	0.80	0.84	0.59	0.68	Good	Better
BW-6	0.89	0.82	0.91	0.89	0.50	0.60	OK	Same
BW-7	0.53	0.54	0.94	0.93	0.81	0.80	Good	Same
BW-8	1.15	1.20	0.90	0.90	0.33	0.28	Poor	Same
BW-9	0.66	0.71	0.87	0.90	0.71	0.67	Good	Same
BW-10	0.29	0.29	0.96	0.96	0.90	0.90	Good	Same
BW-11	0.69	0.68	0.86	0.85	0.58	0.65	Good	Same
BW-12	0.45	0.48	0.90	0.91	0.80	0.79	Good	Same
BW-13	0.42	0.42	0.93	0.92	0.80	0.84	Good	Same
BW-14	0.31	0.34	0.96	0.96	0.91	0.89	Good	Same
BW-15	0.84	0.72	0.90	0.90	0.22	0.40	OK	Better
BW-16	0.46	0.45	0.96	0.96	0.80	0.82	Good	Same
BW-17	0.45	0.42	0.92	0.92	0.79	0.82	Good	Same
BW-18	0.38	0.31	0.95	0.96	0.86	0.92	Good	Same
BW-19	0.57	0.98	0.93	0.85	0.74	0.22	Good	Worse
BW-20	0.46	0.37	0.97	0.94	0.80	0.80	Good	Same
MW-23S	1.01	0.86	0.92	0.91	0.51	0.61	OK	Better
MW-24S	1.00	0.98	0.89	0.89	0.30	0.35	OK	Better
MW-29W	0.54	0.82	0.43	0.46	-0.28	-1.71	OK	Worse
MW-30S	0.82	0.73	0.82	0.81	0.04	0.29	OK	Better
SP-5	0.35	0.30	0.97	0.97	0.90	0.92	Good	Same
SP-6	0.45	0.56	0.94	0.93	0.81	0.68	Good	Same
SP-7	0.54	0.63	0.88	0.80	0.69	0.55	Good	Same

	Final	Test	Final	Test	Final	Test		
Name	MAE	MAE	R_Corr	R_Corr	R2 NS	R2 NS	Overall	Change
SP-9	0.26	0.33	0.97	0.95	0.92	0.89	Good	Same
SP-10	0.59	0.60	0.97	0.96	0.56	0.53	Good	Same
SP-16	0.84	1.09	0.85	0.83	0.37	-0.01	OK	Worse
SP-17	0.93	1.24	0.56	0.47	-1.36	-3.21	OK	Worse
STA-6	1.07	1.24	0.82	0.80	0.19	-0.09	OK	Worse
STA-7	0.63	0.56	0.96	0.96	0.67	0.74	Good	Same
SW_Agg_LM-1	0.51	0.75	0.83	0.79	0.50	0.18	Good	Same
YP-5_SW	1.13	0.68	0.97	0.96	0.55	0.78	OK	Better
YP-8	0.91	0.79	0.91	0.90	0.22	0.40	OK	Better
YP-9	0.63	0.70	0.96	0.96	0.77	0.74	Good	Same
1-GW1	0.95	0.90	0.87	0.85	0.20	0.31	OK	Same
5-GW3	1.04	1.33	0.91	0.84	-0.18	-0.66	Poor	Same
5-GW4	1.14	1.49	0.91	0.89	0.22	-0.25	OK	Worse
5-GW6	0.78	0.97	0.95	0.94	0.66	0.47	OK	Same
5-GW8	0.65	0.73	0.92	0.85	0.47	0.18	Good	Same
16E-GW3	0.70	0.71	0.90	0.88	0.34	0.25	Good	Same
20-GW3	0.64	0.99	0.97	0.94	0.82	0.55	Good	Worse
CH-323	0.58	0.54	0.81	0.82	0.65	0.66	Good	Same
L-721	0.54	1.37	0.97	0.92	0.49	-2.20	Good	Worse
L-3207	0.21	0.29	0.91	0.90	0.82	0.70	Good	Same
MW-3	0.63	0.54	0.85	0.87	0.54	0.70	Good	Same
MW-8	0.64	0.62	0.89	0.88	0.40	0.52	Good	Same
MW-9	0.38	0.46	0.89	0.89	0.74	0.74	Good	Same
MW-14	0.48	0.50	0.89	0.88	0.70	0.70	Good	Same
MW-23D	0.94	0.83	0.93	0.92	0.55	0.64	OK	Same
MW-24D	0.96	0.99	0.90	0.90	0.44	0.44	OK	Same
MW-29E	0.77	1.08	0.87	0.87	0.21	-0.49	OK	Worse
MW-30D	0.76	0.69	0.84	0.83	0.18	0.40	OK	Better
SP-15	0.89	0.72	0.89	0.89	0.36	0.63	OK	Same
SR-6	0.42	0.49	0.94	0.95	0.84	0.81	Good	Same
SR-7	0.71	0.80	0.94	0.94	0.55	0.46	Good	Same
SR-8	0.54	0.67	0.91	0.90	0.73	0.61	Good	Same
SR-9	0.42	0.44	0.92	0.93	0.83	0.82	Good	Same
SR-10	0.37	0.42	0.90	0.88	0.79	0.72	Good	Same
STA-8	0.39	0.43	0.94	0.94	0.86	0.84	Good	Same
SW_Agg_MW-CCI	1.50	1.72	0.95	0.95	-0.38	-0.77	Poor	Same
SW_Agg_MW-E4S	0.39	0.45	0.92	0.91	0.82	0.79	Good	Same
SW_Agg_GW-E2	0.80	1.09	0.78	0.71	-0.01	-0.69	OK	Worse
SW_Agg_GW-S2	0.46	0.92	0.94	0.92	0.49	-0.80	Good	Worse
YP-4	0.57	0.57	0.78	0.79	0.53	0.52	Good	Same
YP-6	0.62	0.67	0.84	0.82	0.55	0.60	Good	Same
Bear Branch Q	4.16	3.92	0.76	0.83	0.48	0.53	Good	Better
Durden Creek Q	3.00	4.28	0.86	0.89	0.72	0.59	Good	Same
Gator_41_Q	6.17	6.84	0.89	0.89	0.78	0.78	Good	Same
Greenwell/Osw_Q	6.11	6.02	0.76	0.79	0.50	0.59	Good	Same
Hog_Q	2.49	2.32	0.81	0.81	0.53	0.61	Good	Same
NS Transfer	2.56	4.36	0.90	0.82	0.81	0.63	Good	Same
YuccaPensCr_Q	6.91	7.66	0.86	0.83	0.72	0.60	Good	Same
Zemel U/S_Q	11.33	10.46	0.69	0.74	0.45	0.51	OK	Better