APPENDIX C
MODEL DOCUMENTATION REPORT
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Model Documentation Report: Proposed Western Everglades Restoration Project L28 South Culvert Initial Operations

RSMGL Simulation **December 11, 2024**

1.0 Overview

Identification

The Western Everglades Restoration Project (WERP; **SFWMD & IMC, 2023**) is part of the Comprehensive Everglades Restoration Plan (CERP) which was authorized by Congress in 2000 as a plan to "restore, preserve, and protect the South Florida ecosystem while providing for other water-related needs of the region, including water supply and flood protection." WERP is cost-shared between the U.S. Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD).

WERP is an Everglades restoration planning effort that aims to improve the quantity, quality, timing, and distribution of water in the western Everglades. The project began in 2016 to develop a Project Implementation Report (PIR) that combines planning and design activities for the Western Basins of South Florida which contain the following five primary basins or watersheds: Feeder, C139 Annex, Eastern Collier, L28 Gap, and L28 Basins. Modeling support for WERP was provided by a team of modelers from the Interagency Modeling Center (IMC) comprised of modelers from the Modeling Section of the Hydrology & Hydraulics Bureau of the SFWMD, and the Hydrologic Modeling Section and IMC of the Jacksonville District of USACE, with direct support from the Everglades National Park (ENP) of the Department of the Interior (DOI). Modeling support for WERP focused on working with the larger project planning team and other interested parties to conceptualize and analyze project features leading to the final identification and refinement of a tentatively selected plan (TSP).

In WERP, three culverts were proposed on the L28S canal to promote water flow between Water Conservation Area 3A (WCA-3A) and Big Cypress National Preserve (BCNP), which were the components selected in the ALTHNFR plan (**Figure 1.1** and **Figure 1.2**). The current investigation, on the other hand, aims to develop and test the initial operations of these proposed culverts based on the Combined Operational Plan (COP; **USACE, 2020a**) rather than operating within the full WERP project. This operational investigation may be used not only to develop information for operations permits but also help inform the ongoing CEPP 1.0 Operations Study.

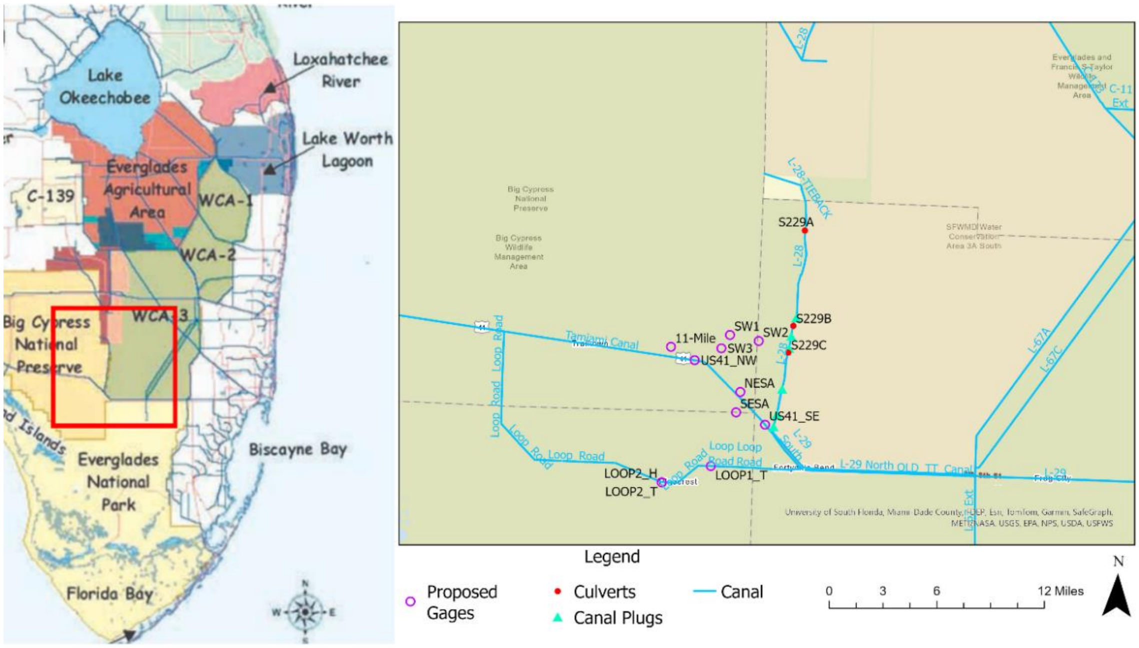

Figure 1.1. L28S culvert study area

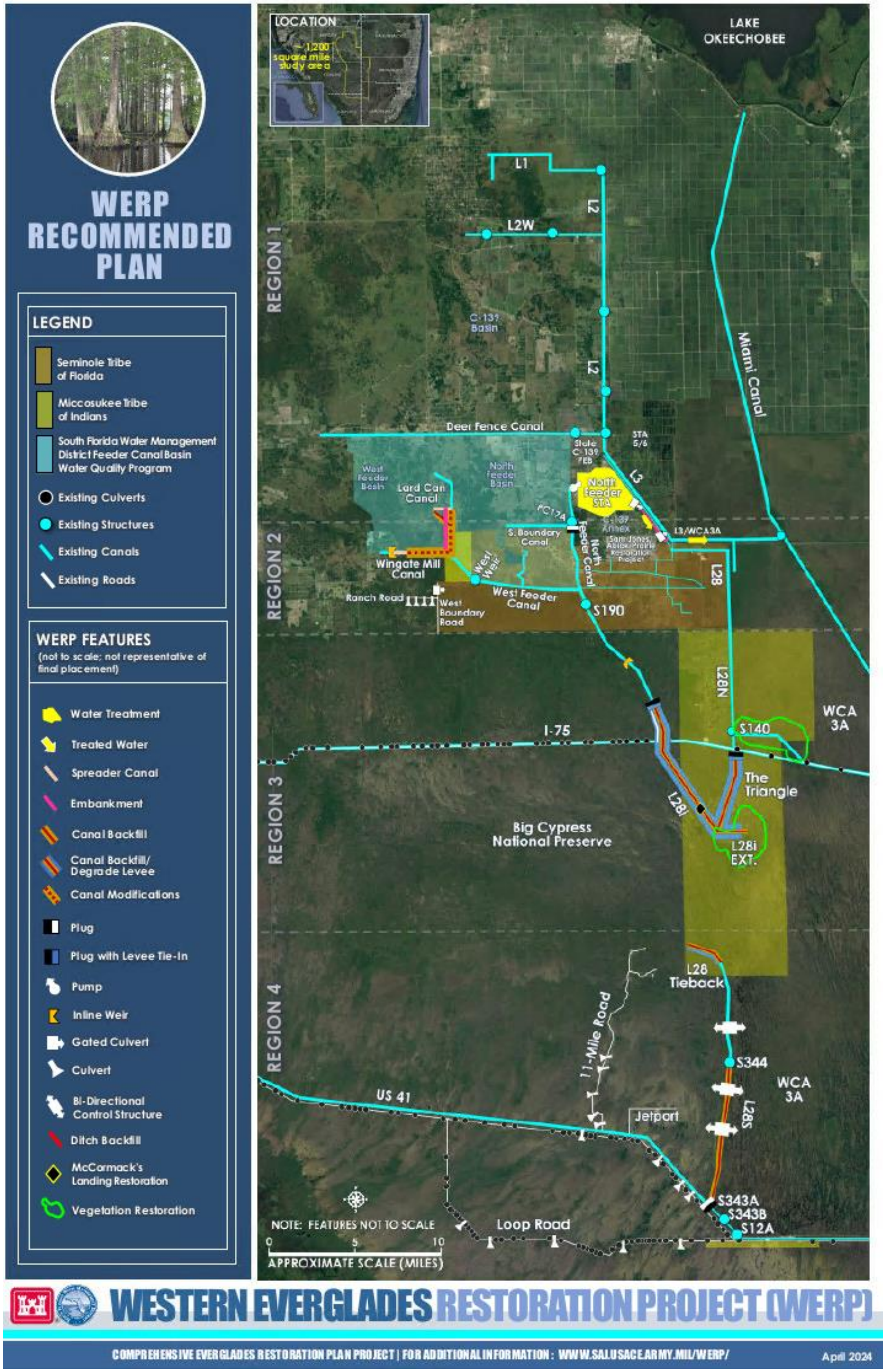

Figure 1.2. WERP selected plan (ALTHNFR modeled as ANFWIN)

Scope and Objectives

The existing infrastructure and operations for the L28S canal provide the starting basis for further exploration. This study intends to evaluate the localized and regional effects of three proposed culverts along the L28S canal, originally proposed in WERP, by modeling the initial operation of the proposed culverts and adding to the current system operations of COP.

Modeling support for this effort focused on applying the Regional Simulation Model Glades-LECSA (RSMGL) - an existing implementation of the Regional Simulation Model (RSM) and working with an interdisciplinary planning team to formulate and test proposed project features. This study was built upon existing modeling datasets and methods consistent with the USACE COP planning effort. Specifically, the COP ECB24 RSMGL modeling scenario was utilized as the planning baseline condition.

Based on WERP, COP ECB24, and Lake Okeechobee System Operating Manual (LOSOM), the operations of existing structures (i.e., S344, S343A, and S343B) in the study area were initiated when water levels in WCA-3A reach Zone A of its regulation schedule, subject to stage constraints in BCNP at Loop Road. The same operating rules were applied to the proposed culverts on the L28S levee, with a range of spatially varying use of these culverts used to analyze an array of alternatives. Subsequently, sensitivity scenarios exploring the use of constraints at other downstream locations were also examined.

2.0 Basis

Project Assumptions

This MDR describes the assumptions, model implementation steps, and observed outcomes associated with RSMGL modeling of the following alternatives:

- Baseline (ECB24) – Existing Condition Baseline 2024 (**Appendix A**); combines the existing condition baseline from the Biscayne Bay & South-Eastern Everglades Restoration (BBSEER) planning effort with improved modeling assumptions for Tamiami Trail operations from the COP deviation planning effort's baseline
- Alternative A (ALTA) – Baseline with proposed new culverts (S229A, S229B and S229C) added
- Alternative B (ALTB) – Same settings as ALTA but reduce the flow capacity at S229B and S229C to 125 cfs.
- Sensitivity Run 1 (ALTAS1) – Same settings as ATLA with 7 additional constraints on culvert operation (**Appendix B**)
- Sensitivity Run 2 (ALTBS1) – Same settings as ATLB with 7 additional constraints on culvert operation (**Appendix B**)

The starting point for L28S structure modeling was the RSMGL work prepared as part of the IMC BBSEER project support (which heavily leverages the LOSOM project modeling) and utilizes the extended period of record modeling encompassing 1965-2016 climate stressors (**SFWMD, 2022**). The existing conditions baseline alternatives attempt to model assumed hydrologic conditions at a pre-defined date. For this study, the existing condition baseline is referred to as ECB24 which is an adaptation of the BBSEER ECB22 simulation plus features from the COP deviation and LOSOM projects. For the ALTs, only the L28S culverts were added to the simulation and additional WERP project elements including improved capacity at US41, LOOP road & 11-mile road or additional plugging beyond the existing L28S canal plugs were not modeled as this investigation focuses on operation of an incremental & interim infrastructure condition, not the full WERP buildout.

Additional details on these alternatives are provided in the subsequent section. In general, the framing of the assumptions and requirements for the RSMGL is the same as that utilized in the COP planning effort, and the baseline conditions used for comparison are similar to versions used in COP.

Model Limitations and Intended Use of Results

The primary modeling products were evaluated based on outputs from the Regional Simulation Model (RSM) (**SFWMD, 2005a** and **2005b**). The RSM is a robust and complex regional scale model. Due to the scale of the model, it is frequently necessary to implement abstractions of system infrastructure and operations that will generally mimic the intent and result of the desired project features while not matching the exact mechanism by which these results would be obtained in the real world. Additionally, it is sometimes necessary to work within established paradigms and foundations within the model code (e.g., use available input-driven options to represent more complex project operations). The RSM was reviewed through the USACE validation process for engineering software, as part of CEPP (USACE, 2014) and was classified as “allowed for use” for South Florida applications in August 2012.

3.0 Simulation

Modeling Tools Used

RSM version dev-bbseer-22341 was used to run the RSMGL model.
Release date 12/7/2022, Source code repository: https://github.com/sfwmd-git/rsm-base.
In addition to RSM, a Hydrologic Engineering Center - River Analysis System (HEC-RAS) two-dimensional (2D) unsteady-flow routing model was developed to conduct the hydraulic analysis for the impacts of L28S culverts. The latest version HEC-RAS V6.3.1 (released Sept 30, 2022) was applied in this study.

Model Set Up

(Regional) Hydrologic Modeling

Modeling alternatives were developed using the RSMGL model (**Figure 3.1**). The model was updated from previous regional modeling runs used in support of the CERP Biscayne Bay & South-Eastern Everglades Restoration (BBSEER) project. It included some model refinement updates taken from other planning studies including the USACE's Combined Operational Plan (COP) (**USACE 2020b**) and Lake Okeechobee System Operating Manual (**IMC, 2021**). The overarching system operation for the area of interest remains the 2020 COP operation. The span of simulation for the RSMGL is from 1965 to 2016.

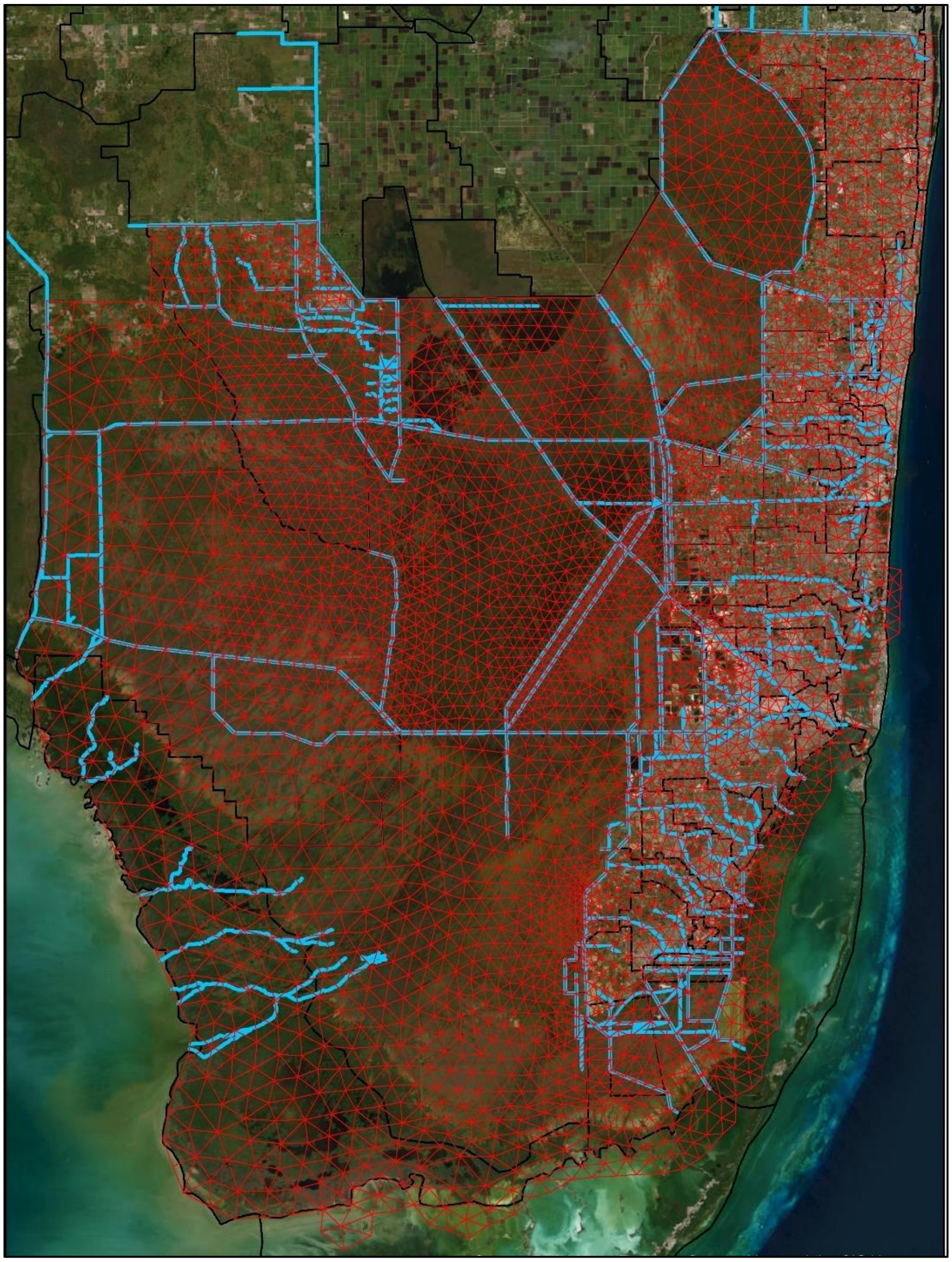

Figure 3.1. RSMGL mesh that indicates the extent of model

Two alternatives, ALTA and ALTB, were formulated in this study. Their descriptions are as follows.

ALTA: Baseline + three new culverts across the L28S levee

Three structures were added across the L28S levee (**Figure 3.2**). Depending on the drop in the stage from WCA-3A to the east and BCNP to the west, the model calculates the amount of discharge through the proposed single structure (S229A) located north of S344, and two structures (S229B and S229C) located south of S344.

S229A will allow flow from the borrow canal located east of the L28S levee (upstream of S344) and into the marsh located west of the same levee. The two structures to the south of S344 allow flow from marsh cells in WCA-3A to the L28S canal located west of the L28S levee (downstream of S344) and spread through the marsh in BCNP.

The three culverts were defined in the model as “management simulation engine” (MSE) units for management and operation purposes (**Table 3.1** and **Table 3.2**). The opening and closing of three culverts are subject to the WCA-3A regulation schedule Zone A and Loop Road stage constraint. The culverts open when the average stage of the red cells is greater than the bottom of Zone A and the stage at the orange cell is lower than 8.5 ft above the mean sea level (NGVD29) (**Figure 3.3**).

In addition to the new culverts, it was proposed in WERP that the existing borrow canal south of S344, on the west side of the L28S levee be backfilled. However, the backfill was not completed. Instead, six plugs along the borrow canal (**Figure 3.4**) were installed in the field with the intent of a) preventing the southward flow of water discharged through the S229B&C structures; b) allowing the different sections of the borrow canal in-between the plugs to overtop and c) eventually, promoting sheetflow along the BCNP landscape west of the L28S levee. These plugs were defined in the model as “junction blocks” to prevent water from exchanging between canal sections.

Table 3.1. Coordinates of proposed three culverts

Culvert	Easting x (ft)	Northing y (ft)
S229A	710546.5	589308.8
S229B	708177.4	561142.1
S229C	707036.8	553246.6

Table 3.2. Dimensions of proposed three culverts (*: Length of barrels may change. Please refer to design drawing for final length)

Culvert Name	Design Capacity (cfs)	Calculated Discharge (cfs)	Design Head (ft)	Number of Barrels	Size of box culvert (H ft x W ft)	Invert Elevation (ft NGVD29)	Invert Elevation (ft NAVD88)	Length (ft)
S229A	250	287	0.5	2	6 x 6	1.0	-0.47	85*
S229B	350	387	0.5	2	6 x 8	0.0	-1.48	85*
S229C	400	430	0.5	3	6 x 6	0.0	-1.48	85*

ALTB: Baseline + three new culverts across the L28S levee

Given the topography and water level observations in the baseline, it was expected that S229B and S229C would have more opportunity to convey flow that S229A. To help evaluate if increased utilization of S229A could improve downstream water levels or avoid high water impacts, ALTB was formulated to explore the different performance associated with an operations scenario that introduced more flow further north on the L28S. ALTB is the same as ALTA except the design capacity of S229B and S229C are less than ALTA. Both S229B and S229C effective flow capacity are set to be 125 cfs in the alternative. This change in “design capacity” is a way of helping the regional model to realize a revised operational mindset (e.g. resulting in less total daily flow) and does not represent an actual change to the culvert design.

Sensitivity Runs ATLAS1 and ALTBS1: Same settings as ATLA/ALTB with 7 additional constraints on culvert operation

These sensitivity runs explored the addition of downstream water level constraints on the alternatives. Discussion of sensitivity run setup and results can be found in **Appendix B**.

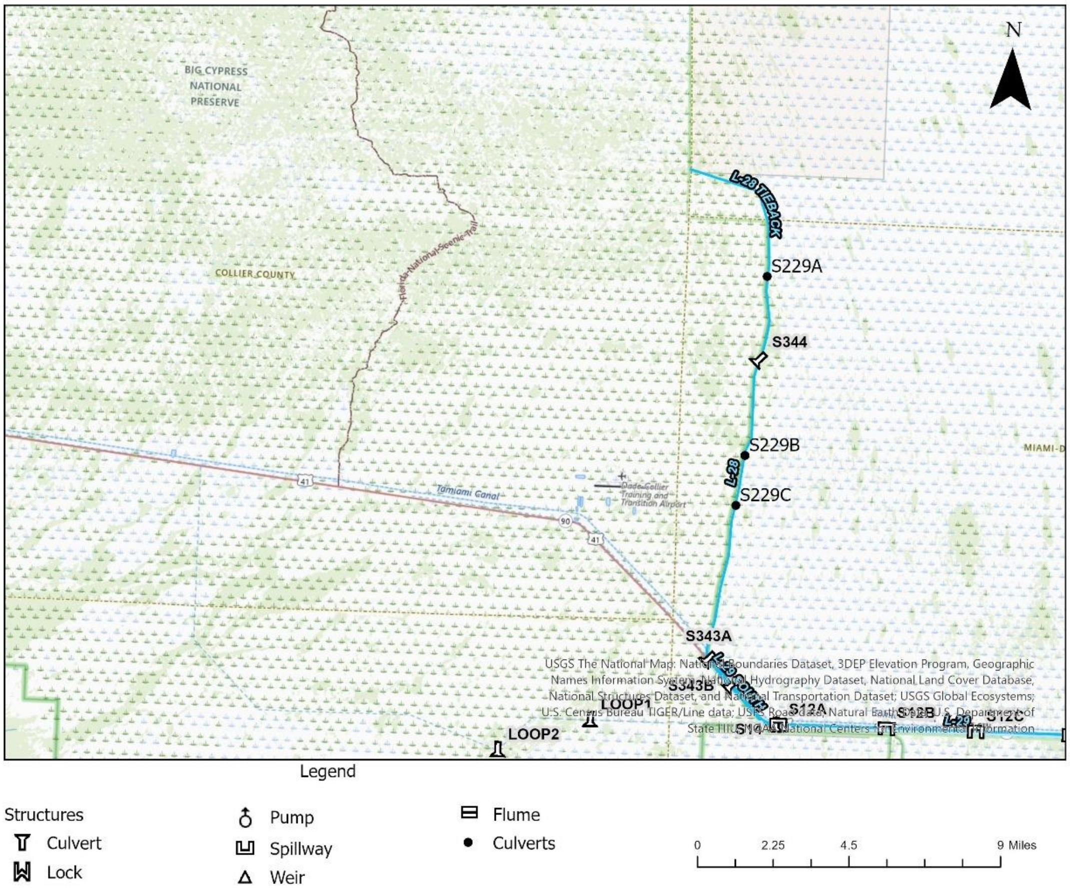

Figure 3.2. Locations of proposed three culverts

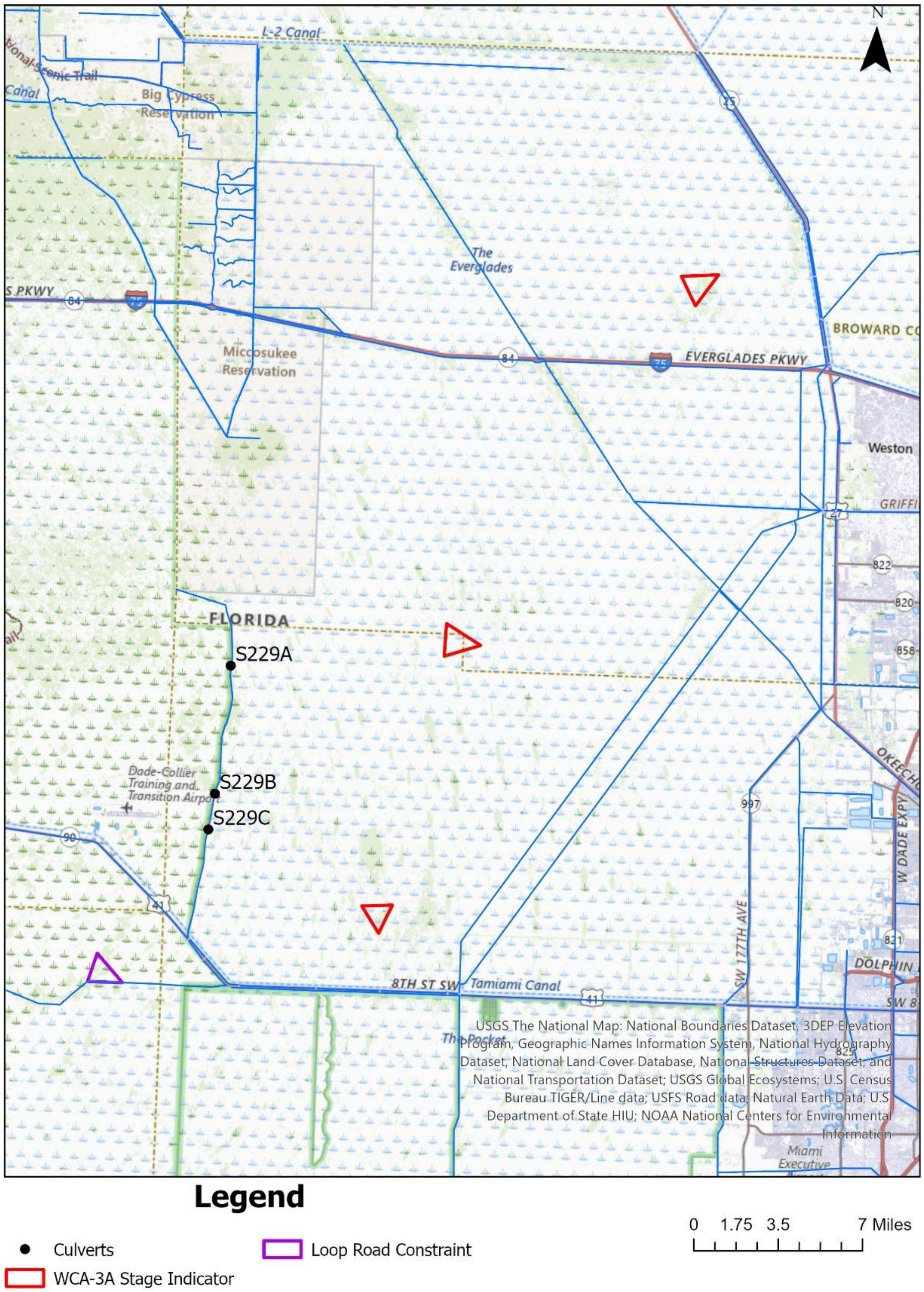

Figure 3.3. Locations of cells whose average stage represents average stage in WCA-3A (red triangle), and the cell whose stage represents the loop road stage (purple triangle).

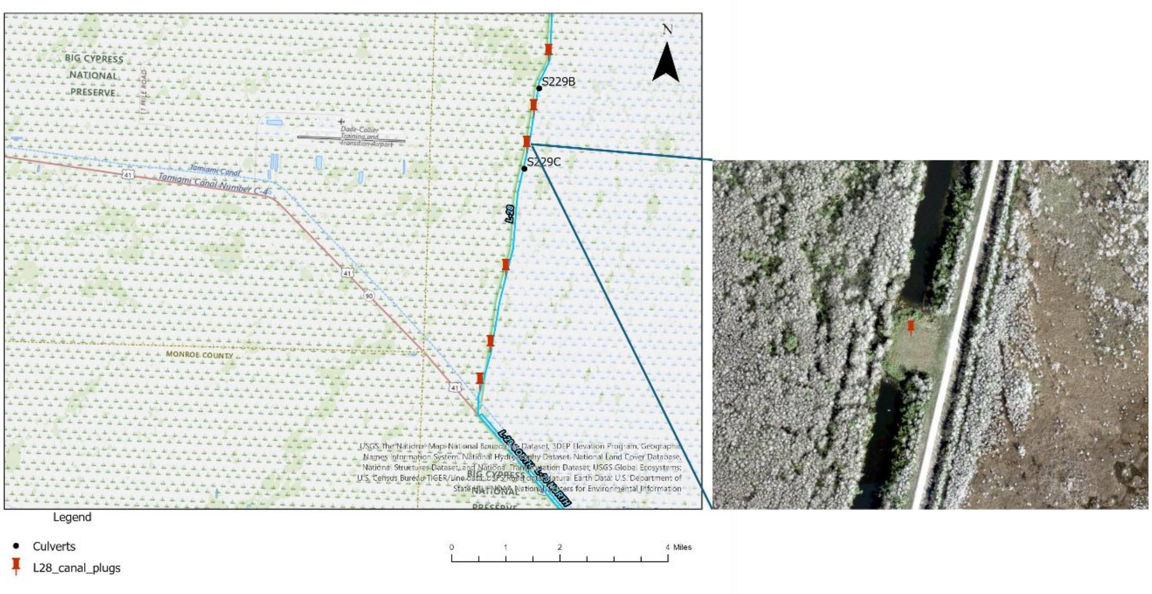

Figure 3.4. Locations of six plugs along the borrow canal south of S344 and an aerial photo of a plug

<u>(Site-specific) Hydraulic Modeling</u>

In line with the RSMGL model runs, the same three scenarios: ECB24, ALTA, and ALTB, were simulated in a localized HEC-RAS (V6.3.1) 2D model, for a wet event (Hurricane Irene 1999). In the HEC-RAS 2D model, a simulation period (10/1/1999 ~ 11/30/1999) covering Hurricane Irene 1999 was chosen to represent a very wet condition in the area. The model domain and the major structures are shown in **Figure 3.5**.

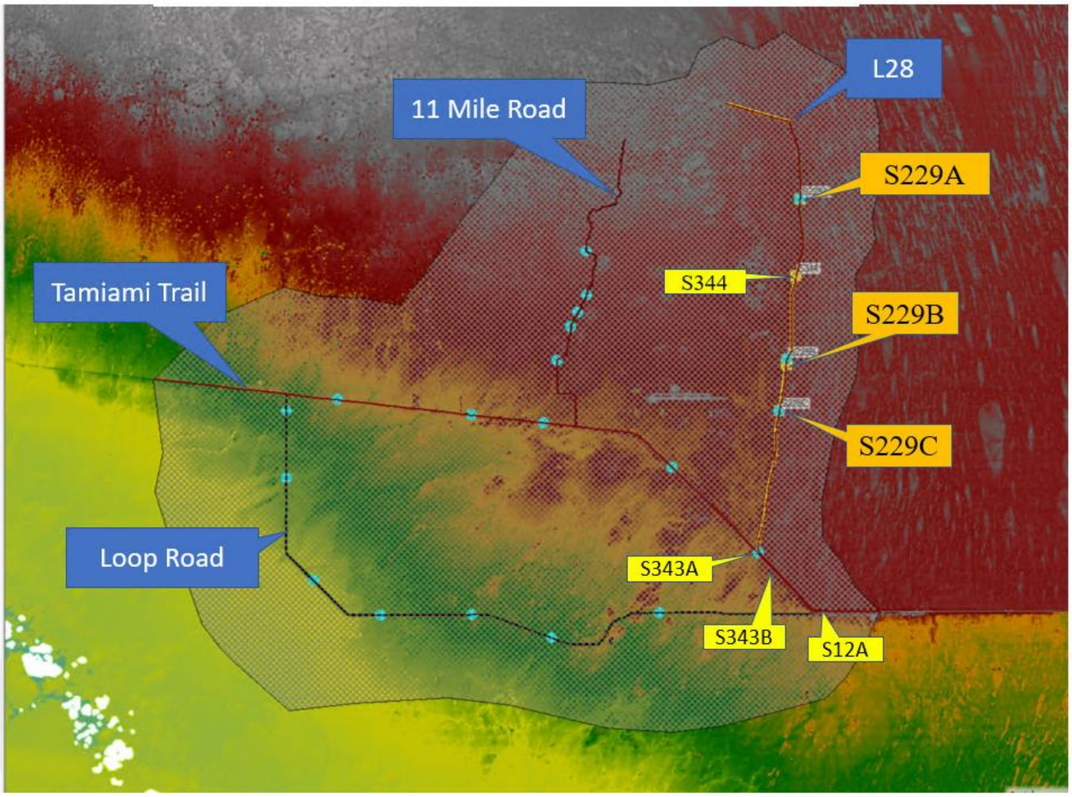

Figure 3.5. HEC-RAS 2D model domain and the culvert S229A, B & C

For the boundary conditions, as shown in **Figure 3.6**, the stage time series for the period 10/1/1999 ~ 11/30/1999 was extracted from the corresponding RSMGL run for all the boundary cells of HEC-RAS model domain. These stage hydrographs were applied as external stage boundary condition for HEC-RAS 2D model.

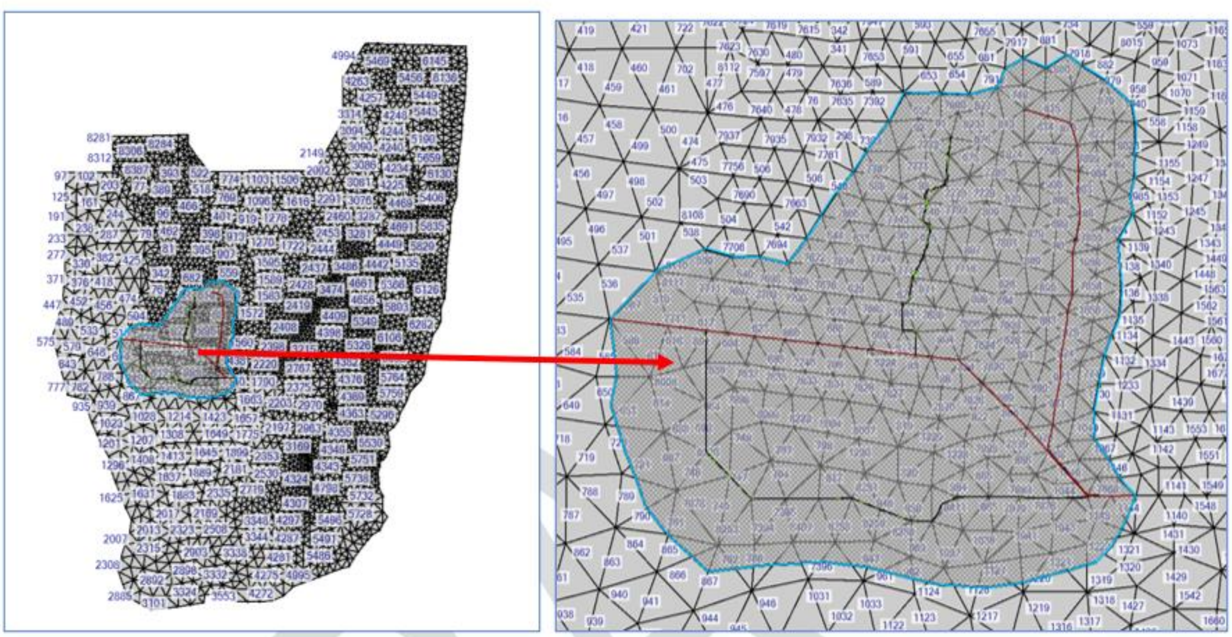

Figure 3.6. RSM model cells around the HEC-RAS 2D model

For the existing operated culverts along L28S Levee within the model domain: S344, S343A, S343B, and the spillway S12A on US41, the extracted flows from the corresponding RSMGL run were input as internal flow boundary condition at the structure location to capture the operation of these existing culverts.

For the three proposed culverts on L28S Levee, S229A, B &C, the flows from the corresponding RSMGL run were input as internal flow boundary condition at the structure location to capture the operation of these proposed culverts. Please notice that in run ECB24 – existing condition, there is no proposed culverts on L28S Levee.

For the initial condition, to be consistent with the previous hydraulic modeling work, in all three HEC-RAS model runs the model cells were started as dry at the beginning (10/1/1999) of the model.

4.0 Results

This study evaluated the impacts of the three proposed culverts on L28S levee and regional flow dynamics. In addition to the baseline (ECB24), two alternatives (ALTA and ALTB) and two sensitivity runs (ATLAS1 and ATLBS1) were simulated for the period of 1965-2016. Summaries of modeling results including surface flow and stage, structure flow, hydroperiod, etc. are provided below.

The final modeling products will be uploaded to the Statewide Model Management System (SMMS) once the project has been finalized. SMMS is a geographic information system (GIS) based application developed at the South Florida Water Management District that: a) stores model input data, select model output data, source code/executable files and documentation; and b) is shared with the public through a web interface. Project modeling products in SMMS will be available (release date to be announced later) by selecting the WERP project from the “project” drop down box or by selecting the WERP study area at:

https://apps.sfwmd.gov/smmsviewer/

While the L28S modeling products will be archived in the above system, the modelers also maintain a Subversion (SVN) repository for this project. SVN software is an open-source version control system that maintains current and historical versions of modeling project files. **Table 4.1** lists more specific modeling information including code version & inputs used. Version numbers and “svnroot” paths refer to a model version control system found exclusively in the SFWMD computer network, i.e., not generally accessible, hence the need to upload into SMMS.

Table 4.1. Version information and model file locations.

WCL28S_ECB24 071024	**RSM_4.0.15**
Input: … https://whqsvn02p.sfwmd.gov/websvn/browse/svnroot/trunk/rsm_imp/WCL28S/Models/RSMGL/Round1/ECB24/ Output:… \\ad.sfwmd.gov\dfsroot\data\hesm_nas\projects\WCL28S\Models\RSMGL\Round1\ECB24\output_071024_xml19466_dev-bbseer22341	
WCL28S_ALTA 071924	**RSM_4.0.15**
Input:… https://whqsvn02p.sfwmd.gov/websvn/browse/svnroot/trunk/rsm_imp/WCL28S/Models/RSMGL/Round1/ALTA/ Output : … \\ad.sfwmd.gov\dfsroot\data\hesm_nas\projects\WCL28S\Models\RSMGL\Round1\ALTA\output_071924_xml19548_dev-bbseer22341	
WCL28S_ALTB 071924	**RSM_4.0.15**
Input: … https://whqsvn02p.sfwmd.gov/websvn/browse/svnroot/trunk/rsm_imp/WCL28S/Models/RSMGL/Round1/ALTB/ Output:… \\ad.sfwmd.gov\dfsroot\data\hesm_nas\projects\WCL28S\Models\RSMGL\Round1\ALTB\output_071924_xml19548_dev-bbseer22341	
HEC-RAS 2D	**HEC-RAS_V6.3.1**
\\ad.sfwmd.gov\dfsroot\data\imc_nas\projects\CEPP1_0\Models\RSMGL\WCL28S\ftp\20240909\HEC_RAS\L28Proj.p33-35	

Review of Local and Regional-Level Results

Two alternatives and two sensitivity simulations were performed and checked to ensure that modeling products accurately represent the proposed project features and operations. Specific summaries of RSM outputs are the following:

- **Figures 4.1 - 4.3** show stage difference maps between ECB24 and the alternatives. As seen in **Figure 4.1**, ALTA and ALTB can increase the water stage in the southeast corner of BCNP. **Figure 4.2** and **Figure 4.3** also show that ALTA and ALTB can increase the wetness in the areas immediately downstream of the culverts and the area between the Tamiami Trail and the Loop Road.
- These trends are further validated by reviewing the stage and ponding depth duration curves at the loop road (location can be found in **Figure 3.3**). **Figure 4.4** shows increase in the ponding near the Loop Road area for ALTA and ALTB.
- Further exploration into effects on overland flow illustrates that the additional culverts facilitate water movement from WCA-3A to BCNP and reduce flow movement from WCA-3A to Everglades National Park (**Figure 4.5, Table 4.2**).
- Average annual and 1995 (wet year) overland flow vector maps are shown in **Figures 4.6** and **4.7**, respectively. The effects of proposed culverts on regional overland flow can be seen when comparing the baseline to ALTA and ALTB. The figure again demonstrates that proposed culverts have the potential to increase the surface flow from WCA-3A to BCNP and then to the loop road area, especially during the wet year.
- Comparison of mean annual hydroperiod between ECB24, ALTA, and ALTB also confirms that proposed culverts can increase hydroperiod on the southeast area of BCNP and the area between Tamiami Trail and Loop Road (**Figure 4.8**).
- **Table 4.3** compares the annual average annual flow at S229A, S229B and S229C. Although S229A is the culvert with the least discharge capacity, the average annual flows at S229B and S229C were significantly higher than S229A indicating that water level gradients from WCA-3A to BCNP across S229B/S229C are more pronounced than those simulated across S229A.
- Overall, the percentages of time that the model simulated WCA-3A stages to be within the WCA-3A Regulation Schedule Zone A are 17.56%, 16.02%, and 16.70% for ECB24, ALTA, and ALTB, respectively. A comparison of the corresponding number of days per month throughout the simulation period (**Table 4.4** and **Table 4.5**) shows that the culverts have the potential to lower the water level in WCA-3A, especially during the wet months.

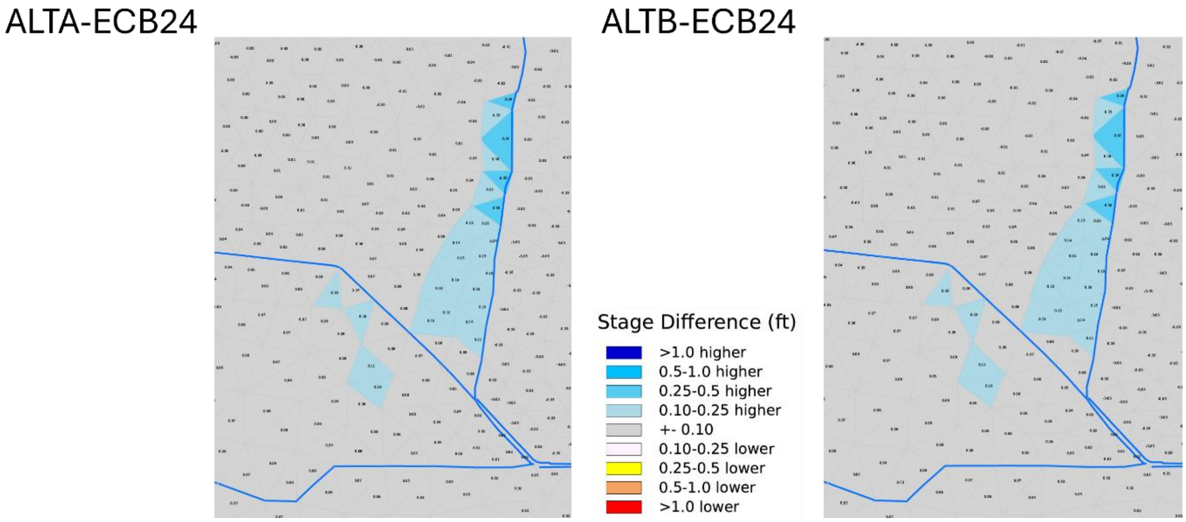

Figure 4.1. Comparisons of the mean annual stage differences between alternatives.

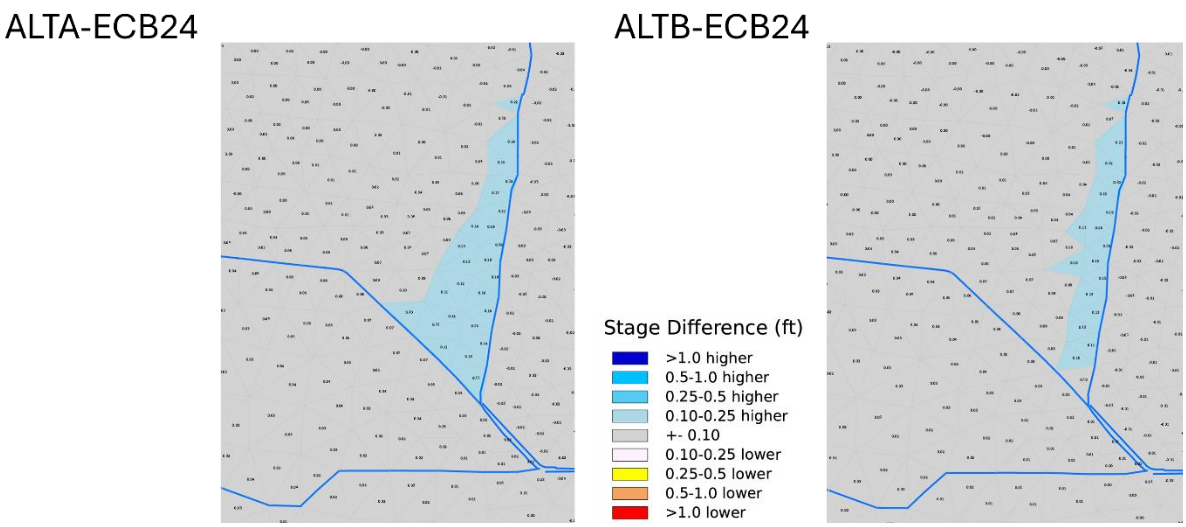

Figure 4.2. Comparisons of the difference in mean October stage between alternatives across the simulation period.

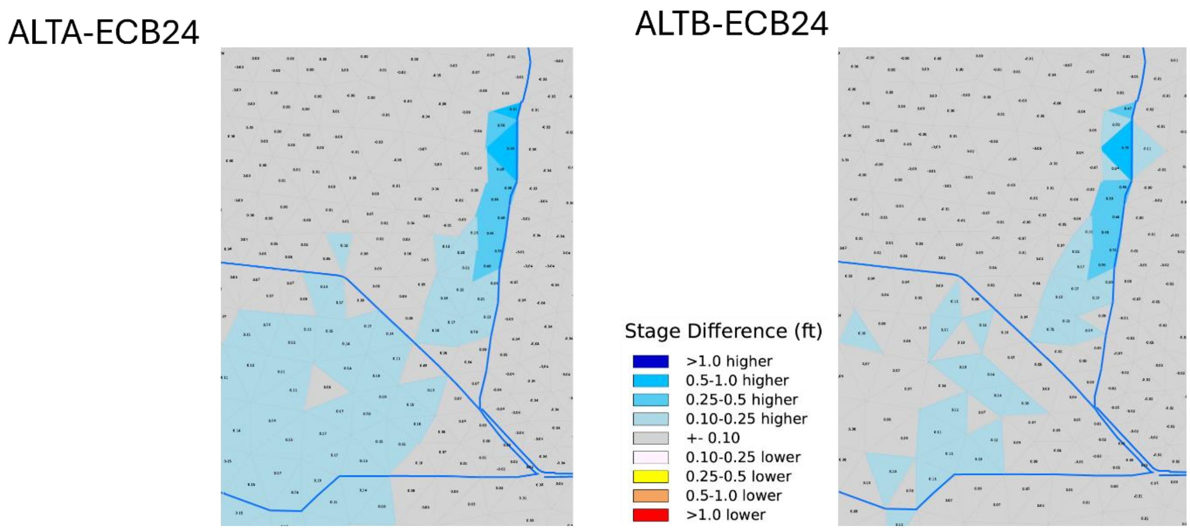

Figure 4.3. Comparisons of the difference in mean April stage between alternatives across the simulation period.

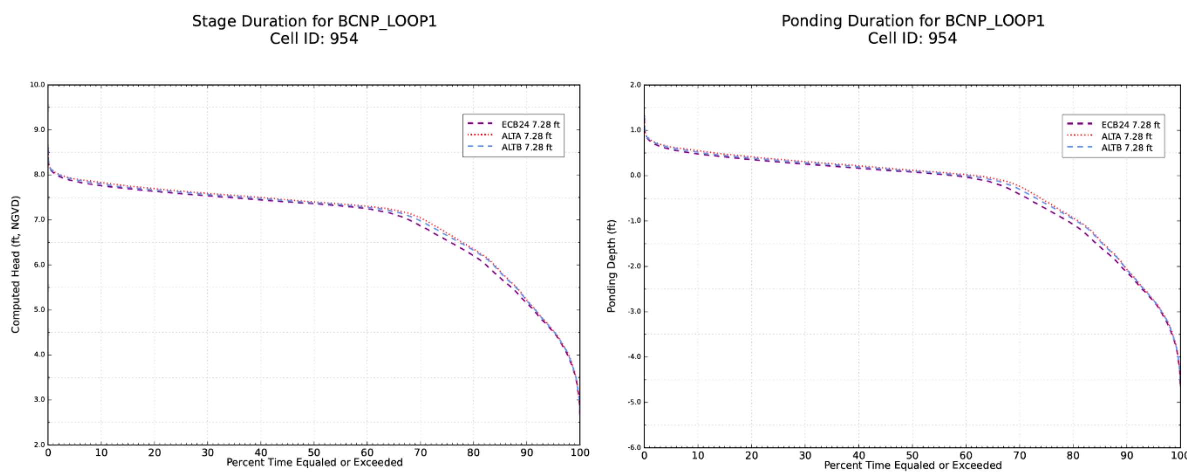

Figure 4.4. Stage and ponding depth duration curves near the Loop Road

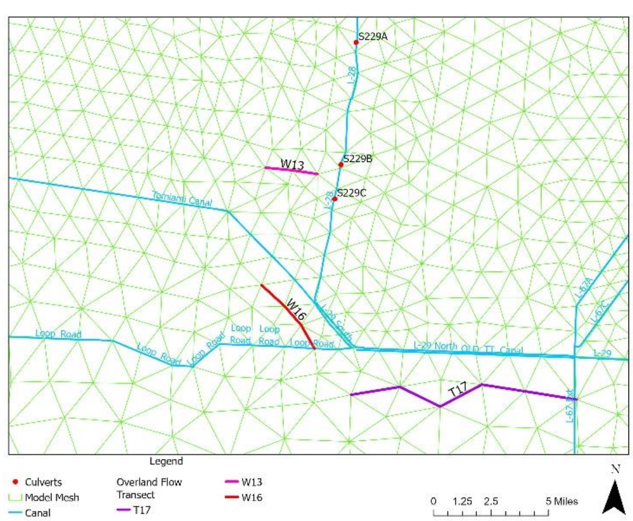

Figure 4.5. Locations of overland flow transects near the additional culverts

Table 4.2. Overland flow at transects near the additional culverts

	W13		W16		T17	
	Wet (Jun-Oct) (1000 ac-ft)	Dry (Nov-May) (1000 ac-ft)	Wet (Jun-Oct) (1000 ac-ft)	Dry (Nov-May) (1000 ac-ft)	Wet (Jun-Oct) (1000 ac-ft)	Dry (Nov-May) (1000 ac-ft)
ECB	5.5	2.7	14.2	6.5	97.6	72.3
ALTA	5.7	3.2	17.2	10.8	88.5	66.0
ALTB	5.6	3.0	16.4	8.7	91.5	68.6

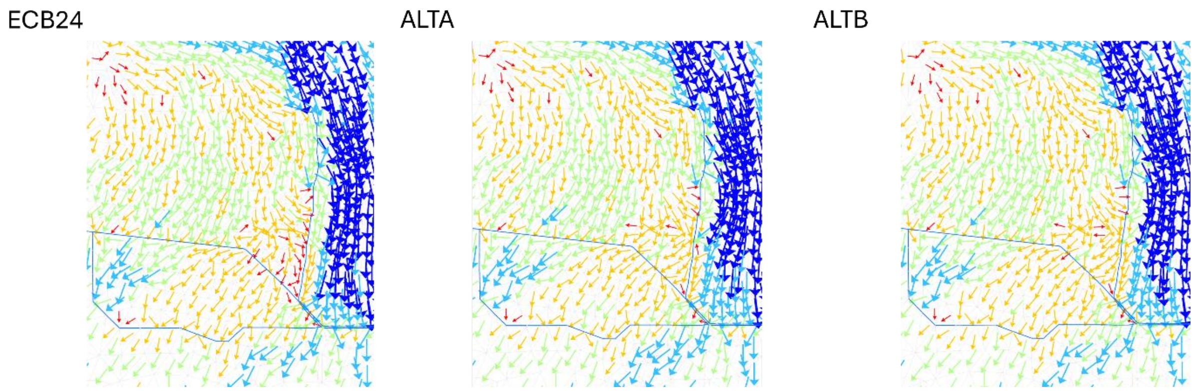

Figure 4.6 Mean annual overland flow vector for alternatives

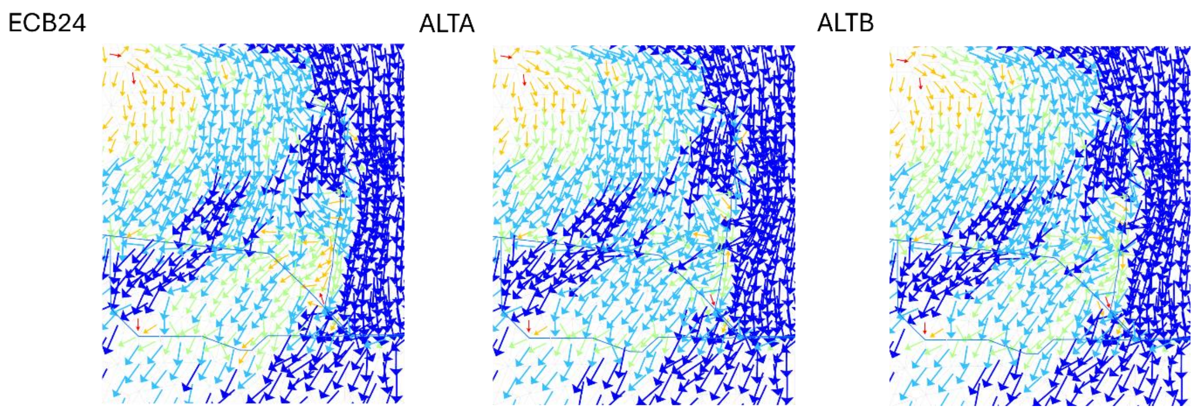

Figure 4.7 Annual average overland flow vector for 1995

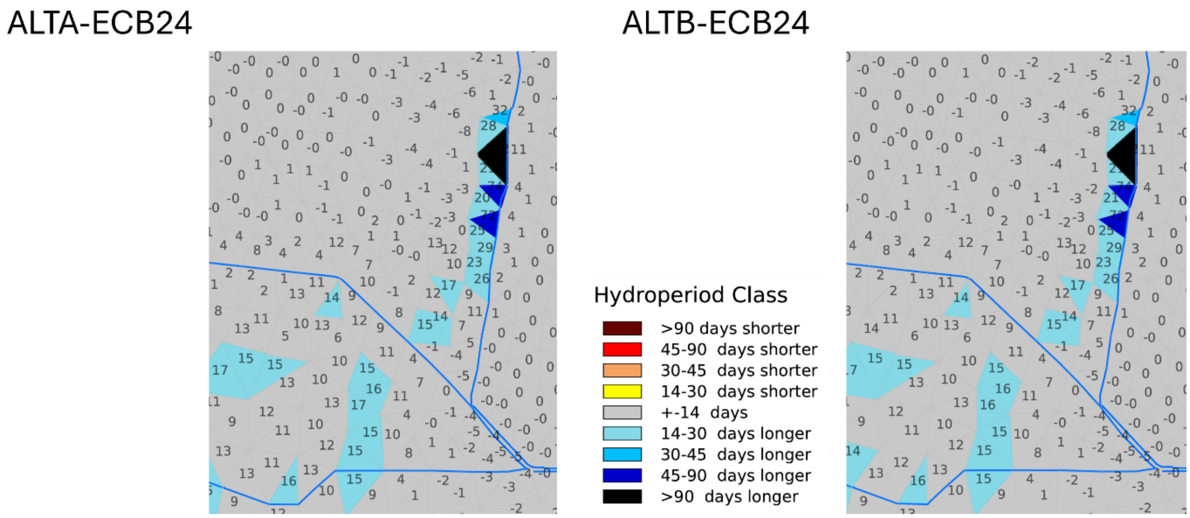

Figure 4.8. Comparisons of mean annual hydroperiod between alternatives and sensitivity runs

Table 4.3. Average annual flow for proposed culverts and nearby structures (1965-2016; Kac-ft)

	S343	S344	S12A	S12B	S229A	S229B	S229C
ECB24	4.1	5.9	25.6	28.1			
ALTA	3.5	5.1	21.4	23.7	3.3	21.3	24.4
ALTB	3.7	5.4	22.7	24.8	4.5	13.2	13.3

Table 4.4. Number of days per month when WCA3A stages were simulated to be within the Regulation Schedule Zone A

Month	ECB24	ALTA	ALTB	ALTA-ECB24	ALTB-ECB24	ALTA-ECB24 (%)	ALTB-ECB24 (%)
Jan	172	136	155	-36	-17	-20.93	-9.88
Feb	166	162	164	-4	-2	-2.41	-1.20
Mar	225	217	220	-8	-5	-3.56	-2.22
Apr	199	186	189	-13	-10	-6.53	-5.03
May	123	102	112	-21	-11	-17.07	-8.94
Jun	181	161	170	-20	-11	-11.05	-6.08
Jul	462	436	442	-26	-20	-5.63	-4.33
Aug	469	441	456	-28	-13	-5.97	-2.77
Sep	407	372	382	-35	-25	-8.60	-6.14
Oct	408	374	396	-34	-12	-8.33	-2.94
Nov	348	299	318	-49	-30	-14.08	-8.62
Dec	176	156	167	-20	-9	-11.36	-5.11
Total	3336	3042	3171	-294	-165		

Table 4.5. Number of days per year when WCA3A stages were simulated to be within the Regulation Schedule Zone A

Year	ECB24	ALTA	ALTB
1965	26	20	23
1966	146	142	144
1967	0	0	0
1968	168	163	165
1969	190	179	185
1970	244	230	239
1971	0	0	0
1972	42	41	41
1973	0	0	0
1974	0	0	0
1975	0	0	0
1976	2	2	2
1977	0	0	0
1978	11	10	10
1979	0	0	0
1980	13	10	11
1981	0	0	0
1982	140	118	124
1983	177	147	159
1984	13	10	12
1985	1	1	1
1986	106	100	102
1987	5	4	4
1988	4	3	4
1989	0	0	0
1990	0	0	0
1991	102	90	94
1992	126	120	125
1993	218	184	195
1994	174	163	167
1995	365	360	365
1996	107	86	95
1997	113	108	110
1998	182	157	168
1999	113	104	109
2000	12	5	8
2001	2	1	2
2002	0	0	0
2003	0	0	0
2004	8	7	8
2005	167	161	166
2006	0	0	0
2007	0	0	0
2008	90	86	88
2009	0	0	0
2010	34	27	30
2011	0	0	0
2012	0	0	0
2013	70	62	65
2014	0	0	0
2015	0	0	0
2016	165	141	150
Total	3336	3042	3171

Review of HEC-RAS Model Results

The simulated WSE (Water Surface Elevation) of three representative locations from all three scenarios were shown in **Figure 4.9**, **4.10**, and **4.11**, representing the stages at the Jetport, north of Jetport, and south of the Jetport, respectively.

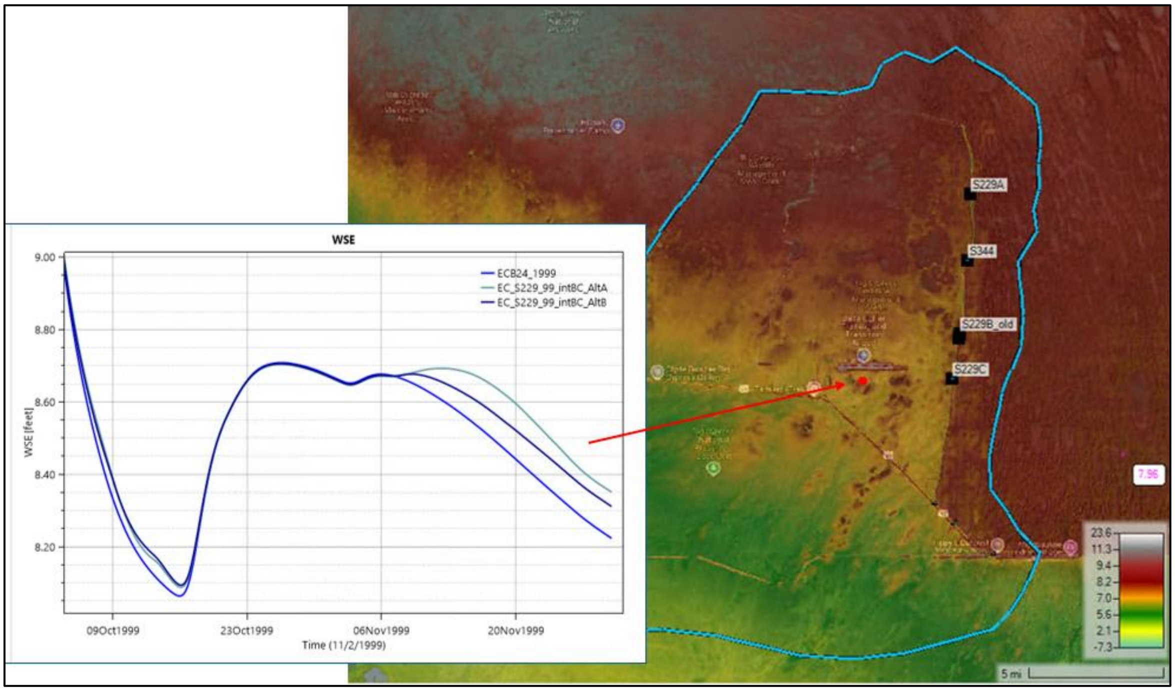

Figure 4.9. WSE at a point near the Jetport

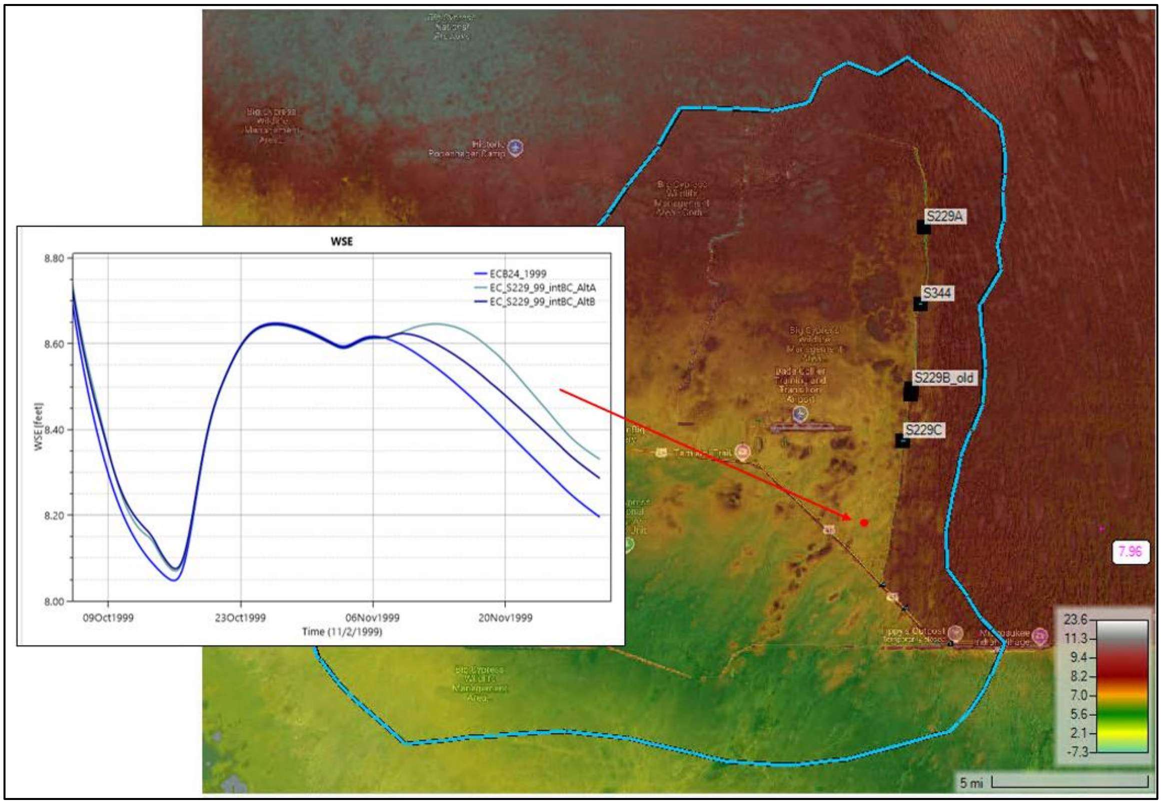

Figure 4.10. WSE at a point south of the Jetport, close to the intersection of US41 and L28S Levee

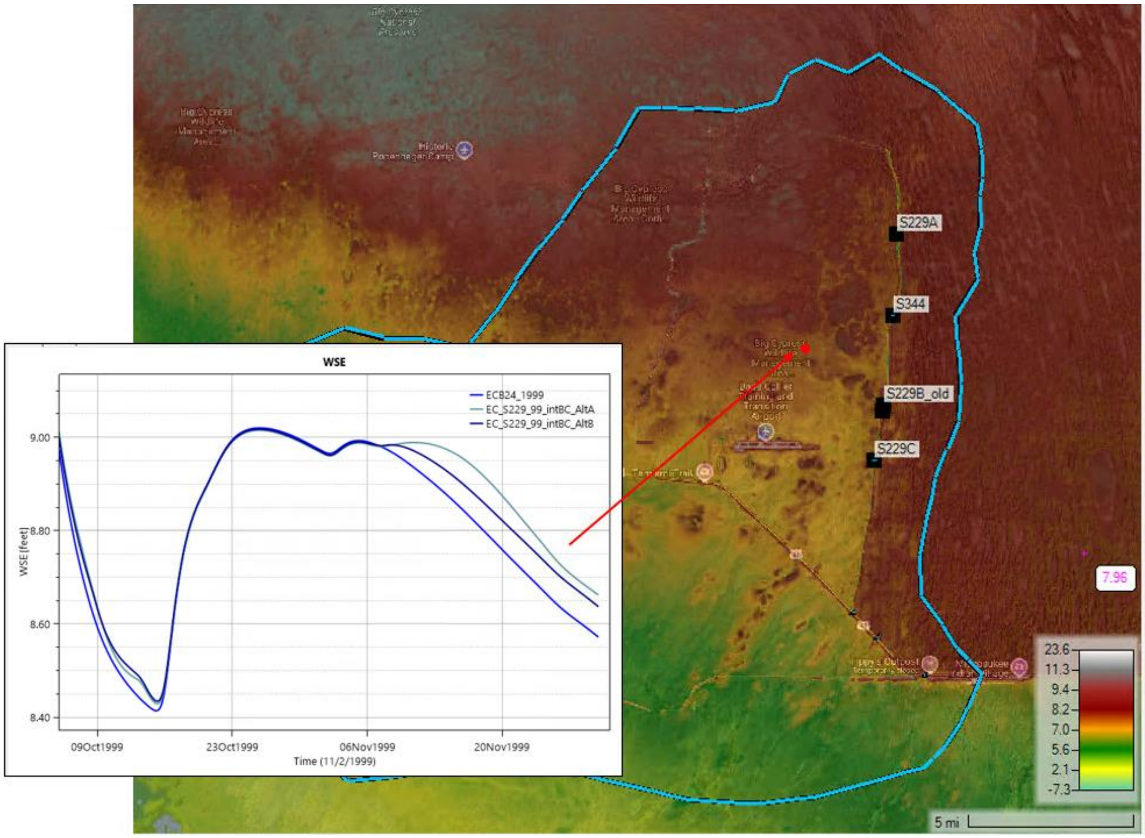

Figure 4.11. WSE at a point north of the Jetport

Three scenarios (ECB24, ALTA, ALTB) were run in HEC-RAS 2D model. Stage boundary conditions were extracted from the corresponding RSMGL runs and applied to all the boundary cells. Culvert flow at S344, S343A&B, and the proposed L28 culvert S229A, B&C, and spillway flow S12A were extracted from the corresponding RSMGL runs and input into the model as internal boundary conditions. This treatment ensured that the three scenario runs are consistent with the corresponding RSMGL runs in proposed project features and operations.

As **Figure 4.9**, **4.10**, and **4.11** show, for the three representative locations, the WSE were almost identical during and after the peak of storm Irene, before 11/8/1999. Afterwards, for all three runs, the same trend was observed: ECB24, representing the existing condition with no proposed culverts on L28 levee, has the lowest WSE among the three runs. ALTA and ALTB runs, with the three L28 culverts operating, has slightly higher stages. WSE in ALTA run are about 0.1 ft higher than ECB24. ALTB has a WSE in between ECB24 and ALTA – about 0.05 ft higher than ECB24.

Summary

The alternatives provided to the project team are deemed to adequately represent the intended planning conditions and provide a reasonable basis of comparison for the necessary evaluations required by the project team. The outcomes illustrate that the proposed culverts a) increases the stages and ponding depths during the dry periods, b) facilitate surface water flow from WCA-3A to BCNP to the south of Tamiami Trail, and c) increases the hydroperiod at the southeastern part of BCNP. Within the scope of the already authorized COP operations, addition of the L28S culverts will provide an increased opportunity to facilitate outflow from WCA-3A towards BCNP.

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USACE, 2020b. Final Environmental Impact Statement for the COP for Broward, Miami-Dade, and Monroe Counties, Florida. Appendix H: Hydraulics and Hydrology, Annex 1-Modeling Strategy. USACE, Jacksonville District, August 2020. 46 pp.

Appendix A – RSMGL Baseline Assumptions Table

Regional Simulation Model Glades-LECSA (RSMGL) 2024 Planned Deviation to COP (COPdev24) Existing Conditions (ECB24) Baseline Table of Assumptions

Feature	
Meteorological Data	• The climatic period of record is from 1965 to 2016 • Rainfall estimates have been revised and updated for 1965-2016, utilizing gauge interpolation through April 2002 and SFWMD NEXRAD from May 2002 to 2016 • Evapotranspiration datasets derived from NOAA's North American Land Data Assimilation System and extended through 2016
Topography	• United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) and Everglades Depth Estimation Network (EDEN) surveys for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park. SFWMD LiDAR datasets available for the Feeder Canal and L28 Annex western basins. • US Army Corps of Engineers (USACE) Digital Elevation Model (DEM) interim version 2017, for the northwestern portions of BCNP, Seminole natural areas and Western Basins (Feeder Canal and C139 Annex). The Western Everglades Restoration Project (WERP) LiDAR project of 2017 covered parts of Hendry and Collier counties, not covered previously by any modern topo data, and a 50-ft WERP DEM was derived. The DEM had some overlap with the original HAEDC/EDEN survey in the western portions of BCNP, south of the L28 Interceptor canal near the 'L28 GAP' area. • Local topographic updates made where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • SFWMD 2018 DEM used to refine coastal wetland areas in Miami-Dade County.
Tidal Data	• Tidal data from two reference stations (Vaca Key and Virginia Key) and 26 RSMGL boundary stations (NOAA primary & secondary and ENP stations) were processed to represent sea level conditions based on NOAA harmonic signals and modeling of "residual" behavior to account for non-harmonic stresses such as wind, surge, etc... • Sea level varies temporally across the 1965-2016 simulation but represents a 2022 sea level (without a sea level rise trend) and includes a 0.4 ft offset from the 1992 reference as indicated by the USACE Intermediate Sea Level Rise curve at Vaca Key. • Low-lying coastal structures utilize a sub-daily tailwater algorithm to limit structure discharge when high tides would cause these structures to close or experience reduced discharge capacity.
Land Use and Land Cover	• Land Use and Land Cover Classification for the Lower East Coast urban areas (east of the Lower East Coast Flood Protection Levee) use 2018 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2018 were used to update the land use in areas where it did not reflect the permit information.

Feature	
	• Land Use and Land Cover Classification for Everglades natural areas (west of the Lower East Coast Flood Protection Levee) is the same as the Calibration Land Use and Land Cover Classification for that area. • Land Use and Land Cover classification for the western basins, BCNP and natural areas west of the L28 levee is based on the 2012 land use coverage prepared by the SFWMD as updated for the Western Everglades Restoration Project (WERP). • Land Use and Land Cover classification for the Southern Everglades, Model Lands and Biscayne Bay Coastal Wetlands areas is based on the 2020 land use coverage prepared by the Biscayne Bay and Southeastern Everglades Restoration (BBSEER) project team. • Land use is modified at locations where reservoirs are introduced (STA1-E, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties were incorporated to address the local drainage and water supply happening at the secondary and tertiary levels not addressed explicitly by the RSM model. • Lake Worth Drainage District maintained by releases from WCA-1 (& Lake Okeechobee). Some releases may instead be replaced by inflows from the C51 and Hillsboro canals when available. • For the Western Basins the local drainage was modeled explicitly using project water control structures like pumps and culverts along with the WERP area canals. The Seminole Water Management areas were modeled using impoundments, in conjunction with the water control structures. The Miccosukee drainage features in the L28 gap basin were modeled explicitly using drainage canals and weirs.
Western Basins	• L-28 Tie-back Levee gaps modeled as a combined weir. • Surface Flows from the Okaloacoochee (OK) slough into the north western model domain estimated using the RSM-DWM. • S190, S140, Westweir, USSO and PC17A canal structures simulated explicitly. • Seminole Water Management Areas (WMA1, WMA2, WMA3 WMA4), Garcia Farms ponds, Pond3 and Pond 5N and Pond 5S, modeled as impoundments. • Jetport runway modeled as no-flow boundary with 2 transverse culverts modeled as weirs • Western Basins local drainage and water supply functions including within Seminole and Miccosukee areas were modeled explicitly using project water control structures (pumps and culverts) along canals.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on Seminole Compact Work Plan acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM.

Feature	
	• AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. Type of crop and water thru G409 were used to set seasonal distribution of demand, then all demands increased to Compact level. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per the District's Final Order and Tribe's Resolution establishing the Big Cypress Reservation entitlement, tribal rights to these quantities are preserved. • LOWSM applies to this agreement. •
Lake Belt Lakes	• Based on 2021 Lake Belt mining areas covered by the USACE Regulatory permit.
EAA Stormwater Treatment Areas	• STA-1E: 5,132 acres total treatment area. • A uniform bottom elevation equal to the spatial average over the extent of STA-1E is assumed.

Comprehensive Everglades Restoration Plan Projects	• C-111 Spreader Canal Project includes the as-built Frog Pond Detention Area and the Aerojet canals as well as the G737 structure per the SFWMD Florida Bay plan. The S199 and S200 pumps are operated per the SFWMD's operating permit and are constrained from Mar 15 – Jun 30 based on stage at the EVER4 andR3110, respectively for the protection of the CSSS Critical Habitat.
	• Biscayne Bay Coastal Wetlands Phase 1 projects as built by 2026:
	  o Deering Estate Flow-way including a 100-cfs inflow pump from C-100A canal triggered by S-123HW
	  o Cutler Wetlands including a 100-cfs inflow pump from C1 canal triggered by S-21HW
	  o L-31E Flow-way includes 10 culverts between C-102 and C-103 and 2 culverts south of C-103 as well as 2 inflow pump stations from the C-102 canal and 3 inflow pump stations from the C-103 canal
	• CEPP New Water seepage wall ~5.0 miles completed around western and northern perimeter of 8.5 SMA
	• CEPP South features are not included, with the following exceptions:
	  o S-333N Gated Spillway
	  o
	  o Old Tamiami Trail Roadway south of S-12C and S-12D is not in the model.

Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule (last updated in 1995). Includes regulatory releases to tide through LEC canals • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels are less than minimum operating criteria of 14 ft. The bottom floor of the schedule (Zone C) is the area below 14 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.

Feature	
	• Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional System
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule (last updated in 1989). Maximum capacity releases are assumed at 1.0 feet above the WCA 2A Regulation Schedule, consistent with current operational practice. Includes regulatory releases to tide through LEC canals. • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels in WCA-2A are less than minimum operating criteria of 10.5 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Water Conservation Area 3A & 3B	• Combined Operational Plan (COP) 2020 regulation schedule for WCA-3A, as per RSM-GL modeled Alternative Q. • Apply Tamiami Trail Flow Formula for inflows into ENP (as in COP Alternative Q) when WCA-3A stage is below Zone A of the regulation schedule. • A simplified version of the Emergency High Water (EHW) trigger line (not using projected stages) is simulated, but never triggers operation of S334 during the simulation period. • Modeling retains the following updates previously incorporated with the 2012 ERTP Regulation Schedule RSM simulations: o Priority use of S-333/S-333N for WCA-3A deliveries, followed by S-12D, S-12C, S-12B & S-12A. o S-12 A&B gate overtopping if headwater stage > 11.0 ft, NGVD, simulated as a weir. o Updated S-12 effective rating curves based on historical observations compared to 3A-28 (Site 65) • Include S-152 operations (design capacity 750 cfs) per Decomp Physical Model, Phase 2 o Assumes September 1 through May 31 operations of S-152 with flow limitation based on actual performance of S-152 (modeled structure design capacity of 400 cfs with 0.5 feet of head o May be operated when L-67A Canal stage at S-151 headwater exceeds 9.3 feet NGVD (surrogate for DPM Phase 2 water quality constraints) o Closed if WCA-3B Site 71 stage exceeds 8.5 feet NGVD o Flows in the model are routed to a cell east of L67C • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2006) • No net outflow to maintain minimum stages in the LEC Service Area canals (salinity control), if water levels are less than minimum operating criteria of 7.5 ft in WCA-3A - defined as when 3-69W marsh gauge falls below 7.5 ft (consistent with COP Alternative Q) or L-67A canal stage at the S333HW falls below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.

Feature	

Everglades National Park	• Water deliveries to Everglades National Park are based on the COP proposed Tamiami Trail Flow Formula (when WCA-3A stage is below Zone A of the regulation schedule) and the COP proposed 2020 regulation schedule for WCA-3A (Zone A), as per RSM-GL modeled Alternative Q.
	• S-333N modeled as an 1150 cfs spillway operated per July 2018 FDEP permit.
	• For normal operations, the S-333/S-333N combined capacity shall be limited to 1500 cfs (consistent with the CERPRA permit issued to SFWMD for S-333N operations). When G3A2, G3A3 gage average is above 11.6 ft for three days or more, the combined capacity increases to 2,500 cfs until the stages drop below 11.0 ft
	    o S-333 and S-333N are concurrently operated. Flows at each structure is pro-rated based on the maximum flow for the day (minimum of design capacity and flow as a function of hw/tw) and combined capacity, subjected to downstream L-29 constraints.
	    o L-29 stage constraint for operation of S-333/S-333N assumed to be 8.5 ft, NGVD incorporating a 120 day FDOT duration constraint (assumed during October through January).
	• L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft.
	• No G-3273 constraint for operation of S-333
	• The one mile Tamiami Trail Bridge as per the 2008 MWD Tamiami Trail Limited Reevaluation Report is modeled as a one mile weir. Located east of the L67 extension and west of the S334 structure.
	• Western 2.6-mile Tamiami Trail Bridge, modeled as a 2.6 miles long weir, and is located east of Osceola Camp and west of Frog City.
	• Tamiami Trail culverts east of the L67 Extension are simulated where the bridge is not located.
	• ~5.5 miles remain of the L-67 Extension Levee.
	• S-355A & S-355B are operated when a positive head exists across the structures.
	• S-356 (500 cfs capacity) is operated to manage seepage & stages in the L-31N Canal, per COP Alternative Q.
	• Partial depth, 5 miles long seepage barrier south of Tamiami Trail (along L-31N), representative of the seepage reduction barrier installed by the Miami-Dade Limestone Product Association.
	• Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8, contract 8A, and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed.
	• S-332D seasonal pumping limits per the COP proposed Alternative Q: no constraint from 15 July –31 December; 325 cfs from 01–31 January; 250 cfs from 01 February – 14 July

Feature	

	• 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per COP Alternative Q.
	    o Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area.
	    o An additional length of seepage canal and the S-357N structure is assumed in the model
	• 8.5 SMA full perimeter seepage wall is simulated (7.3 miles total).
	    • SFWMD ~2.3 mile seepage wall in southwest corner of 8.5 SMA CEPP ~5.0 miles New Water seepage wall completed around remainder of 8.5 SMA

Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay • Pennsuco modeled based on 2021 as-built mitigation infrastructure including DBLEV gap filling.
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2016 consumptive use permit information. • Residential Self Supported (RSS) pumpage are based on 2030 projections from the SFWMD Water Supply Bureau (made in 2016). • Industrial pumpage are based on 2030 projections from the SFWMD Water Supply Bureau (made in 2016). • Irrigation demands for the six irrigation land-use types are calculated internally by the model using 2017-2018 permitted land cover. • Seminole Hollywood Reservation demands are set forth under VI. C of the Tribal Rights Compact. Tribal sources of water supply include various bulk sale agreements with municipal service suppliers.
Canal Operations	• C&SF system and operating rules proposed for COP Alternative Q • Includes S-335 operations to discharge from L-30 Canal (and WCA3A as defined by Alterative Q+) to help maintain the hydraulic ridge between natural and developed areas and provide water to Taylor Slough • Includes operations to meet control elevations in the primary coastal canals for the prevention of saltwater intrusion • Includes existing secondary drainage/water supply system • C-4 Flood Mitigation Project • Western C-4, S-380 structure retained open • C-11 Water Quality Treatment Critical Project (S-381 and S-9A). o S9/S9A operations modified for performance consistency with SFWMM ECB. • S-25B and S-26 pumps are modeled. • Northwest Dade Lake Belt area assumes that the conditions caused by currently permitted mining exist and that the effects of any future mining are fully mitigated by industry • ACME Basin A flood control discharges are sent to C-51, west of the S-155A structure, to be pumped into STA-1E. ACME Basin B

Feature	
	flood control discharges are sent to STA-1E through the S-319 structure • Structures S-343A and S-343B are closed Oct. 1 to July 14; • S-12A and S-12B are closed Oct. 1 to July 14; the WCA-3A high-water exit strategy during October and November (per the COP Alternative Q) is included in the model (i.e. S-12A/B conditionally open in October depending on WCA-3A average stage; S-12B conditionally open in November dependent on WCA-3A average stage). • No seasonal closure at S-344 per proposed COP Alternative Q (open when WCA-3A stage is above Zone A). • South Dade Conveyance System operations will follow COP Alternative Q.

Canal Configuration	• Canal configuration in Everglades / LEC same as calibration except only 5.0 miles remain of the L-67 Extension Canal and CERP project modifications.
	• Additional canals including Tamiami Trail Borrow Canal and Loop Road borrow canals added during WERP & ERTP updates.
	  • Tamiami Trail Borrow Canal, 32 miles
	    o Additional structures: 40 Bridges, modeled as weirs
	    o A plug is assumed between S-12B and S-12C at Shark Valley Tram Road
	  • Loop Road, 23 miles
	    o Additional structures: 56 Culverts, modeled as 17 weirs
	• Old Tamiami Trail Borrow, North Feeder, West Feeder, Wingate Mills, Lardcan canals explicitly modeled.
	• 40 FPL culverts in the southern portion of L31E

Pre-storm drawdown	Limited to high rainfall events only and applies for LEC canals (based on 2-week moving average of rainfall) and associated structures:
	o Palm Beach County:
	  o C51 canal and coastal structures (S155, S41, S40)
	o Broward County:
	  o Hillsboro canal and coastal structure (G56)
	  o C-14 Canal and structure (S37B)
	  o C-14E and coastal structure (S37A)
	  o North Fork Middle River/L35A/C-13 and coastal structure (S36)
	  o North New River and coastal structures (G54, G123)
	  o C-11 Canal and structure (S13S/S13P)
	o Miami-Dade County:
	  • C-9 Canal and coastal structure (S29)
	  • C-8 Canal and coastal structure (S28)
	  • C-7 Canal and coastal structure (S27)
	  • C-6 Canal and coastal structure (S26)
	  • C-2/C-4 Canal and coastal structure (S25B, S22, G93)
	  • C-5/Comfort canal and coastal structure (S25)
	  • C-100B canal and coastal structure (S21)
	  • C-102 canal and coastal structure (S165)
	  • C-103S canal and coastal structure (S167)
	  • C-103N/S179 u/s canal and structure (S179)

Feature	
	◦ C-111 canal and structure (S177) • Pre-storm drawdown for named storms are not captured in the model
Seasonal drawdown	Coastal structures S21A on C-102 per SFWMD structure book: • High Range Operation (May 1 to October 15th) o Open/Close: 2.2/ 1.8 • Intermediate Range Operation (January 1 to April 30th) o Open/Close: 1.8/ 1.4 • Low Range Operation (October 16th to December 31th) o Open/Close: 1.4/ 1.0 Coastal structures S20F on C-103 per SFWMD structure book: • High Range Operation (May 1 to October 15th) o Open/Close: 2.2/ 1.8 • Intermediate Range Operation (January 1 to April 30th) o Open/Close: 1.7/ 1.3 • Low Range Operation (October 16th to December 31th) • o Open/Close: 1.4/ 1.0
Lower East Coast Service Area Water Shortage Management	• Lower east coast water restriction zones and trigger cell locations are equivalent to SFWMM ECB implementation. An attempt was made to tie trigger cells with associated groundwater level gages to the extent possible. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN ECB simulation.

Notes

- The RSM is a robust and complex regional scale model. Due to the scale of the model, it is frequently necessary to implement abstractions of system infrastructure and operations that will, in general, mimic the intent and result of the desired project features while not matching the exact mechanism by which these results would be obtained in the real world. Additionally, it is sometimes necessary to work within established paradigms and foundations within the model code (e.g. use available input-driven options to represent more complex project operations).
- The boundary conditions along the northern boundary of the RSMGL model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Basins Model (RSMBN). The SFWMM was the source of the northern boundary groundwater/surface water flows, while the RSMBN was the source of the northern boundary structural flows.
- COP Deviation 2024 ECB24 assumptions were updated from the CEPP OPS 1.0 Run1 modeling scenario in May 2024.

Appendix B – RSMGL Sensitivity Runs – ALTAS1 & ALTBS1

Sensitivity Run – ALTAS1 and ALTBS1

During the culvert operation plan discussion, questions have been raised regarding the potential impact on the downstream facilities and ecologically sensitive areas, such as the jetport and tribal lands. To address the questions, the project team has proposed increasing the water level monitoring grid in flood-sensitive areas by adding or upgrading stilling wells (**Table B.1**). Water levels at the locations of stilling wells serve as indicators and potential constraints to regulate the operation of three new culverts. Use of these locations as operational constraints were implemented and tested in two sensitivity runs, ALTAS1 and ALTBS1. In these sensitivity runs, when stages at any location exceed the proposed threshold, the L28S culverts will close (similar to how they close when the current LOOP1 threshold is exceeded). The purpose of the sensitivity runs is to bracket a range of project effects if all the locations listed were used as operational constraints. It is expected that work to refine the operations & monitoring plan will continue over time and that not all these locations and specific thresholds will ultimately be recommended, but by testing both the unconstrained scenarios (as in the main body MDR) and the sensitivity tests, the full range of potential effects are available for evaluation.

Alternatives setup

- Sensitivity Run 1 (ALTAS1) – Same settings as ATLA with 7 additional constraints (**Figure B.1**) on culvert operation
- Sensitivity Run 2 (ALTBS1) – Same settings as ATLB with 7 additional constraints (**Figure B.1**) on culvert operation

Table B.1. Coordinates of stilling wells and proposed elevation operational constraints

Gage name	Easting (x)	Northing (y)	proposed threshold elevation (ft; NGVD29)
SW1	689705.95	557757.87	10.95
SW2	698256.61	556281.56	10.45
SW3	683132.11	553725.33	10.95
11-Mile	672431.22	553568.55	N/A
US41_NW	679609.09	549908.46	8.95
NESA	693357.52	541088.50	8.95
SESA	692351.32	535008.48	8.95
US41_SE	701029.95	531699.84	8.95
Loop1_T	685582.08	518913.67	8.50
Loop2_H	671313.38	513635.03	N/A
Loop2_T	671322.03	513555.97	N/A

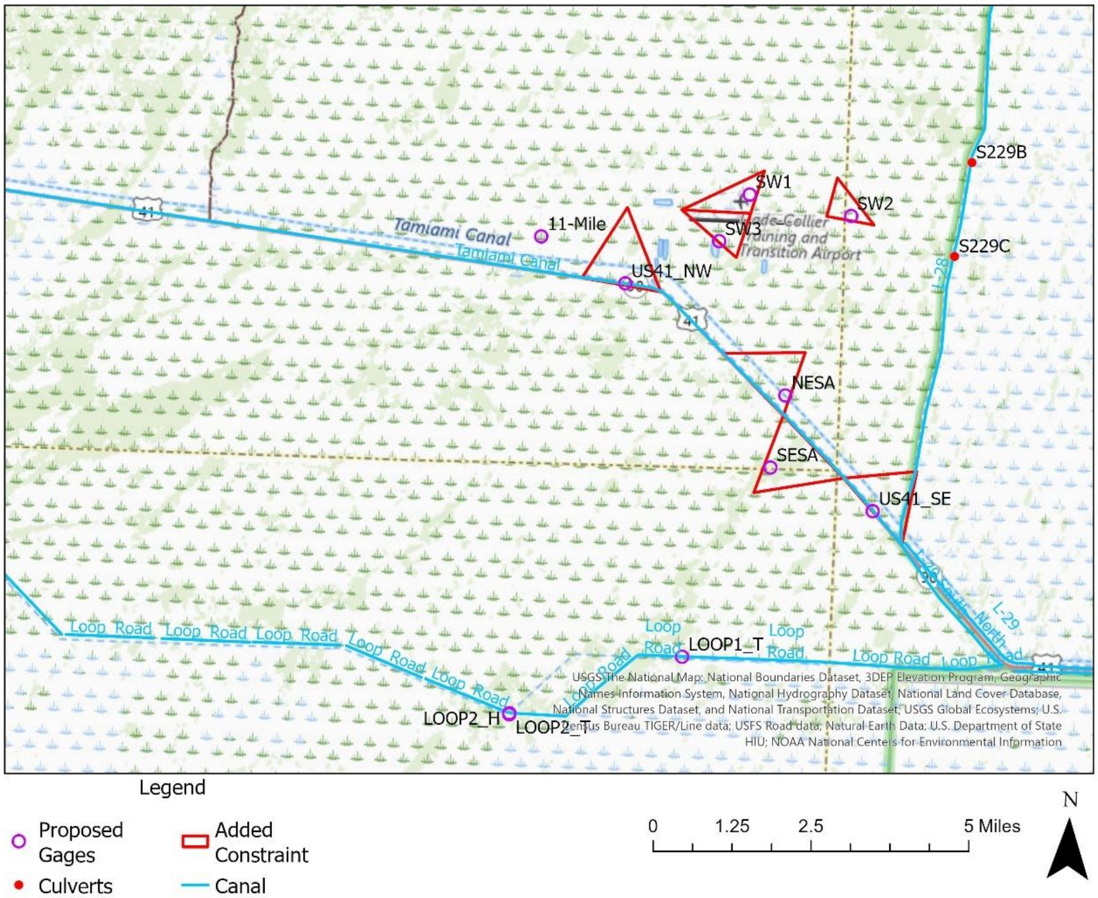

Figure B.1. Locations of proposed new and to-be-upgraded stilling wells, additional constraints (red triangles)

Results

Table B.2 lists more specific modeling information including code version & inputs used.

Table B.2. Version information and model file locations

WCL28S_ALTAS1 082824	RSM_4.0.15
Input: … https://whgsvn02p.sfwmd.gov/websvn/browse/svnroot/trunk/rsm_imp/WCL28S/Models/RSMGL/Round1/ALTAS1/ Output:… \\ad.sfwmd.gov\dfsroot\data\hesm_nas\projects\WCL28S\Models\RSMGL\Round1\ALTAS1\output_082824_xml19717_dev-bbseer22341	
WCL28S_ALTBS1 082824	**RSM_4.0.15**
Input: … https://whgsvn02p.sfwmd.gov/websvn/browse/svnroot/trunk/rsm_imp/WCL28S/Models/RSMGL/Round1/ALTBS1/ Output:… \\ad.sfwmd.gov\dfsroot\data\hesm_nas\projects\WCL28S\Models\RSMGL\Round1\ALTBS1\output_082824_xml19717_dev-bbseer22341	

In general, the results from ALTAS1 and ALTBS1 are similar to what have been found in the ALTA and ALTB for stages, only the magnitude of increased flow via the proposed culverts was smaller.

For the ALTAS1, there were 3,260 days (upstream WCA3A stage is high and downstream Loop Rd stage is low) out of the total period of simulation (18,993 days total) when the culverts would have opened if there were no additional constraints. However, for the same ALTAS1 run, at least one of the constraints was triggered (stage at downstream stilling wells is high) for 1,969 days (60.4%), thus preventing opening of the culverts. Of these constrained days, the constraint was triggered at US41_SE, NESA, SESA, and US41_NW for 99.1%, 91.9%, 70.1%, and 65.8% of the time, respectively. An example of the stage-induced closure operation is for ALTAS1 in Figure B.10.

For the ALTBS1, there were 3,265 days out of the total period of simulation when the culverts would have opened if there were no additional constraints. At least one of the constraints was triggered for 1,961 days (60.1%). Of these constrained days, the constraint was triggered at US41_SE, NESA, SESA, and US41_NW for 99.1%, 92.3%, 70.4%, and 66% of the time, respectively.

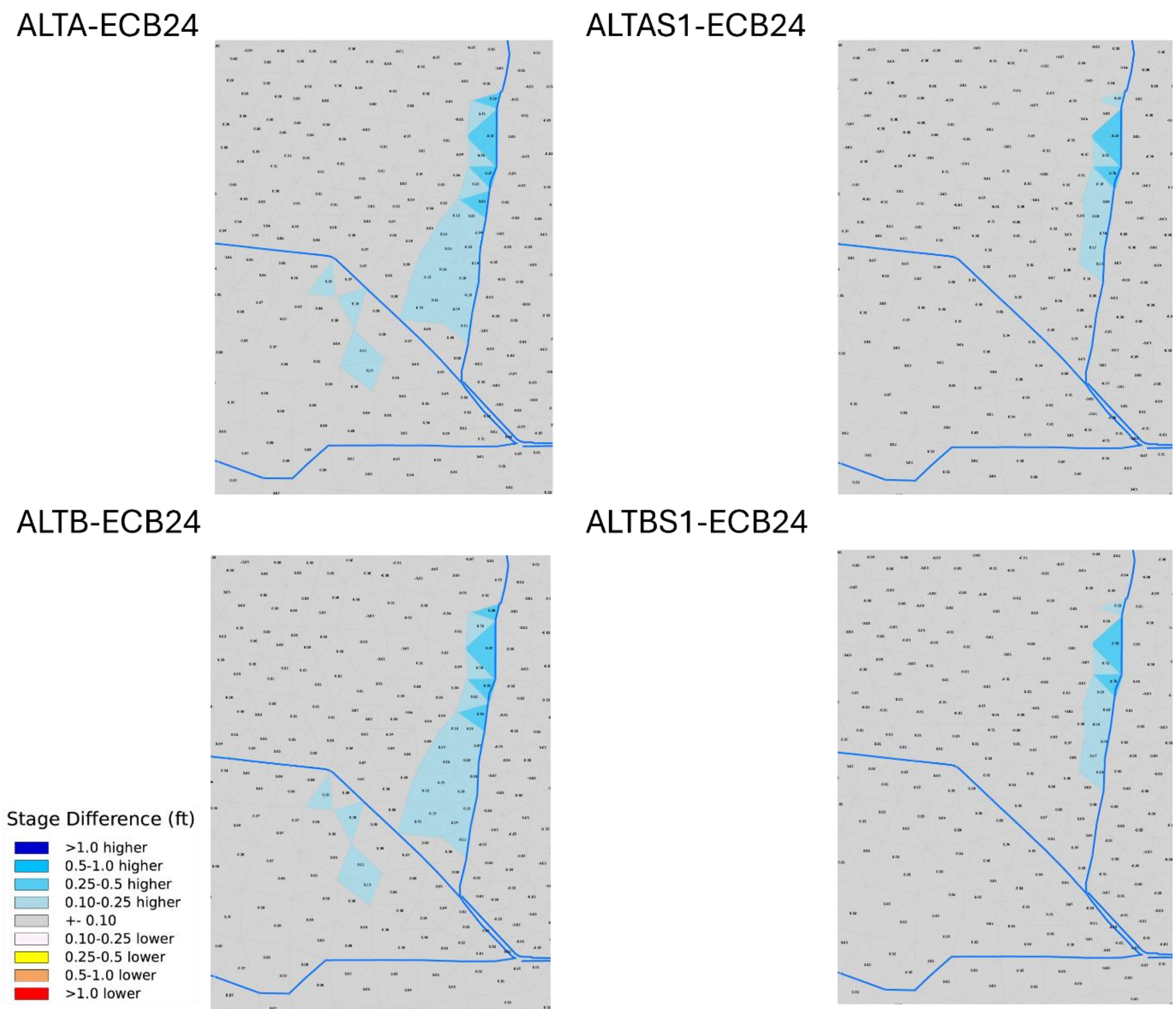

Figure B.2. Comparisons of the mean annual stage differences between alternatives.

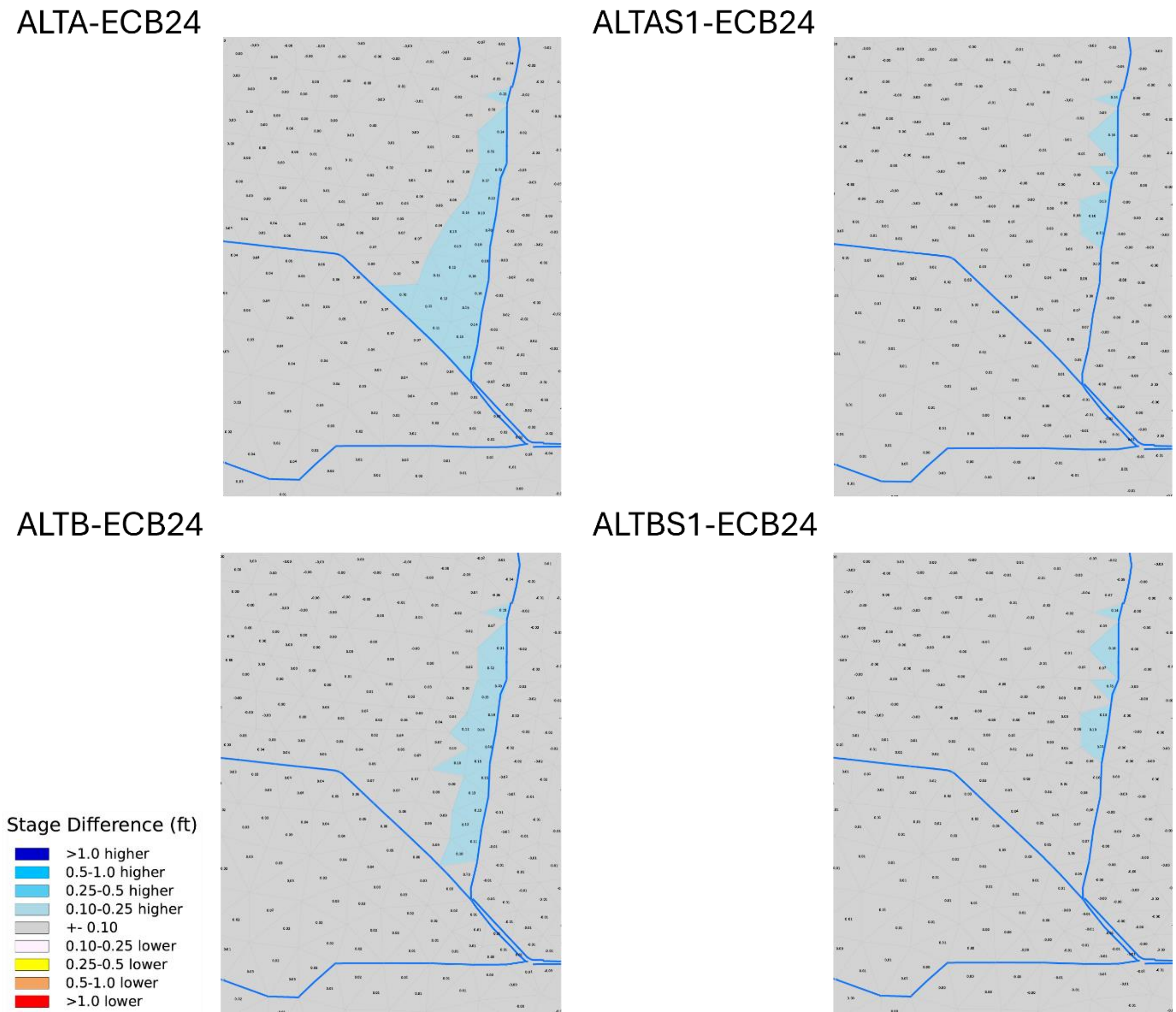

Figure B.3. Comparisons of the mean monthly stage differences for a wet month (October) between alternatives and sensitivity runs.

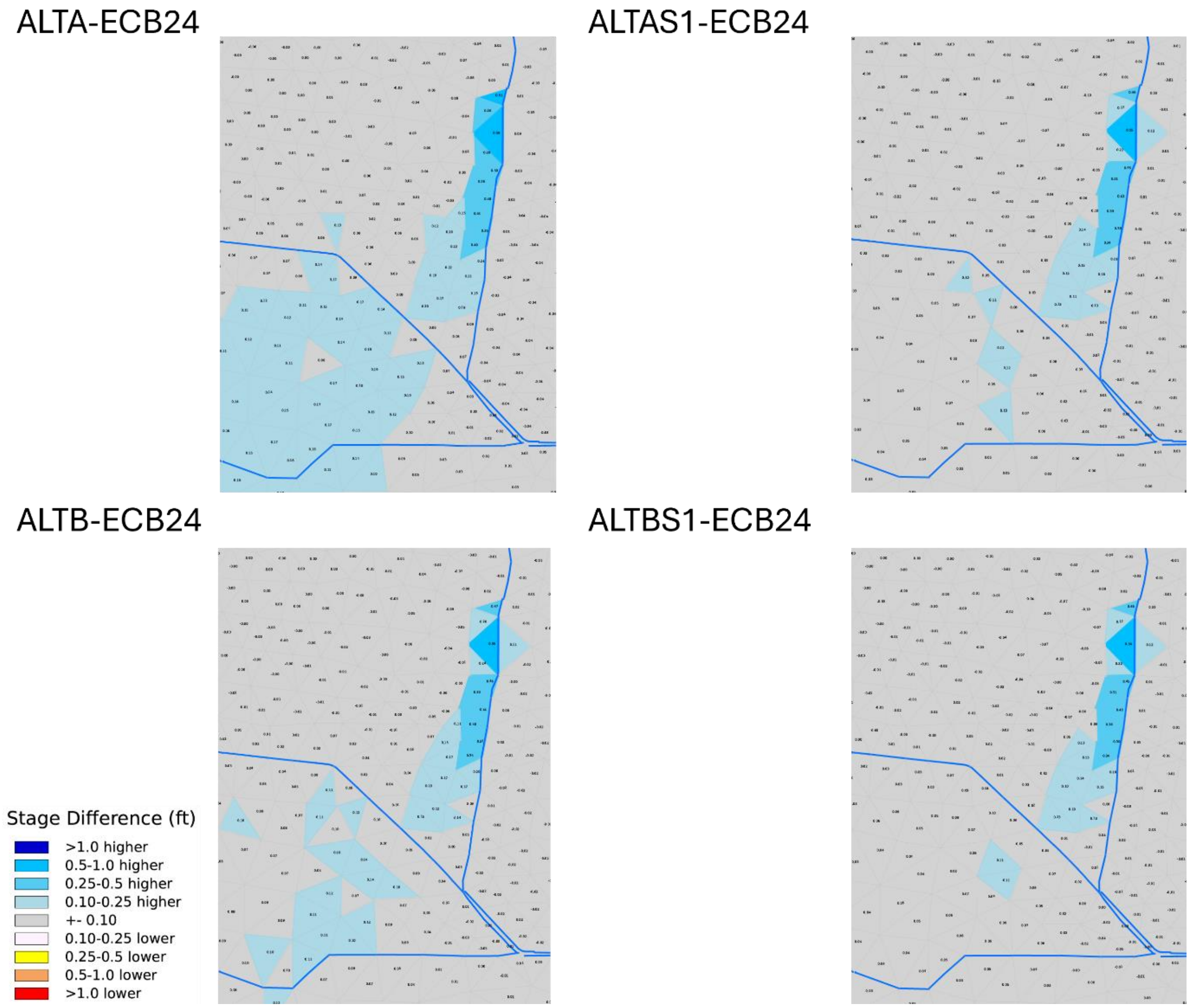

Figure B.4. Comparisons of the mean monthly stage difference for a dry month (April) between alternatives

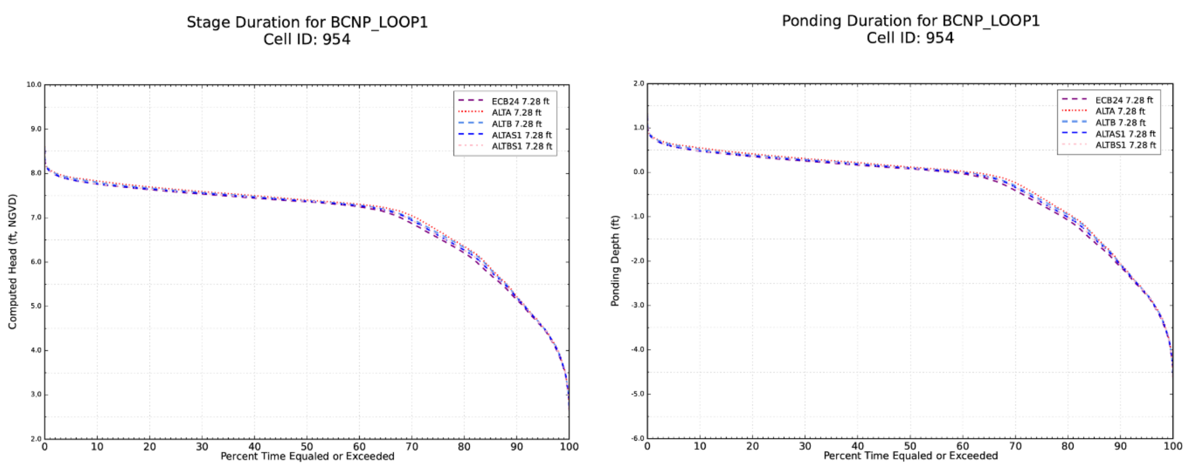

Figure B.5. Stage and ponding depth duration curves near the Loop Road

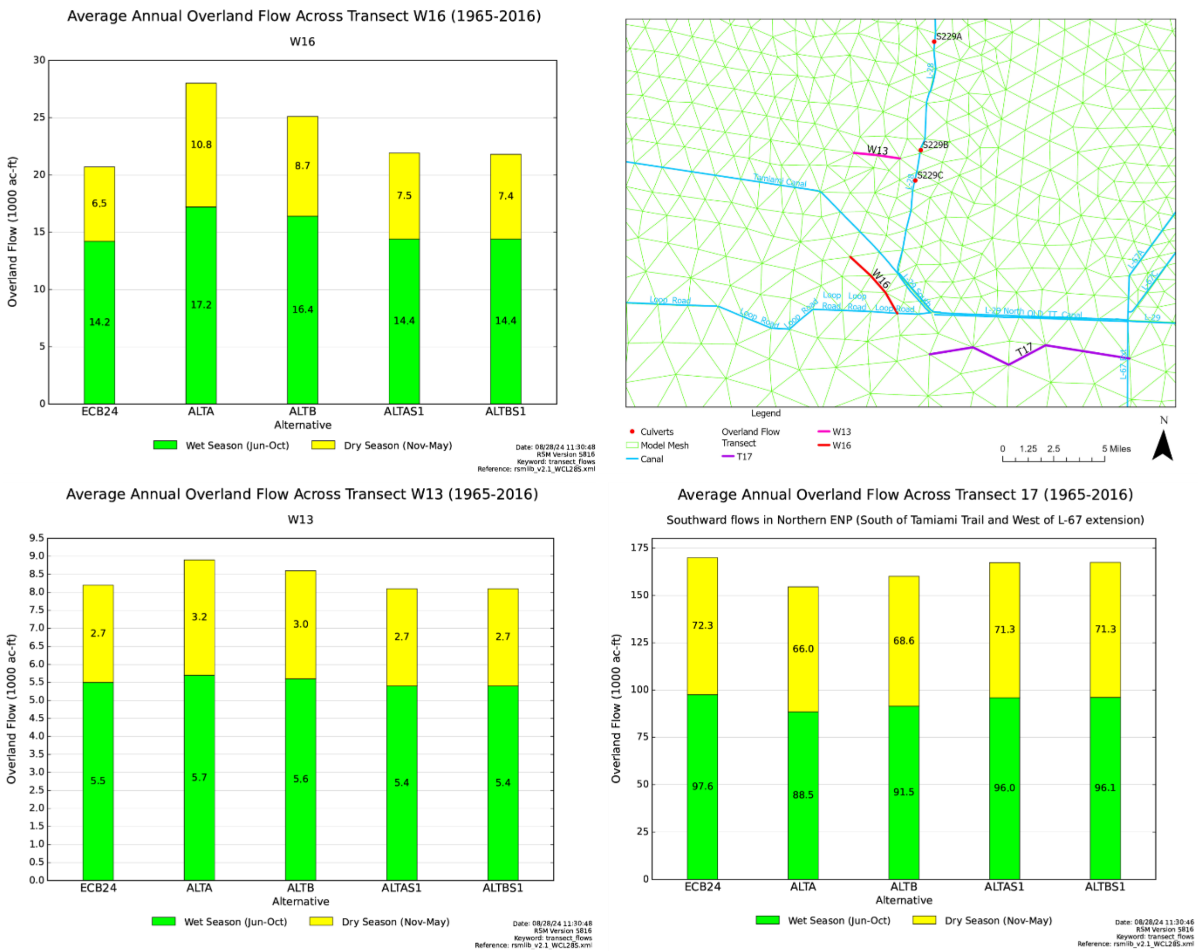

Figure B.6. Overland flow at transects near the additional culverts

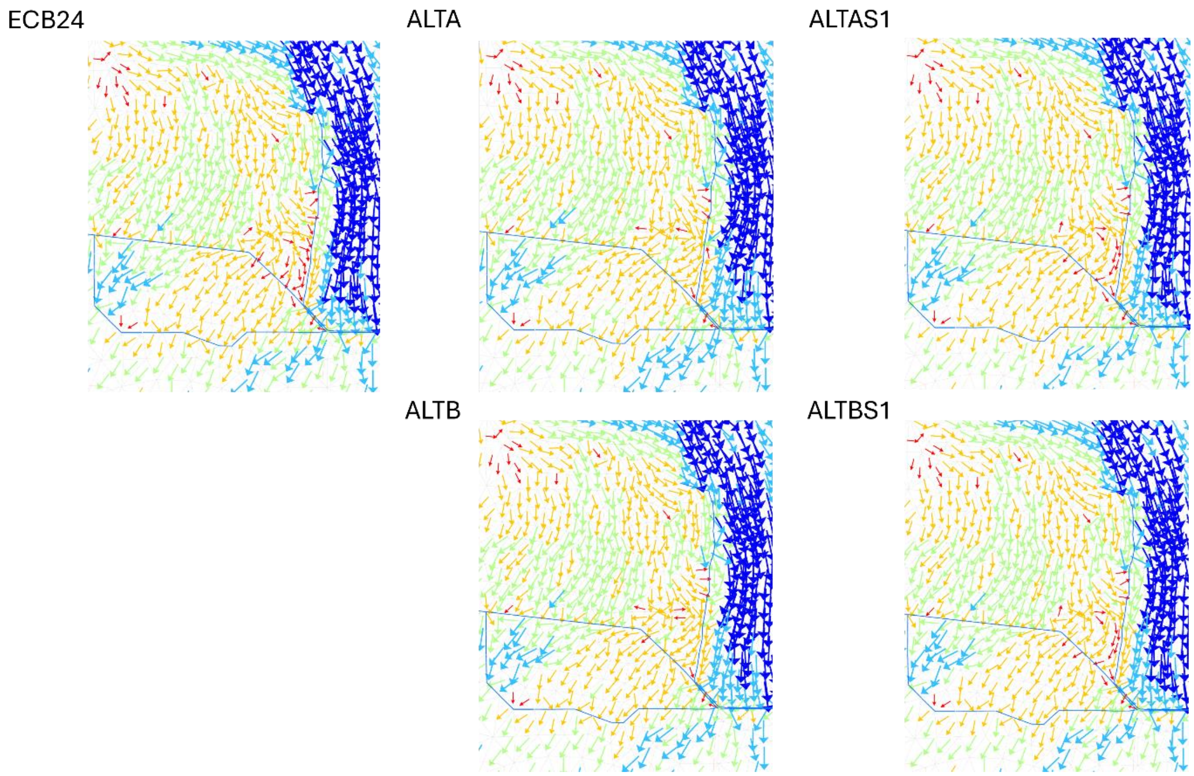

Figure B.7. Mean annual overland flow vector for alternatives

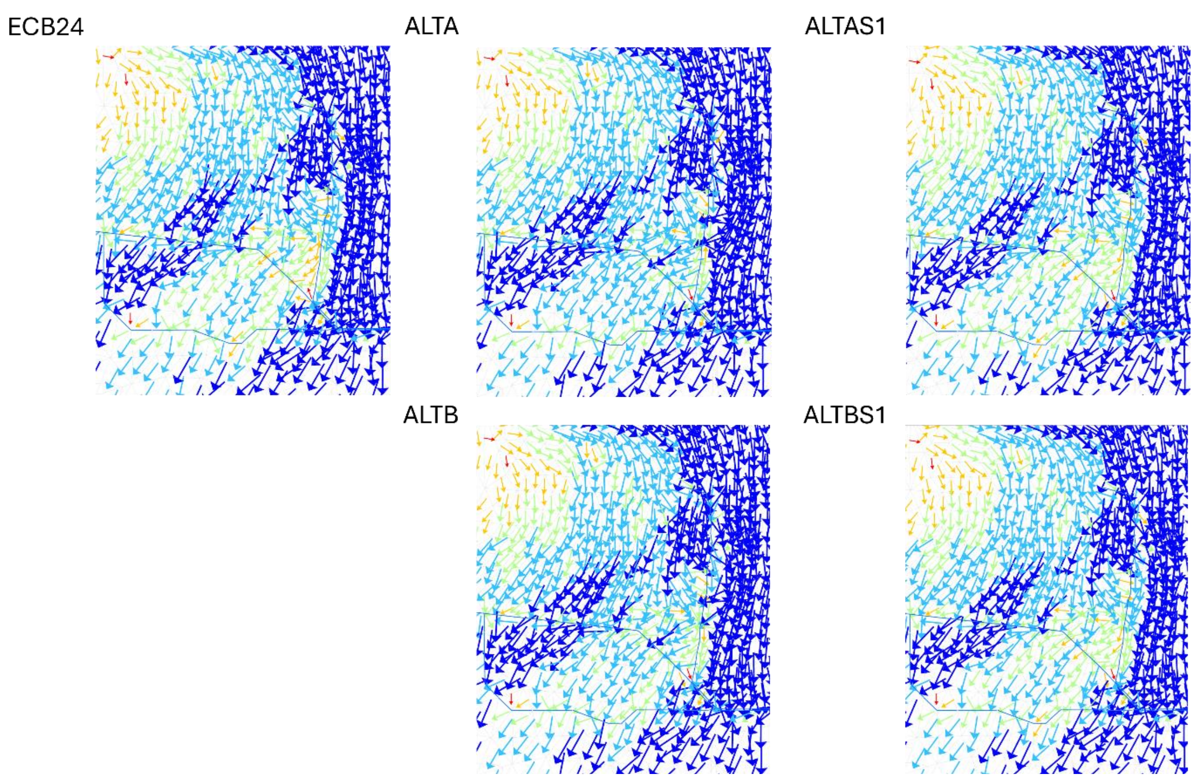

Figure B.8. Annual average overland flow vector for 1995

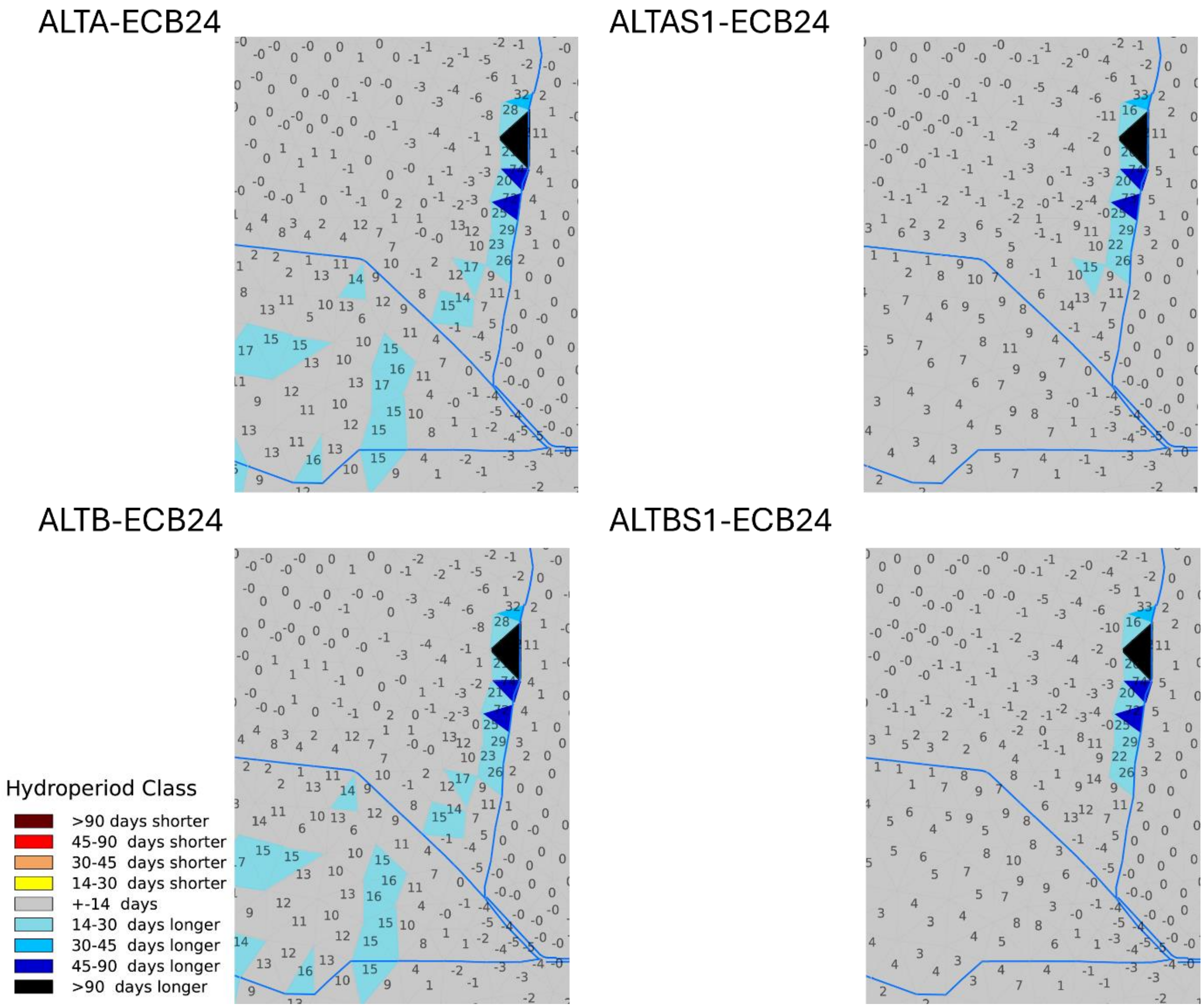

Figure B.9. Comparisons of mean annual hydroperiod between alternatives and sensitivity runs

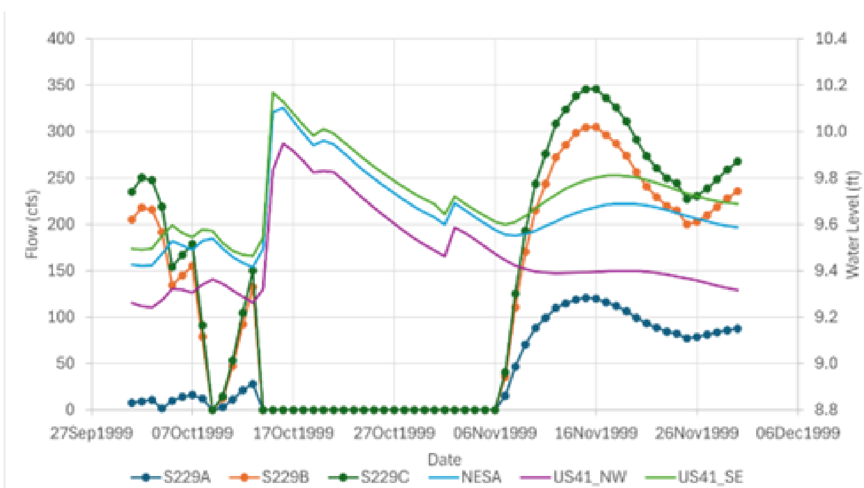

Figure B.10. Example of constraint-driven closure operations for a wet event in ALTAS1

Table B.3. Average annual flow for proposed culverts and nearby structures (1965-2016; Kac-ft)

	S343	S344	S12A	S12B	S229A	S229B	S229C
ECB24	4.1	5.9	25.6	28.1			
ALTA	3.5	5.1	21.4	23.7	3.3	21.3	24.4
ALTB	3.7	5.4	22.7	24.8	4.5	13.2	13.3
ALTAS1	4.0	5.8	25.3	27.8	0.7	4.0	4.6
ALTBS1	4.0	5.8	25.3	27.8	0.7	3.8	4.2

Table B.4. Number of days per month when WCA3A stages were simulated to be within the Regulation Schedule Zone A

	ECB24	ALTA	ALTB	ALTAS1	ALTBS1	ALTA-ECB24	ALTB-ECB24	ALTAS1-ECB24	ALTBS1-ECB24	ALTA-ECB24 (%)	ALTB-ECB24 (%)	ALTAS1-ECB24 (%)	ALTBS1-ECB24 (%)
Jan	172	136	155	164	164	-36	-17	-8	-8	-20.93	-9.88	-4.65	-4.65
Feb	166	162	164	166	166	-4	-2	0	0	-2.41	-1.20	0.00	0.00
Mar	225	217	220	219	220	-8	-5	-6	-5	-3.56	-2.22	-2.67	-2.22
Apr	199	186	189	190	190	-13	-10	-9	-9	-6.53	-5.03	-4.52	-4.52
May	123	102	112	115	116	-21	-11	-8	-7	-17.07	-8.94	-6.50	-5.69
Jun	181	161	170	173	173	-20	-11	-8	-8	-11.05	-6.08	-4.42	-4.42
Jul	462	436	442	447	447	-26	-20	-15	-15	-5.63	-4.33	-3.25	-3.25
Aug	469	441	456	467	467	-28	-13	-2	-2	-5.97	-2.77	-0.43	-0.43
Sep	407	372	382	402	403	-35	-25	-5	-4	-8.60	-6.14	-1.23	-0.98
Oct	408	374	396	406	407	-34	-12	-2	-1	-8.33	-2.94	-0.49	-0.25
Nov	348	299	318	339	340	-49	-30	-9	-8	-14.08	-8.62	-2.59	-2.30
Dec	176	156	167	172	172	-20	-9	-4	-4	-11.36	-5.11	-2.27	-2.27
Total	3336	3042	3171	3260	3265	-294	-165	-76	-71				