COMPREHENSIVE EVERGLADES RESTORATION PLAN, CENTRAL EVERGLADES PLANNING PROJECT, INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT: FINAL JULY 2014, REVISED DECEMBER 2014

COMMUNICATION

FROM

THE ASSISTANT SECRETARY OF THE ARMY, CIVIL WORKS, THE DEPARTMENT OF DEFENSE

TRANSMITTING

THE FINAL COMPREHENSIVE EVERGLADES RESTORATION PLAN INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT, PURSUANT TO THE WATER RESOURCES DEVELOPMENT ACT OF 2000, SEC. 601

PART 1 OF 6

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
CIVIL WORKS
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WASHINGTON DC 20310-0108

AUG 31 2015

Honorable John Boehner
Speaker of the House of Representatives
U.S. Capitol Building, Room H-232
Washington, DC 20515-0001

Dear Mr. Speaker:

In accordance with section 601 of the Water Resources Development Act of 2000, the Secretary of the Army recommends the authorization and construction of the Central Everglades Planning Project (CEPP) in Palm Beach, Broward, and Miami-Dade Counties, Florida for the purpose of ecosystem restoration and other water related needs. CEPP is described in the report of the Chief of Engineers, dated December 23, 2014, which includes other pertinent documents. The Secretary of the Army plans to implement CEPP at the appropriate time, considering National priorities and the availability of funds.

This investigation was conducted to analyze and formulate improvements in the Everglades ecosystem including Florida Bay, Caloosahatchee and St. Lucie estuaries in South Florida. The recommended plan is the National Ecosystem Restoration plan, which includes the following elements listed from north to south in the project area:

a. A 14,000 acre A-2 flow equalization basin (FEB) and associated distribution, inlet, and outlet structures located within the Everglades Agricultural Area. Operation of the A-2 FEB would be integrated with the future operation of the State's Restoration Strategies features, including the A-1 FEB, and the State's existing Stormwater Treatment Area (STA) 2 and STA 3/4 facilities, to deliver new water south.

b. Water Conservation Area (WCA) 2A and northern WCA 3A includes a 500-cubic feet/second (cfs) gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal; a 500 cfs gated spillway to deliver water from the remnant L-5 Canal to the western L-5 Canal (during L-6 diversion operations); a 2,500-cfs gated spillway to deliver water from STA 3/4 to the S-7 Pump Station during peak discharge events (including L-6 diversion operations); approximately 13.6 miles of conveyance improvements to the L-5 Canal; degradation of approximately 2.9 miles of the southern L-4 Levee along the northwest boundary of WCA 3A; a 360-cfs pump station to move water within the L-4 Canal to maintain water supply deliveries to retain the existing functionality of STA-5 and STA-6 and maintain water supply to existing legal users, including the Seminole Tribe of Florida; gated culverts and an associated new canal to deliver water from the Miami Canal (south of the S-8 Pump Station, which pulls water from the L-5 Canal) to the L-4 Canal, along with potential design modifications to the existing S-8 and G-404 pump stations; and backfill of approximately 13.5 miles of the

Miami Canal with construction of tree islands between 1.5 miles south of the S-8 Pump Station and Interstate Highway I-75.

c. Southern WCA 3A, WCA 3B, and the Northern Edge of Everglades National Park include a 1,150-cfs gated spillway adjacent to S-333; a 500-cfs gated culvert in L-67A Levee and an associated 6,000-foot gap in L-67C Levee; a flow-way through the western end of WCA 3B (two 500-cfs gated culverts in L-67A Levee, removal of approximately 8 miles of L-67C Levee, removal of approximately 4.3 miles of L-29 Levee, and construction of approximately 8.5 miles of new levee in WCA 3B); a 1,230-cfs gated spillway in L-29 Canal; removal of approximately 5.5 miles of the L-67 Extension Levee and backfill of approximately 5.5 miles of the L-67 Extension Canal; removal of approximately 6 miles of Old Tamiami Trail; and removal of spoil mounds along the northwestern side of the L-67A Canal.

d. Eastern Edge of Everglades National Park includes a 1,000-cfs pump station and an approximately 4.2-mile long, 35-feet deep tapering seepage barrier cutoff wall along the L-31N Levee just south of Tamiami Trail.

e. Recreational features include gravel parking with boat ramps and trailheads, dry vault toilets, shelters, primitive camping sites, and fishing platforms.

The total first cost of the recommended plan, based upon October 2014 price levels, is estimated to be $1,951,000,000, which includes $1,944,000,000 for ecosystem restoration and $6,600,000 for separable recreation features. In accordance with the cost-sharing requirements of section 601(e) of WRDA 2000, the ecosystem restoration costs are shared 50-50 between the government and non-Federal sponsor. The separable recreation features are cost shared 50-50 based on section 103 of WRDA 1986. The government is responsible for 100% of cultural resources data recovery costs (up to 1% of total project costs). Therefore, the total Federal cost of the recommended plan would be $976,375,000 and the non-Federal cost would be $974,625,000.

The estimated annual costs for restoration Operations, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) are $11,250,000, of which $4,150,000 is attributed to new CEPP infrastructure; $4,000,000 to flowing water through existing State and Central and Southern Florida infrastructure; and $3,100,000 to invasive species management. Post construction monitoring will occur during 10-year cycles for invasive species and performance-based ecological monitoring ($2,700,000 annually for up to 10 years). Monitoring necessary to ensure CEPP implementation complies with all applicable State water quality standards as well as to inform project operations will also be conducted ($2,800,000 annually) and this monitoring will be assessed periodically and revised as needed. In accordance with section 601(e)(4), these OMRR&R costs are cost-shared 50-50 between the government and non-Federal sponsor. The annual OMRR&R costs for the separable recreation features are estimated at $65,000 and are a non-Federal responsibility.

An Independent External Peer Review (IEPR) was conducted by Battelle, which issued a final IEPR report on October 10, 2013. The Corps addressed all IEPR comments by either adopting the IEPR panel's suggestions or revising text and providing additional documentation to the feasibility report to satisfy the panel's concerns.

The Office of Management and Budget (OMB) advises that there is no objection to the submission of the report to Congress and concludes that the report recommendation is consistent with the policy and programs of the President. However, OMB also noted that the project would need to compete with other proposed investments for funding in future budgets. A copy of OMB's letter, dated August 7, 2015, is enclosed. I am providing a copy of this transmittal and the OMB letter to the Subcommittee on Water Resources and Environment of the House Committee on Transportation and Infrastructure, and the Subcommittee on Energy and Water Development of the House Committee on Appropriations. I am also providing an identical letter to the President of the Senate.

Very truly yours,

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

Enclosures

Enclosures

1. Report of the Chief of Engineers, December 23, 2014
2. OMB Clearance Letter, August 7, 2015
3. Record of Decision, August 21, 2015
4. Final Integrated Project Implementation Report and Environmental Impact Statement, July 2014 (Revised December 2014)

DEPARTMENT OF THE ARMY
CHIEF OF ENGINEERS
2600 ARMY PENTAGON
WASHINGTON, D.C. 20310-2600

DAEN

3 DEC 2014

THE SECRETARY OF THE ARMY

SUBJECT: Central Everglades Planning Project, Comprehensive Everglades Restoration Plan, Central and Southern Florida Project.

1. I submit for transmission to Congress my report on ecosystem restoration improvements for the Central Everglades Planning Project (CEPP) located in Martin, Lee, Palm Beach, Broward, Miami Dade and Monroe Counties, Florida. It is accompanied by the report of the Jacksonville District Engineer and South Atlantic Division Engineer. These reports are in response to Section 601(b)(1) of the Water Resources Development Act (WRDA) of 2000, which approved the Comprehensive Everglades Restoration Plan (CERP) as a framework for modifications and operational changes to the Central and Southern Florida (C&SF) project that are needed 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. WRDA 2000 identified specific requirements for implementing components of the CERP, including the development of a decision document known as a Project Implementation Report (PIR). The requirements of a PIR are addressed in this report and are subject to review and approval by the Secretary of the Army. Preconstruction engineering and design activities for this project will be continued under the CERP Design Agreement.

2. The proposed CEPP is comprised of increments of six components of CERP, including the Everglades Agricultural Area (EAA) Storage Reservoir – Phase I, which was conditionally authorized by Section 601(b)(2)(C)(ii) of WRDA 2000. However, the reporting officers recommend new authorization consistent with Section 601(d) of WRDA 2000 due to changes in scope and the inclusion of additional CERP components. The reporting officers recommend increments of the following six components of CERP to be integrated with the existing facilities of the C&SF system: Everglades Agricultural Area Storage Reservoirs (Component G); Water Conservation Area (WCA)-3 Decompartmentalization and Sheetflow Enhancement (Components AA and QQ); S-356 Pump Station Modifications (Component FF); L-31 N Improvements for Seepage Management (Component V); System-wide Operational Changes – Everglades Rain-Driven Operations (Component H); and Flow to Northwest and Central WCA-3A (Component II).

3. The final PIR and integrated Environmental Impact Statement (EIS), developed pursuant to the National Environmental Policy Act (NEPA), recommends a project that contributes significantly to the ecological goals and objectives of CERP: (1) increasing the spatial extent of natural areas; (2) improving habitat function and quality; and (3)

improving native plant and animal abundance and diversity. In addition, it contributes to the economic values and social well being of the project area by providing recreational opportunities and 17 million gallons of water per day of water supply for residents of the Lower East Coast of Florida. The historical Everglades ecosystem was previously defined by a mosaic of uplands, freshwater marsh, deep water sloughs, and estuarine habitats that supported a diverse community of fish and wildlife. Today nearly all aspects of South Florida's flora and fauna have been affected by development, altered hydrology, nutrient input and spread of non-native species that have resulted directly or indirectly from a century of water management for human needs. The PIR/EIS confirms information in the CERP and provides a conceptual plan that evaluated the costs and benefits associated with construction and operation of the Central Everglades components of the CERP. CEPP will help restore the central portion of the Everglades ecosystem towards a state more similar to the historic conditions. The project will improve habitat function and quality and improve native plant and animal abundance and species composition and diversity by delivering approximately 210,000 average annual acre feet of additional water to the Everglades.

4. The reporting officers recommend a plan for ecosystem restoration and recreation. The recommended plan would improve the ecological functions of the South Florida environment, including the Caloosahatchee and St. Lucie Estuaries, WCA-2 and WCA-3, and Everglades National Park (ENP). The CEPP plan includes the following features, listed from north to south in project area:

a. The EAA includes a 14,000 acre A-2 flow equalization basin (FEB) and associated distribution, inlet, and outlet structures. Operation of the A-2 FEB would be integrated with the future operation of the State of Florida's Restoration Strategies features, including the A-1 FEB, and the state's existing Stormwater Treatment Area (STA)-2 and STA-3/4 facilities, to deliver new water south.

b. WCA-2A and Northern WCA-3A include a 500 cubic feet/second (cfs) gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal; a 500 cfs gated spillway to deliver water from the remnant L-5 Canal to the western L-5 Canal (during L-6 diversion operations); a 2,500 cfs gated spillway to deliver water from STA-3/4 to the S-7 Pump Station during peak discharge events (including L-6 diversion operations); approximately 13.6 miles of conveyance improvements to the L-5 Canal; degradation of approximately 2.9 miles of the southern L-4 Levee along the northwest boundary of WCA-3A; a 360 cfs pump station to move water within the L-4 Canal to maintain water supply deliveries to retain the existing functionality of STA-5 and STA-6 and maintain water supply to existing legal users, including the Seminole Tribe of Florida; gated culverts and an associated new canal to deliver water from the Miami Canal (south of the S-8 Pump Station, which pulls water from the L-5 Canal) to the L-4 Canal, along with potential design modifications to the existing S-8 and G-404 pump stations; and

backfill of approximately 13.5 miles of the Miami Canal with construction of tree islands between 1.5 miles south of the S-8 Pump Station and Interstate Highway I-75.

c. Southern WCA-3A, WCA-3B, and the Northern Edge of ENP include a 1,150 cfs gated spillway adjacent to S-333; a 500 cfs gated culvert in L-67A Levee and an associated 6,000 foot gap in L-67C Levee; a flow way through the western end of WCA-3B (two 500 cfs gated culverts in L-67A Levee, removal of approximately 8 miles of L-67C Levee, removal of approximately 4.3 miles of L-29 Levee, construction of approximately 8.5 miles of new levee in WCA-3B); a 1,230 cfs gated spillway in L-29 Canal; removal of approximately 5.5 miles of the L-67 Extension Levee and backfill of approximately 5.5 miles of the L-67 Extension Canal; removal of approximately 6 miles of Old Tamiami Trail; and removal of spoil mounds along the northwestern side of the L-67A Canal.

d. Eastern Edge of ENP includes a 1,000 cfs pump station and an approximately 4.2-mile long, 35 feet deep tapering seepage barrier cutoff wall along the L-31N Levee just south of Tamiami Trail.

e. Recreational features include gravel parking with boat ramps and trailheads, dry vault toilets, shelters, primitive camping sites, and fishing platforms.

5. The total project first cost of the recommended plan, based upon October 2014 price levels, is estimated to be $1,951,000,000 rounded to the nearest million. The project first cost for the ecosystem restoration features is estimated to be $1,944,000,000 and for recreation is estimated to be $6,600,000. In accordance with the cost-sharing requirements of Section 601(e) of WRDA 2000, construction costs for ecosystem restoration are shared 50-50 between the government and non-federal sponsor. Construction costs associated with recreation features are also cost-shared 50-50 in accordance with Section 103 of WRDA 1986, as amended. Additionally, the government is responsible for 100% of cultural resources data recovery costs, up to 1% of total project costs (see paragraph 18.s). Therefore, in consideration of estimated costs for cultural resources data recovery, the federal cost of the recommended plan would be $976,375,000 and the non-federal cost would be $974,625,000. The estimated lands, easements, right-of-way, and relocation (LERRs) costs for the recommended plan are $37,000,000, of which approximately $31,000,000 is creditable to the government and approximately $6,000,000 are creditable to the non-federal sponsor. Federal funds contributed by Department of Interior (DOI) pursuant to Section 390 of the Federal Agriculture Improvement and Reform Act of 1996 (Public Law 104-127, 110 Stat. 1022) are credited to the federal share of the project cost pursuant to Section 601(e)(3) of WRDA 2000. DOI contributed approximately $30,300,000 toward the purchase of the lands associated with the A-2 FEB and FEB Discharge Canal.

6. Although cost sharing of the ecosystem restoration features for this project is governed by Section 601 of WRDA 2000, as amended, cost sharing of the recreation

features is governed by Section 103 of the WRDA 1986, as amended. In particular, in accordance with Section 103(j) of WRDA 1986, 100 percent of the cost of Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) of the recreation features is the non-federal sponsor's responsibility. In addition, section 601(e)(5)(B) of WRDA 2000, as amended, governs credit for non-federal sponsor design and construction work on the ecosystem restoration features of the project, whereas section 221(a)(4) of the Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b(a)(4)), governs credit for non-federal sponsor design and construction work on the recreation features of the project.

7. Based on October 2014 price levels, a 50-year period of economic evaluation and a 3.375 percent discount rate, the equivalent annual cost of the proposed project is estimated at $102,600,000, which includes OMRR&R, interest during construction and amortization. The estimated annual costs for restoration OMRR&R are $11,250,000, of which $4,150,000 is attributed to new CEPP infrastructure; $4,000,000 to flowing water through existing state and C&SF infrastructure; and $3,100,000 to invasive species management. Post construction monitoring will occur during 10-year cycles for invasive species and performance-based ecological monitoring ($2,700,000 annually for up to 10 years). Permit-related monitoring and monitoring that informs project operations will also be conducted ($2,800,000 annually) and this monitoring will be assessed periodically and revised as needed. The OMRR&R costs for recreation features are estimated at $65,000 and are a 100% non-federal responsibility.

8. As a component of the CERP program, an interagency/interdisciplinary scientific and technical team, formed to ensure that system-wide goals are met, will participate in the annual monitoring to assess system-wide changes. In accordance with Sections 601(e)(4) and 601(e)(5)(D) of WRDA 2000, OMRR&R costs and adaptive assessment and monitoring costs for ecosystem restoration will be shared equally between the federal government and the non-federal sponsor. The Project Monitoring Plan was developed assuming that major, ongoing monitoring programs that are not funded by the project would continue to supply data relevant to the Project. The Project Monitoring Plan shall not include items that are already required to be monitored by another federal agency or other entity as part of their regular responsibilities or required by law and shall not include items that are already required to be monitored by the USACE for other South Florida ecosystem restoration projects. In accordance with Section 103(j) of the WRDA 1986, as amended, OMRR&R costs related to recreation features will be funded 100 percent by the non-Federal sponsor.

9. The recommended plan requires the use of several State of Florida facilities constructed and operated pursuant to state permits. The facilities are necessary for the state to meet Clean Water Act requirements as approved by the U.S. Environmental Protection Agency (USEPA), and as litigated by the U.S. Department of Justice. Some

of these requirements are currently subject to a Settlement Agreement filed with and overseen by the federal district court. These facilities, as named below and herein after referred to as the "state facilities", are to be used by CEPP until such time as CEPP is deauthorized or it is determined that use of the state facilities are no longer necessary for the purpose of achieving CEPP project purposes. The State of Florida is responsible for OMRR&R of their State Restoration Strategies and Everglades Construction Project facilities. The reporting officers recommend authorization of CEPP with specific statutory language allowing cost share of the OMRR&R for the following state facilities not previously cost shared by the government for construction under the C&SF project or other federal authority, and listed C&SF features that are currently cost shared pursuant to executed Resolutions: Stormwater Treatment Area 2; Stormwater Treatment Area 3/4; Flow Equalization Basin A-1; G-357 Gated Culvert; G-370 Pump Station; G-371 Gated Spillway; G-372 Pump Station; G-404 Pump Station; G-434 Pump Station; G-435 Pump Station; S-6 Pump Station; S-7 Pump Station; S-8 Pump Station; and S-150 Gated Culverts and their corresponding remote-control facilities. All features required for the State Restoration Strategies and the Everglades Construction Project are independent state facilities and are not CEPP components or features. The state facilities will not be incorporated as federal CEPP project features; however, the operation of state facilities is required to ensure that new water made available by CEPP meets water quality standards and achieves CEPP project benefits.

a. The state retains sole responsibility for performing operations activities at state facilities pursuant to State Operations Plan, with the exception of the FEB A-1 which will be integrated with FEB A-2 and operated pursuant to a mutually agreed upon water control plan. The joint water control plan for the FEBs will integrate the operation of CEPP and the operation of the state facilities used by CEPP. The state has agreed that the U.S. Army Corps of Engineers (USACE) shall have the opportunity to collaborate, review, and comment on the OMRR&R of the state facilities used by CEPP, including updates to optimize operations to achieve federal project purposes. This is intended to ensure continuous achievement of CEPP project purposes and support the federal interest in cost sharing OMRR&R. To the extent applicable, any operational modifications to the state facilities as defined in the PIR/EIS that would impair the usefulness of any USACE project, including all CEPP and other CERP and C&SF project features, may require a 33 U.S.C. Section 408 permit from the USACE.

b. The aforementioned state facilities and C&SF features will use excess capacity to process "new water" provided by CEPP, which has been estimated to comprise approximately 19% of the total water volume that could flow through these facilities. The reporting officers have assumed that OMRR&R costs are linear with flow volumes and thus the additional increase in OMRR&R costs due to the increased flow volumes will be 19% of the total OMRR&R costs. Consistent with the general CERP authorization for cost sharing OMRR&R (WRDA 2000 Section 601(e)(4)), the reporting officers recommend authorization of CEPP to contribute 19% of the OMRR&R costs of

the aforementioned state facilities and C&SF features to the extent that OMRR&R activities are directly related to their use for treating "new water". The federal pro-rated share for OMRR&R for the aforementioned facilities used by CEPP is therefore 50% of the 19%, or 9.5% of the total OMRR&R costs. The 19% CEPP cost share will apply to the state facilities and C&SF features listed previously to the extent that OMRR&R activities are directly related to their use for treating "new water".

c. The reporting officers recommend that project authorization include specific statutory language allowing the government to cost share 19% of the yearly OMRR&R costs of state facilities and listed C&SF features with appropriations made available for CERP OMRR&R activities. The term "OMRR&R costs" is defined the same as the term "project OMRR&R costs" in Article I.E. of the Master Agreement between the Department of the Army and the non-federal sponsor dated 13 August 2009. As a condition of the federal cost share, prior to commencing replacement and rehabilitation actions for the state facilities listed previously that CEPP is dependent on, approval by USACE Headquarters and the Assistant Secretary of the Army (Civil Works) is required as set forth in Section 6.6.2 of the PIR.

d. No cost share of the aforementioned state facilities and C&SF features shall commence before the date that the CEPP project produces "new water" and the associated federal project feature is declared construction complete and the state assumes its OMRR&R responsibilities as established in the appropriate project partnership agreements. Similarly, no cost share for state facilities is allowed until the state facilities are shown to be construction complete and the state begins regular operation of such facility. Additionally, the state facilities will be monitored for the number of years required by the Settlement Agreement and be shown to be in compliance with water quality requirements prior to the addition of CEPP flows.

e. Due to the simplified assumptions used for determining cost-share of the OMRR&R, an adaptive management construct will be developed that prescribes processes and procedures for determining a more accurate allocation of costs once more detailed information is available regarding the impact of CEPP on the OMRR&R of existing state facilities and C&SF features. The reporting officers recommend that after CEPP has operated for an appropriate period of time, an analysis based on monitoring data will be undertaken to evaluate project performance and verify that CEPP successfully delivers an annual average of approximately 210,000 acre-feet of new water for the natural system as described in the PIR/EIS.

(1) If the monitoring data and analysis show that CEPP actually produces less than the anticipated 210,000 acre feet per year on average, then the federal project is not fully realizing the projected benefits and the state facilities and C&SF features are not being burdened as projected. In such a case, the analysis will be used to inform changes in operations in order to achieve the quantity, timing or distribution of water as

described in this PIR/EIS, or recommend changes to the amount of water to be reserved or allocated to the natural system.

(2) If the monitoring data and analysis show CEPP actually processes significantly more or less than the anticipated 210,000 acre-feet per year of "new water" on average then the analysis may be used to adjust the calculation of OMRR&R cost share upward or downward to reflect the actual average annual use of excess capacity by the federal project. This will be accomplished through consultation with the state and USACE Headquarters and is necessary after operations have begun to capture the true federal interest and cost share responsibility.

f. It must be recognized that the state facilities are subject to legal requirements outside of the federal project and will not be operated in such a manner that the federal project will cause exceedances of the state's water quality requirements under state National Pollutant Discharge Elimination System (NPDES) and Everglades Forever Act (EFA) permits and associated Consent Orders. Such state requirements may limit the anticipated federal project benefits.

10. A number of non-CEPP projects must be in place before implementing any CEPP features and certain non-CEPP projects must be integrated into the sequencing of CEPP implementation to avoid unintended adverse consequences. All features of the State Restoration Strategies must be completed and meet state water quality standards prior to initiating construction of most CEPP project features. Implementation of CEPP will occur over many years and the reporting officers recommend that the project be constructed in three phases that are considered separable elements with inter-related project features grouped to provide incremental hydrologic and ecological benefits. The three implementation phases are based upon developing three Project Partnership Agreements (PPAs) and are identified as PPA North, PPA South, and PPA New Water. The features included in each are identified in the PIR/EIS. The phased implementation approach incorporates an adaptive implementation process and recommendations of the National Research Council, maximizing the opportunity to realize incremental restoration benefits by initially building features that utilize existing water in the system that meets state water quality standards. Individual PPAs, or amendments to existing PPAs, will be executed prior to construction of each implementation phase. The project dependencies include:

a. A-1 FEB and State Restoration Strategies: Required prior to implementation of northern WCA-3A distribution features (L-4 degrade, new pump station, S-8 Modifications, L-5 and L-6 improvements, Miami Canal Backfilling) to ensure adequate water quality treatment of inflows;

b. 8.5 Square Mile Area (SMA) and Existing S-356: Construction of the C-358 seepage collector canal and structure S-357N within the 8.5 SMA must be completed to

allow full utilization of the 8.5 SMA features to provide seepage mitigation for increasing flows into Northeast Shark River Slough (NESRS); operation of the existing S-356 pump station (500 cfs) is required prior to significantly increasing flows to NESRS, to provide seepage management;

c. C-111 South Dade: Extension of the detention area levees to connect with 8.5 SMA is required prior to significantly increasing flows to NESRS to enable operation of the S-357 pump station to provide seepage management to 8.5 SMA;

d. Modified Water Deliveries (MWD) to ENP 1-Mile Bridge and Road Raising: The MWD project will be complete and operational prior to implementation of WCA-3B inflow structures along the L-67A&C levees or increasing flows through existing S-333 to NESRS to ensure adequate road protection to allow for increased stages in L-29 canal;

e. Broward County Water Preserve Area (BCWPA) C-11 Impoundment: Required prior to increasing flow through S-333 or implementation of WCA-3B inflow structures along the L-67A&C levees to ensure adequate water quality of inflows to WCA-3B and NESRS;

f. Tamiami Trail Next Steps Bridging and Road Raising: Required prior to increasing capacities of S-333 and S-356 and implementation of WCA-3B inflow structures along the L-67A levee, gaps in L-67C levee and Blue Shanty flowway (L-67C removal, L-29 levee removal);

g. Indian River Lagoon (IRL) South C-44 Reservoir and Connection to C-23 Canal: Required prior to re-directing the maximum amount of water from Lake Okeechobee south to the FEB to meet environmental performance, to avoid reduction in low flows to the St. Lucie Estuary and low Lake Okeechobee water levels that affect the Lake Okeechobee Service Area (LOSA); and

h. Modification to the Lake Okeechobee Regulation Schedule (LORS) is anticipated prior to full utilization of the A-2 FEB in order to achieve the complete ecological benefits envisioned through redirecting the full 210,000 acre feet per year on average south and to avoid low lake levels that would affect the LOSA.

11. To ensure that an efficient ecosystem restoration plan was recommended, cost effectiveness/incremental cost analysis (CE/ICA) techniques were used to evaluate alternative restoration plans for system wide restoration. The engineering and planning models utilized to estimate the outputs that were used in the economic analysis were both reviewed and approved for use in the project. The plan recommended for implementation is the conceptual National Ecosystem Restoration (NER) plan, supports the incremental adaptive restoration principles established by the National Research Council, and was prepared in a collaborative environment. Further investigations are

required during pre-construction engineering and design phase for each project feature to determine specific site conditions, develop detailed designs and operations, and evaluate environmental impacts. Further coordination and consultation will be required to fully comply with the Endangered Species Act, the Clean Water Act, the Coastal Zone Management Act, the National Historic Preservation Act, and the National Environmental Policy Act prior to construction of individual project components.

a. The recommended plan benefits more than 1.5 million acres in the Caloosahatchee and St. Lucie Estuaries, WCA-3A, WCA-3B, ENP, and Florida Bay. The benefits to approximately 994,000 acres in WCA-3A, WCA-3B and ENP are derived by increasing the quantity of freshwater inflow to the natural system by 22% and improving sheetflow through the system. This will improve the depths, duration, and movement of water that will help to restore and sustain the ridge and slough landscape. Reducing high volume freshwater discharges from Lake Okeechobee to the Caloosahatchee and St. Lucie Estuaries by 14% and 34% (respectively), improves approximately 86,000 acres in these estuaries by reducing turbidity, sedimentation, and moderating unnatural fluctuations in salinity that are extremely detrimental to estuarine communities. A 28% increase in the quantity of freshwater sent to ENP will bring the benefits to the Everglades as described above, and then when the water reaches Florida Bay at the southern end of the system it will reduce the intensity, frequency, and duration of hypersaline events in the Bay across approximately 476,000 acres. An average salinity decrease of 1.5 parts per thousand will help to re-establish a persistent and resilient estuarine zone that extends further into the bay.

b. In accordance with WRDA 2000 Section 601(f)(2), individual CERP projects shall be justified by the environmental benefits derived by the South Florida ecosystem. The recommended plan improves fish and wildlife habitat in the Caloosahatchee and St. Lucie Estuaries, WCA-3, ENP, and Florida Bay. The Everglades has been designated an International Biosphere Reserve (1976) and a World Heritage Site (1979) by the United Nations Educational, Scientific, and Cultural Organization, and a Wetland of International Importance (1987) in accordance with the Ramsar Convention. The portion of the Everglades ecosystem directly affected by the project provides habitat for 68 federally-listed endangered or threatened species. Programmatic consultation pursuant to Section 7 of the Endangered Species Act (ESA) was conducted on four federally listed species and it was preliminarily determined that CEPP was not likely to jeopardize the continued existence of the Everglade snail kite, Cape Sable seaside sparrow, wood stork, and eastern indigo snake, nor adversely modify the critical habitat, where applicable, of the species listed above. Further consultation on project effects to federally listed species will occur during the planning, engineering, and design phase of CEPP.

12. Section 601(e)(5)(B) of WRDA 2000 authorizes the Secretary of the Army to provide credit to the non-federal sponsor for work completed by it during the period of

construction pursuant to a project partnership agreement and a determination by the Secretary that the work is integral to the CERP. Such credit would be applied toward the non-federal sponsor's share of the costs associated with the implementation of the CERP as authorized by Section 601(e)(5)(C) of WRDA 2000, shall not include cash reimbursements, and shall be subject to: (a) the authorization of CEPP by law; (b) a determination by the Secretary of the Army that the activities are integral to the CERP restoration project; (c) that the costs are reasonable, allowable, necessary, auditable, and allocable; and (d) that the activities have been implemented in accordance with USACE design and construction standards and applicable federal and state laws.

13. The project complies with the following requirements of WRDA 2000:

a. Project Implementation Report. The requirements of a PIR as defined by Section 601(h)(4)(A.).

b. Water Made Available for the Natural System, Water to be Reserved or Allocated for the Natural System and Water for Other Water-Related Needs. Sections 601(h)(4)(A)(iii)(IV) and (V) require identification of the appropriate quantity, timing, and distribution of water dedicated and managed for the natural system and the amount of water to be reserved or allocated for the natural system. In accordance with the regulations, an analysis was conducted to identify water dedicated and managed for the natural system. Accordingly, the non-federal sponsor will protect the water that was identified as necessary to achieve the benefits of the project, using water reservation or allocation authority under Florida law, subject to the provisions of Paragraph 9(e)(i) of this Report.

c. Effects on Existing Legal Sources of Water. Section 601(h)(5)(A) states that existing legal sources of water shall not be eliminated or transferred until a new source of water supply of comparable quantity and quality is available to replace the water to be lost as a result of the CERP. An analysis of project effects on existing legal sources of water was conducted and it was determined that sources of water to meet agricultural and urban demand in the LOSA and Lower East Coast Service Areas (LECSAs) will continue to be met by their current sources, primarily Lake Okeechobee, the Everglades (including the WCAs), surface water in the regional canal network, and the surficial aquifer system. Sources of water for the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida are also influenced by the regional water management system (C&SF Project, including Lake Okeechobee); however these sources will not be affected by the CEPP project. In addition, water supplies to ENP with implementation of the recommended plan exceed future without project and existing condition baseline volumes. Water sources necessary for fish and wildlife located in the Caloosahatchee and St Lucie Estuaries, WCA-2, WCA-3, Biscayne Bay, and Florida Bay will not be diminished.

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(1) There will be no elimination or transfer as a result of the recommended plan on existing legal sources of water supply for the following:

- Agricultural or urban water supply in the LECSA.
- Allocation or entitlement to the Seminole Tribe of Florida under Section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e).
- The Miccosukee Tribe of Indians of Florida.
- Water supply for ENP.
- Water supply for fish and wildlife.

(2) Some of the water utilized by agricultural users in the LOSA from Lake Okeechobee will be transferred to WCA-3 and further south as a result of the implementation of the recommended plan. This transfer is anticipated to occur after the modification of the LORS that will allow full utilization of the A-2 FEB; the CEPP PIR anticipates that the need for modifications to the LORS will be initially triggered by non-CEPP actions and that these actions will occur earlier than implementation of CEPP. The recommended plan has identified an additional source of water of comparable quantity and quality that will be available to replace the water sent south. Instead of discharging all water stored in the CERP Indian River Lagoon-South C-44 Reservoir/STA to tide via the S-80 or to meet C-44 Basin agricultural water supply demands, as assumed in the future without project baseline condition operations, the recommended plan retains a portion of the water stored in the C-44 Reservoir/STA in the regional system for backflow to Lake Okeechobee via the C-44 Canal and raises the Lake Okeechobee stage criteria to allow increased C-44 Canal backflow. This added operation does not affect existing permitted allocations within the C-44 Basin. The additional C-44 Canal backflow operations to Lake Okeechobee included in the recommended plan improves the ability to meet existing permitted demands in the LOSA by retaining more water in the regional system and making it available to agricultural users. The recommended plan backflow operations capture a portion of releases from the C-44 Reservoir/STA that would otherwise be directed to the Saint Lucie Estuary as excess water.

d. Maintenance of Flood Protection. Section 601 (h)(5)(B) states that the Plan shall not reduce levels of service for flood protection that are in existence on the date of enactment of this Act and in accordance with applicable law. Comparison of canal stages and groundwater levels indicate that implementation of the project will not reduce the levels of service for flood protection within the areas affected by the project, including the EAA, LECSA 2 (Broward County), and LECSA 3 (Miami-Dade County). This includes the areas affected by the project including the Seminole Tribe of Florida's Big Cypress Reservation and the Miccosukee Tribe of Indians of Florida's reservation areas.

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14. On 10 April 2014, the non-federal sponsor's, the South Florida Water Management District (SFWMD), Governing Board (Board) passed Resolution Number 2014-0410, authorizing a letter of support for the CEPP and affirming financial capability to act as the non-federal sponsor. The Board based its implementation, approval, or operation of CEPP features upon several conditions.

a. Recognizing that CEPP has only received a programmatic Biological Opinion from the U.S. Fish and Wildlife Service (USFWS), pursuant to Section 7 of the Endangered Species Act, and that further Section 7 consultations would be required, the Board conditioned its support of CEPP on the Board's approval of requirements in future Biological Opinions, prior to execution of PPAs for CEPP. Sharing this concern, paragraph 15.c documents the requirement that Jacksonville District will provide USACE Headquarters future draft biological opinions for review and approval.

b. Section 4 of the Resolution authorized the Director of Administrative Services Division to sign the CEPP Non-Federal Sponsor's Self-Certification of Financial Capability subject to the condition that "[a]pproval of future fiscal year state budgets by the State Legislature and Governor, and District budgets for CEPP by the State Legislature, Governor and District Governing Board." This condition was deemed unacceptable by USACE and on 9 December 2014, SFWMD submitted a revised sponsor self-certification of financial capability, removing the condition of future approval of state and SFWMD budgets as set forth in the resolution.

c. The sponsor letter of support, however, was not revised and is limited to the terms and conditions set forth in the Board's Resolution. The two conditions described in the Board's Resolution, changing a court-ordered compliance methodology and the development of joint measures for addressing a future exceedance of state water quality requirements, are worded differently than language previously agreed to by the Assistant Secretary of the Army (Civil Works) and SFWMD on the issue of water quality, and seem to require specific outcomes prior to state approval of CEPP. (See Section 8 of the PIR/EIS and paragraph 19 of this Report). The state is currently subject to a Consent Decree (US v. SFWMD, et al., Case No. 88-1886-CIV-Moreno (U.S.D.C., S.D. Fla.)) and state water quality permits requiring certain actions to maintain the state's compliance with the Clean Water Act. The Consent Decree is a judicially enforceable legal instrument overseen by a federal district court judge. Changes to that Decree or the Clean Water Act permits obtained by the SFWMD in association with it are not within the unilateral authority of the United States and/or the State of Florida. Any changes are subject to review and actions by the several parties involved in the litigation and ultimately are subject to the review, alteration, rejection, and/or order of the court. Such an action is beyond the control of both the USACE and the non-federal sponsor for the CEPP project. Furthermore, such action is not within the scope of the CEPP project and therefore would not be appropriate to attempt to accomplish it through CEPP.

d. The language included in Section 8 of the PIR was negotiated with the non-federal sponsor precisely to develop a process for addressing future water quality issues and was to have been the resolution of that concern. Immediately following the conditions described above, in its Resolution the Board actually cites to the PIR/EIS language as what should be used to govern water quality issues with regard to the implementation and operation of CEPP project features. The negotiated language does not require changes in the court-ordered compliance methodology prior to non-federal sponsor support, nor does it presuppose that joint measures be prescribed prior to an exceedance occurring. An exceedance would require a review of the event not only to determine causation, but to also determine what if any measures are necessary to address the exceedance, jointly or otherwise. As such, the negotiated language acknowledges a process by which these issues may be addressed and does not presuppose the outcome. This was the successful process that was implemented to address the Water Year 2012 monitoring issues. The negotiated language in Section 8 of the PIR/EIS, and presented below in paragraph 19, has been agreed upon and describes how such issues will be addressed.

15. Due to the high risks and uncertainties associated with CEPP, the long implementation time, and the significant dependencies on other CERP and non-CERP projects, a number of risk management measures have been developed to ensure future coordination with USACE Headquarters and, as needed, the Office of the Assistant Secretary of the Army (Civil Works). Limited Revaluation Reports (LRRs) are planned to support each of the three PPAs by providing more detailed information and documenting changed conditions. Significant changes from the PIR/EIS may warrant a General Reevaluation Report. The LRR for the final PPA (new water) will be processed through the Office of the Assistant Secretary of the Army (Civil Works).

a. Jacksonville District will provide an annual status report to South Atlantic Division and USACE Headquarters and will conduct a briefing that addresses overall project progress and key uncertainties and/or decisions required as implementation progresses. It will include an update on implementation of CEPP features and those non-CEPP projects on which CEPP is dependent.

b. Jacksonville District will coordinate with South Atlantic Division and USACE Headquarters to develop an adaptive management strategy regarding cost share of OMRR&R of state facilities and C&SF features (see paragraph 9.e); and will provide an analysis of operations at state facilities and C&SF features in providing needed capacity for CEPP flows after CEPP is implemented.

c. Jacksonville District will provide to the South Atlantic Division and USACE Headquarters: draft biological opinions pursuant to ESA for review and approval; notification of development of additional NEPA documents; and, Jacksonville District will

coordinate during planning, engineering and design phase the definition of activities at state facilities as either repair, replacement or rehabilitation actions;

d. If applicable, Jacksonville District will coordinate and obtain approval from USACE Headquarters: for the government to cost share OMRR&R of additional state facilities and C&SF features not identified in the PIR/EIS; for the government to cost share replacement and rehabilitation actions at state facilities; for any changes to the three CEPP implementation phases; to determine appropriate course of action should state water quality compliance not be met after construction and operation of CEPP; and, to use less than a fee estate, including any permits or other instruments obtained for real estate interests other than the provision of fee property for the project, except for the temporary construction easements and the borrow easements, which are approved.

e. USACE policies and procedures will generally be followed for coordination and approval of Project Partnership Agreements, Post-Authorization Change Reports, and Section 408 permits for modifications to federal projects. Early vertical coordination with USACE Headquarters will occur on any policy and legal issues.

16. In accordance with the USACE Engineering Circular on review of decision documents, all technical, engineering, and scientific work underwent an open and dynamic review process to ensure technical quality. This included District Quality Control, (DQC), Agency Technical Review (ATR), Independent External Peer Review (IEPR), and a USACE Headquarters policy and legal review.

a. All concerns of the DQC and ATR have been addressed and incorporated into the final report. The IEPR was managed by Battelle Memorial Institute, a non-profit science and technology organization with experience in establishing and administering peer review panels for the USACE. Eight comments were identified and documented. The comments of high significance were related to potential adverse impacts to cultural resources associated with two federally recognized Native American tribes. Additional information regarding compliance with applicable laws and regulations was provided and the final PIR/EIS included clarification of the plan of action to address cultural resources. All IEPR comments have been addressed in the final report.

b. The final PIR/EIS was published for State and Agency and public review on 8 August 2014. The comment period was extended upon request to 3 October 2014. Many of the comments received from federal and state agencies and the public were favorable and in support of the project. More extensive comments were received from the Seminole Tribe of Florida, the USEPA, and the State of Florida Department of Environmental Protection (FDEP) and Department of Agricultural and Consumer Services (FDACS).

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(1) The Seminole Tribe of Florida's (Seminole Tribe) support of CEPP is based on the understanding that the USACE and SFWMD will continue to work with the Seminole Tribe towards restoring and re-hydrating the Western Everglades system. The Seminole Tribe disagreed with the USACE determination that the project is yet in compliance with Section 106 of the National Historic Preservation Act (NHPA); was concerned with the lack of meaningful discussion of measures to avoid, minimize or mitigate impacts to cultural resources; disagreed with applicability of the Everglades Restoration Transition Plan (ERTP) Programmatic Agreement and associated Human Remains Policy; and expressed concerns for cultural resources on state owned lands and management of those resources prior to CEPP authorization. The USACE has determined that compliance appropriate for this phase of the study has been achieved, but the PIR/EIS acknowledges that due to the conceptual nature of the recommended plan and lack of site specific information, consultation per the NHPA will continue during planning, engineering, and design phases through completion of construction. The PIR/EIS provides specific examples of avoidance measures and potential effects to cultural resources were determined through consultations with Native American Tribes, Everglades National Park, the Advisory Council on Historic Preservation, the State Archeologist and others. The USACE recognizes that the Programmatic Agreement and associated Human Remains Policy that applies to ERTP provide principles and treatment measures that are generally relevant to USACE activities, but the Agreement is only applicable to ERTP. As agreed upon during consultation, the Burial Resources Agreement will apply to the treatment of burial resources for CEPP implementation.

(2) The USEPA provided significant comments regarding assurances that flows to the Everglades meet applicable water quality standards and concerns with the later phase implementation of the A-2 FEB which provides a substantial portion of the hydrological benefits of CEPP. The PIR/EIS indicates that completion of the A-1 FEB through the State of Florida's Restoration Strategies project is required prior to implementation of the CEPP northern WCA-3A distribution features to ensure adequate water quality treatment of inflows. Additionally, the benefits of PPA New Water phase (which includes the A-2 FEB) are dependent on features in PPA North and PPA South phases. An agreement for the PPA New Water phase may be executed after agreements for both PPA North and PPA South phases are complete. Construction may be in parallel.

(3) The State of Florida provided comments from agencies that were conflicting in their support of the recommended plan. Significant comments were received from FDEP and FDACS. While FDEP expressed staunch support for expediting the CEPP project to achieve the system-wide ecological benefits, they were concerned with the discussion in paragraph 14 of the proposed report of the Chief of Engineers. This section is included in this Report to reiterate the process negotiated and agreed to by the non-federal sponsor and the Assistant Secretary of the Army (Civil Works) that will be used to address water quality issues during CEPP implementation.

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Additionally, this Report makes clear that the court-ordered compliance methodology is beyond the control of both the USACE and the non-federal sponsor and cannot be addressed through CEPP as requested by the FDEP.

The FDACS recognized the value of the CEPP as a planning process, but does not believe it satisfies the planning requirements necessary for preparation of a PIR to implement CERP components. There are a suite of project dependencies that are necessary to meet the Savings Clause requirements of CERP and provide other project assurances. The FDACS believes the constraints should be reasonably resolved prior to authorization and such resolution should occur within the context of PIRs prepared for implementing the CERP components. Additionally, the FDACS is concerned that a number of project dependencies associated with the CEPP are substantial and affect compliance under Florida law. The PIR/EIS recognizes the risks and uncertainties of the CEPP and prior to implementation of each phase of the project, additional detailed information pertaining to that phase will be developed. The PIR will be updated as appropriate as revisions are made to Water Control Plans and Project Operating Manuals for each phase. The USACE will ensure that all legal requirements are met for each phase and compliance will be maintained throughout the entirety of CEPP implementation.

c. Washington level review indicates that the plan recommended by the reporting officers is environmentally justified, technically sound, cost effective, and socially acceptable. The plan conforms to essential elements of the 1983 U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies and complies with other administration and legislative policies and guidelines. The views of interested parties, including federal, state and local agencies have been considered.

17. I generally concur with the findings, conclusions, and recommendations of the reporting officers. Accordingly, I recommend that the plan described herein for ecosystem restoration and recreation be authorized in accordance with the reporting officers' recommended plan at an estimated project first cost of $1,951,000,000, with such modifications as in the discretion of the Chief of Engineers may be advisable. My recommendation is subject to cost-sharing, financing, and other applicable requirements of federal laws and policies including Section 601 of WRDA 2000, as amended. In addition, I recommend that the non-federal sponsor be authorized to receive credit for work accomplished prior to execution of a PPA for this project, in accordance with the terms described in paragraph 18 of this Report. The non-federal sponsor would provide the non-federal cost share and all lands, easements, rights of way, relocations, and dredged or excavated material disposal areas. The non-federal sponsor would be responsible for all OMRR&R.

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18. This recommendation is subject to the non-federal sponsor agreeing to comply with all applicable federal laws and the following items of local cooperation:

a. Provide 50 percent of total project costs consistent with the provisions of Section 601(e) of WRDA 2000, as amended, including authority to perform design and construction of project features consistent with federal law and regulation;

b. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations that the government and the non-federal sponsor jointly determine to be necessary for the construction and OMRR&R of the project and valuation will be in accordance with the Master Agreement;

c. Shall not use the ecosystem restoration features or lands, easements, and rights-of way required for such features as a wetlands bank or mitigation credit for any other non-CERP projects;

d. Give the government a right to enter, at reasonable times and in a reasonable manner, upon land that the non-federal sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of constructing, completing, operating, maintaining, repairing, replacing, or rehabilitating the project;

e. Assume responsibility for OMRR&R of the project or completed functional portions of the project, including mitigation features, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and specific directions prescribed in the OMRR&R manuals and any subsequent amendments thereto. Cost sharing for OMRR&R will be in accordance with Section 601(e) of WRDA 2000, as amended. Notwithstanding Section 528(e)(3) of WRDA 1996 (110 Stat. 3770), the non-federal sponsor shall be responsible for 50 percent of the cost of OMRR&R activities authorized under this section;

f. The State of Florida shall provide the USACE an opportunity to collaborate, review and comment on the State Operations Plans for the state facilities used by CEPP, including updates to optimize operations for federal project purposes;

g. The non-federal sponsor shall OMRR&R the recreational features of the project and is responsible for 100 percent of the cost;

h. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

i. Unless otherwise provided for in the statutory authorization for this project, comply with Section 221 of the Flood Control Act of 1970 (Public Law 91-611), as

amended, and Section 103 of WRDA 1986 (Public Law 99-662), as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

j. Hold and save the government free from all damages arising from construction and OMRR&R of the project and any project-related betterments, except for damages due to the fault or negligence of the government or the government's contractors;

k. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs in accordance with the Master Agreement between the Department of the Army and the non-federal sponsor dated 13 August 2009, including Article XI Maintenance of Records and Audit;

l. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the government determines to be subject to the navigation servitude without prior specific written direction by the government;

m. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-ways that the government determines necessary for construction, operation, maintenance, repair, replacement and rehabilitation;

n. As between the government and the non-federal sponsor, the non-federal sponsor shall be considered the operator of the project for purposes of CERCLA liability. To the maximum extent practicable, the non-federal sponsor shall OMRR&R the project in a manner that will not cause liability to arise under CERCLA;

o. Prevent obstruction of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

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p. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

q. Comply with all applicable federal and state laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964 (Public Law 88-352 [42 U.S.C. 2000d]) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army;" and all applicable federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act [formerly 40 U.S.C. 276a et seq.], the Contract Work Hours and Safety Standards Act [formerly 40 U.S.C. 327 et seq.] and the Copeland Anti-Kickback Act [formerly 40 U.S.C. 276c]);

r. Comply with Section 106 of the National Historic Preservation Act in completion of all consultation with the Florida State Historic Preservation Officer, and other interested parties including federally recognized Tribes and as necessary, the Advisory Council on Historic Preservation, prior to construction as part of the Preconstruction Engineering and Design phase of the Project;

s. Provide 50 percent of that portion of total data recovery activities associated with historic preservation that exceed one percent of the amount authorized to be appropriated for CEPP; data recovery costs under one percent of the authorized CEPP cost will be funded in its entirety by the government. Any costs of data recovery that exceed one percent of the amount authorized to be appropriated for CEPP shall not be included in project construction costs or project OMRR&R costs (as defined by the Master Agreement); therefore, credit shall not be afforded to the non-federal sponsor for costs or work in kind associated with data recovery activities that exceed one percent of the amount authorized to be appropriated for CEPP;

t. Do not use federal funds to meet the non-federal sponsor's share of total project costs unless the federal granting agency verifies in writing that the expenditure of such funds is expressly authorized and in accordance with Section 601 (e)(3) of WRDA 2000, as amended, and in accordance with the Master Agreement;

u. The non-federal sponsor agrees to participate in and comply with applicable federal floodplain management and flood insurance programs consistent with its statutory authority:

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(1) Not less than once each year the non-federal sponsor shall inform affected interests of the extent of protection afforded by the project;

(2) The non-federal sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

(3) The non-federal sponsor shall comply with Section 402 of WRDA 1986, as amended (33 U.S.C. 701b-12), which requires a non-federal interest to have prepared, within one year after the date of signing a project partnership agreement for the project, a floodplain management plan. The plan shall be designed to reduce the impacts of future flood events in the project area, including but not limited to, addressing those measures to be undertaken by non-federal interests to preserve the level of flood protection provided by the project. As required by Section 402, as amended, the non-federal interest shall implement such plan not later than one year after completion of construction of the project. The non-federal sponsor shall provide an information copy of the plan to the government upon its preparation;

(4) The non-federal sponsor shall prescribe and enforce regulations to prevent obstruction of or encroachment on the project or on the lands, easements, and rights-of-way determined by the government to be required for the construction and OMRR&R of the project, that could reduce the level of protection the project affords, hinder operation or maintenance of the project, or interfere with the project's proper function.

v. The non-federal sponsor shall execute, or certify that the Florida Department of Environmental Protection (FDEP) executed, under state law the reservation or allocation of water for the natural system as identified in the PIR as required by Section 601(h)(4)(B)(ii) of WRDA 2000 and the non-federal sponsor shall provide information to the government regarding such execution. In compliance with 33 CFR 385, the District Engineer will verify such reservation or allocation in writing. Any change to such reservation or allocation of water shall require an amendment to the project partnership agreement after the District Engineer verifies in writing in compliance with 33 CFR 385 that the revised reservation or allocation continues to provide for an appropriate quantity, timing, and distribution of water dedicated and managed for the natural system after considering any changed circumstances or new information since completion of the PIR for the authorized CERP project.

w. Consistent with the 14 September 2011 Memorandum from the Assistant Secretary of the Army (Civil Works) the non-federal sponsor shall be 100% responsible for the cost of all actions taken due to the presence of residual agricultural chemicals, at

no expense to the government and any future costs associated with the presence of residual agricultural chemicals at the federal project site are 100% a non-federal sponsor cost and responsibility. As stated in the 14 September 2011 Memorandum, normal project engineering and construction activities will remain part of the total project cost provided that these are the same activities required to implement the project features absent the presence of residual agricultural chemicals.

19. In addition to the aforementioned items of local cooperation, the USACE, the Assistant Secretary of the Army (Civil Works) and the non-federal sponsor agreed on the following concepts regarding water quality that is intended to govern the implementation and operation of CEPP project features:

a. Restoration of the Everglades requires projects that address hydrologic restoration as well as water quality improvement. This has been recognized by the National Academy of Sciences in its most recent biennial report where it noted that near-term progress to address both water quality and water quantity improvements in the central Everglades is needed to prevent further declines of the ecosystem. The significant amount of water resulting from CEPP is contemplated to significantly improve restoration of the Everglades. Both the federal and state parties recognize that water quantity and quality restoration should be pursued concurrently and have collaborated to develop and concur on a suite of restoration strategies being implemented by the state to improve water quality ("State Restoration Strategies"), as well as other state and federal restoration projects, both underway and planned, to best achieve Everglades hydrologic objectives. Specific examples of federally authorized projects include the Everglades Restoration Transition Plan, Modified Water Deliveries to Everglades National Park Project, and the Tamiami Trail Next Steps Project. One of the goals of these projects and their associated operating plans, as well as certain components of the CERP awaiting authorization or that are being planned as part of the CEPP is to improve water quantity and quality in the Everglades through more natural water flow within the remnant Everglades which includes the water conservation areas and ENP. Variations in flows of the C&SF system may result from a variety of reasons. These reasons include natural phenomena (e.g. weather) and updates to the operating manuals to achieve the purposes of the C&SF Project such as flood control and water supply.

b. One goal of the Consent Decree is to restore and maintain water quality within ENP. The Consent Decree established, among other things, long-term water quality limits for water entering ENP to achieve this goal. The existing limits for ENP are flow dependent and, generally, increased volume of water results in a lower allowable concentration of phosphorus to maintain the overall load of phosphorus entering the ENP. There will be redistribution of flows and increased water volume above existing flows associated with system restoration efforts beyond the current State Restoration Strategies projects. The USACE and its federal and state partners recognize that to

achieve long-term hydrologic improvement, water quality may be impacted, particularly as measured by the current Consent Decree Appendix A compliance methodology. The USACE and the state partners agree that the monitoring locations/stations for inflows to ENP will require revision. An evaluation of this and other aspects of the compliance methodology are currently being conducted by the Technical Oversight Committee (TOC).

c. In an effort to address these potential impacts and determine updates to Appendix A to reflect increased inflows and new discharges into ENP since the Consent Decree was entered, the parties to the Consent Decree have established a process and scope for evaluating and identifying necessary revisions to the Appendix A compliance methodology utilizing the scientific expertise of the TOC. The TOC may consider all relevant data, including the 20 years of data collected since Appendix A was implemented. Ultimately, such evaluations and changes to the Appendix A compliance methodology would be recommended by the Consent Decree's TOC for potential agreement by all parties. Failure to develop a mutually agreed upon and scientifically supportable revised compliance methodology will impact the State's ability to implement or approve these projects.

d. The aforementioned State Restoration Strategies will be implemented under a Clean Water Act discharge permit that incorporates and requires implementation of corrective actions required under a State law Consent Order, as well as a Framework Agreement between the U.S. Environmental Protection Agency and the state discharge permitting agency, the Florida Department of Environmental Protection, to ensure compliance with Clean Water Act and State water quality requirements for existing flows into the Everglades. The Clean Water Act permit for the state facilities, the associated Consent Order (including a detailed schedule for the planning, design, construction, and operation of the new project features), and technical support documents were reviewed by, and addressed all of, the U.S. Environmental Protection Agency's previous objections related to the draft NPDES permits, prior to issuance.

e. All parties are committed to implementing the State Restoration Strategies, joint restoration projects, and associated operational plans, in an adaptive manner that is consistent with the objectives of the underlying C&SF Project. The USACE and the state will use all available relevant data and supporting information to inform operational planning and decision making, document decisions made, and evaluate the resulting information from those decisions to avoid adverse impacts to water quality where practicable and consistent with the purposes of the C&SF Project. Based upon current and best available technical information, the federal parties believe at this time that the State Restoration Strategies, implemented in accordance with the State issued Consent Order and other joint restoration projects, are sufficient and anticipated to achieve water quality requirements for existing flows to the Everglades. If there is an exceedance of the Appendix A compliance limits, which results from a change in operation of a federal

DAEN
SUBJECT: Report of the Chief of Engineers, Central Everglades Planning Project, Comprehensive Everglades Restoration Plan, Central and Southern Florida Project.

project, and it has been determined that an exceedance cannot be remedied without additional water quality measures, the federal and state partners agree to meet to determine the most appropriate course of action, including what joint measures should be undertaken as a matter of shared responsibility. These discussions will include whether it is appropriate to exercise any applicable cost share authority. If additional measures are required and mutually agreed upon, then they shall be implemented in accordance with an approved process, such as a general reevaluation report or limited reevaluation report, and if necessary, supported through individual project partnership agreements. Failure to develop mutually agreed upon measures and cost share for these measures may impact the state's ability to operate the federal project features.

20. The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program or the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before it is transmitted to the Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the state, interested federal agencies, and other parties will be advised on any significant modifications and will be afforded an opportunity to comment further.

THOMAS P. BOSTICK
Lieutenant General, USA
Chief of Engineers

XXX

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

August 7, 2015

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, DC 20310-0108

Dear Ms. Darcy:

As required by Executive Order 12322, the Office of Management and Budget has reviewed a December 2014 Army Corps of Engineers (Corps) project implementation report (report) that recommends a series of new structures, modifications to existing structures, and related operational changes to enable the Corps and the South Florida Water Management District to better manage the waters of the central Everglades, and increase the quantity of water available for restoration, at a first cost of $1.9 billion ($951 million Federal) (October 2014 prices). We have concluded that an authorization to construct these improvements and adopt these operational changes would be consistent with the program and policies of the President.

The Corps would implement this plan for the central Everglades in three phases, and plans to complete a re-evaluation report for each phase before proceeding to construct the features that comprise that phase. Due to the high level of risk and uncertainty associated with the overall plan at the time of this report, particularly for the final phase (PPA New Water), the Army should submit the re-evaluation report for the PPA New Water phase to the Office of Management and Budget for review prior to implementation of that phase.

The Office of Management and Budget does not object to you submitting this study to the Congress. However, when you do so, please inform the Congress that this project would need to compete with other proposed investments in future Budgets.

Sincerely,

John Pasquantino
Deputy Associate Director
Energy, Science, and Water

RECORD OF DECISION

CENTRAL AND SOUTHERN FLORIDA PROJECT
CENTRAL EVERGLADES PLANNING PROJECT, SOUTH FLORIDA

The Final Integrated Project Implementation Report and Environmental Impact Statement (PIR/EIS), dated July 2014 and revised December 2014, and the report of the Chief of Engineers, dated December 23, 2014, address ecosystem restoration in south Florida. Based on these reports, the reviews of other Federal, State, and local agencies, input from the public, and the review by my staff, I find the plan recommended by the Chief of Engineers to be technically feasible, environmentally justified, cost effective, in accordance with environmental statutes, and in the public interest.

The PIR/EIS, incorporated herein by reference, evaluated various alternatives to improve the quantity, quality, timing and distribution of water flows to the Northern Estuaries, Central Everglades Water Conservation Area (WCA) 3, Everglades National Park (ENP), and Florida Bay while increasing water supply for municipal and agricultural users. The recommended plan, Alternative 4R2, is the National Ecosystem Restoration (NER) plan, and includes:

- Construction of a 14,000-acre Flow Equalization Basin (FEB) and associated distribution features, operationally integrated with A-1 FEB and existing facilities.
- Backfill of 13.5 miles of the Miami Canal and removal of 2.98 miles of the southern L-4 levee to convert the L-4 canal into a spreader canal. Spoil mounds along the Miami Canal will be used as a backfill source. Spoil mounds will be maintained and constructed tree islands will be added in areas with historic ridges.
- Construction of a new Blue Shanty levee that will divide WCA 3B into two units.
- Installation of culverts to connect WCA 3A and WCA 3B.
- Removal of approximately 5.5 miles of the L-67 Extension Levee and approximately 6 miles of the Old Tamiami Trail to increase the outlet capability of the S-333 structure at the terminus of the L-67A.
- Construction of a 4.2 mile partial depth seepage barrier south of Tamiami Trail along L-31N.
- Modification of the S-356 pump station to increase capacity to 1,000 cubic feet per second.
- Construction of parking, trailheads, shelters, and fishing platforms for recreation.
- Implementation of the Adaptive Management and Monitoring Plan dated July 2014 (Annex D of the PIR/EIS).

In addition to the "no action" plan, four alternatives are identified and evaluated in the PIR/EIS. The alternatives included different combinations of storage and treatment, distribution and conveyance, and seepage management components. The alternatives

Technical, environmental, economic, and risk criteria used in the formulation of alternative plans are those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, Executive Orders, regulations and local government plans are considered in the evaluation of alternatives and the selection of the recommended plan. Based on review of these evaluations, I find that the recommended plan reasonably maximizes the benefits compared to the costs and any adverse effects. This Record of Decision completes this phase of the National Environmental Policy Act process.

aug. 31, 2015
Date

Jo-Ellen Darcy
Assistant Secretary of the Army
(Civil Works)

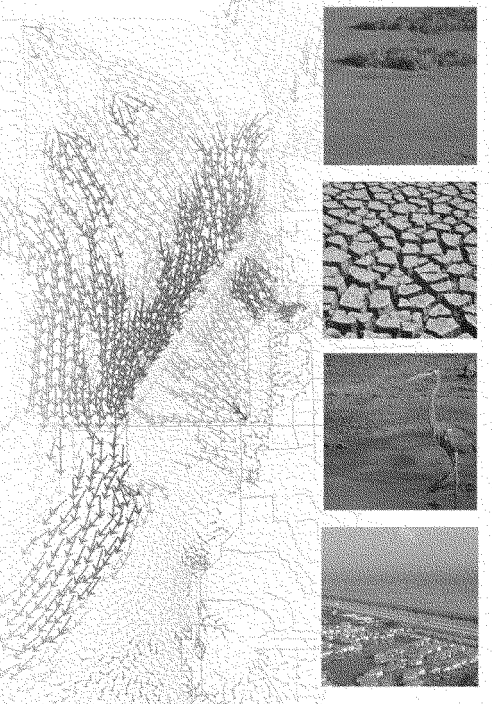
RESTORING THE HEART OF THE EVERGLADES

CENTRAL EVERGLADES PLANNING PROJECT

COMPREHENSIVE EVERGLADES RESTORATION PLAN

CENTRAL EVERGLADES PLANNING PROJECT

FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT



July 2014
Revised December 2014

Cover insets (left to right):

Landscapes: Lake Okeechobee, Water Conservation Area 3, Everglades National Park, Florida Bay; **Map:** Depicts Average Annual Overland Flow across the period of record (1965-2005) for existing conditions, as modeled by the CEPP regional hydrologic model (the coloration of the arrows represents the relative volume of flow, while the direction of the arrows represents the movement of flow across the landscape); **Small Landscapes:** Ponding, soil oxidation (peat reduction), dry area of Everglades National Park, juxtaposition of urban development.

CENTRAL AND SOUTHERN FLORIDA PROJECT
COMPREHENSIVE EVERGLADES RESTORATION PLAN
CENTRAL EVERGLADES PLANNING PROJECT
FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT
AND
ENVIRONMENTAL IMPACT STATEMENT

ADDENDUM
DECEMBER 2014

Following are updated costs and benefits of the Recommended Plan, escalated to FY15 price levels.

The total project first cost[1] of the Recommended Plan from the final PIR/EIS, escalated to FY15 price levels, is estimated at $1,951,000,000. Total first cost for the ecosystem restoration features is estimated to be $1,944,000,000, and for recreation is estimated to be $6,600,000. In accordance with the cost-sharing requirements of Section 601(e) of the WRDA 2000, as amended, the Federal cost of the Recommended Plan is $976,375,000 and the non-Federal cost is $974,625,000. The Federal cost includes $1,750,000 for cultural resources data recovery represented at 100% federal responsibility. The estimated lands, easements, right-of-way, and relocation (LERRs) costs for the recommended plan are $37,000,000.

Based on FY15 price levels, a 50-year period of economic evaluation and a 3.375% discount rate, the equivalent annual cost of the proposed project is estimated to be $102,600,000, which includes OMRR&R, monitoring, interest during construction and amortization, and is inclusive of recreation costs.

The Recommended Plan will produce an average annual increase of 280,094 habitat units per year at an annual cost of $102,300,000. The average annual cost per average annual habitat unit is $365. Based on these parameters, the Central Everglades Planning Project is justified by the environmental benefits derived by the South Florida ecosystem. The recreation first cost of the recommended plan is $6,600,000. The average annual cost for recreation is $355,000 and average annual net benefits are $569,000. The benefit to cost ratio for the proposed recreation features is approximately 1.6 to 1.

[1] Construction costs have been rounded to the nearest million

CENTRAL EVERGLADES PLANNING PROJECT
FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT
AND ENVIRONMENTAL IMPACT STATEMENT
Dated July 2014

ERRATA SHEET
December 2014

The following corrections, clarifications and augmentations are made to the Final Integrated Project Implementation Report and Environmental Impact Statement:

Main Report, Executive Summary
Page ES-7. The text in the last sentence of the third paragraphs says "This includes the Seminole Indian Tribe of Florida's Big Cypress Reservation and the Miccosukee Tribe of Indians of Florida's reservation areas and resort." The text was changed to "This includes the Seminole Tribe of Florida's Big Cypress Reservation and the Miccosukee Tribe of Indian of Florida's reservation and resort".

Page ES-14. The text in the last sentence says "To ensure that the recommended plan meets State water quality standards, discharge permit with associated effluent limits will govern discharges from the State facilities." The text was changed to "To ensure that the recommended plan meets State water quality standards, NPDES discharge permits and Everglades Forever Act Watershed permits with associated effluent limits will govern the Stormwater Treatment Area discharges from State facilities."

Main Report, Section 2.6 Native Americans
Page 2-20. The text in the third sentence says "Members of the Seminole Tribe of Florida have several reservations in the State of Florida as well as an easement in WCA 3A for such purposes as hunting, fishing and frogging." The was changed to "...for such purposes as hunting, trapping, fishing and frogging."

Main Report, Section 6.8.2.1 Savings Clause – Water Supply From Existing Legal Sources
Page 6-77. Text in the second bulleted item says, "...the Seminole Indian Tribe of Florida...". The text was changed to "...the Seminole Tribe of Florida...".

Main Report, Section 6.8.2.2 Savings Clause: Flood Protection
Page 6-79. Text in the forth sentence says, "...the Seminole Indian Tribe of Florida...". The text was changed to "...the Seminole Tribe of Florida...".

Appendix A, Section A.3.2 Recommendation for Design Completion
Page A-13. The text in the second sentence says "All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and

information as it becomes available." New text was added immediately following the above sentence "Prior to finalizing design, an economic analysis will be conducted on pump station components to be in compliance with EM 1110-2-3102". The last sentence remains unchanged, "Design completion recommendations are provided by geographic region and discipline specific areas."

Appendix A, Section A.5.3.3.2.1.4 Pump Stations
Page A-39. The text in the fourth sentence of the third paragraph says "The diesel engine driven pumps are required per SFWMD Major Pump Station Engineering Guidelines." The text was changed to "The diesel engine driven pumps are required per EM's, ER's and jointly developed DCM-5, Major Pump Station Engineering Guidelines."

Appendix A, Section A.5.4.1 General Status of Completed and Non-Executed Efforts
Page A-54. The text in the last sentence of the first paragraph says "The structural design will conform with the appropriate Engineering Manual (EM), Engineering Regulations (ER), or Design Criteria Memorandums (DCM)." The text was changed to "The structural design will conform with the appropriate Engineering Manual (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM)."

Appendix A, Section A.6.4.1 General Status of Completed and Non-Executed Efforts
Page A-83. The text in the last sentence of the first paragraph says "The structural design will conform with the appropriate Engineering Manual (EM), Engineering Regulations (ER), or Design Criteria Memorandums (DCM)." The text was changed to "The structural design will conform with the appropriate Engineering Manual (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM)."

Appendix A, Section A.7.3.3.2.1 .3 Pump Stations
Page A-114. The text in the last sentence of the first paragraph says "The design condition of 1,000 cfs will be achieved with two 500 cfs diesel engine driven pumps, with one 500 cfs diesel engine to serve as a redundant pump unit, per SFWMD Major Pumping Station Engineering Guidelines." The text was changed to "The design condition of 1,000 cfs will be achieved with two 500 cfs diesel engine driven pumps, with one 500 cfs diesel engine to serve as a redundant pump unit, per EM's, ER's and jointly developed DCM-5, Major Pumping Station Engineering Guidelines."

Appendix A, Section A.7.4.1 General Status of Completed and Non-Executed Efforts
Page A-123. The text in the last sentence of the first paragraph says "The structural design will conform with the appropriate Engineering Manuals (EM), Engineering Regulations (ER), or Design Criteria Memorandums (DCM)." The text was changed to "The structural design will conform with the appropriate Engineering Manuals (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM)."

Appendix A, Section A.7.5.3 Pumping Station S-356 Replacement Features
Page A-124. The last sentence of the first paragraphs says "One of the pumping systems for this station is a redundant system as required by SFWMD's Major Pumping Station Engineering Guidelines." The text was changed to "One of the pumping systems for this station is a redundant system as required per EM's, ER's and jointly developed DCM-5, Major Pumping Station Engineering Guidelines."

Appendix A, Section A.8.3.1 Baseline Condition Modeling
Page A-149. The text in the second sentence of the second paragraph says "....second generation CERP projects still pending Congressional authorization....". The text was changed to "second generation CERP projects authorized by Congress in WRRDA 2014...".

Appendix A, Annex A-2, Section 3.1 CEPP Baseline Condition Modeling
Page A-2-18. The text in the third sentence of the second paragraph says "....second generation CERP projects still pending Congressional authorization....". The text was changed to "second generation CERP project authorized by Congress in WRRDA 2014...".

Appendix A, Annex B, Section GC-3 Optimize Pump Station Design
Page B-1-42. The second sentence of the first paragraph says "Design precedent has been to adhere to SFWMD standards." The text was changed to "Design precedent has been to adhere to jointly developed DCM-5, Major Pumping Station Engineering Guidelines."

Appendix C, Section C.1.3 FUTURE PROJECT CONDITIONS OF RESOURCES
Page C.1-87. The text in the forth sentence of the first paragraph says "Second generation of CERP projects for Congressional authorization....". The text was changed to "Second generation of CERP project, authorized in WRDDA 2014,..."

Appendix C, Section C.1.3.8 Hydrology
Page C.1-94. The text in the third sentence of the first paragraph says "....second generation CERP projects still pending Congressional authorization....". The text was changed to "second generation CERP project authorized by Congress in WRRDA 2014...".

Appendix C, Section C.1.3.9 Regional Water Management (Operations)
Page C.1-109. The text in the second sentence of the first paragraph says "....second generation CERP projects still pending Congressional authorization....". The text was changed to "second generation CERP projects authorized by Congress in WRRDA 2014..."

Appendix C, Section C.2.2.20 Past, Present, and Reasonably Foreseeable Actions Affecting Resources within the Project Area
Page C.2.2-151. The text in the third sentence of the fifth paragraph says "The second generation of CERP projects for Congressional authorization....". The text was changed to "The second generation of CERP projects, authorized in WRRDA 2014, includes..."

Appendix C, Section C.3 Pertinent Correspondence
Page C.3-444. The response to EPA-22 says "State and Federal water quality experts....". The text was changed to "State and Federal water managers...".

Appendix C, Section C.3 Pertinent Correspondence
Page C.3-722. The response to Citizen-11 Comment-1 says "The second generation of CERP projects, which are awaiting Congressional authorization,...". The text was changed to "The second generation of CERP projects authorized by Congress in WRRDA 2014...".

Annex B, Section B.3.1.2 Lower East Coast Service Area
Page B-23. The text in the second sentence of the first paragraph says "The Seminole Tribe of Florida also withdrawals...". The text was changed to "The Seminole Tribe of Florida also withdraws...".

Annex D, Part 1
Page 88. The text in the fifth sentence of the first paragraph says "Minimum Flows and Levels Rule; SFWMD proposed Water Reservation Rule for the CERP Biscayne Bay Coastal Wetlands Project – Phase I." The text was changed to "Minimum Flows and Levels Rule; SFWMD Water Reservation Rule for the CERP Biscayne Bay Coastal Wetlands Project – Phase I."

FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT

Central Everglades Planning Project
St. Lucie, Martin, Okeechobee, Glades, Hendry, Palm Beach, Broward, Miami-Dade, Monroe, Collier, Lee and Charlotte Counties, FL

Lead Agency: **Department of Army**
U.S. Army Corps of Engineers, Jacksonville District

Abstract:
The purpose of the Central Everglades Planning Project (CEPP) is to improve the quantity, quality, timing and distribution of water flows to the Northern Estuaries, central Everglades (Water Conservation Area 3 (WCA 3) and Everglades National Park (ENP)), and Florida Bay while increasing water supply for municipal, industrial and agricultural users. The recommended plan would achieve these benefits by reducing the large pulses of regulatory flood control releases sent from Lake Okeechobee by redirecting approximately 210,000 acre-feet of water on an annual basis to the historical southerly flow path. Prior to delivering additional water to existing State-owned and State-operated stormwater treatment areas (STAs), water will be delivered first to the flow equalization basins (FEBs) which will: (1) provide storage capacity, (2) attenuate high flows, and (3) provide incidental water quality benefits. The STAs reduce phosphorus concentrations in the water to meet required water quality constraints. Rerouting this treated water south and redistributing it across spreader canals will facilitate hydropattern restoration in WCA 3A. This, in combination with Miami Canal backfilling and other CERP components, will re-establish a 500,000-acre flowing system through the northern most extent of the remnant Everglades. The treated water will be distributed through WCA 3A to WCA 3B and ENP via structures and creation of the Blue Shanty Flowway. The Blue Shanty Flowway will restore continuous sheetflow and re-connection of a portion of WCA 3B to ENP and Florida Bay. A seepage barrier wall and pump station will manage seepage to maintain levels of flood protection and water supply in the urban and agricultural areas east of the WCAs and ENP. The CEPP recommended plan was chosen based upon detailed estimates of hydrology across the 41-year period of record (January 1965 – December 2005) generated by the Regional Simulation Model for Basins (RSM-BN) for the Northern Estuaries and the RSM for the Glades and Lower East Coast Service Area (RSM-GL) for the Greater Everglades and Florida Bay. The first cost (2014 price level) of the recommended plan is $ 1,900,000,000.

Send your comments by:
September 8th, 2014

For further information on this statement, please contact
Dr. Gretchen Ehlinger
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, FL 32232-0019
Telephone: 904-232-1682
E-mail: ceppcomments@usace.army.mil

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EXECUTIVE SUMMARY

The Final integrated project implementation report (PIR) and environmental impact statement (EIS) evaluates the Federal interest in implementing the Central Everglades Planning Project (CEPP), a component of the Comprehensive Everglades Restoration Plan (CERP), which was approved as a framework for restoring the south Florida ecosystem while providing for other water-related needs of the region in the 2000 Water Resources Development Act (WRDA). The Final PIR/EIS presents a description of existing and expected future conditions in the south Florida Everglades ecosystem, formulation and evaluation of plans considered to address ecosystem restoration needs in the region, analysis of environmental effects of the recommended plan, project costs, and implementation issues.

PURPOSE AND NEED

The purpose of the CEPP is to improve the quantity, quality, timing and distribution of water flows to the Northern Estuaries, central Everglades (Water Conservation Area 3 [WCA 3] and Everglades National Park [ENP]), and Florida Bay while increasing water supply for municipal and agricultural users. Since the CERP was approved, three projects were authorized in the 2007 WRDA and proceeded into construction (Indian River Lagoon-South, Picayune Strand, and Site 1 Impoundment) and a fourth project, Melaleuca and Other Exotic Plants Biological Controls, was implemented under the programmatic authority in WRDA 2000. Despite this progress, ecological conditions and functions within the central portion of the Everglades ridge and slough community continue to decline due to lack of sufficient quantities of freshwater flow into the central Everglades and timing and distribution problems (**Figure 1**). To respond to this concern, the U.S. Army Corps of Engineers (Corps) and the South Florida Water Management District (SFWMD) initiated the CEPP in November 2011 to evaluate alternatives for restoring ecosystem conditions in the central portion of the Everglades and opportunities for providing for other water-related needs in the region.

AUTHORITY

The CEPP study is being conducted under the authority provided by Section 601(d)(2)(b) of WRDA 2000, which requires preparation of a PIR to implement components of the CERP. Upon approval of the PIR by the Governing Board of the SFWMD and the Assistant Secretary of the Army for Civil Works (ASA-CW), the recommended plan will be submitted to Congress for authorization. The CEPP is also a national pilot project for the Corps, testing opportunities for expediting the planning phase of civil works projects, confirming Federal interest, and providing a recommendation to Congress. The goal of this pilot project was to identify a draft recommended plan within 18 months of initiating the study and preparing a recommendation to Congress in less than three years.

ALTERNATIVE PLANS AND THE RECOMMENDED PLAN

Planning goals for CERP projects include enhancing ecological values and enhancing economic values and social well-being. Both goals were considered during the formulation of CEPP alternative plans, and project specific objectives and constraints were established to evaluate the plans. In general, ecosystem restoration objectives focused on providing additional water to the Everglades by capturing freshwater discharges from Lake Okeechobee to the St. Lucie and Caloosahatchee Estuaries. Timing of deliveries and distribution of flows to the Everglades and improvements to water supply for municipal, agricultural, and Tribal use were also evaluated.

The plan formulation strategy for CEPP consisted of multiple formulation phases that followed the natural southerly flow of water from Lake Okeechobee through the Everglades ecosystem to Florida Bay. The strategy involves the formulation of management measures and components that serve to restore

the central portions of the Everglades including WCA 3A, WCA 3B, and ENP, while improving the northern and southern estuary ecosystems and increasing water supply for municipal, industrial and agricultural users.

The plan formulation framework started with consideration of measures north of the Everglades in the Everglades Agricultural Area (Red Line) to capture, store, and deliver water south to the Everglades (**Figure 2**). The sequential formulation which followed then considered measures for redistributing water within WCA 3A (south of the Red Line) creating additional hydrologic connectivity between WCA 3A, WCA 3B (Green Line), and ENP (Blue Line), and effectively managing seepage along the eastern boundary of the Everglades (Yellow Line). The CEPP study recommends increments of six components of the CERP:

- Everglades Agricultural Storage Reservoirs (Component G)
- WCA 3 Decompartmentalization and Sheetflow Enhancement (Components AA and QQ)
- S-356 Pump Station Modifications (Component FF)
- L-31 N Improvements for Seepage Management (Component V)
- System-wide Operational Changes – Everglades Rain-Driven Operations (Component H)
- Flow to Northwest and Central WCA 3A (Component II)

To facilitate the evaluation of thousands of possible combinations of measures, screening criteria were developed to select the array of measures and plans for detailed modeling and evaluation. Four alternative plans (**Figure 2**) and the no-action plan were evaluated using hydrologic simulation model outputs. Performance measures were used to evaluate the degree to which proposed alternative plans met restoration targets representative of pre-drainage conditions. Planning-level cost estimates were developed for the four alternative plans, ecosystem restoration benefits were calculated, and additional selection criteria were applied.

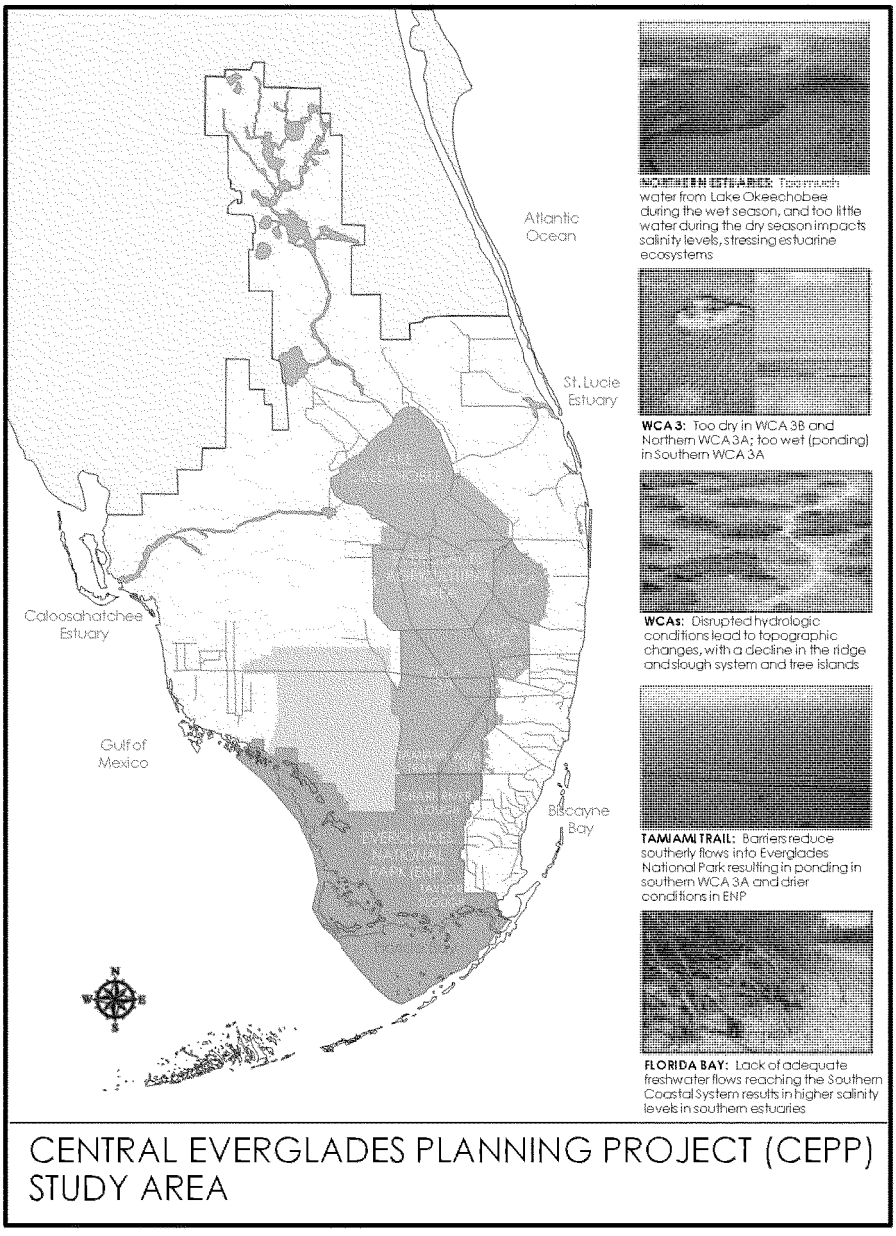

Figure 1. Map of Study Area

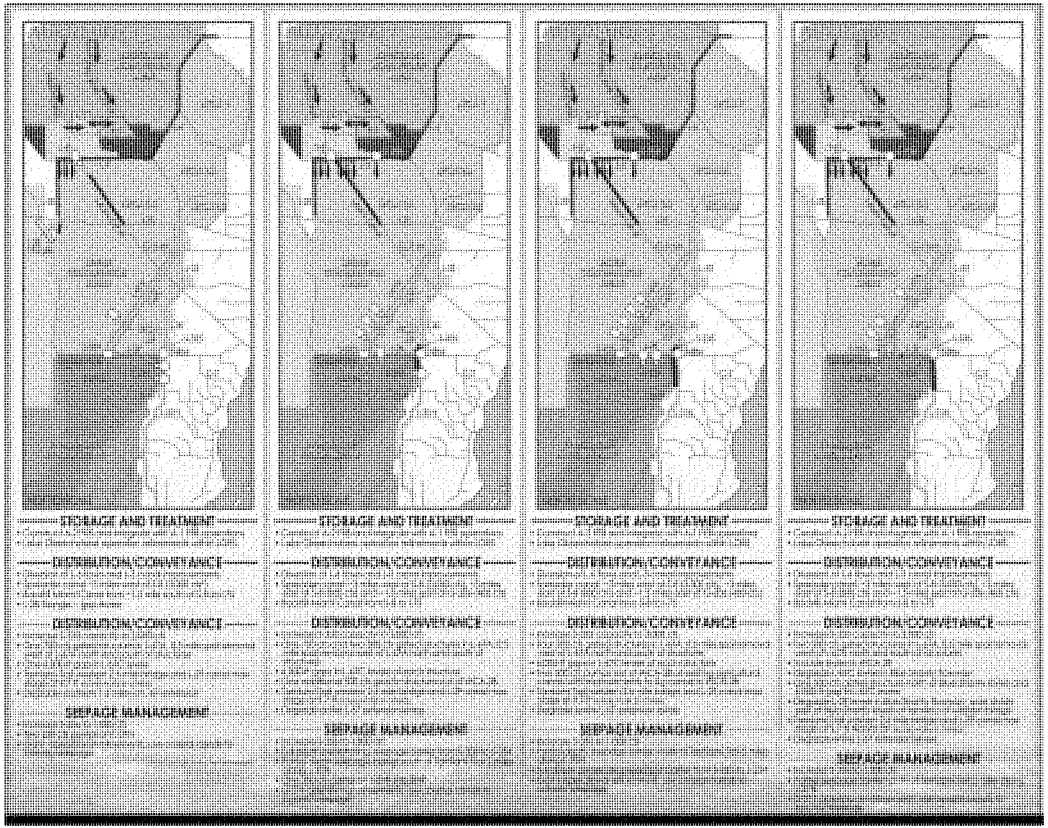

Figure 2. Alternative Plans

Combining alternative plan benefits, costs, and other selection criteria, a modified version of Alternative 4 (Alternative 4M) was identified as both cost-effective and with the most ecosystem restoration benefits. Alternative 4R2 was developed from Alternative 4M by optimizing its operations to improve water supply performance and to address WRDA 2000 Savings Clause concerns about effects on the Biscayne Aquifer and Biscayne Bay. Alternative 4R2 (**Figure 3**) is the Recommended Plan and consists of the following features:

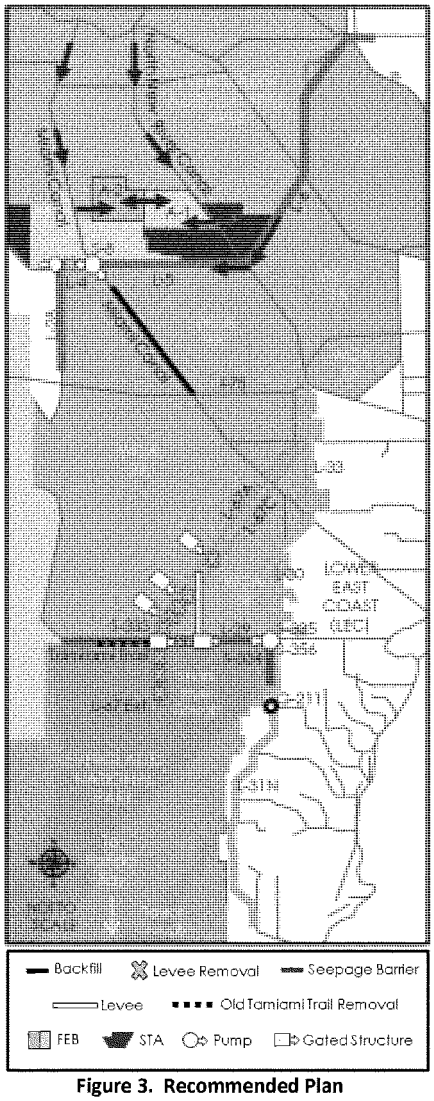

Figure 3. Recommended Plan

- A-2 Flow Equalization Basin (FEB) (14,000 acres), including exterior and internal levees
  - Seepage Pump Station (500 cubic feet per second (cfs))
  - Water Control Structures (culverts, spillway)
  - Emergency Overflow Weir
  - Canals (inflow, seepage collection, internal collection, and discharge)
- L-6 Canal Flow Diversion
- L-5 Canal Conveyance Improvements
- S-8 Pump Station Complex Modifications
- L-4 Levee Degrade (approximately 2.9 miles) and Pump Station (360 cfs)
- Miami Canal Backfill (approximately 13.5 miles from 1.5 miles south of S-8 to Interstate 75)
- S-333 Spillway Modification (1,150 cfs gated spillway adjacent to S-333; 2,500 cfs total)
- L-29 Canal Gated Spillway (1,230 cfs)
- L-67A Conveyance Structures (three, 500 cfs)
- L-67C Levee Gap (6,000 feet)
- L-67C Levee Degrade (approximately 8 miles)
- Blue Shanty Levee, WCA 3B (approximately 8.5 miles)
- L-29 Levee Degrade (4.3 mi, within Blue Shanty Flowway)
- L-67 Extension Levee Degrade and Canal Backfill (approximately 5.5 miles)
- Old Tamiami Trail Removal (approximately 6 miles)
- S-356 Pump Station Modifications (increase to 1,000 cfs)
- Seepage Barrier,L-31N Levee (approximately 4.2 miles)
- System-wide Operations Refinements

BENEFITS OF THE RECOMMENDED PLAN

The recommended plan beneficially affects more than 1.5 million acres in the St. Lucie and Caloosahatchee Estuaries, WCA 3A, WCA 3B, ENP, and Florida Bay. In addition to redistributing existing treated water in a more natural sheetflow pattern, the recommended plan provides an average of approximately 210,000 acre-feet per year of additional clean freshwater flowing into the central portion of the Everglades. This increase in freshwater flow to the Everglades is approximately two-thirds of the additional flow estimated to be provided by the CERP. The recommended plan also reduces the number and severity of undesirable, high-volume discharges from Lake Okeechobee, improving salinity in the St. Lucie and Caloosahatchee Estuaries. The additional water flowing into northern WCA 3A and ENP will help to restore pre-drainage vegetative communities and habitat for fish and wildlife while providing incremental improvement of natural processes critical for the development of peat soils and tree islands, which are essential features of the Everglades ridge and slough landscape. Increased flows to Florida Bay will improve salinities, resulting in greater abundance and diversity of sea grasses and other estuarine plant and animal species.

Ecosystem services provided by the recommended plan include carbon sequestration, reduced fire risks, increased commercial and recreational fish catches (such as pink shrimp and spotted sea trout), increased water supply, and other recreational use and aesthetic values associated with the Everglades and south Florida's estuaries. The recommended plan also boosts resiliency to potential climate change effects by increasing freshwater in the Everglades and buffering natural system areas and the underlying aquifer against possible sea level rise and minor decreases in rainfall.

Recreational benefits provided by the recommended plan include enhanced outdoor recreation opportunities and improved access to Everglades marshes for tourists and Floridians. The cost to construct the recreational features is cost-shared. Operations, maintenance, repair, and rehabilitation (OMRR&R) of recreational features becomes the sole responsibility of the non-Federal sponsor. The average annual cost of the recreation features is $355,000 and the average annual benefits are $570,000, resulting in net benefits of $215,000 and a benefit to cost ratio of 1.6 to 1.

The recommended plan fulfills WRDA 2000 Project Assurance requirements (Section 601(h)(4)) by identifying the water for the natural system (**Table 6-17 in Section 6.8**). The quantity, timing and distribution of water are identified at three locations: inflows to WCA 3, inflows to ENP, and overland flows to Florida Bay. Protection of water made available by CEPP project features is required for the SFWMD and the Department of the Army to enter into one or more project partnership agreements (PPA) to construct the CEPP project features. The SFWMD has already protected the pre-project water for the natural system in the Holey Land and Rotenberger Wildlife Management Areas; WCA 1, WCA 2A, WCA 2B, WCA 3A and WCA 3B; and ENP through the Restricted Allocation Area Rule for the Everglades and North Palm Beach/Loxahatchee River Watershed water bodies. The SFWMD will protect the water made available by the CEPP project features using its reservation or allocation authority as required by Section 373.470, Florida Statutes. The combination of protecting the pre-project existing water and the water made available by the CEPP project features is needed for the CEPP to achieve its intended benefits.

The project also increases the amount of water available for agricultural, municipal and industrial use in Lower East Coast Service Area (LECSA) 2 (Broward County) and LECSA 3 (Miami-Dade County) and maintains existing water supply performance for agricultural users in the Lake Okeechobee Service Area (LOSA) and the Seminole Tribe of Florida.

The recommended plan fulfills WRDA 2000 Saving Clause requirements (Sections 601(h)(5)(A) and 601(h)(5)(C)) which, in part, ensure existing legal sources of water supply such as water for municipal, agricultural, and fish and wildlife uses continue to be available with project implementation. If a CERP project is expected to eliminate or transfer an existing legal source of water, the PIR must include a replacement source of water in its implementation plan. Sources of water to meet agricultural and urban demand in the LECSAs will continue to be met by their current sources, primarily Lake Okeechobee, the Everglades (including the WCAs), surface water in the regional canal network, and the surficial aquifer system. Sources of water for the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida will not be affected by the CEPP project. In addition, water supplies to ENP and water supplies for fish and wildlife located in the Northern Estuaries, WCA 2, WCA 3, Biscayne Bay, and Florida Bay will not be diminished.

Some Lake Okeechobee water utilized by agricultural users in the LOSA will be transferred to WCA 3A and further south as a result of implementation of the recommended plan. This transfer is anticipated to occur after the future modifications of the Lake Okeechobee Regulation Schedule that will allow full utilization of the CEPP A-2 FEB. Water of comparable quantity and quality will be available to replace the water sent south by backflowing a portion of the water stored in the CERP Indian River Lagoon-South C-44 Reservoir/Stormwater Treatment Area (STA) to Lake Okeechobee via the C-44 Canal and raising the Lake Okeechobee stage criteria to allow increased C-44 Canal backflow. The additional volume of water back-flowed to Lake Okeechobee from the C-44 Reservoir/STA and the C-44 Canal averages 57,300 acre-feet annually and represents approximately 10% of LOSA's average annual demand. The transfer of water from Lake Okeechobee to WCA 3A will not be implemented until the CERP C-44 Reservoir/STA, the canal connecting the C-44 Reservoir to the C-23 Canal, and the CEPP A-2 FEB site are operational.

The recommended plan also ensures that CERP implementation does not reduce the level of service for flood protection consistent with WRDA 2000 Savings Clause requirements (Section 601(h)(5)(B)). Comparison of canal stages and groundwater levels at key locations indicates the project will not reduce the flood protection within the areas affected by the project, including the EAA, LECSA 2, and LECSA 3. This includes the Seminole Tribe of Florida's Big Cypress Reservation and the Miccosukee Tribe of Indians of Florida's reservation areas and resort.

ENVIRONMENTAL CONSIDERATIONS

The recommended plan has been identified to be environmentally preferable and the least environmentally damaging practicable alternative. All practicable means to avoid or minimize adverse environmental effects were incorporated into the recommended plan. An Adaptive Management and Monitoring Plan is included in the Final PIR/EIS. Temporary short term impacts to air quality, the noise environment, aesthetic resources, vegetation, and disturbances to and displacement of fish and wildlife resources to other nearby habitat are expected from operation of construction equipment in lands designated for staging, access, and construction. Due to increased water flow and changes in water distribution, it is anticipated that overdrained areas in northern WCA 3A will be rehydrated, triggering a vegetation transition from upland to wetland habitat. Although mammals occurring within the project area are adapted to the naturally fluctuating water levels in the Everglades, there is an increased potential that mammals currently utilizing upland habitat may be negatively affected. Refuge for mammals will be provided by the retention of a portion of existing spoil mounds located adjacent to the Miami Canal in northern WCA 3A and the creation of additional upland landscape (constructed tree islands). Non-native and invasive plant infestations in the project area may be exacerbated by soil disturbance during construction and hydrological modification and may require active management.

Introduction or expansion of non-native fish species due to changes in water distribution and increased connectivity between WCA 3A, WCA 3B and ENP is expected to occur; however, the extent of the ecological impact is uncertain at this time and there are invasive species control programs in place.

Publicly owned lands will be utilized for the recommended plan. Portions of the A-2 footprint are currently leased for agricultural production, including sugar cane. Potential adverse impacts on prime and unique farmland will be assessed during detailed design. Adverse impacts on wetlands would occur within WCA 3B with implementation of the recommended plan as a result of the construction of the Blue Shanty Levee (L-67D). This loss would be offset by improved conditions in wetlands elsewhere within the project area.

To comply with the Endangered Species Act (ESA), the Corps entered formal consultation with USFWS on the Everglade snail kite (*Rostrhamus sociablis plumbeus*), and its designated critical habitat, Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), (CSSS) and its designated critical habitat, wood stork (*Mycteria americana*) and eastern indigo snake (*Drymarchon corais couperi*). A Programmatic Biological Opinion (BO) was received from USFWS on April 9, 2014, which clearly states that further consultation will be needed when more specific project details are finalized during project design and implementation activities. While the Biological Opinion does not authorize incidental take of three endangered avian species (CSSS, snail kite, and wood stork), it does describe the anticipated effects based on current information. When the Corps is closer to constructing phases of CEPP that will affect listed species, USFWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable reasonable and prudent measures (RPMs) and terms and conditions (TCs). Upon completing ESA Section 7 consultation for each PPA, the Corps will undertake the agreed-to avoidance and minimization measures and implement any applicable TCs.

The recommended plan may have adverse effects on cultural resources, some of which are unavoidable and long term, and/or cannot be assessed until the detailed design phase of the project. Avoidance of adverse effects to cultural resources is preferred, and therefore, throughout the planning process for CEPP, the project considered alternatives and features of alternatives that reduce or eliminate impacts to cultural resources. Pursuant to 36 CFR 800.1, where possible, the project design will be modified to avoid affecting significant historic properties and culturally significant sites. Where avoidance is not possible, other mitigation measures will be considered. Future mitigation measures will be developed during the preconstruction, engineering, and design phase in consultation with the State Historic Preservation Office, tribal groups and other interested parties as established in implementing regulations for Section 106 of the National Historic Preservation Act.

COST ESTIMATE AND IMPLEMENTATION PLAN

The first (2014 price level) cost of the recommended plan is $1,900,000,000, including construction, non-construction items, and contingency (**Table 1**). Comparatively, the updated cost estimate (2014 price level) for similar features of the recommended plan included in the 1999 CERP is approximately $1.7 billion. Differences are attributable to new information gained since 1999 about design and construction of similar projects in south Florida, and risk analysis establishing appropriate contingencies to better assure project cost estimates submitted for authorization will not be exceeded during implementation.

Table 1. CEPP Cost Estimates (2014 Price Level) [1,2]

Construction and Operation, Testing, and Monitoring Phase Items	Cost
Ecosystem Restoration Costs	
06 Fish and Wildlife (monitoring and adaptive management)	$106,000,000
09 Channels & Canals	$370,000,000
11 Levees	$399,000,000
13 Pumping Plant	$133,000,000
15 Floodway Control and Diversion	$342,000,000
18 Cultural Resources Preservation	$26,000,000
32 HTRW Investigations	$1,000,000
Construction Features Sub-Total	**$1,377,000,000**
Preconstruction Engineering and Design (PED), Engineering During Construction (EDC) and Planning	**$345,000,000**
Construction Management (S&A)	**$135,000,000**
Lands & Damages	**$37,000,000**
Total Ecosystem Restoration Costs	**$1,894,000,000**
Recreation Costs	
14 Recreation Facilities	$6,000,000
Total First Cost	**$1,900,000,000**

1. Construction costs in this table include contingencies
2. Costs are rounded to the nearest $1,000,000.

Implementation of CEPP will occur over many years and includes many actions by the Corps and SFWMD. Development of sequencing for CEPP features considers that a number of CERP and non-CERP projects (**Table 6-13**) must be constructed and operating before implementing many CEPP features to avoid unintended consequences.

Multiple PPAs composed of separable project elements that provide hydrologic and ecologic benefits in a cost effective manner will be executed prior to construction (**Table 2**). These PPAs include the construction of logical groupings of plan elements that maximize benefits to the extent practicable consistent with project dependencies. PPAs are legally binding agreements that describe the roles and responsibilities of the Corps and SFWMD for real estate acquisition, construction, construction management and operations and maintenance. Other factors that influence implementation include funding availability, cost-share balance between the Federal government and non-Federal sponsor, as well as the integration of projects that are to be constructed by other agencies. These groupings include a PPA of project features in northern WCA 3A (PPA North), a PPA of project features in southern WCA 3A, 3B and ENP (PPA South), and a final PPA which provides the new water and required seepage management that benefits the entirety of the study area (PPA New Water).

Table 2. Project Features by PPA.

PPA North	
• L-6 Diversion	
• S-8 Pump Modifications	
• L-4 Levee Degrade and Pump Station	
• L-5 Canal Improvements	
• Miami Canal Backfill	
PPA South	
• L-67 A Structure North	• L-67 C Levee Degrade (approx 8 miles)
• L-67 C Levee Gap (6,000 ft)	• Remove L-67 Extension Levee (No Backfill)
• Increase S-356 capacity to 1,000 cfs	• 8.5 Mile Blue Shanty Levee
• Increase S-333 capacity	• Remove L-29 Levee Segment
• L-29 Gated Spillway	• Backfill L-67 Extension
• L-67 A Structures 2 and 3 South	• Remove Old Tamiami Trail*
• L-67 A Spoil Mound Removal	
PPA New Water	
• Seepage Barrier L-31 N	
• A-2 FEB	

*Removal of Old Tamiami Trial can be completed at any time during implementation, but must precede backfilling of L-67 Extension Canal.

PPA North and PPA South are expected to achieve regional benefits by utilizing existing inflows to improve deliveries to WCA 3, ENP, and Florida Bay. PPA North includes the hydropattern restoration features in northern WCA 3A and the backfilling of the Miami Canal. Construction of these features that redistribute inflows into WCA 3A provide the benefits identified in the recommended plan associated with restoration of hydroperiods in northern WCA 3A, associated reduction in the risk of muck fires, and restoration of more natural sheetflow. A limited portion of these benefits could be realized through improvements in the re-distribution and delivery of water currently entering northwest WCA 3A prior to bringing in any additional water from Lake Okeechobee.

Features of the recommended plan to be implemented in PPA South would include conveyance features that function to re-distribute water from WCA 3A to WCA 3B and ENP. Benefit from PPA South facilities could be realized within WCA 3A, WCA 3B, and NESRS from the added outlet capacity. Improved hydrologic conditions in ENP are expected to result in improved salinity conditions in Florida Bay.

The ability to increase flows to the south as envisioned with the recommended plan depends on the construction of the A-2 FEB and seepage wall in PPA New Water, as well as the distribution and conveyance features in PPA North and PPA South. Implementation of all three PPAs are needed to realize all of the CEPP's improvements associated with the reduction of undesirable high volume discharges to the Northern Estuaries and the restoration of hydroperiods and sheetflow from WCA 3 and ENP to the coastal mangroves of Florida Bay. The total benefits predicted with implementation of the recommended plan cannot be achieved without the combination of storage and treatment, distribution and conveyance, and seepage management.

Uncertainty surrounding the timing of CEPP project dependencies, funding, resources, stakeholder input and potential conflicting priorities will likely lead to an extended implementation period. **Figure 4** illustrates the construction duration associated with implementation Scenario 1 (sequentially

constructing PPA North, then PPA South and finally PPA New Water) and assumes constrained project funding of $100 million per year ($50 million Federal, and $50 Million non-Federal sponsor).

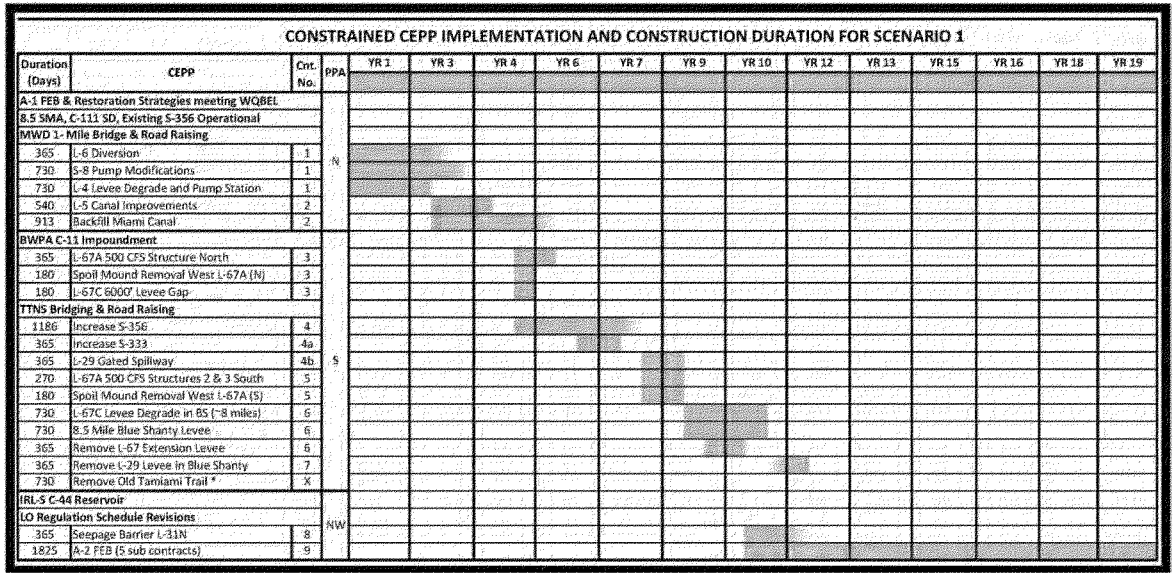

Figure 4. Constrained CEPP Implementation and Construction Duration for Scenario 1

Other viable options for the implementation of groupings into PPAs may be considered in the future. This flexibility is essential to successful CEPP implementation given the uncertainties associated with the lengthy implementation period and the inevitable improvement in scientific knowledge about the functioning of the greater Everglades that will occur as planned CERP and non-CERP projects are completed. The Corps and the SFWMD will incorporate the CEPP recommended plan and other CERP projects awaiting authorization into the south Florida ecosystem restoration programs' integrated delivery schedule through a public engagement process.

COORDINATION WITH AGENCIES AND THE PUBLIC

The expedited planning process for the CEPP study required extensive coordination with the public and Federal, Tribal, State, and local resource management and regulatory agencies. An interagency project team was formed and met regularly throughout the study, providing Federal, Tribal, State, and local agencies opportunities to comment on planning assumptions, evaluation tools and methods, and alternative plans. The South Florida Ecosystem Task Force's Working Group sponsored 18 public workshops throughout the study (November 2011 through February 2013) providing opportunities for the public to provide input to the Task Force, which in turn informed the study team. Formal consultation with the Task Force also occurred throughout the study, including presentations of the final array of alternatives (December 2012) and the recommended plan (July 2013). The SFWMD's Governing Board and Water Resources Advisory Commission also met monthly throughout the study, providing opportunities for information to be provided to elected and appointed officials and the public. The CEPP study project team also hosted public meetings (November – December 2012 and September 2013) summarizing the alternative plans, the recommended plan, and effects.

Initial public and agency comments received in response to a December 2, 2011 public notice of intent to prepare an Integrated PIR and EIS were mostly supportive of the project. Comments focused on the uncertainty in the expedited planning process, specific features, links to other CERP projects and planning constraints. Two National Environmental Policy Act (NEPA) public scoping workshops were held in December 2011. Five public workshops were held in December 2012 to receive comments on the final array of alternatives. Stakeholders, local governments, and representatives of non-governmental environmental organizations provided written comments and statements. The primary concerns centered on the need to move as much water south as possible, reduce releases to the Caloosahatchee and St. Lucie Estuaries, the effect of water levels on recreation opportunities, impacts to Biscayne Bay and Florida Bay, and water supply.

Similar issues, as well as new concerns, were raised in response to the public and agency review and comment of the CEPP Draft PIR/EIS, for which a notice of availability was published in the Federal Register on August 30, 2013. During the 64 day review period, a project overview was presented and questions answered at five public meetings held in south Florida. While there was tremendous support for the project and the expedited planning process, additional concerns included the implementation schedule, water supply and operating plans.

AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

PROVIDING ADDITIONAL REGIONAL ECOSYSTEM RESTORATION NEEDS

Although the recommended plan provides a significant increase in freshwater needed for the restoration of the central Everglades and Florida Bay, additional actions are needed to further reduce undesirable discharges of freshwater from Lake Okeechobee to the St. Lucie and Caloosahatchee

Estuaries such as the completion of the Indian River Lagoon South and C-43 CERP projects and additional storage associated with other CERP components that would be cost shared with the SFWMD. Additionally, the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida have voiced concerns about conditions on Tribal lands in the western Everglades and the lack of progress on CERP components or other initiatives that would benefit those areas.

PROVIDING ADDITIONAL WATER FOR OTHER WATER-RELATED NEEDS

During the CEPP study, agricultural and municipal/industrial water supply stakeholders expressed concerns about the lack of progress on CERP projects intended to increase supplies of water for these users. To address this concern, the modeled operations of the recommended plan were optimized to improve water supply performance, including increasing the amount of water made available by the project for consumptive use allocation in LECSA 2 (Broward County) and LECSA Area 3 (Miami-Dade County) without reducing the beneficial effects on the natural system. In addition, the recommended plan maintains water supply for agricultural users in the LOSA and the Seminole Tribe of Florida. The Corps and the SFWMD will undertake updated project assurances and Savings Clause analyses, if necessary, for the implementation phases that are selected to be included in each PPA.

SYSTEM-WIDE OPERATIONS AND THE WRDA 2000 SAVINGS CLAUSE

CEPP study planners modeled and evaluated system-wide operations changes envisioned in the CERP to evaluate hydrologic conditions in, discharges to, and deliveries from the St. Lucie and Caloosahatchee Estuaries, Lake Okeechobee, WCA 3A, WCA 3B, WCA 2A, WCA 2B, ENP, Biscayne Bay, and Florida Bay. Some stakeholders expressed concerns that system-wide operations modeled and evaluated involve changes to current approved operating plans and that the quantity of water available for irrigation and water supply had been reduced by intervening changes, including the Lake Okeechobee Regulation Schedule (adopted in 2008) and the Everglades Restoration Transition Plan (ERTP, 2012). Furthermore, modeling results for the recommended plan indicate that some of the water utilized by water users in the LOSA will be transferred to WCA 3 and further south as a result of CEPP implementation. To address the requirements of the WRDA 2000 Savings Clause, the recommended plan identifies an additional source of water of comparable quantity and quality available to replace the water that will be transferred to WCA 3. However, this replacement source is dependent on implementation of another CERP project (Indian River Lagoon-South - C-44 Reservoir/STA). This transfer, if actualized, would not occur until the C-44 Reservoir, the canal connecting it to the C-23 Canal, and the A-2 FEB are built and operating. Since recommended plan implementation involves other system-wide operations changes, water managers for the Corps and the SFWMD will continue to evaluate system-wide operations as conditions change, such as Herbert Hoover Dike rehabilitation and implementation of other CERP projects including the Indian River Lagoon - South project to determine if changing conditions warrant changes to system-wide operations. Under Corps regulations, such operations changes require notifying the public, evaluating the effects of proposed alternatives, preparation and coordination of proposed revisions to water control manuals, and other requirements, as applicable.

WATER QUALITY AND EFFECTS ON STATE FACILITIES

The recommended plan depends on water quality treatment facilities owned and operated by the SFWMD (STAs 2 and 3/4) and is integrated with the yet-to-be constructed A-1 FEB included in SFWMD's "Restoration Strategies" project. To achieve restoration objectives for WCA 3A, the recommended plan involves discharges from these STAs to WCA 3A. Concerns were expressed about the effects of the new discharges on water quality and native flora and fauna in WCA 3A. Discharges into WCA 3A must meet State water quality standards before discharges to un-impacted areas occur. To ensure that the recommended plan meets State water quality standards, NPDES discharge permits and Everglades Forever Act Watershed permits with associated effluence limits will govern the Stormwater Treatment Area discharges from State facilities.

The recommended plan also increases flows into Shark River Slough in ENP subject to the limits for total phosphorus contained in Appendix A of the 1991 Settlement Agreement for U.S. vs. SFWMD (Case No. 88-1886-Civ-Moreno) and in accordance with State water quality standards. Since the compliance determination calculation is inversely proportional to flow, increases in flow will lower the compliance limit. State and Federal water managers expressed concerns that the recommended plan may increase the probability of exceeding the compliance limit and agreed to consider re-evaluating the Shark River Slough compliance calculation. Based upon current and best available technical information, the Federal parties believe at this time that the State Restoration Strategies, implemented in accordance with the State issued Consent Order and other joint restoration projects, are sufficient and anticipated to achieve water quality requirements for existing flows to the Everglades.

EFFECTS ON ENDANGERED SPECIES

To achieve restoration objectives, the recommended plan increases the amount of water delivered into areas inhabited by endangered species, including the critically-endangered CSSS. USFWS supports the recommended plan and is independently developing measures, outside the scope of CEPP, to improve the number and distribution of sparrows, but expressed concerns about operations during nesting periods and effects on sparrow habitat. During the detailed design phase, USFWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable RPMs and TC). Upon completing ESA Section 7 consultation for each PPA, the Corps will undertake the agreed-to avoidance and minimization measures and implement any applicable TCs.

EFFECTS OF INVASIVE SPECIES ON THE SOUTH FLORIDA ECOSYSTEM

South Florida contains numerous harmful invasive plant and animal species that have the potential to significantly alter ecological communities throughout the region. Concerns have been expressed that hydrologic restoration efforts to improve the greater Everglades, including the CEPP, may be ineffectual if invasive plant and animal species continue to spread and overtake natural communities of plants and animals. Scientists generally agree that restoring natural system processes and managing those areas provide greater resilience to threats posed by invasive species.

CLIMATE CHANGE

Although the magnitude of the effects of climate change, including rising sea levels, temperature changes, and changing rainfall patterns is uncertain, it is generally acknowledged that climate change will affect both natural system and human environmental conditions in south Florida during the next century. Although the CERP was formulated in 1999 to address declining conditions in the greater Everglades ecosystem and restoration of ecological functions without the benefit of the current level of understanding about possible climate change effects, scientists and agency water managers agree that implementation of the plan will provide an important adaptation response for both the natural system and the human environment considering future climate change scenarios. As the mean tide level increases, the additional water from CEPP will provide a buffer of freshwater that will limit salinity related impacts to freshwater wetland vegetation, reduce peat soil degradation, and impede saltwater intrusion into the groundwater aquifer. The effects of sea level change have been analyzed per Engineering Circular 1165-2-212. This analysis looked at the effect of sea level change on the benefits predicted for the recommended plan. The results indicate that within a 50-year planning horizon the average annual net project benefits are likely to be reduced by less than 8 percent in comparison to the projected net annual average project benefits estimated assuming no sea level rise. This relatively moderate decrease in average annual project benefits occurs largely because of closely matching habitat losses that would occur under the future without project condition.

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1.0 INTRODUCTION

Please open the foldout figure at the end of this section to reference while reading.

The Everglades ecosystem has been altered from 120 years of highly effective efforts to drain water off the land. As a result, south Florida, including the remaining Everglades ecosystem, no longer exhibit the functionality, richness, and spatial extent that historically defined the pre-drainage system. Direct land impacts due to development and farming of natural areas has reduced the spatial extent by almost 50% and the ecosystem of south Florida has been largely impacted as a result of water management activities intended to control flooding and provide water supply to those developed and agricultural areas (**Figure 1-1**).

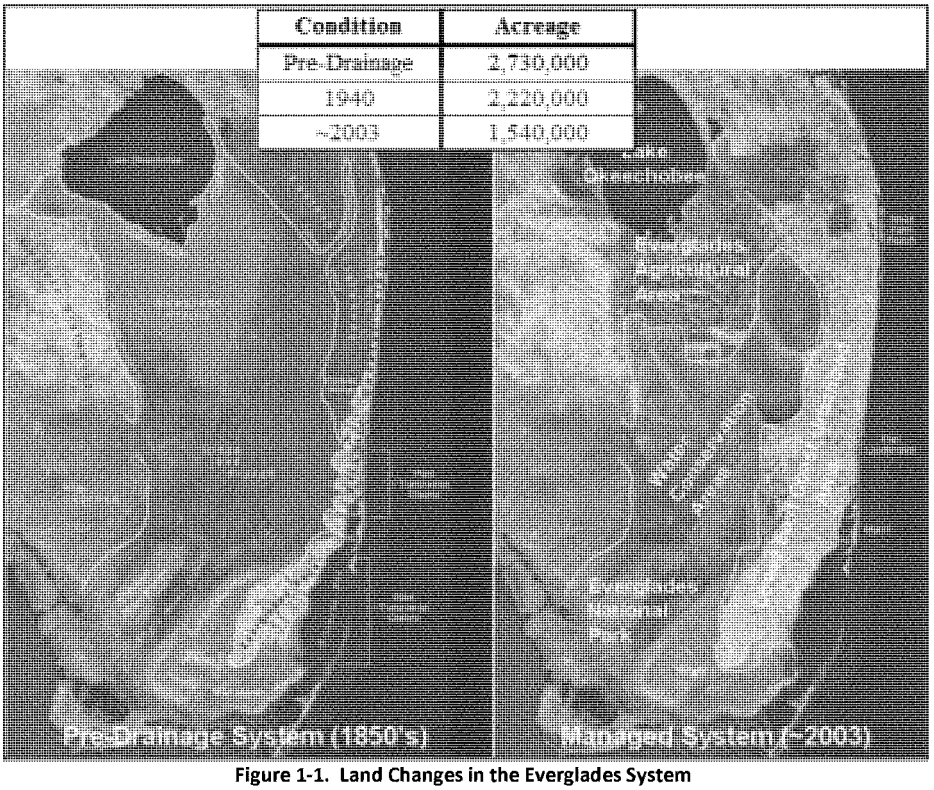


Figure 1-1. Land Changes in the Everglades System

Water that once flowed from Lake Okeechobee south through the Everglades, down Shark River Slough (SRS), and to the Southern Estuaries has been impounded in the lake and discharged to the Northern Estuaries (i.e., Caloosahatchee and St. Lucie Estuaries) via regulatory releases through the C-43 and C-44 canals. Prolonged high volume discharges of water from Lake Okeechobee to the Northern Estuaries coupled with excessive nutrient concentrations in Lake Okeechobee water and downstream basin water have resulted in great damaging effects on the plants and animals inhabiting these areas. The damage

can take years to recover and negatively affects the economy of the area. Conversely, the reduction in flows that traditionally reached the Everglades have resulted in landscape pattern changes, peat loss, tree island losses and flora and fauna changes within the greater Everglades landscape and negative changes in salinity patterns and its resultant effects on estuarine species and habitats in Florida Bay.

1.1 PROJECT PURPOSE AND NEED

The Central Everglades Planning Project (CEPP) is encompassed in the Comprehensive Everglades Restoration Plan (CERP), which was approved by Congress as a framework for the restoration of the natural system under Section 601 of the Water Resources Development Act of 2000 (WRDA 2000). The CERP, as documented in the 1999 Central and Southern Florida (C&SF) Project Comprehensive Review Study Final Integrated Feasibility Report and Programmatic Environmental Impact Statement (Yellow Book), consists of 68 different components. The purpose of the CERP is to modify structural and operational components of the C&SF Project to achieve restoration of the Everglades and the south Florida ecosystem, while providing for other water-related needs such as urban and agricultural water supply and flood protection. The 68 components identified in the Yellow Book will work together to benefit the ecological structure and function of more than 2.4 million acres of the south Florida ecosystem by improving and/or restoring the proper quantity, quality, timing and distribution of water in the natural system. The CERP will also address other concerns such as urban and agricultural water supply and maintain existing levels of service for flood protection in those areas served by the project. The CERP components were originally planned for implementation over an approximate 40 year period. The CERP is designed to achieve more natural flows by re-directing current flows that are currently discharged to the Atlantic Ocean and Gulf of Mexico, to a more restored flow of water that is distributed throughout the system similar to pre-drainage conditions (**Figure 1-2** and **Figure 1-3**).

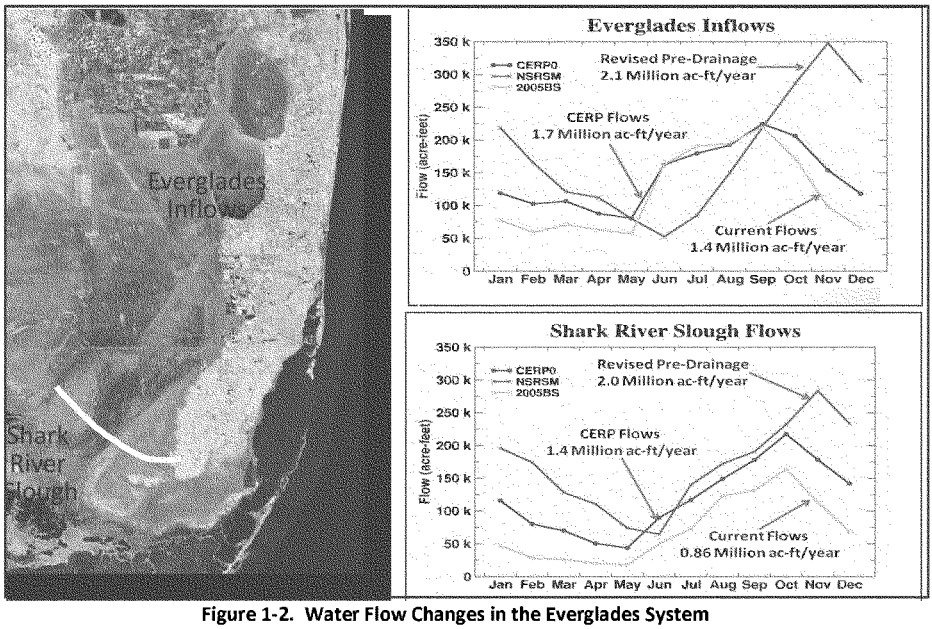


Figure 1-2. Water Flow Changes in the Everglades System

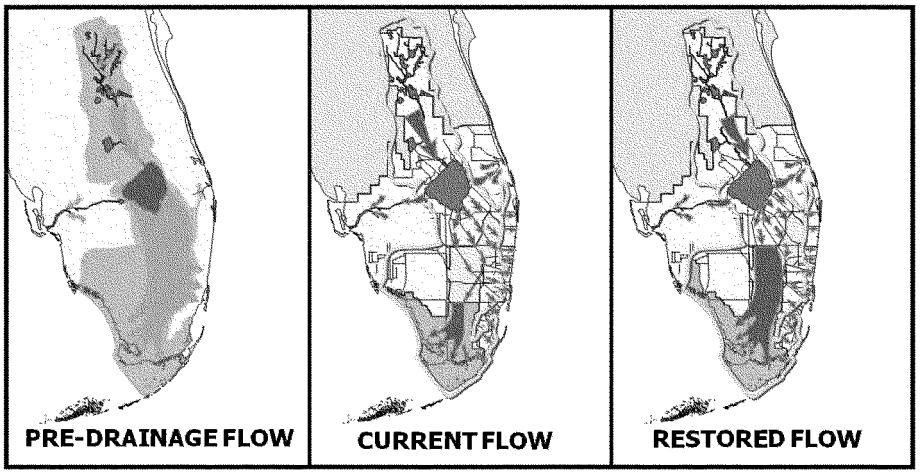


Figure 1-3. Pre-drainage, Current, and Restored Flows to Illustrate CERP Restoration

Since the CERP was approved, three projects were authorized in the 2007 WRDA and proceeded into construction (Indian River Lagoon-South, Picayune Strand, and Site 1 Impoundment) and a fourth project, Melaleuca and Other Exotic Plants Biological Controls, was implemented under the programmatic authority in WRDA 2000. Despite this progress, ecological conditions and functions within the central portion of the Everglades ridge and slough community continue to decline due to lack of sufficient quantities of freshwater flow into the central Everglades and timing and distribution problems. To respond to this concern, the U.S. Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD) initiated the CEPP in November 2011 to evaluate alternatives for restoring ecosystem conditions in the central portion of the Everglades and opportunities for providing for other water-related needs in the region.

The purpose of the CEPP is to improve the quantity, quality, timing and distribution of water flows to the Northern Estuaries, central Everglades (Water Conservation Area 3 [WCA 3] and Everglades National Park [ENP]), and Florida Bay while increasing water supply for municipal, industrial and agricultural users. Too much water from Lake Okeechobee during the wet season, and too little water during the dry season impacts salinity levels within the Northern Estuaries, stressing estuarine ecosystems. Construction and operation of the WCAs compartmentalized a significant extent of the historical Everglades landscape and in turn degraded the structure and function of the remaining system. As a result, the Everglades are approximately half their original size, water tables are lowered, wetlands altered, freshwater flows diverted, water quality degraded, and habitats invaded by non-native plants and animals. All of these impacts are caused directly or indirectly by changes in hydrology. Changes in hydrology have led to the degradation of the historic slough, tree island and sawgrass mosaic that previously characterized much of the study area, as well as the marl prairies that exist in the southern portion of the area in ENP. The changes in the landscape pattern have had adverse effects on wildlife. Changes in hydrology of the freshwater systems have led to effects on the estuarine and marine environments of Florida Bay. Alterations in seasonal inflow deliveries to Florida Bay have resulted in extreme salinity fluctuations. The already degraded state of the Everglades will continue to worsen in the absence of increased water deliveries, improved water timing and restored distribution. Redirecting

a portion of the approximately 1.7 billion gallons of water per day on average that is discharged to the Atlantic Ocean and the Gulf of Mexico is essential to meeting the quantity, quality, timing and distribution of water required to realize a portion of the benefits envisioned in the CERP.

1.2 SCOPE OF STUDY

The CEPP is composed of increments of project components that were identified in the CERP, reducing the risks and uncertainties associated with project planning and implementation. The term "increment" is used to underscore that this study will formulate portions (scales) of individual components of the CERP. It is envisioned that later studies will investigate additional scales of components of the CERP to expand upon this initial "increment" to achieve the level of restoration envisioned for the CERP. This study approach is consistent with the recommendations from the National Research Council to utilize Incremental Adaptive Restoration to both achieve timely, meaningful benefits of the CERP and to lessen the continuing decline of the Everglades ecosystem.

Prior planning efforts and the development of scientific goals and targets for the CERP have led to a determination that some components are interdependent features that necessitate formulation from a systems approach. Recently authorized CERP projects generally do not greatly depend upon or influence other CERP projects. However, the components in the central part of the Everglades (interior CERP projects) are hydrologically connected from Lake Okeechobee to Florida Bay, and the downstream areas are reliant on the upstream areas for flows. These interdependencies require system plan formulation and analysis in order to optimize structural and operational components, rather than formulating separable components that may not be compatible when looking at them cumulatively.

The scope of the CEPP considered increments of the following components that were part of the CERP:

- Everglades Agricultural Area Storage Reservoirs (G)
- Modified Holey Land Wildlife Management Area Operation Plan (DD)
- Flow to Northwest and Central WCA 3A (II)
- WCA 3 Decompartmentalization and Sheetflow Enhancement (AA, QQ and SS)
- Dade-Broward Levee/Pennsuco Wetlands (BB)
- Bird Drive Recharge Area (U)
- L-31N Improvements for Seepage Management and S-356 Structures (V and FF)
- Everglades Rain-Driven Operations (H)

Since approval of the CERP in WRDA 2000, important advances in scientific understanding and evaluation tools have occurred that will contribute towards restoration success. Information from paleo-ecological indicators and pre/post drainage information gives us a better understanding of the evolution of the Everglades ecosystem. More recently, extensive planning and scientific investigations conducted as part of Restoration Coordination and Verification (RECOVER), adaptive monitoring and assessment, and formulation and evaluation of the first and second generation CERP projects has greatly increased scientific knowledge and understanding of the historic system, the current system, and the actions needed to restore the ecosystem. Application of this knowledge has improved the capability to plan and design for restoration of the desired central Everglades ecosystem.

1.3 STUDY AREA

The study area for the CEPP encompasses the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), Lake Okeechobee, the Everglades Agricultural Area

(EAA), the Water Conservation Areas (specifically WCAs 2 and 3); ENP, the Southern Estuaries (specifically focused on Florida Bay), and portions of the Lower East Coast (LEC) (See foldout map at end of section and **Table 1-1**). Adjacent areas were also evaluated. For purposes of this study, the term Greater Everglades is defined as the region encompassing WCA 3 and ENP.

Table 1-1. Description of the CEPP Study Area

CEPP Study Area Region	Description of the Study Area Region
Lake Okeechobee	Lake Okeechobee is a large, shallow lake (surface area 730 square miles) 30 miles west of the Atlantic coast and 60 miles east of the Gulf of Mexico. It is impounded by a system of levees, with 6 outlets: St. Lucie Canal eastward to the Atlantic Ocean, Caloosahatchee Canal/River westward to the Gulf of Mexico, and four agricultural canals (West Palm Beach, Hillsboro, North New River and Miami). The lake is surrounded by the 143 mile long Herbert Hoover Dike. The lake has many functions, including flood risk management, urban and agricultural water supply, navigation, recreation, fisheries, and wildlife habitat. It is critical for flood control during wet seasons and water supply during dry seasons. Agriculture in the Lake Okeechobee Service Area (LOSA), including the EAA, is the predominate user of lake water. The lake is an economic driver for both the surrounding areas' and south Florida's economy.
Northern Estuaries	Lake Okeechobee discharges into the 2 Northern Estuaries. The St. Lucie Canal flows eastward into the St. Lucie Estuary, which is part of the larger Indian River Lagoon Estuary. The Caloosahatchee Canal/River flows westward into the Caloosahatchee Estuary and San Carlos Bay, which are part of the larger Charlotte Harbor Estuary. The St. Lucie and Caloosahatchee estuaries are designated Estuaries of National Significance, and the larger Indian River Lagoon and Charlotte Harbor estuaries are part of the U.S. Environmental Protection Agency (USEPA)-sponsored National Estuary Program. The landscape includes pine-flatwoods, wetlands, mangrove forests, submerged aquatic vegetation, estuarine benthic areas (mud and sand) and near-shore reefs.
Everglades Agricultural Area	The EAA is approximately 630,000 acres in size and is immediately south of Lake Okeechobee. Much of this rich, fertile land is devoted to sugarcane production, and is crossed by a network of canals that are strictly maintained to manage water supply and flood protection. The landscape includes natural and man-made areas of open water such as canals, ditches, and ponds, wetlands, and lands associated with agricultural and urban use. Within the EAA there is approximately 45,000 acres of stormwater treatment areas (STAs) and the Holey Land and Rotenberg Wildlife Management Areas.
Water Conservation Areas	WCA 2 and, WCA 3 (the largest of the three) are situated southeast of the EAA and are approximately 1,328 square miles. The WCAs extend from EAA to ENP. They provide floodwater retention, water supply for urban and agricultural uses, and are the headwaters of ENP. The landscape includes open water sloughs, sawgrass marshes, and tree islands.
Everglades National Park	ENP was established in 1947, covering ~2,353 square miles (total elevation changes of only 6 feet from its northern boundary at Tamiami Trail south to include much of Florida Bay). The landscape includes sawgrass sloughs, tropical hardwood hammocks, mangrove forest, lakes, ponds, and bays.
Florida Bay	Florida Bay is a shallow estuarine system (average depth less than 3 feet) comprising a large portion of ENP. It is the main receiving water of the greater Everglades, heavily influenced by changes in timing, distribution, and quantity of freshwater flows into the Southern Estuaries. The landscape includes saline emergent wetlands, seagrass beds, and mangrove forests.
Lower East Coast	The LEC encompasses Palm Beach, Broward, Monroe and Miami-Dade Counties. Water levels in this area are highly controlled by the C&SF water management system to provide flood damage reduction and sufficient water supply to minimize the risk of detrimental saltwater intrusion. Biscayne Bay and the contiguous water bodies of Card, Little Card, and Barnes Sounds and Manatee Bay lie along the southeastern mainland boundary of the LEC and receive their freshwater supplies as inflows of surface and groundwater that are

CEPP Study Area Region	Description of the Study Area Region
	dependent on water table stages east of L-31 N. The CEPP is focused on the portions of the LEC adjacent to the natural areas and susceptible to seepage.

1.4 PROBLEMS AND OPPORTUNITIES

Current operations of the C&SF Project involve water supply and flood releases to manage stage levels in Lake Okeechobee, the WCAs, and the Everglades. Prolonged high volume discharges of water from Lake Okeechobee to the Northern Estuaries coupled with excessive nutrient concentrations in Lake Okeechobee water and downstream basin water have resulted in damaging effects on the plants and animals inhabiting these areas. System changes have resulted in point source peak flows that are higher just prior to and/or following major rain events, and flow rates that decline more abruptly during the end of the wet season. Due to limited storage capacity and water quality treatment requirements, flows to the Everglades from Lake Okeechobee have shifted from primarily wet season flows in response to rainfall to controlled dry season deliveries in response to urban and agricultural water demands. The impoundment of the natural system, construction of drainage canals and conveyance features, and current C&SF operations have disrupted the annual pattern of rising and falling water depths in the remaining wetlands. These hydrologic changes have contributed to degradation and loss of valuable tree islands. The current system is now too wet in some areas and too dry in others.

Additionally, the conversion of natural areas for urban and agricultural uses and the network of C&SF Project canals have altered the natural system, causing complete shifts in vegetative communities and loss of fish and wildlife resources. The result is reduced water storage capacity in the remaining natural system and an unnatural mosaic of impounded, fragmented, over-inundated and over-drained marshes.

1.4.1 Lake Okeechobee and the Northern Estuaries

Drainage for urban and agricultural development in the Caloosahatchee and St Lucie basins has increased the volume and altered the timing of local basin discharges to the river and estuary. In many cases, these increased flows precede regulatory releases from Lake Okeechobee and introduce large amounts of undesirable floodwaters westward to the Caloosahatchee River and Estuary, and eastward to the St. Lucie River and Estuary and southern Indian River Lagoon. Both Northern Estuaries can suffer from insufficient dry season flows, but this is a chronic phenomenon in the Caloosahatchee Estuary. Changes in the quantity, quality, timing and distribution of freshwater entering the estuaries lead to abnormal salinity fluctuations. Submerged aquatic vegetation in these estuaries are stressed, and in some areas have been reduced or eliminated by salinity fluctuations, turbidity, sedimentation, nutrient enrichment, and severe algal blooms. A reduction in the size and health of submerged aquatic vegetation (SAV) beds effects the location, abundance, and species richness of fisheries in the estuary. Severe algal blooms can result in ulcerated fish and fish kills. Flows less than 450 cubic feet per second (cfs) in the Caloosahatchee River Estuary are considered undesirable since these flow levels allow salt water to intrude, raising salinity above the tolerance limits for communities of submerged aquatic plants (tape grass [*Vallisneria americana*]), in the upper estuary. The distribution of oysters in these estuaries has been severely limited because of the freshwater pulses that cause low salinity conditions and degradation of substrate needed for colonization and growth. Based on the salinity tolerances of oysters, flows less than 350 cfs in the St. Lucie Estuary result in higher salinities at which oysters are susceptible to increased predation and disease. Submerged aquatic vegetation and oyster reefs are important habitats for fish and other organisms and contribute to ecological values. Estuaries also contribute socio-economic value via fisheries and recreation. For further information on where target

flows are measured with respect to regional hydrologic modeling, please refer to **Appendix G (Benefit Model)**.

1.4.2 Water Conservation Area 3

In response to expansive sheetflow from Lake Okeechobee, seasonal rainfall and periodic fire, the pre-drainage landscape of WCA 3 consisted of a complex mosaic of vegetative habitats interspersed on the flat peat bed that had accumulated for 5,000 years. Construction and operation of the C&SF Project has had unintended and adverse effects on the ecosystems of WCA 3 which continues to decline.

The northern end of WCA 3A has been over-drained and the natural hydroperiods for WCA 3A have been shortened. Hydrologic changes have resulted in the loss of the ridge and slough landscape that was characteristic of the area historically and prior to construction of the C&SF Project. This has resulted in a loss of land surface elevations, principally through soil oxidation and peat fires, as shown in **Figure 1-4**. This figure displays a minimum and maximum estimation of change in elevation as a difference in land surface elevations from 1946 to the land surface elevations surveyed in 1996 (Scheidt, et al. 2000). Since the 1946 peat thickness was reported in 2-foot intervals, soil volume differences from 1946 to 1996 are presented as a range. Calculation of soil loss during that 50-year period indicate that northern WCA 3A lost between 39% and 65% of its organic soils.

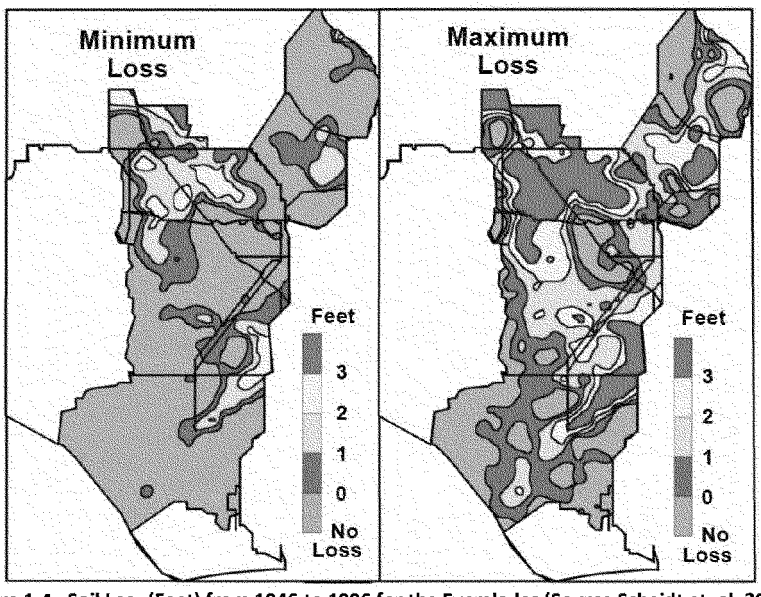


Figure 1-4. Soil Loss (Feet) from 1946 to 1996 for the Everglades (Source Scheidt et. al. 2000)

Currently, northern WCA 3A is largely dominated by sawgrass, cattail and scattered shrubs, and lacks the natural structural diversity of plant communities seen in central and western WCA 3A as can be seen in **Figure 1-5** and **Figure 1-6**.

Northern WCA 3A has lost the landscape pattern characteristic of the ridge-slough-tree island mosaic as can be seen in **Figure 1-6**. The vegetation image compared to the image on the right side of the figure showing historic ridge and slough patterning clearly displays the impacts caused by lack of sheetflow, water depths and inundation durations. Decreased hydroperiods in northern WCA 3A have allowed major peat fires that have changed much of the ridge and slough topography in northern WCA 3 into cattail, willow, or sawgrass mix (Rutchey 2010).

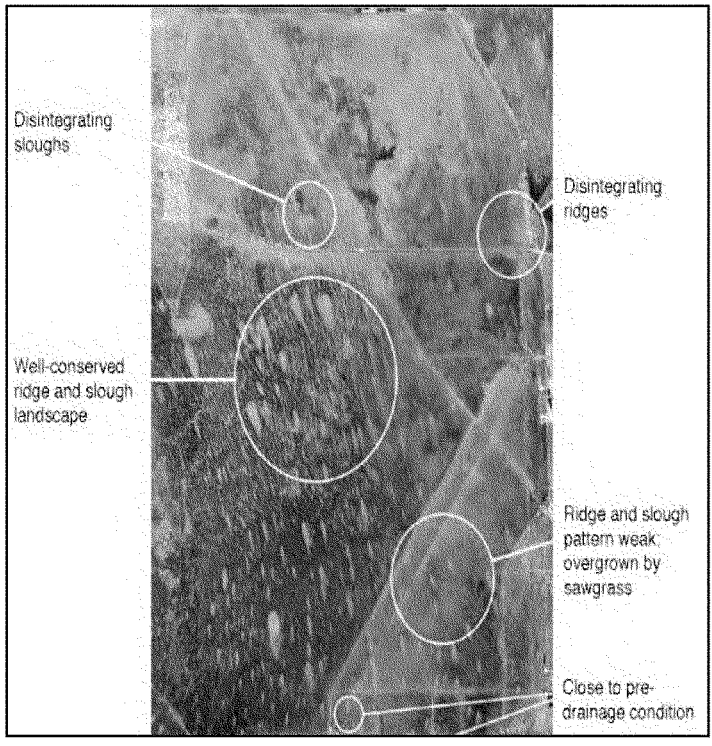


Figure 1-5. WCA 3A and 3B Ecological Conditions

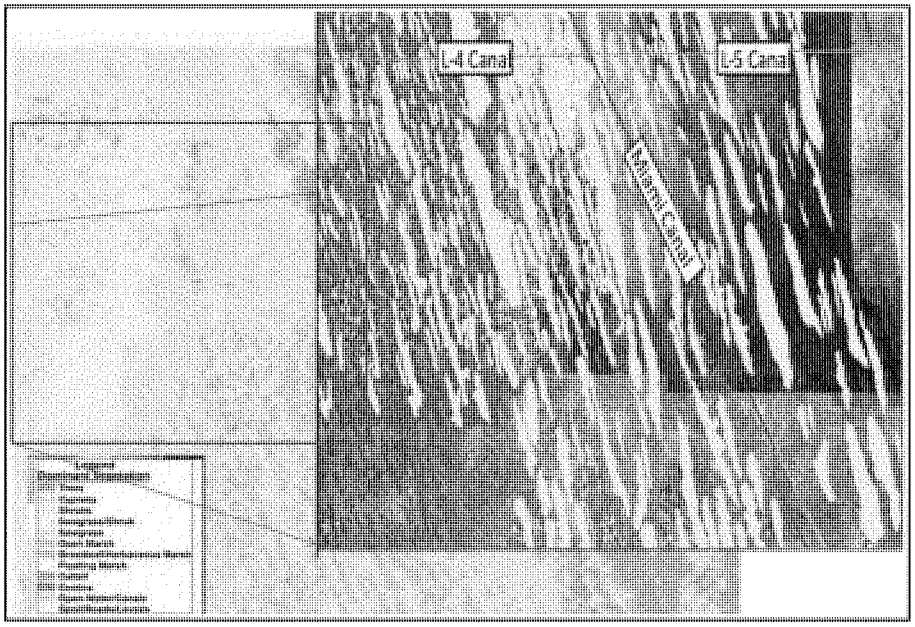


Figure 1-6. Dominant Vegetation and Current and Historic Landscape Patterns in Northern WCA 3A. The image in the background (left) shows the 2004 dominant vegetation in northern WCA 3A. The image in the foreground (right) is a zoomed-in image of the area with a shading representing locations of historic ridges that are no longer apparent in the 2004 vegetation.

Vegetation and patterning in the central portion of WCA 3A resembles the pre-drainage conditions most closely (McVoy, et al. 2011) and represents some of the best examples of Everglades habitat left in south Florida. This region of the Everglades appears to have changed little since the 1950s (which was already post-drainage) and contains a mosaic of tree islands, wet prairies, sawgrass stands, sawgrass ridges, and aquatic sloughs similar to those reported by Loveless (1959). The southern portion of WCA 3A is primarily affected by high water, lack of seasonal variability and prolonged periods of inundation created by impoundment structures (i.e., the L-67A/C and L-29 levees).

Increased hydroperiods within southern WCA 3A have negatively impacted tree islands and caused fragmentation of the sawgrass ridges, again resulting in the loss of historic landscape patterning.

Within WCA 3B, the ridge-slough-tree island structure has been severely compromised by the virtual elimination of overland sheetflow since the construction of the L-67 Canal/Levee system in the early 1960s. WCA 3B has become primarily a rain-fed compartment, experiencing very little overland flow; it has largely turned into a sawgrass monoculture, where relatively few sloughs or tree islands remain. **Figure 1-7** shows tree island loss from 1940 to 1995 in WCA 3 (Rutchey 2010).

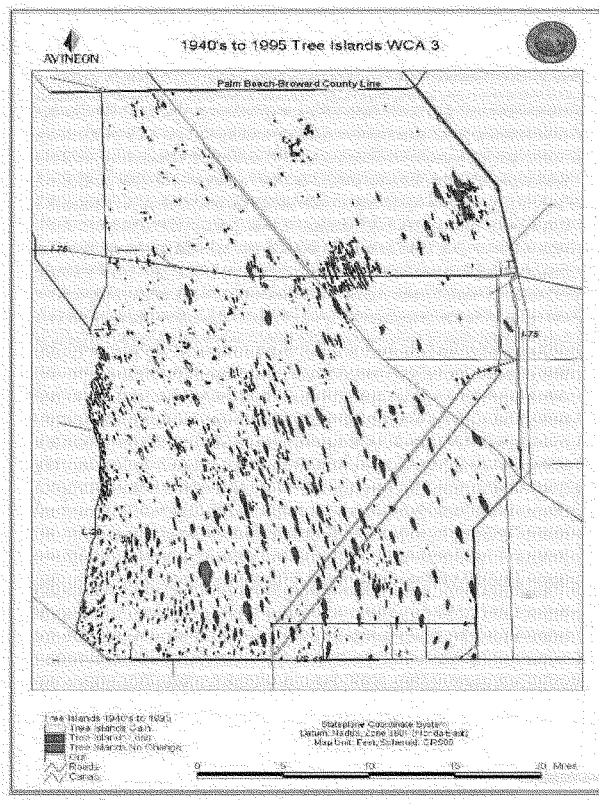


Figure 1-7. Tree Island Loss in WCA 3 from 1940 to 1995

1.4.3 Everglades National Park

ENP experiences many of the same issues that occur within WCA 3. One significant problem is the extreme dry downs that occur during many dry seasons. Although typically there is reduced rainfall during the dry season, the historic Everglades system did not experience water levels that fell below ground surface for long periods. Currently, the limited capability to store and treat Lake Okeechobee outflows for delivery to the Everglades, current C&SF operations, and water loss through seepage along the eastern levees cause these extreme dry downs to occur, resulting in substantial peat subsidence and muck fires. The USEPA found that in the 50 years from 1946-1996, more than 3 feet of peat soil was lost from the Northeast Shark River Slough (NESRS) and eastern WCA 3B due to soil oxidation and peat fires (Scheidt et al. 2000). The subsidence and fires damage the substrate, limit water retention, and alter vegetative communities. The dry downs have reduced the number of prey species that used to be available in the deepwater refugia, causing detriment to breeding populations of wading birds.

1.4.4 Florida Bay

Florida Bay is a shallow estuarine system comprising a large portion of ENP. Freshwater inflow to Florida Bay has decreased in volume, and has changed in timing and distribution during the twentieth century because of water management practices. This has resulted in increased salinities in the bay (Rudnick et. al. 2005). Hydrologic alteration began in the late 1800s but accelerated with construction of drainage canals by 1920, the Tamiami Trail by 1930, and the C&SF Project and the South Dade Conveyance System from the early 1950s through 1980 (Light and Dineen 1994). The magnitude of this salinity increase, as well as the amount of freshwater inflow loss associated with this salinity change, has been estimated by Marshall et al. (2009) and Marshall and Wingard (2012). Bay salinity has increased by 5 parts per thousand (ppt) to 20 ppt across a wide range of bay sites. These studies also estimated that pre-drainage flows to the bay down Taylor Slough were roughly 4 times greater than present flows and these flows down SRS were roughly 2 times greater than present flows. Associated pre-drainage stages were about 30% higher in SR5 than present and more than double current stages in Taylor Slough. Decreased input of freshwater flow from the Everglades and associated increases in salinity are thought to be the primary causes of ecological changes within the bay including mass mortality of turtle grass (*Thalassia testudinum*) and reductions in fish (e.g. spotted seatrout, *Cynoscion nebulosus*) and catches of pink shrimp (*Farfantepenaeus duorarum*) (Rudnick et.al. 2005).

1.4.5 Water Supply

The C&SF project is a multi-purpose project that includes providing water supply to meet municipal, industrial, and agricultural uses. Drainage, water supply, and flood protection afforded by the C&SF Project have provided for the growth of south Florida's population. In south Florida's LEC, groundwater from the surficial aquifer system is the predominant source of water for municipal and industrial uses. User's reliance on water from alternative sources such as the Floridan aquifer, reuse and other sources has grown significantly and is expected to increase because of population growth and possible rainfall decreases and evapotranspiration increases due to climate change. Lake Okeechobee is an important source of water to both natural and developed areas, particularly during low rainfall years. The growing demand for dependable water for agriculture, industry, and municipal water supply at a reasonable cost could exceed the limits of readily accessible sources during the planning horizon. When the needs of the region's natural systems are factored in, conflicts for water among users will become more severe.

1.4.6 Recreation

Tourism is a "critical industry", as identified by the Governor's Commission for a Sustainable South Florida Initial Report (1995). A healthy ecosystem and its attendant tourism are the mainstays of the regional economy, as reflected by the relative domination of economic activity there in the services,

retail trade, and fisheries industries. Many Floridians also visit the natural areas regularly to enjoy a variety of outdoor activities, primarily hunting and fishing. The ability to sustain the region's economy and quality of life depend, to a great extent, on the success of the efforts to protect and better manage the region's water resources. A stable and healthy environment will directly benefit the local economy through increases in tourism and dollars generated by the residents who enjoy outdoor activities.

1.5 PURPOSE: OBJECTIVES AND CONSTRAINTS

1.5.1 CERP and CEPP Goals and Objectives

Section 601(h) of WRDA 2000 states "[*t*]*he overarching objective of the Plan is the restoration, preservation, and protection of the South Florida Ecosystem while providing for other water-related needs of the region, including water supply and flood protection*". These same objectives apply to the CEPP study efforts (**Table 1-2**).

Table 1-2. Goals and Objectives of CERP and CEPP

CERP Goal: Enhance Ecological Values	
CERP Objective	**CEPP Objective**
Increase the total spatial extent of natural areas	No corresponding CEPP objective; consider this objective in future increments
Improve habitat and functional quality	Restore seasonal hydroperiods and freshwater distribution to support a natural mosaic of wetland and upland habitat in the Everglades System
	Improve sheetflow patterns and surface water depths and durations in the Everglades system in order to reduce soil subsidence, the frequency of damaging peat fires, the decline of tree islands, and salt water intrusion
	Reduce high volume discharges from Lake Okeechobee to improve the quality of oyster and SAV habitat in the northern estuaries
Improve native plant and animal species abundance and diversity	Reduce water loss out of the natural system to promote appropriate dry season recession rates for wildlife utilization
	Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function
CERP Goal: Enhance Economic Values and Social Well Being	
Increase availability of fresh water (agricultural/municipal & industrial)	Increase availability of water supply
Reduce flood damages (agricultural/urban)	No corresponding CEPP objective; consider this objective in future increments
Provide recreational and navigation opportunities	Provide recreational opportunities
Protect cultural and archeological resources and values	Protect cultural and archeological resources and values

1.5.2 Constraints

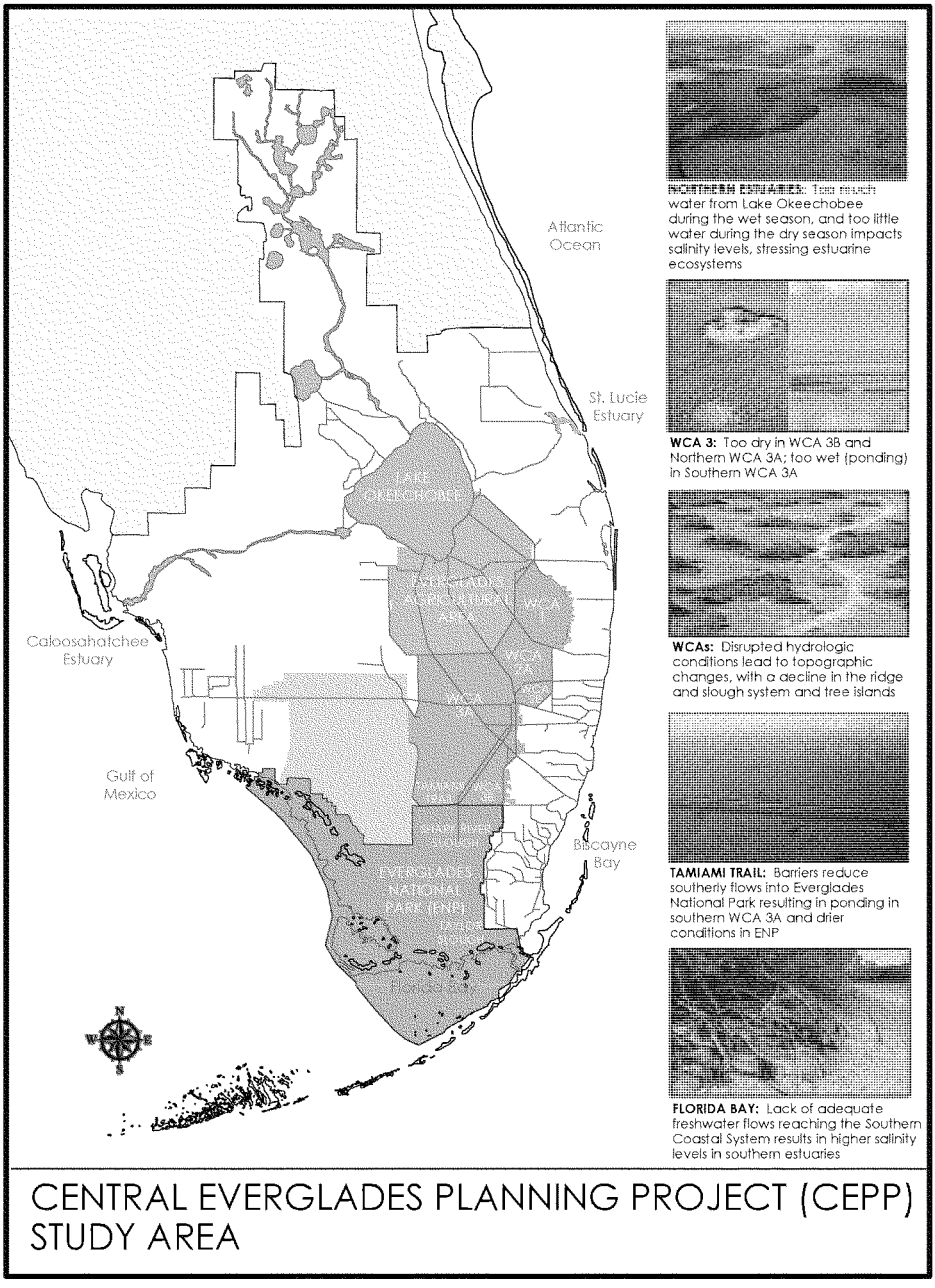
Project constraints were recognized to ensure that the proposed project would not reduce the level of service for flood protection, protect existing legal users, and meet applicable water quality standards for the natural system. When a project is expected to result in an elimination or transfer of an existing legal source of water, the Project Implementation Report (PIR) shall include an implementation plan that ensures a new source of water of comparable quantity and quality is available to replace the source that is being transferred or eliminated. Implementation of the project will not reduce the levels of service for flood protection within the areas affected by the project.

WRDA 2000 requires the inclusion of "Savings Clause" analyses within each CERP PIR. The "Savings Clause" protects existing legal sources of water supply, such as water for municipal and agricultural uses, and ensures that CERP implementation does not reduce the level of service for flood protection. In accordance with Section 601(h)(4) and (5) of WRDA 2000 the following are constraints for CEPP implementation:

- Avoid reduction in the existing level of service for flood protection caused by Plan implementation
- Provide replacement sources of water of comparable quantity and quality for existing legal sources that could experience water supply reductions caused by Plan implementation
- Meet applicable Water Quality Standards

1.6 REPORT AUTHORITY

The WRDA of 2000 approved the CERP as a framework for modifications to the C&SF Project in Section 601(b)(1)(A). The CEPP PIR will be submitted in compliance with Section 601(d) WRDA 2000, titled 'Authorization of Future Projects'.



NORTHERN ESTUARIES: Too much water from Lake Okeechobee during the wet season, and too little water during the dry season impacts salinity levels, stressing estuarine ecosystems

WCA 3: Too dry in WCA 3B and Northern WCA 3A; too wet (ponding) in Southern WCA 3A

WCAs: Disrupted hydrologic conditions lead to topographic changes, with a decline in the ridge and slough system and tree islands

TAMIAMI TRAIL: Barriers reduce southerly flows into Everglades National Park resulting in ponding in southern WCA 3A and drier conditions in ENP

FLORIDA BAY: Lack of adequate freshwater flows reaching the Southern Coastal System results in higher salinity levels in southern estuaries

CENTRAL EVERGLADES PLANNING PROJECT (CEPP) STUDY AREA

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2.0 EXISTING AND FUTURE WITHOUT CONDITIONS

Please open the foldout figure at the end of this section to reference while reading.

This section provides a description of existing and future without (FWO) project conditions within the study and a definition of the FWO project condition and how and why it is developed.

2.1 "WITH" AND "WITHOUT" COMPARISONS

The U.S. Water Resources Council's *Principles and Guidelines* provide the instructions and rules for Federal water resources planning. One *Principles and Guidelines* requirement is to evaluate the effects of alternative plans based on a comparison of the most likely future conditions with and without those plans in place. In order to make this type of comparison, descriptions (often called forecasts) must be developed for two different future conditions: the FWO project condition and the future with project condition. Note that the project referred to in this context is any one of the alternative plans that have been considered in the study. The FWO project condition describes what is assumed to be in place if none of the study's alternative plans are implemented. The FWO project condition is the same as the alternative of "no action" that is required to be considered by the Federal regulations implementing the National Environmental Policy Act (NEPA) of 1969. For consistency of the report, the **No Action Alternative** is referred to as the **FWO** for the remainder of the report. The future with project condition describes what is expected to occur as a result of implementing each alternative plan that is being considered in the study. The differences between the future without project condition and the future with project condition are the effects of the project.

2.2 PLANNING HORIZON

The planning horizon encompasses the Planning Study period, construction period, economic analysis period, and the effective life of the project. The time frame used when forecasting future with and without project conditions while considering impacts of alternative plans is called the period of economic analysis. It may also be referred to as simply the period of analysis. It is the period of time over which scientists think extending the analysis of the plan impacts is important. This time period is frequently confused with the planning horizon, which is a longer and more encompassing concept. **Figure 2-1** shows that the period of analysis is part of the planning horizon.

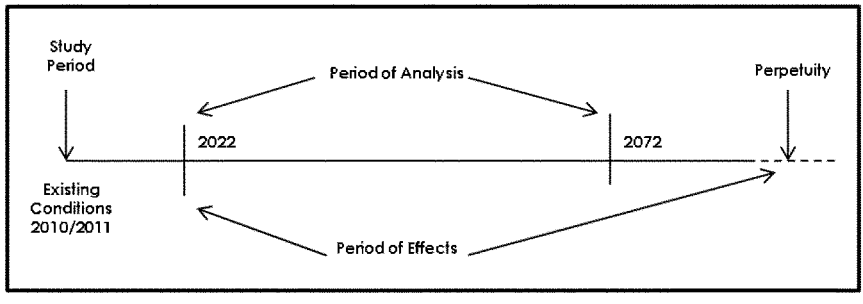


Figure 2-1. Planning Horizon

The period of analysis for water resources projects usually falls between 50 and 100 years. Even if project structures last more than 100 years, there is too much inherent uncertainty to reliably forecast conditions and impacts beyond 100 years. The base year for the period of analysis for the Central

Everglades Planning Project (CEPP) is 2022. The base year assumes an unconstrained implementation timeline in which CEPP will be authorized, designed, and constructed. By incorporating a 50-year period of analysis to reflect beneficial and adverse effects of the project through time, the period of analysis for the proposed project will be 50 years, ending in the year 2072.

The typical period of analysis for Comprehensive Everglades Restoration Plan (CERP) studies differs from traditional studies because of the programmatic requirement to calculate system-wide benefits. In order to accurately predict system needs and project operations for the entire system, all CERP projects have utilized the same ending date for the period of analysis as the most current version of the plan (i.e. the April 1999 "Final Integrated Feasibility Report and Programmatic Environmental Impact Statement" used 2050).

Accounting for the beneficial and adverse effects of CEPP through time is largely based on hydrologic modeling and performance measure evaluation. Extending the ending date out to 2072 will not substantially change the outcome of the analysis since future conditions assume that land use and water supply are fixed at existing condition levels. Land use is fixed since development in the CEPP benefit area (natural areas) is prohibited and potential increases to public water supply allocations in general, have been capped by State rule at the 2006 actual withdrawals (per the Lower East Coast (LEC) water supply plan). The operations projected in the absence of a project would be similar to 2050 estimates, as would the non-CEPP projects that are being implemented since most of these are expected to be complete well prior to 2050. The latest and best available data was used to project the future conditions, including rainfall patterns. Based on the assumptions used for future forecasting, there is little reason to believe that hydrologic conditions in the central Everglades would be substantially different between 2050 and 2072.

2.3 EXISTING AND FORECASTED ECOLOGICAL DESCRIPTION/SETTING

The following describes a summary of the existing and FWO project conditions within the study area. Existing and FWO project conditions are further documented in **Appendix C.1**.

Lake Okeechobee is the largest lake in the southeastern United States and is a central part of the south Florida watershed. Lake Okeechobee receives water from a 5,400 square mile watershed that includes four distinct tributary systems: Kissimmee River Valley, Lake Istokpoga-Indian Prairie/Harney Pond, Fisheating Creek, and Taylor Creek/Nubbin Slough. With the exception of Fisheating Creek, all major inflows to Lake Okeechobee are controlled by gravity-fed or pump-driven water control structures. Lake Okeechobee provides water supply to urban areas, agriculture, and downstream estuarine ecosystems during the dry season (November-May) and is used for flood control during the wet season (June-October). In the Lake Okeechobee Service Area (LOSA), the Okeechobee Utility Authority is the only remaining public water supply (PWS) utility using water directly from Lake Okeechobee. Clewiston, South Bay, Belle Glade, and Pahokee have discontinued the use of Lake Okeechobee as their supply source and use Floridan aquifer water treated by reverse osmosis for all of their PWS since 2008. The Okeechobee Intercoastal Waterway (OIWW) provides economically and politically important commerce between the eastern and western coasts of Florida. The waterway connects the Atlantic Intracoastal Waterway to the Gulf Intracoastal Waterway and is a congressionally authorized project, with depths and operations required for efficient navigation on the system. The authorized Central and Southern Florida (C&SF) project depths for Lake Okeechobee navigation are based on 12.56 feet (ft) National Geodetic Vertical Datum (NGVD).

Under pre-drainage conditions, Lake Okeechobee is thought to have been eutrophic (Steinman et al. 2002) and was considerably deeper and larger (spatially) than it is today (Aumen 1995). Outflows from the lake were largely restricted to sheet flow to the south and east. A southern marsh comprised the northern headwater of the Florida Everglades, with the lake often supplying water during periods of high lake levels or as a result of tropical storms. The historic high and low stages for the lake are estimated at approximately 22.5 ft and 19 ft, respectively (Wright 1911). Historic observations indicate the presence of a substantial sawgrass community located along the western side of the lake suggesting a historic eight month hydroperiod for the area during which soils were saturated with water. Historically, stages within the lake may have risen around two feet above the marsh ground elevation in the wet season and may have fallen up to a foot by the end of the dry season (McVoy et. al. 2005).

Currently, Lake Okeechobee differs from the historic lake in size, range of water depth and connection with other parts of the regional ecosystem. Connecting Lake Okeechobee to the Caloosahatchee River and construction of the St. Lucie Canal in the early 1900s greatly reduced system-wide water storage and sheetflow to the south during drier periods (NRC 2007). Construction of Herbert Hoover Dike (HHD) around the lake reduced the size of Lake Okeechobee's open-water zone by nearly 30 percent, resulting in considerable reductions in average water levels, and produced a new littoral zone within the dike that is only a fraction of the size of the natural one (Aumen 1995, Havens and Gawlik 2005). Today, the lake has a surface area of 730 square miles and is extremely shallow. The lake has an average depth of 8.6 ft (average stages 14.11 ft NGVD) based on the period of record from 1972 to 2012). Composition of vegetative communities within the remaining littoral zone of the lake has changed. They remain essential for the ecological health of the Lake but are stressed by extreme high and low lake levels and by the spread of exotics. Lake Okeechobee has also been the recipient of increasingly excessive inputs of nutrients primarily from agricultural activities in the watershed (Flaig and Havens 1995, Havens et al. 1996). The sustained influx of nutrients has resulted in dramatic undesirable changes in water quality. In the open water or pelagic region of the lake, large algal blooms have occurred which can result in lower dissolved oxygen levels and fish kills. Vast quantities of soft organic, nutrient-laden sediments have accumulated which are easily re-suspended causing Lake Okeechobee to become turbid. Plants have been impacted and in turn, those organisms that utilize plant communities as a food source for habitat have been affected.

The St. Lucie River, which is part of the Indian River Lagoon ecosystem, is located on the east coast of Florida. The St. Lucie River is approximately 35 miles long and has two major forks, the North and the South, that flow together and then eastward to the Indian River Lagoon and Atlantic Ocean at the St. Lucie Inlet. Historically, the St. Lucie River system was a freshwater stream flowing into the Indian River Lagoon. An inlet was dug in the late 1800s by local residents to provide direct access from the Indian River Lagoon to the Atlantic Ocean, thus changing the St. Lucie from a river to an estuary. The St. Lucie Estuary is now connected to Lake Okeechobee by the C-44 canal constructed in the early 1900s. The C-44 canal discharges into the St. Lucie Estuary via the S-80 lock and flow control structure. Other major canals constructed in the watershed include the C-23, C-24, and C-25 canals.

The Caloosahatchee River and Estuary is located on the west coast of Florida. The Caloosahatchee River is the major source of freshwater for the Caloosahatchee Estuary. Alterations to the Caloosahatchee River and watershed over the past century have resulted in a major change in freshwater inflow to the estuary. The Caloosahatchee River was originally a shallow, meandering river with headwaters in the proximity of Lake Hicpochee, near Lake Okeechobee. The Caloosahatchee River is now connected to Lake Okeechobee by the C-43 canal constructed in the early 1900s. Today, the river extends from Lake Okeechobee to San Carlos Bay. The river now functions as a primary canal (C-43) that conveys both

runoff from the Caloosahatchee watershed and releases from Lake Okeechobee. The canal has undergone numerous alterations including channel enlargement, bank stabilization, and a series of three lock and dam structures. The final downstream structure, W.P. Franklin Lock and Dam (S-79), demarcates the beginning of the estuary and acts as a barrier to salinity and tidal action, which historically extended farther east to near the LaBelle area.

Major modifications to the hydrology of the St. Lucie and Caloosahatchee watersheds through water management, including water releases from Lake Okeechobee, along with land-use transformations, increased development, and dredging for navigation, have resulted in alterations within the estuaries. Alterations in the quantity, quality, timing and distribution of fresh water entering the estuary have resulted in adverse ecological impacts in the estuaries. As a result of channelization (C-43 and C-44) and operation of water control structures (S-79 and S-80) freshwater flows into the estuaries tend to be excessive in the wet season and occasionally (St. Lucie Estuary) or chronically (Caloosahatchee) insufficient in the dry season. The estuaries have lost large acreages of both submerged aquatic vegetation (SAV) and oysters due to large fluctuations in salinity caused by excessive freshwater during wet times and a lack of base flow during extremely dry years. There is also a problem with re-colonization in areas where salinity conditions are favorable, due to the lack of suitable substrate needed to support benthic fauna and flora. This substrate problem includes both large areas of thick organic mucky sediment which is especially a problem in the St. Lucie Estuary as well as lack of hard bottom substrate needed for oyster colonization. The natural ability of the estuaries to filter nutrients has also been impacted contributing to degraded water quality.

Undesirable flood control discharges from Lake Okeechobee would still occur in the future scenario. These may be partially offset by future optimization of Lake Okeechobee regulation schedules and risk reduction actions related to HHD combined with possible increases in lake storage. Local, State and Federal wetland regulatory programs would likely limit impacts to high value, estuarine wetlands, and compensatory mitigation would be required to offset any loss of wetland function or value that may occur. Any future effects from local stormwater runoff and resulting eutrophication would likely be offset by stormwater facility construction and/or best management practices.

The remaining portion of the Greater Everglades wetlands includes a mosaic of interconnected freshwater wetlands and estuaries located primarily south of the Everglades Agricultural Area (EAA). A ridge and slough system of patterned, freshwater peat lands extends throughout the Water Conservation Areas (WCAs) into Shark River Slough in Everglades National Park (ENP). The ridge and slough wetlands drain into tidal rivers that flow through mangrove estuaries into the Gulf of Mexico. Higher elevation wetlands that flank either side of Shark River Slough are characterized by marl substrates and exposed limestone bedrock. Those wetland areas located to the east of Shark River Slough include the drainage basin for Taylor Slough, which flows through an estuary of dwarf mangrove forests into northeast Florida Bay. The Everglades wetlands merge with the forested wetlands of Big Cypress National Preserve to the west of WCA 3.

Declines in ecological function of the Everglades have been well documented. In the pre-drainage system, the inundation pattern supported an expansive system of freshwater marshes including long hydroperiod sawgrass "ridges" interspersed with open-water "sloughs", higher elevation marl prairies on either side of Shark River Slough, and forested wetlands in the Big Cypress marsh. Rainfall and seasonal discharge from Lake Okeechobee resulted in overland surface flows (sheet flow) which helped to maintain the microtopography, directionality, and spatial extent of ridges and sloughs. Accretion of peat soils typical of the ridge and slough landscape required prolonged flooding, characterized by 10 to

12 month annual hydroperiods, and ground water that rarely dropped more than one foot below ground surface (Tropical BioIndustries 1990). The depths, distributions and duration of surface flooding largely determined the vegetation patterns, as well as the distribution, abundance and seasonal movements, and reproductive dynamics of all of the aquatic and many of the terrestrial animals in the Everglades (Kushlan 1989, Davis and Ogden 1994, Holling et al. 1994, Walters and Gunderson 1994).

Construction of canals and levees by the C&SF project resulted in the creation of artificial impoundments and has altered hydroperiods and depths within the study area. For example, northern WCA 3A has been over drained and its natural hydroperiod shortened while the eastern and southern portion of WCA 3A is primarily affected by high water and prolonged periods of inundation. The result has been substantially altered plant community structures, reduced abundance and diversity of animals and spread of non-native vegetation. The once vast, naturally connected landscape has been cut into a mosaic of various-sized habitat patches. The ridge and slough habitat has become severely degraded in a number of locations and is being replaced with a landscape more uniform in terms of topography and vegetation with less directionality (NRC 2012). The canals adjacent to the project area likely serve as an effective barrier to wildlife movement, interfering with or preventing life functions of many native wildlife species.

The remaining portions of the Everglades are stressed and exhibit levels of reduced aquatic function. The overall negative ecological trends in the remaining portions of the Everglades are expected to continue into the future, with additional loss of resources through landscape alterations and degradation of habitat. The effects of the existing infrastructure and future water management practices will continue to cause dry downs in the natural system. The threat of extreme fires will persist, destroying peat that is necessary for plant growth and water retention. Although less extreme, soil subsidence will also continue as dry downs, particularly during periods of extreme drought, contribute to further soil oxidation. Droughts may increase in frequency and intensity as a result of climate change as well. Unnatural shorter or longer hydroperiods will likely continue to cause detriment to remaining tree islands. The overall spatial extent of WCA 3 and ENP is not expected to decline, as these areas are publicly-owned and protected from development; however, current problems plaguing the areas are expected to continue and worsen in some areas. Future rates of sea level change are expected to result in significant impacts on coastal canals and communities, with loss of flood protection and increased saltwater intrusion being the primary effects. Coastal ecosystems and estuaries are expected to be adversely affected and require additional deliveries of freshwater to maintain desirable salinity patterns and healthy ecosystems. Climate change also has the potential to change temperature and precipitation in the Everglades.

2.4 COMPARISON OF EXISTING AND FUTURE WITHOUT PROJECT CONDITIONS

Table 2-1 provides a comparison of existing and FWO project conditions. Existing and FWO project conditions are further documented in **Appendix C.1**. Sections within **Appendix C.1** are included for reference in **Table 2-1**.

Table 2-1. Existing Conditions and Future Without Project Conditions

Conditions	Existing Conditions	Future Without Project Conditions
Vegetative Communities (Sections C.1.1.1 and C.1.3.1)	Sawgrass prairie, slough vegetation, tree islands, spike rush and beak rush flats, mangroves, freshwater wetlands, muhly prairie, cypress stands, native dominated forested wetlands, hydric hammocks and exotic-dominated forests.	Possible future development, changes in availability and distribution of freshwater and further disruption of natural sheet flow from discontinuities in hydrology due to possible construction of levees, roads, canals, etc. could exacerbate the changes occurring in the natural sawgrass, marl prairie, tree island, and mangrove ecotones.
Fish and Wildlife Resources (Sections C.1.1.2 and C.1.3.2)	A great diversity of fish and wildlife species occur throughout south Florida including freshwater and saltwater species. Fish and wildlife resources include aquatic macroinvertebrates, small freshwater marsh fishes, larger predatory sport fishes, amphibians and reptiles, colonial wading birds and mammals.	Declining environmental trends from existing C&SF drainage structures would continue to cause stress on the ecosystem. Disruption of the natural hydrology has resulted in changes in aquatic vegetation communities, and disruption of aquatic productivity and function. These changes have had repercussions throughout the food web, including wading birds, raptors, larger predatory fishes, reptiles, and mammals. These detrimental effects are likely to continue.
Invasive and Nuisance Species (Sections C.1.1.3 and C.1.3.3)	Existing resources indicate 163 species of non-native plants have been documented to occur within the project area; 123 of the plant species are considered invasive or noxious weeds. Existing information indicates 89 non-native animal species have been documented to occur within the project area.	It is expected that anthropogenic effects would continue to negatively impact the project area. New invasions and the expansion of invasive plant and animal species currently present would continue in the future. Native nuisance species such as cattail would persist and expand in the project area.
Threatened and Endangered Species (Sections C.1.1.4 and C.1.3.4)	A total of 40 Federally protected species occur or have the potential to occur within the project area. Species include but are not limited to the Florida panther, Florida manatee, Everglade snail kite, wood stork, American alligator, American crocodile, and Eastern indigo snake. Designated critical habitat for the American crocodile, Everglade snail kite, West Indian manatee, small tooth sawfish, and Cape Sable seaside sparrow also occurs within the project area. Many state listed species also occur throughout the project study area.	Existing Federal regulations such as the Endangered Species Act, Marine Mammal Protection Act and Fish and Wildlife Coordination Act, along with similar state regulations should be sufficient to preserve the continued existence of most endangered plant and animal species in the proposed project area. Given the expected decline of the system, there would likely be adverse effects on many threatened and endangered species that live solely within the greater Everglades; however, some of these effects would potentially be partially mitigated by development and implementation of species recovery plans and other public and private efforts.
Essential Fish Habitat (Sections C.1.1.5 and C.1.3.5)	The project is located in areas designated as Essential Fish Habitat for corals and live bottom habitat, and is habitat for numerous species of fish and invertebrates. The absence of freshwater flows and/or the release of high level freshwater discharges into estuarine systems and coastal areas currently promote unfavorable conditions.	The Magnuson-Stevens Fishery Conservation and Management Act should be sufficient to maintain existing fisheries. Current disruptions caused by flood control regulatory freshwater releases would continue to cause harm to estuarine systems in coastal areas. Potential negative effects to active fisheries could occur as a result of unregulated agricultural runoff and other secondary effects of development.

Conditions	Existing Conditions	Future Without Project Conditions
Climate (including Sea Level Rise) (Sections C.1.1.6 and C.1.3.6)	The project area is characterized by a subtropical climate with distinct wet and dry seasons, high rates of evapotranspiration and floods, droughts, and hurricanes. The climate represents a major physical driving force that sustains the Everglades while creating water supply and flood control issues in the agricultural and urban segments. Of the 53 inches of annual average rain in south Florida, 75 percent falls during the wet season (May – October). Multi-year high and low rainfall periods often alternate on a time scale approximately on the order of decades. Average annual temperature for the southern Everglades is 76°F (24° C).	Climate change is expected to alter rainfall and evapotranspiration patterns over the next 100 years. U.S. Army Corps of Engineers (USACE) sea level change projections for the period from 2015 to 2065 for Key West, Florida and the broader south Florida area for historic, intermediate and high rates of future sea level change are +4 inches, +10 inches and +26 inches, respectively http://publications.usace.army.mil/publications/eng-circulars/EC_1165-2-212.pdf. Some examples of sea level change impacts in the future would be continued saltwater intrusion, reduced freshwater supply, retreating shoreline, and habitat transition. Flood damage reduction may also decline as a result of sea level rise. Most coastal flood control structures are gravity driven. Discharge capability of these structures may be reduced. The regional hydrologic models used to simulate with- and without project conditions require climatic and tidal data as boundary conditions. Given the uncertainty in future climatic conditions, the historic climate conditions used in the period of record are assumed to represent conditions that are expected to occur in the study area in the future. The model tidal boundary used in the regional hydrologic model was developed using historic tidal data from two primary (Naples and Virginia Key) and five secondary National Oceanic and Atmospheric Administration stations (Flamingo, Everglades, Palm Beach, Delray Beach, and Hollywood Beach). Simulation model tidal boundary conditions that reflect future sea level change were not available for the range of potential sea level rise expected. However, the impact of sea level change on project benefits is assessed for the FWO and with project conditions per USACE guidance Engineering Circular 1165-2-212 (see **Section 6.0** and **Annex I**).
Geology and Soils (Sections C.1.1.7 and C.1.3.7)	The regional geology of EAA, WCA 3 and ENP consists of (from youngest to oldest) recent fill material, undifferentiated sandy, clay materials, and limestone. Recent fill material consists of poorly graded gravel, sand, silt and minor shell. Layers of peat are embedded within the clay layers. Miami Limestone represents the upper portion of the Biscayne Aquifer. South Florida is underlain by Cenozoic age rocks to a depth of approximately 5,000 ft below land surface with various percentages of sand, limestone, clay and dolomite. The marl soils are typically characterized as silts with high concentrations of lime. Marl soils form under shallow water	Based on current land use indicators, the landscape of south Florida would be developed consistent with County Growth Management Plans. While the majority of development is expected to occur on previously farmed lands, some wetland soils located in the area could be altered as a result of potential development. Wetland soils would be drained and/or displaced with fill materials to support the urban development. Existing C&SF drainage structures will continue to maintain reduced hydroperiod in many locations, continuing peat soil loss by oxidation and lightning-induced fires.

Conditions	Existing Conditions	Future Without Project Conditions
	conditions and are an important constituent of the whole ecosystem, typically having standing water for short periods of time and are associated with thick algal mats and periphyton.	
Municipal and Industrial (M&I) Water Supply/ Demand (Sections C.1.1.11 and C.1.3.11)	Well fields in the surficial aquifer are the primary source of municipal water supplies and are recharged by surface water, rainfall, and the WCAs. The WCAs maintain groundwater levels and canal stages in the coastal area for purposes of public water supply, irrigation (i.e. agricultural, industrial, landscape), and maintain a freshwater head along the LEC to slow saltwater intrusion. The South Florida Water Management District (SFWMD) adopted a restricted allocation area rule for the Everglades and Loxahatchee River Water Bodies in 2007. The rule, in general, caps consumptive use withdrawals from the Everglades to actual use as of April 1, 2006. The actual demand as of 2010 was 839 million gallons per day (MGD) for public water supply from all sources. Like public water supplies, industrial demands dependent on the surficial aquifer system have also been capped.	In the LEC, groundwater from the surficial aquifer system is the predominant source of water for M&I uses. This trend is expected to continue in the future. Since the Restudy, M&I users reliance on water from alternative sources such as the Floridan aquifer, reuse and other sources has grown significantly. Use of these alternative sources to meet a portion (10-15%) of future demands will continue in the future. Economic forecasts have changed since the Restudy, decreasing the population projections. Since adoption of the rule restricting allocations, the SFWMD has issued 20-year permits allocating 996 MGD from the surficial aquifer system for public water supply as of 2010. The 2050 demands contemplated in the Restudy without project condition were 1,276 MGD, which are much higher than the 20-year permits issued by the SFWMD allocating 996 MGD from the surficial aquifer system as of 2010. Like public water supplies, industrial demands are turning to alternative sources of water than the surficial aquifer system. The projected industrial demands in 2030 from the surficial aquifer, including thermoelectric, are 12 MGD.
Flood Control (Sections C.1.1.10 and C.1.3.10)	Areas may become flooded during heavy rainfall events due to antecedent conditions that cause saturation and high runoff from developed areas.	Flood damage reduction needs have increased since the original C&SF Project was constructed and will likely continue to increase in the future. As agricultural and urban development continues, the volume, duration, and frequency of floodwaters may increase, and the actual level of flood damage reduction may decline in some areas. Flood damage reduction may also decline as a result of sea level change. Most coastal flood control structures are gravity driven. Discharge capability of these structures may be reduced. Potential future sea level change scenarios are not included in the CEPP FWO modeling.
Water Quality (Sections C.1.1.12 and C.1.3.12)	Existing water quality conditions within most of the study area (Lake Okeechobee, coastal estuaries, EAA, WCAs and ENP) are impaired mostly related to nutrient concentrations. The Florida Department of Environmental Protection (FDEP) is in the process of implementing numeric nutrient criteria. Where water bodies are impaired, FDEP develops total maximum daily load (TMDL) limits, which when enforced will improve water quality conditions. Total phosphorus concentrations	Implementation of water quality TMDL's and associated basin management action plans (BMAPs) within the study area should result in improved water quality conditions. The SFWMD Restoration Strategies water quality treatment plan will be fully in place by 2025. Compliance with the 2012 Consent Order water quality based effluent limits (WQBELs) is expected after 2025 when the SFWMD has completed implementation of the Restoration Strategies water quality treatment plan. The NPDES permit that accompanied the 2012 Consent Order also requires that the Restoration

Conditions	Existing Conditions	Future Without Project Conditions
	and loads to the Everglades Protection Area (EPA) (WCAs, ENP) have been the subject of ongoing litigation between State, Federal and Tribal parties. The 2012 Consent Order and associated National Pollutant Discharge Elimination System (NPDES) permits require the SFWMD to construct additional water treatment facilities in order to meet discharge criteria in the WCAs. Additional discussion of TMDLs and water quality is included in **Appendix C.1** and **Annex F.**	Strategies plan be implemented and specifies that the WQBEL is effective immediately. Effects on water quality from agricultural activities should be reduced as land use near urban areas converts to residential and commercial development. Water quality in urban areas should improve somewhat as stormwater controls are retrofit in areas that undergo redevelopment.
Air Quality (Sections C.1.1.14 and C.1.3.13)	Existing air quality in the affected environment is good to moderate. All areas of Florida, except one, are now attainment areas. Orange County, Duval County, the Tampa Bay area including Hillsborough and Pinellas Counties, and Southeast Florida including Miami-Dade, Broward, and Palm Beach Counties continue to be classified by the United States Environmental Protection Agency (USEPA) as attainment/maintenance areas for the pollutant ozone and a portion of Hillsborough County is a non-attainment area for lead.	It is anticipated that increased population and economic expansion in southeast Florida will result in an increase in ozone and other air quality pollutants. It is possible that Miami-Dade, Broward, and Palm Beach Counties may be classified as air quality non-attainment zones. This is more likely to occur if air quality standards become more stringent by 2050.
Hazardous, Toxic and Radioactive Waste (HTRW) (Sections C.1.1.15 and C.1.3.14)	Lands potentially used for this project are very likely to have a past or present agricultural land use. Activities conducted over the past 100 years are likely to have resulted in the presence of some HTRW materials on some of this land. State and Federal databases include information on the known HTRW contamination sites. Phase I and II environmental site assessments will be used to identify unknown HTRW sites as well as test cultivated areas for the presence of residual agricultural chemicals.	In the absence of the project, potential project lands would likely continue to be farmed. This would likely result in continued minor HTRW contamination associated with storing and applying agricultural chemicals as well as petroleum products. Cultivated soils would continue to have agricultural chemicals applied which may accumulate in the soils depending upon the properties of chemicals. Should the subsequent land owner opt to change the land use to something other than agriculture, they would have to meet all applicable Federal and State regulatory levels for that land use, which may require remediation of residual agricultural chemicals.
Cultural Resources (includes Culturally Significant and Historic Properties) (Sections C.1.1.16 and	Several thousand cultural resources exist within south Florida. Due to the existence of known cultural resources within previously surveyed portions of the study area, there is a high probability of unrecorded resources within the project area of potential effect. Further cultural resources investigations will need to be conducted for this project in order to assess effects to significant historic properties. Lands leased to the Miccosukee Tribe of Indians of Florida are experiencing long-term high water staging in the southern part of WCA 3A,	Two significant cultural resource sites (8PB16039 and 8PB16040) will potentially be adversely affected if agricultural practices continue within the A-2 footprint. Cultural resources within ENP will continue to be managed under the Park's established management plan. Cultural resources within WCA 3 and EAA A-2 will continue to be managed by the District in consultation with the Florida State Bureau of Archaeological Research. Investigations mandated in the August 2012 Programmatic Agreement for the Everglades Restoration Transition Plan (ERTP) will be completed by ca. 2016. Climate change as described in **Appendix C.1** will potentially affect

Conditions	Existing Conditions	Future Without Project Conditions
C.1.3.15)	which may affect culturally significant sites.	cultural resources in the future.
Populations (Sections C.1.1.17 and C.1.3.16)	From 1950 to 2000, Florida achieved dynamic change in population. In relation to the remainder of the United States, Florida outgrew the other states by almost 500 percent. This growth can be attributed to Florida's desirable climate and historically low property costs. With population expansion comes the myriad of challenges related to infrastructure, land use/pattern changes, water demand, environmental impacts, depletion of resources, and health and human safety issues.	It is expected that the study area will continue to grow both in population and in associated infrastructure and commercial development. Both Florida and the region are expected to grow at a rate exceeding the national growth rate, but the growth rate is expected to diminish in the future. Counties that have traditionally grown at a rate exceeding the state growth rate will slow and other counties will likely experience more intense population growth.
Economy (Sections C.1.1.17 and C.1.3.16)	Generally, a strong wholesale and retail trade, government and service sectors characterize Florida's economy. Compared to the national economy, the manufacturing sector has played less of a role in Florida, but high technology manufacturing has begun to emerge as a significant sector over the last decade. Employment in the LEC when compared to employment in the rest of Florida and the region shows a greater emphasis toward service or tourism related industries.	Future economic growth within the study area is expected to remain consistent with the population growth of the area, while maintaining a mix of service, retail, and administrative jobs. Also to be expected is a shift of income and employment from Miami-Dade County to the surrounding counties of Broward and Palm Beach.
Agriculture (Sections C.1.1.18 and C.1.3.17)	Agricultural production is an important sector of the state's economy. Despite continued urban expansion, agriculture throughout south Florida remains a valuable industry and employer. South Florida is a major source of nuts and vegetables, tropical fruits (melons and berries), sugarcane, and other crops.	Agriculture is considered fully developed in most areas of south Florida, where permitted acres and cropping practices are not projected to change significantly. Other field crops, sod, and greenhouse/nursery are expected to increase slightly over the planning horizon, while other fruits and nuts and vegetables, melons, and berries are expected to fall slightly.
5tudy Area Land Use (Sections C.1.1.18 and C.1.3.17)	The existing use of land within the study area varies widely from agriculture to high-density multi-family and industrial urban uses to natural areas for conservation. A large portion of south Florida remains natural, although much of it is disturbed land.	Urban or commercial development should occur within major urban service areas located within the project area. Agriculture is expected to remain a strong economic force, yet conceding some ground to urban development and restoration efforts.
Recreation (Sections C.1.1.20 and C.1.3.18)	Many areas throughout south Florida are used for recreational activities including hunting, camping, bicycling, hiking, horseback riding, canoeing, boating, swimming, and freshwater and saltwater fishing.	Ecosystems support a significant amount of outdoor recreation in the LEC. A significant portion of the expenditures comes from tourists. All of the areas throughout south Florida are expected to have significant increases in demands for selected recreation activities with a commensurate need to increase development of the region's recreational resources and facilities. Recreational activities that are projected to have a lack of supply as a result of increased demands include hunting, camping, bicycling, hiking, horseback

Conditions	Existing Conditions	Future Without Project Conditions
		riding, canoeing, boating, scuba and snorkeling, and freshwater and saltwater fishing.
Noise (Sections C.1.1.21 and C.1.3.19)	Within natural areas, external sources of noise are limited. Existing sources of noise are mainly limited to recreational users including air boats, off road vehicles, swamp buggies, and motor boats. Existing sources of noise outside of the rural communities are limited to vehicular traffic, agricultural vehicles, etc. Within urban areas, existing sources of noise include noise associated with transportation arteries, operations of construction and landscaping equipment, and operations at commercial and industrial facilities.	Sources of noise associated with surrounding land use are expected to be similar to those described in existing conditions. Noise impacts will change in areas where land use is projected to change from agriculture to residential/commercial. Within rural municipalities and urban areas, sound levels would be expected to be of greater intensity, frequency, and duration as areas are further developed from agricultural to residential/commercial due to increased noise from traffic, construction associated with development, and increased operations at commercial and industrial facilities.
Aesthetics (Sections C.1.1.22 and C.1.3.20)	Natural areas within south Florida are comprised of a variety of wetlands, sawgrass marshes, wet prairies, and tree islands. The land is very flat, with slight topographic rises on some tree islands. Much of the visible topographic features are a result of human development, such as canals and levees. Views of much of the area offer pleasant perspectives of the Everglades and tree islands.	Urbanization is expected to occur in the future, resulting in a potential loss of opportunity to aesthetically view open agricultural and natural areas due to build-out.

2.5 STRUCTURAL AND OPERATIONAL ASSUMPTIONS IN THE FUTURE WITHOUT PROJECT CONDITION

The FWO project condition for CEPP assumes the construction and implementation of authorized CERP and non-CERP projects, and other Federal, State or local projects constructed or approved under existing governmental authorities that occur in the CEPP study area. Construction has begun on the first generation of CERP projects already authorized by Congress. These include the Indian River Lagoon (IRL-S) Project, the Picayune Strand Restoration Project, and the Site 1 Impoundment Project. The second generation of CERP projects, authorized in the Water Resources Reform and Development Act (WRRDA) of 2014, include the Biscayne Bay Coastal Wetlands (BBCW) Project, Broward County Water Preserve Areas (WPA) Project, the Caloosahatchee River (C-43) West Basin Storage Reservoir, and the C-111 Spreader Canal Western Project. The first generation and second generation of authorized CERP projects listed here were previously referenced as the CERP "Band 1" Projects in the 2005 CERP Master Implementation Sequencing Plan (MISP), with the "Band 1" list also originally including the Acme Basin B, Loxahatchee River Watershed, and the EAA Storage Reservoir (Part 1) CERP projects. Non-CERP projects included within the FWO project condition consist of the SFWMD Restoration Strategies, C&SF Canal-51 West End Flood Control Project, the C-111 South Dade Project, the Kissimmee River Restoration Project, Modified Water Deliveries (MWD) to ENP Project, and the Department of Interior (DOI) Tamiami Trail Modifications Next Steps (TTNS) Project. **Table 2-2** summarizes the status of non-CERP projects, CERP projects and operational plans assumed to differ between the existing condition baseline (ECB) and FWO project condition. Project features listed in **Table 2-2** were represented in the hydrologic model simulation of the FWO project condition unless otherwise noted in **Sections 2.5.1** through **2.5.15**. The ECB and FWO project condition assumptions, which were established early during the CEPP preliminary screening process (prior to February 2012), were not modified during the CEPP formulation process in order to maintain a consistent set of base conditions for screening and alternative evaluation purposes. Following identification of the recommended plan in June 2013, the base condition assumptions were subsequently revisited and updated to represent the most current information for the analysis of Savings Clause requirements and Project-Specific Assurances in **Annex B**.

Table 2-2. Status of Non-CERP Projects, CERP Projects, and Operations Plan for Existing and Future Without Project Conditions

Category	Existing Condition	Future Without Project Condition
Status of Non-CERP Projects	Modified Water Deliveries to ENP Project (MWD) features, including the S-355A and S-355B gated spillways, 4-mile degrade of L-67 Extension Levee, 8.5 Square Mile Area Flood Mitigation Project have been constructed and are operational.	Construction completed and features operated: C-111 South Dade (Contracts 8 and 9); C&SF C-51 West End Flood Control Project; Kissimmee River Restoration; SFWMD Restoration Strategies (Central Flow Path features); DOI TTNS Project (5.5 miles of additional bridges); Seepage Barrier Near the L-31 N Levee (Miami-Dade Limestone Products Association) MWD Project features including existing condition components plus Tamiami Trail Modifications (1-mile eastern bridge) are constructed. However no operational changes for the L-29 Canal stage, G-3273 constraint, or the S-356 pump station were represented in the CEPP FWO project condition.
Status of CERP Projects	No completed projects. Construction in progress.	Construction completed and features operated: IRL-S Project; Picayune Strand Restoration Project; Site 1 Impoundment Project; BBCW Project; Broward County WPA Project; Caloosahatchee River (C-43) West Basin Storage Reservoir; C-111 Spreader Canal Western Project.

Category	Existing Condition	Future Without Project Condition
Operations Plan for WCA 3A, ENP and the SDCS	Interim Operational Plan (IOP) (2002, 2006); L-29 Canal maximum operational stage limit: 7.5 ft NGVD; G-3273 constraint: 6.8 ft NGVD	ERTP (2012); L-29 Canal maximum operational stage limit: 7.5 ft NGVD; G-3273 constraint: 6.8 ft NGVD

2.5.1 Lake Okeechobee Operations

The CEPP existing condition and FWO project condition assumption for the operation of Lake Okeechobee is the 2008 Lake Okeechobee Regulation Schedule (2008 LORS) (USACE 2007). When it was approved in April 2008, the 2008 LORS was identified as an interim schedule. USACE expects to operate under the 2008 LORS until there is a need for revisions due to the earlier of either of the following actions: (1) system-wide operating plan updates to accommodate CERP Band 1 Projects, or (2) completion of sufficient HHD remediation for reaches 1, 2, and 3, and associated culvert improvements, as determined necessary to lower the Dam Safety Action Classification (DSAC) rating from Level 1. Until a new operating schedule is developed under a future study, the 2008 LORS is the best estimate for operations in the FWO project condition.

2.5.2 Herbert Hoover Dike

The HHD surrounds Lake Okeechobee, which is 720 square miles in size. The HHD was first authorized in 1930 and built by hydraulic dredge and fill methods. HHD has 143 miles of embankment with 5 spillway inlets, 5 spillway outlets, 32 Federal culverts, 9 navigation locks and 9 pump stations. There are structural integrity concerns with the embankment and internal culvert structures that resulted in a DSAC risk rating of Level 1. DSAC Level 1 represents the highest USACE dam risk of failure rating and requires remedial action. The Major Rehabilitation Report (MRR) from 2000 divided the 143 mile dike into eight (8) Reaches with the initial focus on Reach 1. The current approved and planned remediation measures will address the highest points of potential failure in the system based on known areas of concern. These efforts are intended to lower the DSAC rating from Level 1. The CEPP FWO project condition will assume the planned remediation of HHD will lower the DSAC risk rating and be completed by 2022. The following text provides the basis for this assumption.

Historically, the majority of embankment and foundation issues have occurred in Reaches 1, 2, and 3 related to one of the following primary potential failure modes: internal erosion through the embankment, and internal erosion through the foundation. The additional failure modes associated with the culvert structures are: internal erosion along the conduits, and internal erosion into the conduits.

Current approved HHD remediation measures consist of a cutoff wall in Reach 1 which was completed in 2013 and 32 culvert replacements or removals around the lake that are scheduled for completion in 2019. Planned remediation measures consist of a cutoff wall and/or seepage management system in Reaches 2 and 3. These planned measures are dependent on the results of the ongoing Dam Safety Modification Study (DSMS) and can be implemented by 2022. These remediation measures will not resolve all issues with the dam, nor will all current design criteria be met. To assess other issues and address additional future modifications to HHD, a comprehensive potential failure mode analysis and risk assessment are being performed on the entire HHD system as part of the DSMS. The DSMS is scheduled for completion with report approval in 2015.

Prior to the 2008 LORS, Lake Okeechobee operated under the Water Supply and Environmental Regulation Schedule (WSE). The 2006-2008 LORS study was initiated because of adverse environmental impacts that WSE had on the lake ecology. Dam safety was later added as a performance criterion since lowering of the lake, as the LORS study was pursuing, is one of the basic Interim Risk Reduction Measures implemented for deficient dams until appropriate remediation is effectuated. The WSE held Lake Okeechobee stages approximately 1.0 – 1.5 ft higher than the 2008 LORS under wet conditions. Studies for the remediation of HHD are based on the 2008 LORS, which was used as the basis for the development of the Standard Project Flood (SPF) condition. The SPF is the design condition used for the risk assessment and remediation to address internal erosion failure modes.

2.5.3 SFWMD Restoration Strategies Project

The SFWMD is required to meet a numeric discharge limit, referred to as the WQBEL, which is contained in the NPDES permit for discharges from the stormwater treatment areas (STAs) into the EPA. The WQBEL was developed to assure that such discharges do not cause or contribute to exceedances of the 10 parts per billion (ppb) total phosphorus (TP) criterion (expressed as a long-term geometric mean [LTGM]) established under 62-302.540, Florida Administrative Code (F.A.C.). The TP criterion is measured at a network of stations across the EPA marsh and is intended to prevent imbalances of aquatic flora and fauna. The WQBEL is measured at the discharge points from each STA and requires that the total phosphorus concentration in STA discharges shall not exceed: 1) 13 ppb as an annual flow weighted mean in more than three out of five water years on a rolling basis; and 2) 19 ppb as an annual flow-weighted mean in any water year. Excess phosphorus discharged into the EPA has caused ecological impacts within the Everglades.

To address water quality concerns associated with existing flows to the EPA, the SFWMD, FDEP, and USEPA engaged in technical discussions starting in 2010. The primary objectives were to establish a WQBEL that would achieve compliance with the State of Florida's numeric phosphorus criterion in the EPA and to identify a suite of additional water quality projects to work in conjunction with the existing Everglades STAs to meet the WQBEL. Based on this collaborative effort, a suite of projects has been identified that would achieve the WQBEL. The Restoration Strategies Regional Water Quality Final Plan (SFWMD 2012) describes those resulting projects and the evaluation tools and assumptions that were utilized in the technical evaluation. The projects have been divided into three flow paths (Eastern, Central and Western), which are delineated by the source basins that are tributary to the existing Everglades STAs. The identified projects primarily consist of flow equalization basins (FEBs), STA expansions, and associated infrastructure and conveyance improvements. The primary purpose of FEBs is to attenuate peak stormwater flows prior to delivery to STAs and provide dry season benefits, while the primary purpose of STAs is to utilize biological processes to reduce phosphorus concentrations in order to achieve the WQBEL. The Eastern Flow Path contains STA-1E and STA-1W. The additional water quality projects for this flow path include an FEB in the S-5A Basin with approximately 45,000 acre-feet (ac-ft) of storage and an STA expansion of approximately 6,500 acres (5,900 acres of effective treatment area) that will operate in conjunction with STA-1W. The Central Flow Path contains STA-2, and STA-3/4. The additional project is an FEB with approximately 60,000 ac-ft of storage that will attenuate peak flows to STA-3/4, and STA-2. The Western Flow Path contains STA-5, Compartment C and STA-6. An FEB with approximately 11,000 ac-ft of storage and approximately 800 acres of effective treatment area (via internal earthwork) within STA-5 are being added to the Western Flow Path. Based on the CEPP project objectives, only the Central Flow Path features are included in the CEPP modeling representation of the FWO project conditions. The FEB located within the Central Flow Path will be located on the A-1 Talisman site.

2.5.4 Caloosahatchee River (C-43) West Basin Storage Reservoir Project

The Caloosahatchee River (C-43) West Basin Storage Reservoir Project is a CERP project located within Hendry County (USACE 2010). The project was authorized in WRRDA 2014. The purpose of the project is to improve the timing, quantity, and quality of freshwater flows to the Caloosahatchee River and Estuary. The project provides approximately 170,000 ac-ft of above-ground storage volume in a two-cell reservoir. Major features of the project include external and internal embankments, and environmentally responsible design features to provide fish and wildlife habitat such as littoral areas in the perimeter canal and deep water refugia within the reservoir. The project contributes toward the restoration of ecosystem function in the Caloosahatchee Estuary by maintaining a desirable minimum flow of freshwater to the estuary during the dry season. The project also contributes to a reduction in the number and severity of events where harmful amounts of freshwater from basin runoff and Lake Okeechobee are discharged to the estuary. These two primary functions help to moderate unnatural changes in salinity that are detrimental to estuarine communities.

2.5.5 Indian River Lagoon-South Project

The IRL-S Project is a CERP Project that is located within Martin and St. Lucie Counties (USACE 2004a). The purpose of the project is to improve surface-water management in the C-23/C-24, C-25, and C-44 basins for habitat improvement in the St. Lucie River Estuary and southern portions of the Indian River Lagoon. Project features include the construction and operation of four above ground reservoirs to capture water from the C-44, C-23, C-24, and C-25 canals for increased storage (130,000 acre-ft), the construction and operation of four STAs to reduce sediment, phosphorous, and nitrogen to the estuary and lagoon, the restoration of over 90,000 acres of upland and wetland habitat, the redirection of water from the C-23/24 basin to the north fork of the St. Lucie River to attenuate freshwater flows to the estuary, muck removal from the north and south forks of the St. Lucie River and middle estuary. The project is expected to provide significant water-quality improvement benefits to both the St. Lucie River and Estuary and Indian River Lagoon by reducing the load of nutrients, pesticides, and suspended materials from basin runoffs.

2.5.6 Operations at Southern WCA 3A, ENP, and the South Dade Conveyance System

The 2006 IOP for Protection of the Cape Sable seaside sparrow was the governing regulation schedule for the project area at the start of the CEPP planning process. In addition, existing hydrologic conditions within the project area are a result of IOP operations from 2002 to 2012. Therefore, for planning purposes, the existing condition includes IOP as the operational plan. The current approved operational plan for southern WCA 3A, ENP, and the SDCS as of October 2012 is known as the ERTP. It superseded the 2006 IOP and is intended to be a transitional plan to be used until completion of the final operational plan for the MWD and C-111 South Dade Projects. The final operational plan for these two projects has not yet been developed. Therefore, for planning purposes, the CEPP FWO project condition includes ERTP as the operational plan. The ERTP contains an operational constraint at gage G-3273 of 6.8 ft NGVD and a maximum operational stage limit of 7.5 ft NGVD in the L-29 borrow canal. The CEPP alternatives will consider and potentially include higher stages in the L-29 borrow canal.

2.5.7 Modified Water Deliveries Project

The 1989 Everglades National Park Protection and Expansion Act (Public Law 101-299) directed the Secretary of the Army, in consultation with the Secretary of the Interior, to construct modifications to the C&SF to improve water deliveries to ENP, and, to the extent practicable, take steps to restore the natural hydrological conditions within the park. Construction of modifications to the C&SF project as authorized in the 1989 Act are justified by the environmental benefits to be derived by the Everglades ecosystem in general and by the Park in particular and shall not require further economic justification.

The goal of the MWD Project is to improve water deliveries into ENP and, to the extent practicable, take steps to restore the natural hydrologic conditions within ENP.

The following MWD features have been constructed or are in progress.

1. Conveyance and Seepage Control Features
   a. Spillway Structure S-355 A and B in the L-29 Levee - complete, no operational permit;
   b. S-333 and S-334 Modifications - complete;
   c. Tigertail Camp Raising - complete;
   d. Osceola Camp Elevation Evaluation - complete;
   e. S-331 Command and Control - complete;
   f. Pump Station S-356 – complete (temporary pump station), no operational permit;
   g. Degradation of 9 miles of the L-67 Extension Canal and Levee - 4 miles complete.

2. Flood Mitigation for 8.5 Square Mile Area
   a. Perimeter Levee - complete;
   b. Seepage Collector Canal - complete;
   c. Pump Station S-357 - complete;
   d. Detention Area - complete;
   e. Seepage Collection Addition – construction in progress (complete May 2014).

3. Tamiami Trail Modifications
   a. One Mile Bridge Construction - complete;
   b. Road Reconstruction and Resurfacing Construction (to accommodate maximum stages in the L-29 Canal up to 8.5 feet NGVD) - construction complete (December 2013).

4. Project Implementation Support
   a. Monitoring and Mitigation – ongoing;
   b. Technical and Project Management Support – ongoing;
   c. G-3273 Relaxation and S-356 Pump Station Test (planning for the G-3273/S-356 field test has started but is not complete, and necessary approvals (including FDEP) have not been attained).

The 1989 Act requires the project to be constructed *"generally as set forth"* in a General Design Memorandum (GDM), which was completed by the USACE in 1992. Most of the structural features contained in the 1992 GDM and subsequent revisions are complete or under construction and nearing completion. However, some features originally included in the MWD 1992 GDM, including features to provide hydrologic connectivity between WCA 3A and WCA 3B and complete degradation of the L-67 Extension Levee and adjacent canal, have not been completed for various reasons, including operational (water level) constraints within WCA 3B, lowered MWD maximum operational stages for the L-29 Canal (9.7 ft NGVD was assumed with the 1992 GDM), and potential water quality concerns. In March 2012, ENP Superintendent requested Army concurrence that "remaining unconstructed features" should be deleted and the determination made that the MWD project is complete. The superintendent requested that features needed to accommodate additional restoration flows should be examined under the ongoing CEPP. The U.S. Army Corps of Engineers (USACE) continues to work with the DOI on evaluating, based on a technical analysis, whether the constructed features and the features currently under construction satisfy the goals of the statute.

Following completion of the ongoing MWD construction for Tamiami Trail modifications and the 8.5 Square Mile Area seepage collection addition, water levels in the L-29 Canal adjacent to the Tamiami Trail may be raised up to 8.5 feet NGVD following development and NEPA assessment of an operational plan to integrate the completed MWD features. The ongoing CEPP envisions a significant increase in flow and modified flow-path to ENP to include an additional bridging (2.6 miles) of Tamiami Trail not envisioned as part of the 1992 GDM.

For CEPP planning purposes, the MWD Project is assumed to be complete upon completion of those features currently under construction. In the absence of a final operational plan for the MWD Project, the modeling of operations for the CEPP FWO project condition assumes the L-29 borrow canal maximum operational limit at 7.5 ft NGVD and the G-3273 constraint at 6.8 feet NGVD as per 2012 ERTP operations, and the S-356 pump station is not operated. The one mile MWD eastern MWD Tamiami Trail bridge is represented in the Regional simulation Model for the Glades and Lower East Coast Service Area (RSM-GL) simulation of the FWO condition.

2.5.8 Site 1 Impoundment Project

The purpose of the Site 1 Impoundment Project is to capture and store excess surface water runoff from the Hillsboro watershed as well as releases from the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) and Lake Okeechobee (USACE 2006). Located in the Hillsboro Canal Basin in southern Palm Beach County, the project will supplement water deliveries to the Hillsboro Canal by capturing and storing excess water currently discharged to the Intracoastal Waterway. These supplemental deliveries will reduce demands on LNWR. Project features include a 1,660 acre above ground storage reservoir, an inflow pump station, discharge gated culvert, emergency overflow spillway, and a seepage control canal with associated features. Project features will also provide groundwater recharge, help reduce seepage from adjacent natural areas and prevent saltwater intrusion by releasing impounded water back to the Hillsboro Canal when conditions dictate.

2.5.9 Picayune Strand Restoration Project

The Picayune Strand Restoration Project involves the restoration of natural water flow across 85 square miles in western Collier County that were drained in the early 1960s in anticipation of extensive residential development (USACE 2004b). This subsequent development dramatically altered the natural landscape, changing a healthy wetland ecosystem into a distressed environment. The Picayune Strand Restoration Project will restore wetlands in Picayune Strand (Southern Golden Gate Estates) and in adjacent public lands by reducing over-drainage, while restoring a natural and beneficial sheetflow of water to the Ten Thousand Islands National Wildlife Refuge. Project features include plugging 48 miles of canals (with more than 100 plugs to block the flow), 260 miles of road removal, and the addition of pump stations (3) and spreader swales to aid in rehydration of the wetlands. The Picayune Strand Restoration Project is located west of the RSM-GL hydrologic model domain.

2.5.10 Broward County Water Preserve Areas Project

The Broward County WPA Project is a CERP project that is located within the study area of CEPP (USACE 2012a). The project was authorized in WRRDA 2014. Three impoundment areas will be constructed to reduce seepage, provide groundwater recharge, provide water supply to urban areas, and help prevent saltwater intrusion. Pollution load reduction targets necessary to protect water quality within the receiving waters are included in the design. The three project features consist of the WCA 3A/3B Levee Seepage Management system designed to reduce seepage by allowing higher water levels within the L-33 and L-37 borrow canals; the C-11 Impoundment in western Broward County, which will collect direct runoff from the western C-11 drainage basin, thereby reducing the S-9 pumping into WCA 3A and the C-

9 Impoundment, located in the western C-9 Basin, designed to store runoff from the C-9 drainage basin and divert water from the western C-11 Basin and aid to reduce seepage. Once constructed, the Broward County WPA will reduce storm water deliveries to WCA 3, thereby increasing the overall quality of water available for delivery to ENP.

2.5.11 Tamiami Trail Modifications: Next Steps Project

The DOI, through the National Park Service (NPS) and ENP, completed a study to evaluate the feasibility of additional Tamiami Trail bridge length, beyond that to be constructed pursuant to the MWD Project to restore more natural water flow to ENP and Florida Bay and for the purpose of restoring habitat within ENP (NPS 2010). This study was authorized by the 2009 Omnibus Appropriations Act passed by Congress on March 10, 2009. The TTNS approved plan called for 5.5 miles of bridging and downstream flow enhancements which would be in addition to the 1-mile bridge authorized by the MWD Project and currently under construction. The remaining unbridged sections of roadway would be elevated to allow a design high water stage of 9.7 ft NGVD in the L-29 borrow canal and to improve distribution of downstream flows. This road height is expected to accommodate the maximum potential range of future stage increases envisioned by CERP without damage to the road. The project was authorized by Congress in the Consolidated Appropriations Act, 2012. The DOI is preparing an implementation strategy. Preliminary indications from the DOI are that the proposed western bridging along Tamiami Trail will be included in the initial DOI implementation increment.

The FWO project condition assumes that additional bridging and road elevation will be accomplished under DOI authority. Since a final operational plan for the MWD Project has not been completed, for planning purposes, the CEPP FWO project condition will assume the 7.5 ft NGVD operational constraint in the L-29 borrow canal that is associated with ERTP will remain in place. CEPP alternatives will identify if and how much bridging and roadway raising are needed to convey CEPP flows. No additional Tamiami Trail bridges, corresponding to the TTNS project features, were represented in the RSM-GL simulation of the CEPP FWO project condition due to uncertainty regarding the implementation sequence and schedule for the TTNS bridges.

2.5.12 Seepage Barrier near the L-31N Levee

As mitigation for a Section 404 permit, the Miami-Dade Limestone Products Association (Association) constructed a 1,000 foot long, 18 foot deep slurry wall to reduce seepage between ENP and rock mine properties to the east of ENP. In July 2012, the Association completed construction of a 2 mile long, 35 foot deep seepage wall in this same location south of Tamiami Trail. Although results appear promising, further analysis for CEPP is necessary to determine the extent to which the 2 mile long, 35 foot deep seepage wall will reduce seepage to the east, or whether the Association will construct an additional wall if tests determine the current wall is ineffective. The association also may construct an additional 5 miles of seepage wall south of the 2-mile seepage wall if permitted. Since the capability of the seepage wall to mitigate seepage losses is under ongoing analysis, CEPP will not include any length and depth of seepage wall in the FWO project condition. The CEPP alternative plans will have to identify and develop the total amount and types of seepage management needed for the volume and distribution of water that the plans would deliver from WCA 3B and/or ENP. Consistent with these assumptions, no seepage or slurry wall was represented in the RSM-GL simulation of the FWO project condition.

2.5.13 Biscayne Bay Coastal Wetlands Project

The BBCW is a CERP project. The project was authorized in WRRDA 2014. The purposes of the BBCW project is to rehydrate wetlands and reduce point source discharge, improve water quality and provide more natural timing and quantity of water to Biscayne Bay (USACE 2012b). The project would replace

lost overland flow and partially compensate for the reduction in groundwater seepage by redistributing available surface water entering the area from regional canals. The BBCW Project features were not explicitly included in the CEPP modeling representation of the FWO project condition since these features along the coast in Miami-Dade County were not considered significant for CEPP formulation.

2.5.14 C-111 Spreader Canal Western Project

The C-111 Spreader Canal Western Project is a CERP project that is located within the study area of CEPP (USACE 2009). The project was authorized in WRRDA 2014. It will improve quantity, timing and distribution of water delivered to Florida Bay via Taylor Slough; improve hydroperiods and hydropatterns in the Southern Glades and Model Lands (located in southeastern Miami-Dade County adjacent to the eastern boundary of ENP) to restore historic vegetation patterns; and to return coastal salinities to historical recorded conditions though the redistribution of water that is currently discharged to the Atlantic Ocean and Gulf of Mexico. These objectives will be realized through the creation of a hydrologic ridge between Taylor Slough and the C-111 Canal, to reduce seepage loss from Taylor Slough and its headwaters. SFWMD has implemented the features of this project. Information gained from the C-111 Spreader Canal Western Project will be used for the planning and design of a spreader canal system to replace the existing C-111 Canal (C-111 Spreader Canal Eastern Project).

2.5.15 C-111 South Dade Project

The C-111 South Dade County 1994 Integrated General Reevaluation Report and Environmental Impact Statement (EIS) was published in May 1994 (USACE 1994). This report described a conceptual plan for five pump stations and levee-bounded retention/detention areas to be built west of the L-31N Canal, between the proposed S-332B and S-332D pump stations, to control seepage out of ENP while providing flood mitigation to agricultural lands east of C-111 Canal. The original and current configuration of these structural features is further discussed in the description of IOP Alternative 7R, within the 2006 IOP Final Supplemental EIS (USACE 2006). Operational guidance for the new S-332DX1 structure was included in the ERTP Final EIS (USACE 2012c).

For the FWO project condition, the USACE assumed the C-111 South Dade Project will be completed with Contract 8 (C-111 North Detention Area) and Contract 9 (L-31W canal plugs). The FWO project operations of the C-111 South Dade project features are assumed consistent with ERTP. The FWO project condition assumes no inflows to the C-111 North Detention Area from the 8.5 Square Mile Area detention Area, consistent with MWD 2011 8.5 Square Mile Area Interim Operating Criteria.

2.6 NATIVE AMERICANS

There are two Federally recognized tribes within Florida: the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida. Living tribal members today still recall growing up on tree islands in the Everglades and living the lives their ancestors did 100 years before. Tribal members born before big gaming in 1979 recall selling their beadwork or patchwork, wrestling alligators and dancing for tourists to bring in money to support their families. These people have lived in the heart of the Everglades since the 1830s, well before the first efforts to drain the land began in the 1880s, and have seen first-hand the impact of those efforts on their homes and livelihood (http://www.seminole.com/History/). Refer to the Native American sections in **Section 5**, **Appendix C.1** (**Sections C.1.2 and C.1.4**) and **Appendix C.5** for more information concerning the Tribes.

Today, members of Miccosukee Tribe of Indians of Florida have administration of four reservations all located within the CEPP study area: the Tamiami Trail (Forty-Mile-Bend) Miccosukee Tribe of Indians of Florida's Trail Reservation, the Alligator Alley Miccosukee Reservation, the Krome Avenue Miccosukee

Reservation, and the Dade Corners Reservation. The Miccosukee Tribe of Indians of Florida also has a perpetual lease from the State of Florida for nearly 190,000 acres in WCA 3A. The Tribe is authorized to use this land for such purposes as hunting, fishing, trapping, and frogging. Members of the Seminole Tribe of Florida have several reservations in the State of Florida as well as an easement in WCA 3A for such purposes as hunting, trapping, fishing and frogging. Of particular note in regard to this project implementation report are the Big Cypress, Immokalee, Hollywood, and Coconut Creek reservations as these reservations are all located within the CEPP study area (**Figure C.1-17 Appendix C.1**).

The Seminole Tribe of Florida has surface water entitlement rights pursuant to the 1987 Water Rights Compact between the Seminole Tribe of Florida, the State of Florida, and the SFWMD (Pub. L. No. 100-228, 101 Stat. 1566 and Ch 87-292 Laws of Florida as Codified in section 285.165, Florida Statues.) Additional documents addressing the Water Rights Compact entitlement provisions have since been executed. Two of the Seminole Tribe of Florida's reservations rely on Lake Okeechobee as a secondary irrigation supply source for their surface water entitlement, with specific volumes of water identified for this purpose for the Seminole Tribe of Florida's Big Cypress Reservation and an operational plan addressing water shortage operations for the Brighton Reservation, located northwest of Lake Okeechobee.

Members of both Tribes continue to rely upon the Everglades, the largest portion of the CEPP planning area, to support their cultural, medicinal, subsistence, and commercial activities. The specific issues impacting each tribe have been different over the last few decades, but they are all related to impacts due to man-made changes to the Everglades ecosystem. The Miccosukee Tribe of Indians of Florida's focus has been on the detrimental ponding of water on tribal property in WCA 3A, which affects subsistence practices and increases inundation risks to islands utilized by the Tribe. The Miccosukee Tribe of Indians of Florida has also voiced concerns with regards to the impacts of nutrient pollution on the system. The Seminole Tribe of Florida's focus has been on the detrimental drainage of water from the western basin and their Big Cypress Reservation, in addition to the impacts of nutrient pollution on the delicate Everglades system.

CENTRAL EVERGLADES PLANNING PROJECT (CEPP) GENERAL PROJECT AREA

LEGEND

- Structure or Cluster of Structures (pumps, weirs, culverts)
- STAs
- State-owned Land

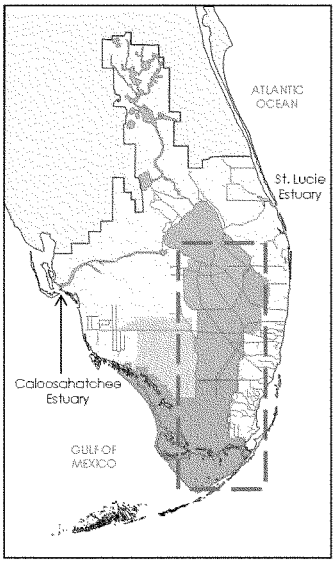
Future Without Project Conditions – Other Related Projects and Operations:

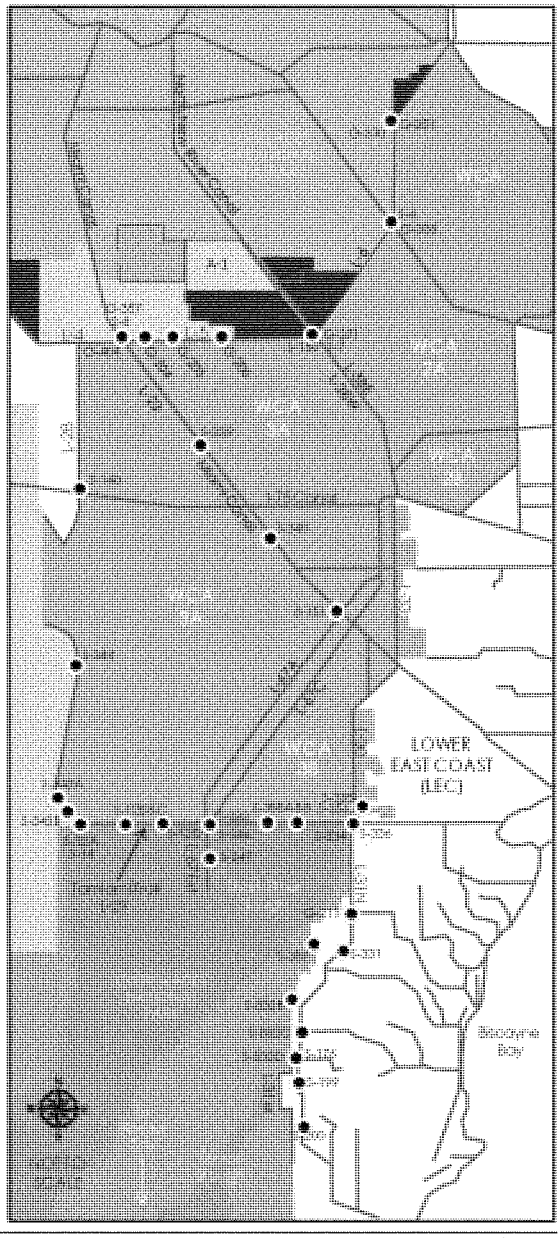
Projects (Non-CERP& CERP)

1. Modified Water Deliveries to ENP Components: Tamiami Trail Modifications (1-mile eastern bridge); 8.5 SMA;
2. C-111 South Dade (contracts 8 & 9)
3. Kissimmee River Restoration
4. SFWMD Restoration Strategies (Central Flow Path)
5. DOI Tamiami Trail Modifications (5.5 miles of bridges)
6. CERP Indian River Lagoon
7. CERP Picayune Strand Restoration
8. CERP Site 1 Impoundment
9. CERP Broward County Water Preserve Areas
10. CERP C-43 West Basin Storage Reservoir
11. CERP C-111 Spreader Canal Western Project

Operations

- Everglades Restoration Transition Plan (ERTP) 2012
- L-29 Canal Maximum Operational Limit
- G-3273 Constraint





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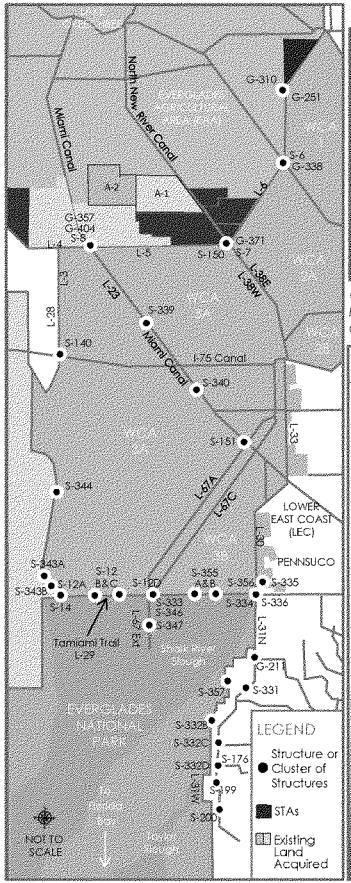
3.0 FORMULATION OF ALTERNATIVE PLANS

3.1 PLAN FORMULATION CONCEPTS

The Central Everglades Planning Project (CEPP) incorporates twelve years of updated science, new information, and improved hydrologic modeling tools since authorization of the Comprehensive Everglades Restoration Plan (CERP) in 2000. This new science reveals that certain key attributes of quality, quantity, timing and distribution are needed to achieve restoration of the Everglades. See **Section 3.1.2** for more detail. These attributes affect the formulation strategy of CERP features being addressed in this study.

The overall intent for formulating CEPP alternative plans is to reduce regulatory freshwater discharges from Lake Okeechobee that are currently contributing undesirable conditions in the Northern Estuaries (Caloosahatchee and St. Lucie) and redirect this water southward through the Everglades Agricultural Area (EAA). These environmentally beneficial releases from Lake Okeechobee will restore a more natural mosaic of habitat conditions in Water Conservation Area 3 (WCA 3), Everglades National Park (ENP), and Florida Bay. See **Figure 3-1** and foldout Figure in back of this section.



CEPP ECOSYSTEM RESTORATION PLANNING FRAMEWORK

- CERP, including CEPP, intends to achieve more natural flows by re-directing flows currently discharged to the Atlantic Ocean and Gulf of Mexico, to a more restored flow of water that is distributed throughout the system similar to pre-drainage conditions.
- Plan formulation conceptually follows the natural **southerly flow of water** and pursues alternatives that **improve ecological conditions compared to the future-without project conditions** while respecting **constraints** (e.g., water quality, flood control, and water supply/groundwater levels/saltwater intrusion, habitat for endangered and threatened species and others)
- Efforts supported by:
  - **Hydrologic models** that predict flows based on regional parameters (e.g., topography, vegetation, location and operation of infrastructure, etc.)
  - **Ecological models** with **performance measures** related to **target water flows, depths, durations, and quality** for **healthy habitats** and **predictive flows for alternatives based on hydrologic modeling**
  - **RECOVER** with **system-wide targets** for **indicator species and related habitat conditions**
  - **Adaptive Management** to monitor plan implementation in **short and long term;** includes strategies to reduce uncertainties over time, to effectively respond to unknowns, and to modify implementation as more is learned about the system

CEPP AND RELATED CONDITIONS IN THE SOUTH FLORIDA ECOSYSTEM

Managed water delivery system with competing needs leads to (1) hydrological changes (water volumes/velocities/depths, durations); (2) either too much or too little water; (3) unintended stress to the natural system.

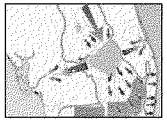
REGION	HABITAT AFFECTED	REPRESENTATIVE DEPENDENT SPECIES
NORTHERN ESTUARIES (St. Lucie and Caloosahatchee)  High volume flows to estuaries due to regulatory releases (flood control): ▪ Resultant salinity fluctuations stress estuarine systems ▪ Increased turbidity, nutrients, and sedimentation. Dry season estuarine conditions also are exacerbated due to flows needed for water supply and lake ecology.	▪ Estuarine salinity levels ▪ Submerged Aquatic Vegetation (SAV)	Lifecycle Needs (nesting, birthing, foraging, growing) ▪Shellfish ▪Oysters ▪Marine Fish
GREATER EVERGLADES (WCAs, ENP, Shark River Slough, Taylor Slough) Low volume/velocity of surface and groundwater, & disruptions to southerly flow due to infrastructure (e.g., levees) causes: ▪ Peat oxidation and subsidence ▪ More intense fires ▪ Loss of ridge and slough topographic conditions ▪ Loss in slough vegetation	GENERAL ▪ Overdrying : N. WCA 3A, WCA 3B, & ENP Shark River Slough ▪ Ponding : S. WCA-3A SPECIFICALLY ▪ Ridge & Slough System ▪ Tree Islands ▪ Marsh ▪ Periphyton	Lifecycle Needs (nesting, birthing, foraging, growing) ▪Alligators ▪Crocodiles ▪Wading Birds Snail Kite ▪Fish
SOUTHERN COASTAL SYSTEM Low volume, and resultant low velocity flows of surface and groundwater, leads to higher salinity levels in Florida Bay.	▪ Bay salinity levels (not enough freshwater flows) ▪ Submerged Aquatic Vegetation (SAV) ▪ Mangroves	Lifecycle Needs (nesting, birthing, foraging, growing) ▪Shellfish ▪Oysters ▪Marine Fish

Figure 3-1. Planning Framework Used for CEPP

The plan formulation framework for this study required a sequential analytical screening process to develop alternative plans. This process resulted in a limited, yet refined final array of alternatives to be evaluated in detail in **Section 4** of this report. The plan formulation concepts include:

- Incorporating an incremental approach to restoration of the Everglades
- Considering updated scientific knowledge
- Using interdependent but discrete geographic sub-regions to formulate alternative plans
- Incorporating an alternative development strategy that combines management measures into components, options, and ultimately alternative plans

3.1.1 Incremental Implementation

It is important to view the incremental implementation of CERP from the perspective of Everglades restoration goals and updated science of the natural Everglades ecosystem. This study incorporates the National Research Council (NRC) recommendation that the implementation of CERP projects should provide some immediate restoration benefits while addressing scientific uncertainties. This study is not a "comprehensive" solution leading to the end state resolution of problems existing in the Everglades ecosystem, but will provide meaningful progress towards restoration of the CEPP study area while greatly reducing the potential for further degradation. The planning and design of project features will incorporate, to the extent practical, flexibility and robustness to ensure compatibility with future Everglades restoration efforts.

3.1.2 Updated Science

Expertise offered by project delivery team (PDT) scientists and both Tribes of south Florida contributed to the formulation of CEPP, consisting collectively of decades if not centuries of scientific knowledge of the Everglades, Lake Okeechobee, and the estuaries. Specifically, in the twelve years since the formulation of CERP published studies have identified needs within these ecosystems in order to achieve a more natural, restored state resembling recent pre-drainage centuries. For example, paleoecological studies have revealed, with reasonable agreement among scientists, the quantity of water necessary flowing through the Everglades and into the receiving bays to achieve diversity and distributions of species that resemble the historic ecosystems. These studies estimate that the northern inflow to the Everglades was an average of two million acre-feet (ac-ft) annually. Further research has determined that in order to restore habitat features such as slough-ridge-tree island topography, which are essential to support the historic suite of species and contribute to the historic hydrologic timing and distribution patterns, water should flow uninhibited and parallel to the ground surface rather than ponding in areas where flow is impeded by structures (McVoy et al. 2011; RECOVER 2011, Section 1.1). The flow rate of the water should reach at least 2.5 centimeters per second (cm/s) during high volume precipitation events to drive restoration of the historical ridge and slough landscape patterns and tree islands (RECOVER 2011, Section 1.4), and water levels must have natural variation and cycling during events such as El Nino and La Nina. The decadal oscillation cycles and sea surface temperatures seem to be very important to tree island development and health, as well as for other important features of the system such as the ridges, sloughs, and receiving bays (RECOVER 2011).

The increased scientific understanding of the greater Everglades system and its attributes allows for a more refined formulation in the central Everglades planning process through an awareness of the complex characteristics and timing that support a healthy ecosystem. The modeling strategy for CEPP incorporates this new information into computer models used to guide plan formulation.

3.1.3 Plan Formulation Strategy

The plan formulation process applied during CEPP analyzed the environmental effects and benefits of the project alternatives through qualitative and quantitative comparisons between the future without (FWO) project condition and the future with project condition. The FWO project condition describes what is assumed to be in place if none of the study's alternative plans are implemented. The FWO project condition for CEPP assumes the construction and implementation of authorized CERP and non-CERP projects, and other Federal, State or local projects constructed or approved under existing governmental authorities that occur in the CEPP study area, as described in **Section 2** of this report. The future with project condition describes what is expected to occur as a result of implementing each alternative plan that is being considered in the study. Based on this formulation and evaluation approach, the CEPP alternatives were analyzed as the next–added increment of CERP projects to be added to a system of projects identified as likely to have been implemented prior to implementation of the CEPP project. The CEPP alternatives were formulated, evaluated, and justified based on the ability of the CEPP alternatives: (1) to contribute to the goals and purposes of the CERP Plan, and (2) to provide benefits that justify costs on a next-added basis.

The Everglades is a complex ecosystem comprising multiple physical and biological elements whose functions and responses are highly interdependent. The Everglades lie at the center of the complex South Florida regional water management system in which water distributed to any part of the system affects many others. In order to achieve incremental restoration of the central Everglades ecosystem, management measures and components cannot be evaluated in isolation, but must be combined and evaluated. The CEPP formulation and modeling strategies acknowledge that the storage and conveyance of water, distribution of water, and seepage management are interacting, interdependent elements that must work together to move restoration forward.

The plan formulation strategy for CEPP consisted of multiple formulation phases that followed the natural southerly flow of water from Lake Okeechobee through the Everglades ecosystem to Florida Bay. The strategy involves the formulation of interdependent management measures and components that serve to restore the central portions of the Everglades including WCA 3 and ENP, while improving the northern and southern estuary ecosystems and increasing water supply for municipal and agricultural users. The plan formulation process used data and findings developed in previous plan formulation efforts including CERP planning and restoration initiatives, such as the EAA Reservoir project, WCA 3 Decompartmentalization and Sheetflow Enhancement project (Decomp), and the ENP Seepage Management project. CEPP used a sequential analytical screening process that increasingly became more comprehensive and detailed as plan formulation progressed.

The plan formulation was conducted from a spatial perspective (**Figure 3-2**). The study area was divided into four sub-regions recognizing that physical and environmental boundaries create distinctive water management issues. This allowed for the development and screening of alternatives, by sub-region, to proceed from upstream to downstream in an orderly and systematic manner to assist in the development and screening of alternatives.

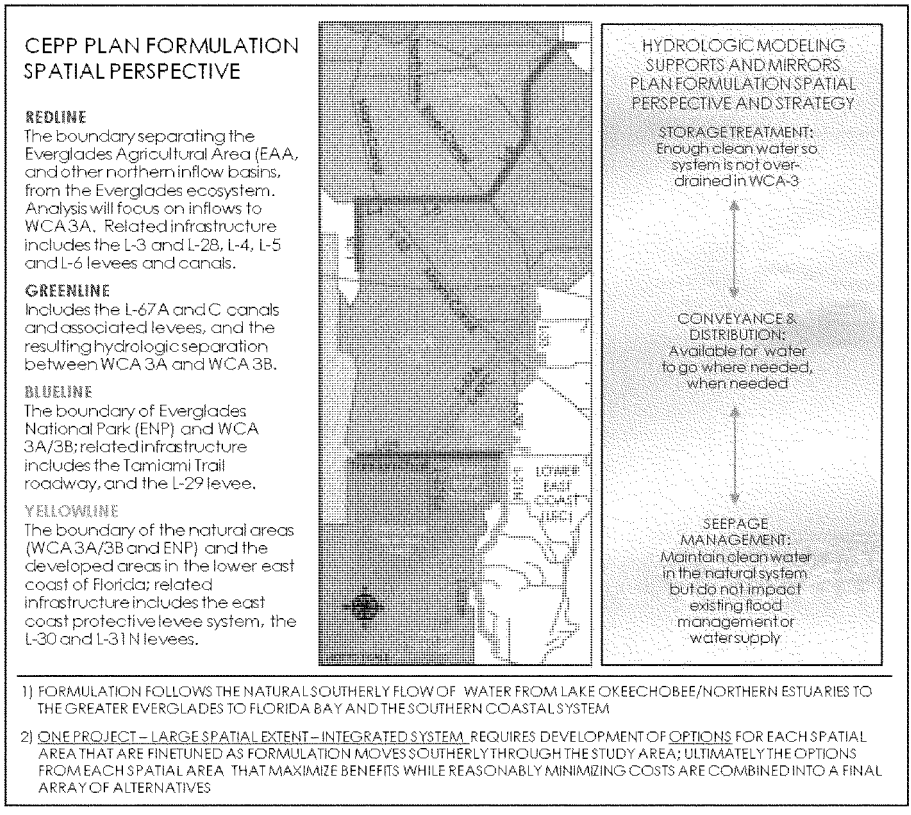


Figure 3-2. Spatial Perspective of Plan Formulation

3.1.4 Alternative Development and Evaluation Overview

Following this spatial perspective, CEPP alternative development began with an initial screening to identify feasible management measures (structural and non-structural features or activities that address one or more planning objectives). Retained management measures underwent a rigorous screening analysis to evaluate, optimize, refine, and finally group into components (i.e. one or more management measures that can be implemented at a specific geographic site) and options (i.e. a grouping of one or more components that function together to provide a sub-regional restoration approach to address objectives and avoid constraints). The term "option" is used to signify that these sub-regional solutions are not complete alternatives. Combining options from the screening of treatment and storage, distribution and conveyance, and the resulting seepage management analysis ultimately led to a limited number of discrete alternative plans that were considered in the final array and underwent a comprehensive system-wide evaluation.

Multi-Criteria Decision Analysis (MCDA) was used to organize the formulation and selection of options which were included in the final array of alternatives. The MCDA was used to support an inclusive and transparent evaluation process for selecting options. The criteria utilized for MCDA were specific to the phase and location of plan formulation. The analysis provided a normalized and aggregated evaluation

score for project options, which prioritized achievement of project objectives, simultaneously considering costs, constraints, and other important considerations. For the cost portion, a parametric capital cost evaluation tool was used for all screening-level costs to provide quick estimates. See **Appendix B** for details.

The evaluation scores were compared to costs to ensure that cost-effective plans (plans with the lowest cost per output) were included in the final array. Because all alternatives contain the same cost assumptions and requirements for lands, easements, rights-of-way, relocation, disposal, preconstruction engineering and design, and construction management; these costs were not developed for the project configurations for the screening analysis, nor included in the MCDA. The product of MCDA is a list of viable, well-vetted, and cost-effective options for each sub-region of the project, to be refined and combined into the final array of alternatives.

3.2 SCREENING

3.2.1 Screening of Storage and Treatment (North of the Redline)

Increasing the volume of water provided to the Everglades ecosystem is essential to meeting CEPP objectives of restoring seasonal hydroperiods and re-establishing appropriate dry season recession rates. Providing storage and treatment will serve to both increase water volume and improve the timing of water deliveries to the Everglades. Additional storage will also reduce the frequency of damaging high water volume discharges to the Northern Estuaries and utilization of operational flexibility within the existing 2008 Lake Okeechobee Regulation Schedule (LORS) will improve availability of water to EAA consistent with CEPP objectives. In order to meet CEPP objectives (**Section 1**, **Table 1-2**), water will be redirected from Lake Okeechobee through the EAA (instead of discharged to the Northern Estuaries), stored, treated, and delivered to the Everglades.

Establishing the existing quantity of water currently entering WCA 3A (existing water budget) and quantifying potential new water that CEPP could capture from excess water currently discharged from Lake Okeechobee to the Northern Estuaries was a prerequisite to determining how much storage and treatment was needed. The CEPP formulation efforts initially quantified existing flows entering WCA 2A and the northern and northwestern portions of WCA 3A, identified by a transect known as the "Red line". See **Figure 3-3** and foldout Figure in back of this section. Sources of water include runoff from EAA, the C-139 and C-139 Annex Basins, and discharges from Lake Okeechobee. Proposed non-CEPP projects, including the South Florida Water Management District's (SFWMD) Restoration Strategies project, will ensure that water considered part of the existing water budget will undergo treatment to meet applicable water quality standards. A significant percentage of the existing inflows to WCA 2A from STA-2 and WCA 1 are subsequently discharged to eastern WCA 3A through the S-11 gated spillways. Since STA-2 outflows may be affected by the CEPP storage within the EAA and since STA-2 outflows contribute to WCA 3A inflows, STA-2 discharges were included in CEPP quantification of existing water. The total volume of water currently entering WCA 2A and WCA 3A across the "Red line" is approximately one million ac-ft on an average annual basis, based on hydrologic modeling for a historical climatologic period from 1965 to 2005.

To quantify the maximum potential water available to CEPP, a FWO condition baseline scenario was evaluated with the CEPP hydrologic modeling tools to identify water discharged from Lake Okeechobee in excess of defined target flows for the Northern Estuaries. Over 500,000 ac-ft of excess water is discharged to the Northern Estuaries on an average annual basis under the current 2008 Lake Okeechobee Regulation Schedule (LORS). The CEPP formulation examined scenarios that used a portion of this water, subject to the project objectives and constraints.

STORAGE & TREATMENT MEASURES/COMPONENTS/OPTIONS

EAA – North of the Redline

PURPOSE

Increase the quantity of water that can be delivered from Lake Okeechobee and the Everglades Agricultural Area (EAA) to WCA 3A within state water quality standards with improved seasonal timing.

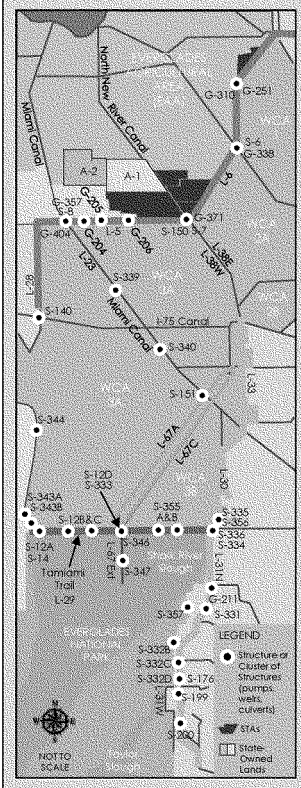
CEPP OBJECTIVES

1 Restore seasonal hydroperiods & freshwater distribution to support a natural mosaic of wetland/upland habitat in Everglades system.

3 Reduce water loss out of natural system to promote appropriate dry season recession rates for wildlife utilization.

5 Reduce high volume discharges from Lake Okeechobee to improve quality of oyster & SAV habitat in northern estuaries.

6 Increase availability of water supply to the Lake Okeechobee Service Area.



1 SCREEN MANAGEMENT MEASURES 3.2.1.1

1 Identify available "new" water (water budget)

2 Canvass CERP efforts for measures and identify new measures

3 Determine consistency with CEPP objectives

4 Screen & optimize configurations of measures (sizes, locations, combinations) based on:

- Operational flexibility
- Environmental effectiveness
- Human health and safety
- Constructability
- Land available
- Cost

RESULT

Storage

- Above-ground Storage Reservoirs
- Lake Okeechobee Operations
- Flow Equalization Basin (FEB)

Treatment

- Stormwater Treatment Areas (STAs)

2 LOCATE MANAGEMENT MEASURES 3.2.1.2

1 Identify Region – north, south, east, west of Lake Okeechobee based on:

- Inflow
- Linkage to flow areas
- Land available
- Suitable substrate
- Existing infrastructure

RESULT

South of Lake - EAA

2 Identify Footprint based on:

- Infrastructure
- Socio-political & environmental concerns
- Hydrology
- Construction efficiency

RESULT

- Existing lands acquired by the State of Florida (A1 & A-2)
- Future Without Project Condition indicates an FEB on A-1

3 FORMULATE OPTIONS 3.2.1.3

1 **Reservoir Sizing and Operations Screening (RESOPS)** model to predict benefits attributed to configurations

2 **Lake Okeechobee Operations (LOOPS)** model to determine optimal configurations with changes to Lake Okeechobee operations

RESULT

27 options of 9 storage and treatment configurations and 3 Lake Okeechobee operational measures

DEEP RESERVOIR

- (6' Deep) Reservoir (24,000 ac) w/STA (4,000 ac)
- (6' Deep) Reservoir (11,000 ac) w/STA (17,000 ac)
- (12' Deep) Reservoir (24,000 ac) w/STA (4,000 ac)
- (12' Deep) Reservoir (21,000 ac) w/STA (7,000 ac)
- (12' Deep) Reservoir (17,000 ac) w/STA (11,000 ac)

OTHER

- FEB (28,000 ac)
- STA (28,000 ac)
- Shallow (4' Deep) Reservoir (24,000 ac) w/STA (4,000 ac)
- Shallow (4' Deep) Reservoir (14,000 ac) w/STA (14,000 ac)

4 EVALUATE OPTIONS 3.2.1.4

1 Multi-Criteria Decision Analysis (MCDA)

LEVEL 1
CEPP Objectives

- Additional Flow to Everglades
- Everglades Dry Standard
- Estuary condition
- Increased Water Available (Water Supply)

LEVEL 2
Other Important Considerations

- Lake Water Levels
- Adaptability (Robustness & Future CERP Increment Compatibility)
- On-site Habitat (Wildlife Utilization, Vegetation, Hydrology)

2 Cost-Effectiveness Evaluation

- Two cost-effective options:
  - (12') Reservoir (21,000 ac) w/STA (7,000 ac)
  - FEB (28,000 ac)

RESULT

28,000-ac FEB reasonably maximizes benefits while minimizes costs

Flow Equalization Basin (FEB) is an above-ground impoundment that would provide surface water storage, flow equalization, and also some limited water quality improvement function

Figure 3-3. Storage and Treatment North of the Redline

3.2.1.1 Screening of Storage and Treatment Management Measures

Management measures were compiled from previous CERP planning efforts and new measures were identified for CEPP. See **Appendix E.1.1** and **Appendix E.1.2** for details of storage and treatment measures. These measures were screened with criteria established specifically for CEPP:

- **Effectiveness:** ability to meet objectives and avoid constraints
- **Operational Flexibility:** ability to adapt to changing conditions
- **Environmental Effects:** avoidance of negative impacts
- **Constructability:** feasibility of construction
- **Human Health and Safety**: avoid or minimize risks
- **Land Availability:** sufficient or suitable property for construction and operation
- **Efficiency:** relative cost effectiveness in meeting downstream objectives

An array of 13 distinct management measures was identified with multiple size and configuration potentials for each measure. The primary factors in eliminating management measures were if the measures did not sufficiently address project objectives or would result in unacceptable environmental impacts. Cost estimates were not generated for infeasible measures; consequently, no measures were eliminated solely based on high capital cost. Several management measures were evaluated based on a qualitative cost effectiveness of the measure in relation to other measures. The application of the screening criteria to the 13 management measures resulted in 4 management measures retained for configuring size, locations, and combinability (**Table 3-1**). **Appendix E, Table E-1.1,** identifies all measures and the reasons for elimination.

Table 3-1. Retained Storage and Treatment Management Measures

Storage Management Measures	Treatment Management Measures
• Above-Ground Storage Reservoir • Lake Okeechobee Operational Changes • Flow Equalization Basin (FEB)	• Stormwater Treatment Area (STA)

3.2.1.2 Locations of Storage and Treatment Management Measures

Identifying an acceptable storage and treatment location governs the range and scale of management measures that could be considered. A siting analysis was conducted with two primary considerations, identifying the regional geographic location and the specific footprint. See **Appendix E.1.2.1** for details of siting analysis.

The regional location for suitable storage and treatment measures was determined by identifying locations that could meet project objectives and areas that could maximize use of existing infrastructure. CERP included storage components to be located north of Lake Okeechobee (North of Lake Okeechobee Storage Reservoir), east of Lake Okeechobee (C-44 Basin Storage Reservoir), west of Lake Okeechobee (C-43 Basin Storage Reservoir), and south of Lake Okeechobee (Everglades Agricultural Storage Reservoirs). Building off CERP's recommended plan, CEPP identified EAA as the location with the greatest potential for minimizing costs by using existing infrastructure capacity (STAs and canals) and publicly owned land, which also provides a source of inflow and linkage to targeted flow areas.

After considering the possible regional geographic areas, the specific location for the storage and treatment measures within EAA was selected based upon the factors identified in **Table 3-2**.

Table 3-2. Siting Criteria for Locating Storage and Treatment Features within the EAA

Infrastructure	Socio-Political and Environmental	Hydrology	Construction Efficiency
• Use of existing major canal networks (Miami Canal, Bolles & Cross Canal and North New River Canal) • Proximity to move water from water source (Lake Okeechobee) • Proximity to existing public works (STAs, existing pump stations, roads, minor canal networks)	• Avoid unwilling sellers, eminent domain authority • Minimize impacts to local tax rolls • Use lands already acquired for purpose of environmental restoration • Minimize effects on Cultural Resources • Use previously impacted lands	• Reduce regulatory releases to the Northern Estuaries • Hydraulic connection to Lake Okeechobee with flexibility to manage high water levels • Improve the timing of environmental deliveries to the WCAs	• Topography • Muck depths • Construction and maintenance access • Seepage Management • Availability of construction material

The storage and treatment management measures south of Lake Okeechobee are recommended to be located on and maximize the usage of A-1 and A-2 Compartments of EAA land south of Lake Okeechobee that are owned by the State of Florida (**Figure 3-4**). The identified project lands are located between and adjacent to the North New River and Miami Canals, which reduces the need to construct any additional conveyance features to move water from Lake Okeechobee to the project components and the WCAs. The project lands are adjacent to existing water quality treatment facilities (STA 3/4 and STA 2) that are currently being used for environmental purposes, creating a unique ability to optimize Central and South Florida (C&SF) Project operations. The FWO includes a Flow Equalization Basin (FEB) on the 15,000 acre A-1 footprint that is being financed, constructed, and operated by SFWMD as part of the Restoration Strategies water quality compliance remedy. However, the formulation of management measures assumed the State A-1 facility could be modified and integrated with the Federal CEPP project features as long as project constraints for water quality and water supply were not violated. The A-1 FEB, and all projects required for the State's Restoration Strategies, are independent State facilities and are not CEPP components or features; therefore, the State's Restoration Strategies features will not be incorporated as a Federal CEPP project feature. Any CEPP features that require modifications to the State's Restoration Strategies may require modifications to: (1) the State permits authorizing the Restoration Strategies, and (2) Federal permits, such as Clean Water Act (CWA) 404 permits, both of which may require additional consultation under the Endangered Species Act (ESA) or analysis under the National Environmental Policy Act (NEPA). Additionally, any modifications to the State Restoration Strategies that would impair the usefulness of any Federal project, including all CERP/CEPP features, may also require a 33 USC Section 408 permit from the USACE.

The siting analysis identified the 28,000 acre A-1 and A-2 footprints as being the largest, most efficient footprint for this increment of CEPP. The CERP identified the need for 360,000 ac-ft of water storage in EAA and the new science demonstrates that the need for flows passing through EAA is even higher than envisioned in CERP. This suggests that storage greater than 360,000 ac-ft, and necessary treatment, is likely needed if CERP goals and objectives are going to be fully achieved. The entire footprint of the A-1 and A-2 compartments was used to configure the storage and treatment component to maximize additional flows to the Everglades. During CEPP formulation, the State decided to use the A-1 parcel for another priority effort (Restoration Strategies). Because their project on the A-1 site was complementary and compatible with CEPP, the formulation of CEPP continued to include this parcel of land.

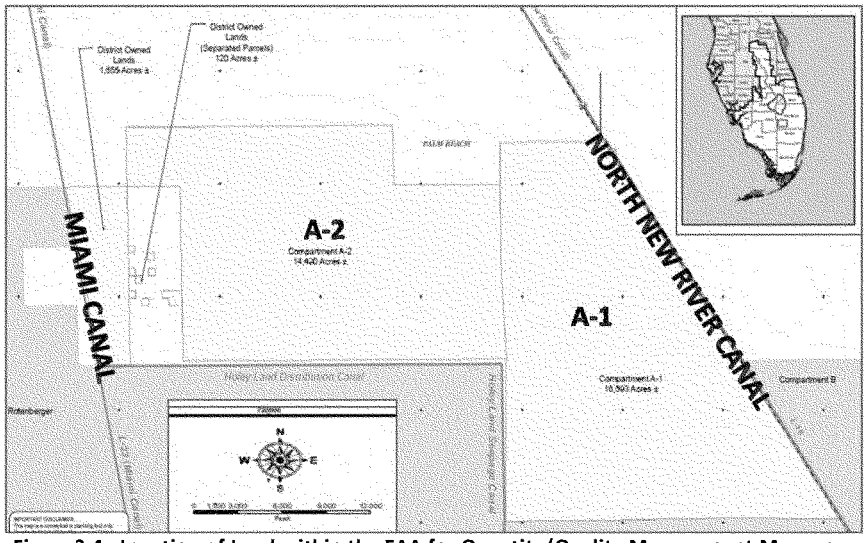


Figure 3-4. Location of Land within the EAA for Quantity/Quality Management Measures

3.2.1.3 Formulation of Storage and Treatment Options

The Reservoir Sizing and Operations Screening (RESOPS) model was used to quickly predict water deliveries, timing of flow, and reduction in discharge to the Northern Estuaries for thousands of scales and configurations of management measures. See **Appendix E.1.3 and E.1.4** for details.

The combinations of storage and treatment management measures for the options modeled for the A-1/A-2 footprint included:

- STA only: emergent and submerged marsh treatment facility.
- FEB: 4 foot depth emergent marsh storage with limited treatment capability.
- Shallow reservoirs (4 foot depth) with added STA capacity combinations
- Deep reservoirs (6 foot and 12 foot depth) with added STA capacity combinations
- FEB with added STA capacity combinations.

In addition to determining the configuration of storage and treatment management measures on the site footprint, consideration was given to incorporating assumed operational flexibility in Lake Okeechobee (within the existing 2008 LORS) when additional storage capacity is available by using the Lake Okeechobee Operations Screening (LOOPS) model. More specifically, the LOOPS screening modeling included proposed revisions to the 2008 LORS flow chart guidance of maximum allowable discharges, which are dependent on the following criteria: class limits for Lake Okeechobee inflow and climate forecasts, including tributary hydrologic conditions, seasonal climate outlook, and multi-seasonal climate outlook; stage level, as delineated by the Regulation Schedule management bands; and stage trends (whether water levels are receding or ascending). The 2008 LORS Regulation Schedule management bands and sub-bands were not modified, consistent with the original modeling intent to remain within the operational flexibility available in the 2008 LORS. Most of the 2008 LORS refinements applied in the CEPP modeling lie within the bounds of the operational limits and flexibility available in

the current 2008 LORS, with the exception of the adjustments made to the class limits for the Lake Okeechobee inflow and climate forecasts. Under some hydrologic conditions, the class limit adjustments made to the Lake Okeechobee inflow and climate forecasts reduced the magnitude of allowable discharges from the Lake, thereby resulting in storage of additional water in the Lake in order to optimize system-wide performance and ensure compliance with Savings Clause requirements. These class limit changes represent a change in the flow chart guidance that extends beyond the inherent flexibility in the current 2008 LORS. However, the determination that the proposed adjustments to the Regulation Schedule class limits were outside of the operational flexibility available in the 2008 LORS was not established during the CEPP formulation effort, and this determination was ultimately made following completion of the hydrologic modeling effort and shortly prior to identification of the recommended plan. Throughout the subsequent description of the CEPP formulation process, the proposed revisions to Lake Okeechobee operations are therefore denoted as "within the assumed operational flexibility of the 2008 LORS" (or similar), consistent with the information available during CEPP formulation.

Nine highly functioning combinations of storage and treatment measures were identified with three different Lake Okeechobee operational measures. These resulting 27 storage and treatment options (See **Table 3-3**) were evaluated using MCDA.

Table 3-3. Resulting 27 Storage and Treatment Options

Storage and Treatment Configuration	Lake Okeechobee Operations
FEB	• Water Supply Optimized • Estuarine Performance optimized • Lake Okeechobee Performance Optimized
28,000 acres	
4 ft Shallow Storage & STA	
24,000 acre Reservoir & 4,000 acre STA	
14,000 acre Reservoir & 14,000 acre STA	
6 ft Deep Storage & STA	
24,000 acre Reservoir & 4,000 acre STA	
11,000 acre Reservoir & 17,000 acre STA	
12 ft Deep Storage & STA	
24,000 acre Reservoir & 4,000 acre STA	
21,000 acre Reservoir & 7,000 acre STA	
17,000 acre Reservoir & 11,000 acre STA	
STA	
28,000 acres	

3.2.1.4 Evaluation Criteria and Results of Options Analysis

A MCDA and a cost-effectiveness evaluation were used to evaluate the 27 options that resulted from the preliminary screening of storage and treatment measures in EAA. There were two levels of criteria evaluated (**Table 3-4**): Level 1 corresponded to the primary objectives of CEPP and Level 2 was used to ensure other important considerations were included in determination of what options were carried forward. See **Appendix E.1.4** and **E.1.5** for detailed criteria description, evaluation tools used, scoring methodology and results.

Table 3-4. Level 1 and Level 2 Screening Criteria for Storage and Treatment Options

Level 1 – Criteria Based on CEPP Objectives
• **Additional Flow to Everglades**: Volume of additional average annual flow delivered to WCA 3A by reducing in-lake triggered high discharges to the Northern Estuaries. • **Everglades Dry Standard Score**: Numeric (1-100) score determined by comparing magnitude and timing of water flows that will be provided by CEPP vs. Everglades target restoration flows, especially during the dry season, with higher scores given to options that provide the most restoration-like flows. • **Estuary condition**: Reduction in high flows to the St. Lucie and Caloosahatchee Estuaries. • **Increased Water Availability (Water Supply)**: Total cutback volumes (water demand not met) for the eight worst drought years during the 41-year period of analysis.
Level 2 – Other Important Considerations
• **Lake Okeechobee:** Ability of the options to maintain lake water stages within the preferred ecological stage envelope range of 12.5 – 15.5 ft, and to minimize the occurrence of both extreme high lake stage events above 17 ft and extreme low lake stage events below10 ft (National Geodetic Vertical Datum, NGVD 1929). • **Adaptability (Robustness and Future Compatibility):** Robustness was defined as the ability to function effectively in the face of variability and uncertainty of future events. Future compatibility is the efficiency of using the project configuration to complement future CEPP increments. • **On-site Habitat:** Potential for wetland and aquatic wildlife within storage and treatment footprint based on three criteria (Wildlife Utilization, Vegetation, Hydrology).

3.2.1.5 Results of Storage and Treatment Options Screening Analysis

The screening effort resulted in two cost-effective measures with large differences in costs. Other measures were screened out due to their scoring on the screening criteria, where measures did not deliver as much water or did not deliver the water in the dry season when it is most needed by the ecosystem. See **Appendix E.1.5**, for costs and scoring results. The evaluation of Level 1 criteria led to the identification of two options and Level 2 criteria supported the outcome/conclusions. The two remaining options are as follows:

- A 28,000 acre FEB, which included the A-1 and A-2 parcels, with Lake Okeechobee operations optimized for agricultural water supply in the EAA is the least cost option at an expected cost range of $360-550 million. This option is estimated to provide approximately 200,000 ac-ft of additional water annually to the Everglades system.
- A 12-foot deep reservoir, also with Lake Okeechobee operations optimized for agricultural water supply in the EAA, provides the greatest benefits to the Everglades. This reservoir is sized at 21,000 acres with an additional 7,000 acre STA to handle the water stored that would exceed the treatment limitations of the existing STA system. This configuration provides the greatest benefits to the Northern Estuaries and delivers up to 240,000 ac-ft of additional water to the Everglades rather than 200,000 ac-ft. The cost (nearly $2 billion) increased between 400-600% over the FEB while providing only slightly greater benefits (~20%). The 12-foot reservoir configuration was eliminated from further consideration due to excessive cost and low economic efficiency.

3.2.1.6 Storage and Treatment Option Conclusion

The option recommended in the final array of alternatives is a 28,000-acre FEB (14,000 acres will be constructed and operated by the State as part of the State's Restoration Strategies) that reasonably maximizes benefits while minimizing costs.

The FEB on the EAA Compartment A-2 footprint will be operated in a mutually beneficial, integrated fashion with the State Restoration Strategies (water quality compliance remedy) on the A-1 footprint (**Figure 3-5**). This option maximizes the use of previously acquired real estate, while utilizing existing State-owned infrastructure. This option is dependent upon the State constructing the A-1 FEB, use of the excess storage and treatment capability of the A-1 FEB, use of the G-370 and G-372 structures as well as utilization of available excess treatment capacity in STA 3/4 and STA 2 when not needed to treat EAA local basin runoff. The State of Florida's compliance remedy has been sized to handle peak runoff rates and the associated treatment requirements. Thus, the State facilities will not be operating continually at the peak rate and will have capacity to accept and treat additional water from Lake Okeechobee during off-peak times. CEPP formulation considers potential benefits from using the excess capacity in the State facilities (A1-FEB, STA 3/4, and STA-2). CEPP proposes primarily utilizing the State facilities approaching and after the peak of the wet-season when capacity is available.

This option uses the assumed flexibility within the existing 2008 Lake Okeechobee Regulation Schedule, with operations optimized for water supply (**Table 3-3** and **Appendix E**, **Figure E-7**). The intent of the operations optimized for water supply was to maintain existing levels of service, and no improvement in agricultural water supply was identified. This option can provide approximately 200,000 ac-ft per year of additional water flow to the Everglades across the Redline, water which is currently being discharged to the Atlantic Ocean and Gulf of Mexico via the St. Lucie and Caloosahatchee Estuaries. This is nearly 2/3 of the overall water that CERP envisioned providing to the natural system.

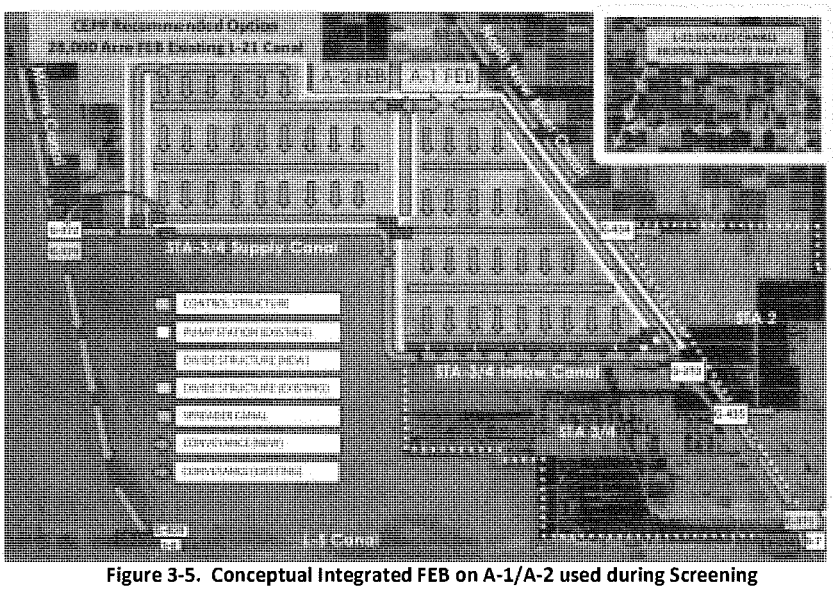


Figure 3-5. Conceptual Integrated FEB on A-1/A-2 used during Screening

3.2.2 Screening of Northern Distribution and Conveyance - Northern Water Conservation Area 3A (South of the Redline)

The formulation of northern distribution and conveyance options focused on improving the location, direction, depth, volume, and/or timing of water into and through WCA 3A, WCA 3B, and ENP in order to meet the project objectives. See **Figure 3-6** and foldout Figure in back of this section. The approximately 200,000 ac-ft per year of additional water flow to the Everglades identified with the FEB and Lake Okeechobee operations was the basis for formulating management measures and options for distribution and conveyance south of EAA.

Northern distribution management measures (Hydropattern Restoration Features [HRF]) along the northern boundary of WCA 3A provide a means for distributing treated STA discharges into northern WCA 3A in a manner that will aid in restoration of natural sheetflow from the northern boundary of WCA 3A to the south. Reducing the harmful drainage effects of the Miami Canal make up the conveyance management measures. Options for northern distribution and conveyance in northern WCA 3A were formulated by combining these management measures.

CONVEYANCE AND DISTRIBUTION MEASURES/COMPONENTS/OPTIONS Northern WCA 3A – South of the Redline

PURPOSE

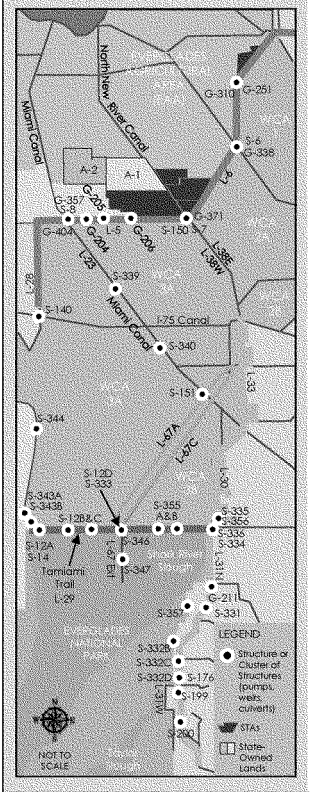
Improve the location, direction, depth volume, and/or timing of water into and through WCA 3A.

CEPP OBJECTIVES

1 Restore seasonal hydroperiods & freshwater distribution to support a natural mosaic of wetland/upland habitat in Everglades system.

2 Improve sheetflow patterns and surface water depths and durations in the Everglades system to reduce soil subsidence, frequency of damaging fires, decline of tree islands, and decrease saltwater intrusion.

4 Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function.



1 SCREEN MANAGEMENT MEASURES 3.2.2.1

1 Select Hydropattern Restoration Features (HRF) for **distribution** of water across the EAA/WCA 3A boundary (reestablish sheetflow) and **conveyance** features/measures to move the water southward reduce impacts from Miami Canal disruptions to flow)

2 Determine consistency with CEPP objectives

3 Screen features based on:

- Environmental effectiveness
- Maintenance needs
- Cost

RESULT

Distribution (HRF)

- Levee Removal
- Levee Degradation/Gaps
- New Pump Station/Pump Station Modifications
- Spreader Canal

Conveyance

- Plug Miami Canal to Marsh Grade
- Backfill Miami Canal to Marsh Grade
- Spoil Mound Removal along Miami Canal
- Conveyance Canal Modifications (L-5 and L-6)

2 LOCATE MANAGEMENT MEASURES 3.2.2.2

Distribution (HRF)

1 Identify potential canal segments for distribution measures:
- L-4
- L-5
- Remnant L-5 (portion south of STA 3/4)

2 Identify HRF distribution breaks to help reestablish sheetflow:
- Trisect Northern WCA 3A boundary
- Sub-divide Northern WCA 3A boundary (west & east of G-205)
- Full WCA 3A boundary

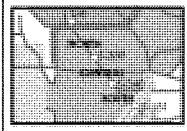
3 Screen sites:
- Hydrology: flexibility, connectivity, sheetflow
- Biogeochemistry: phosphorus movement, over-drained areas,
- Wading bird foraging & nesting
- Vegetation: ridge & slough, tree islands
- Connectivity: spatial extent

RESULT

For further consideration:
- Full Northern WCA 3A boundary
- West of G-205

Conveyance

1 Develop configurations of measures along Miami Canal based on existing infrastructure



2 Screen using CERP & CEPP criteria:
- Reduced dry-outs in Northern WCA 3A
- Degree of increased sheetflow
- Water quality constraint
- Reduced ponding in Southeastern/Central WCA 3A
- Minimized risk/uncertainty
- Spatial extent of ecosystem restoration
- Ecological & hydrologic connectivity

RESULT

Top 4 configurations:
- Backfill N, C, S
- Backfill N,C
- Backfill N,
- Backfill N, partial S

3 FORMULATE OPTIONS 3.2.2.4

1 15 possible combinations of measures identified for potential options

2 **Regional Simulation Model (RSM)** using existing water budget

RESULT

7 options retained for more detailed evaluation

A. Full HRF and complete Miami Canal backfill (S-8 to S-151)

B. Full HRF and North Miami Canal Backfill (S-8 to S-339)

C. Full HRF and plugging Miami Canal (S-8 to S-151) 4,000 ft with 2,000 ft spacing

D. West of G-205 HRF and complete Miami Canal backfill (S-8 to S-151)

E. West of G-205 HRF and North Miami Canal backfill (S-8 to S-339)

F. Full HRF Only

G. West of G-205 HRF and I-75 Backfill Miami Canal to I-75

4 EVALUATE OPTIONS 3.2.2.5

1 Multi-Criteria Decision Analysis (MCDA) & Cost-Effectiveness Evaluation for 7 options

LEVEL 1
- CEPP OBJECTIVES
- PERFORMANCE MEASURES:
  - Ridge and slough inundation duration
  - Ridge and slough sheetflow
  - Hydrologic surrogate for soil oxidation
  - Slough vegetation suitability

LEVEL 2
- OTHER ECOLOGICAL CONCERNS
- STAKEHOLDER CONCERNS:
  - Excessive ponding
  - Adaptability (robustness & future compatibility with future CERP increments)
  - Ecologic connectivity
  - Recreational impacts

RESULT

4 Cost effective options (D, E, F,G)

18 possible options for refinement using **new** water budget from "above the redline" features

4 options with most overall flexibility retained for additional modeling

2 final options

2 final options:

- Levee removal ~ 3 miles west of S-8 pump station (HRF)
- Spreader canal ~ 3 mile east of S-8 pump station (HRF)
- Spreader canal 1.5 mile at G-206 (HRF)
- Full backfill of the Miami Canal from S-8 to I-75
- STA-2 outflow diverted to WCA 3A via the L-6 and L-5 canals

- Levee removal ~ 3 miles west of S-8 pump station (HRF)
- Full backfill of the Miami Canal from 1.5 miles south of S-8 to I-75
- STA-2 outflow diverted to WCA 3A via the L-6 and L-5 canals

Figure 3-6. Conveyance and Distribution South of the Redline

3.2.2.1 Screening of Northern Distribution and Conveyance Management Measures

Management measures were compiled from previous CERP planning efforts and new measures were identified for CEPP. See **Appendix E.2.1.1** and **Appendix E.2.1.2** for detailed descriptions of management measures. These measures were organized by distribution and conveyance features and were screened with the following criteria that were established specifically for northern WCA 3A (**Appendix E.2.2**):

- **Effectiveness:** ability to meet objectives and avoid constraints
- **Environmental Effects:** avoidance of negative impacts
- **Maintenance:** avoid measures that are difficult and costly to manage and maintain

The measures that were retained for consideration and potential inclusion in components for the final array of alternatives are listed in **Table 3-5**. Cost estimates were not generated for infeasible measures; consequently, no measures were eliminated based on cost. Minor restoration features such as littoral shelves in canals, creation of tree islands, exotic removal along levees, etc., were not evaluated in the initial screening process as those features would generally not influence the modeling outcome or affect comparison of alternatives; however, they will be considered during detailed design of the recommended plan as there may be associated costs and construction requirements with these minor features.

Table 3-5. Management Measures for Northern Distribution and Conveyance

Distribution Measures (HRF):	Conveyance Measures
HRF Infrastructure: • Spreader Canal • Levee Removal/Degrade or Gaps Associated Infrastructure: • New or Modified Pump Stations • Canal Modifications	Miami Canal Infrastructure: • Plug to Marsh Grade • Backfill to Marsh Grade • Spoil Mound Removal

3.2.2.2 Locations of Northern Distribution Management Measures

Northern WCA 3A contains three existing canals that were identified as an efficient means to locate distribution measures:

- L-4 (levee removal/degrade west of the Miami Canal);
- L-5 (new spreader canal or levee gaps between the North New River and the Miami Canal);
- Remnant L-5 (remnant L-5 as spreader south of STA 3/4)

From these canals, six HRF locations were identified from the physical characteristics of northern WCA 3A to evaluate specific locations to distribute water across northern WCA 3A (**Figure** 3-7).

- Three segments established in northern WCA 3A;
  - East (remnant L-5 from the STA3/4 outlet canal to S-7)
  - West (West of S-8): L-4 levee degrade canal from L-28 intersection to S-8
  - Mid (L-5 Canal from S-8 to the STA 3/4 outlet canal)
- Two segments established in northern WCA 3A;
  - West of G-205 (western half of northern WCA 3A)

- East of G-205 (eastern half of northern WCA 3A)
- One complete segment distributes water across full northern WCA 3A boundary;
  - Full (L-4/L-3 intersection to S-7)

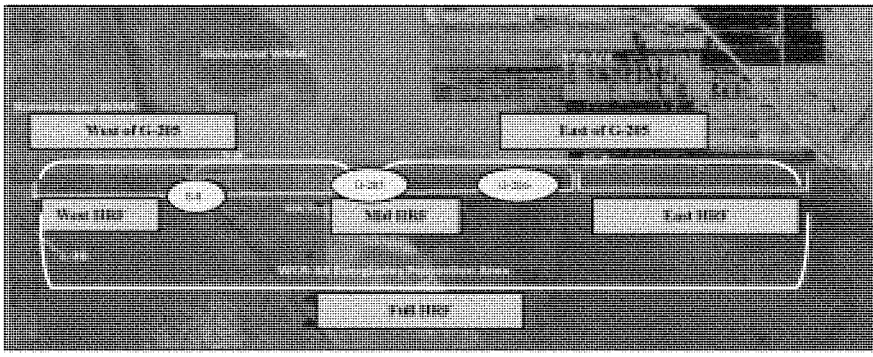


Figure 3-7. Six HRF Locations to Evaluate to Distribute Water Across Northern WCA 3A

All of the HRF measures include the appropriate pump stations and canal improvements required to deliver water from STA 3/4 to northern WCA 3A while maintaining the design capacity of the S-8 pump station. The six management measure locations could be combined to form numerous components. Therefore, to reduce the potential number of HRF measures, screening criteria derived from CEPP and CERP objectives were developed specifically for northern WCA 3A and applied to examine the locations and combinations of locations. Of the six locations, the East of G-205, West HRF, Mid HRF, and East HRF scored the lowest due to poorer abilities to place flows where they are most useful and to promote project objectives such as ecological connectivity. See **Appendix E.2.2.1** for details and results of screening.

The primary screening criteria included:

- Maximizes spatial extent of restoration potential (maximizes acreage)
- Flexibility to move water where most needed
- Promotes longer flow path through WCA 3A (connectivity)
- Maximizes sheetflow objectives (overall distribution – includes minimizing short-circuiting along eastern and western boundaries)
- Minimizes likelihood to increase phosphorus movement from impacted areas (large volume inflow in small area)
- Best addresses dry downs in over-drained areas
- Improves conditions for wading birds (foraging/nesting)
- Maximizes potential to restore and sustain ridge and slough pattern and tree islands where desired

Two HRF locations were retained for further consideration after application of the primary screening criteria: the Full HRF across northern WCA 3A, and the HRF West of G-205.

3.2.2.3 Locations of Northern Conveyance Management Measures

The formulation of conveyance measures relies on determining the best locations for backfill and plugs in the Miami Canal in order to restore more natural hydropatterns in WCA 3A and minimize negative effects caused by the canal. The initial CEPP formulation used findings and data developed during previous plan formulation efforts from the CERP Decomp project. Since the full Miami Canal in WCA 3A is 27.65 miles from S-8 to S-151, to aid in incrementally building Miami Canal conveyance management measures, the Miami Canal was divided into three segments defined by existing water control structures.

- North segment only: 9.45 miles (S-8 to S-339)
- Central segment only: 8.45 miles (S-339 to S-340)
- South segment only: 9.75 miles (S-340 to S-151)

An array of 23 plugging and filling combinations were developed within the three identified reaches. The following criteria related to meeting CEPP and CERP objectives and constraints were used to evaluate the 23 Miami Canal combinations. The screening criteria evaluation led to the components being ranked from 1 to 23 in a multi-agency exercise. Implementation cost estimates were used to distinguish between similarly ranked components. See **Appendix E.2.2.2** for details.

- Reducing dry downs in northern WCA 3A
- Reducing ponding in southeastern/central WCA 3A
- Maintaining water quality constraint
- Providing ecologic and hydrologic connectivity
- Increased sheetflow
- Minimizing risk and uncertainty

The top four ranked management measure locations were identified for further consideration. Generally, the remaining 19 were ranked lower due to lesser abilities to promote project objectives, lesser abilities to work together with other CEPP management measures, and due to important considerations such as coordination with other restoration efforts including State planted and maintained tree islands in the area. Miami Canal backfill to bedrock grade was the conceptual design for all backfill configurations and each of these locations incorporates spoil mound removal. The exact location and extent of the spoil removal and refined Miami Canal backfill design was not identified until the evaluation of the final array.

- Complete backfill of the north segment, plug central and south segments
- Complete backfill of the north, central & south segments
- Complete backfill of the north and central segments
- Plug north, central and south segments from S-340 to C-11 Extension

3.2.2.4 Formulation of Initial Options for Northern Distribution and Conveyance

An initial array of options for distribution and conveyance in northern WCA 3A was developed by combining the retained three HRF (2 locations plus no action) and five Miami Canal backfill (4 locations plus no action) locations. Fifteen possible combinations were then screened (**Appendix E, Table E.1-25**) to identify the 7 options that would undergo further detailed modeling with the Regional Simulation Model-Glades and Lower East Coast Service Area (RSM-GL). The RSM-GL provides detailed (cell-based)

stage and flow information on a regional scale and can account for current or proposed changes in infrastructure and operations. The 7 options were selected because they would, when compared to each other, produce the greatest amount of information on the effectiveness of the individual distribution and conveyance measures. It was generally recognized through the Decomp formulation effort that if plug performance was determined as comparable to the full backfill, plugs could be incorporated into any of the other options that included full backfill of all or portions of the Miami Canal. Due to this recognition, only one plug option was carried forward for the modeling effort.

The following seven options were modeled with the RMS-GL for the Decomp project:

A. Full HRF and complete backfill of Miami Canal (S-8 to S-151)
B. Full HRF and north backfill of Miami Canal (S-8 to S-339)
C. Full HRF and plugging of Miami Canal (S-8 to S-151) with 4,000 ft length plugs and 2,000 ft spacing between plugs
D. West of G-205 HRF and complete backfill of Miami Canal (S-8 to S-151)
E. West of G-205 HRF and north backfill of Miami Canal (S-8 to S-339)
F. Full HRF Only (no Miami Canal modifications)
G. West of G-205 HRF and I-75 backfill of Miami Canal (S-8 to I-75)

While providing valuable insight and information, this first RSM-GL modeling only considered distribution of the pre-project existing volume of water. Additional RSM-GL screening modeling and evaluation would be necessary to account for the additional water provided by the FEB and Lake Okeechobee operational refinements.

3.2.2.5 Evaluation Criteria and Results of Initial Options Analysis - Northern Water Conservation Area 3A

MCDA and a cost-effectiveness evaluation were used to evaluate the 7 options that resulted from the preliminary screening of distribution and conveyance measures in northern WCA 3A. There were two levels of criteria evaluated (**Table 3-6**). Level 1 corresponded to the primary objectives of CEPP and Level 2 assessment was used to ensure ecologically significant considerations and other stakeholder concerns were included in determination of what options were carried forward. See **Appendix E.2.4** for detailed criteria descriptions, evaluation tools used, scoring methodology and results. Four options (Options D, E, F, and G) from the initial array of seven were identified as cost effective.

Table 3-6. Level 1 and Level 2 Criteria for Northern Distribution and Conveyance Options

Level 1 – Criteria Based on CEPP Objectives
Project Performance Measures • **Inundation Duration in the Ridge and Slough Landscape:** Provides a measure of the percent period of record inundation. • **Sheetflow in the Ridge and Slough Landscape:** Provides a measure of the timing, distribution, and continuity if sheetflow across the landscape. • **Hydrologic Surrogate for Soil Oxidation:** Provides a measure of cumulative drought intensity to reduce exposure to peat to oxidation. **Slough Vegetation Suitability:** Provides a measure to evaluate the hydrologic suitability for slough vegetation (Hydroperiod, Dry down, and Wet and Dry Season Depths).

Hydrologic Mapping Results: Performance of each project configuration, in WCA 2A, 2B, 3A and 3B, for each of the six project objectives was compared using hydroperiod distribution maps, ponding depth maps, and overland flow vector maps from the Decomp modeling.
Level 2 – Other Important Considerations
• **Excessive Ponding:** Everglades Viewing Windows used to evaluate ponding depths over a percent period of record from 1965 through 2005 along transects in WCA 3A. • **Adaptability: Robustness** is the ability to function effectively with future variability and uncertainty. **Future compatibility** is the efficiency of features complementing future increments. • **Ecologic Connectivity:** Qualitative criterion that evaluates increases in marsh connectivity directly associated with the removal of man-made barriers to flow. • **Recreational Impacts:** Substantive changes to the landscape and hydrology will potentially affect recreational opportunities in the Everglades marsh.

3.2.2.6 Refinement of Northern Distribution and Conveyance and Options

As previously described, the options evaluated used the existing water budget entering WCA 3A and needed to be refined and expanded to address the additional water provided by FEB and Lake Okeechobee operations and to address other formulation uncertainties.

The refinements resulted in the potential for 18 options (**Table 3-7**) to be evaluated using regional hydrologic model output. Due to the expedited schedule for CEPP and the resource requirements for executing modeling simulations, only a limited number of options were able to be modeled and the simulations were developed starting from the Decomp RSM-GL final array modeling (CEPP inflows to WCA 3A were increased from existing inflows; however, additional WCA 3A outlet capacity was limited to the 1500 cfs identified for the MWD Project). Rather than model all possible combinations, the options selected for modeling were chosen because these options would allow the project team to evaluate the potential benefits of lengthening the HRF, adding additional features (plugs) in the Miami Canal south of I-75, and including a new distribution management measure that diverts additional water from STA 2 to WCA 3A via the L-6 canal. Four combinations of options were identified to be modeled: Options 4a, 6a, 7a, and 7b. See **Appendix E, Section E.2.6** for details of refinement.

Table 3-7. Combinations of HRF and Miami Canal Options

Option	HRF	Miami Canal	L-6 Diversion (a/b)
1a, 1b	West G-205	North I-75	With/Without
2a, 2b	West G-205	North I-75, Plug at S-340	With/Without
3a, 3b	West G-205	North I-75, Plug at S-340, Plug South of C-11	With/Without
4a, 4b	West G-206	North I-75	With/Without
5a, 5b	West G-206	North I-75, Plug at S-340	With/Without
6a, 6b	West G-206	North I-75, Plug at S-340, Plug South of C-11	With/Without
7a, 7b	Full	North I-75	With/Without
8a, 8b	Full	North I-75, Plug at S-340	With/Without
9a, 9b	Full	North I-75, Plug at S-340, Plug South of C-11	With/Without

Directing water west of the G-206 structure (Options 4a) resulted in more hydrologic improvement in comparison to the full HRF (Option 7a). The full HRF was not determined to be cost effective, since it costs more and provided fewer benefits.

Compared to complete Miami Canal backfill north of I-75 (Option 4a), construction of additional plugs located directly adjacent to S-340 and south of C-11 Extension (Option 6a) provided minimal project benefits as localized hydrologic improvements were only seen during the driest years. The relatively small increase in potential project benefits does not warrant the additional construction cost required. Because the CEPP RSM-GL screening modeling did not include increased WCA 3A outlet capacity beyond the MWD Project (based on the Decomp modeling assumptions), which would provide further reduction to the existing ponding conditions within southern WCA 3A, consideration of Miami Canal modifications south of I-75 may warrant reevaluation under future CERP/CEPP increments.

The model results demonstrated that the re-direction of flow from STA-2 to the HRF via the L-6 and L-5 canal offered significant project benefits (Option 7a compared to Option 7b). Redirection of flow requires conveyance improvements to the L-5 canal, new structures, and increased operations and maintenance costs. The L-5 conveyance improvements also provides a substantial amount of fill material available to be used in the Miami Canal backfill feature, thereby eliminating the need to import additional fill material from outside the CEPP project for the final 18 options evaluated in the refinement. The results demonstrated that without the diversion of the flow from STA-2 to the west (Option 7b), detrimental impacts due to excessive ponding would occur in WCA 2, and potential Zone A regulation schedule constraint impacts in WCA 3A could occur due to exacerbated ponding south of the S-11s (which affect the 3A-3 gauge stages). Taking into account the negative impacts that would occur without diverting the STA-2 water and the ability to use the L-5 canal modification as a source of fill for the Miami Canal, the L-5 modifications with L-6 water diversion operations from STA-2 to WCA 3A were retained.

The combinations of Miami Canal, HRF, and L-6 diversion features for northern distribution and conveyance that were retained for inclusion in the final alternatives are described in the next section.

3.2.2.7 Northern Distribution and Conveyance Conclusion

Northern distribution and conveyance screening, based on the water budget provided from the North of the Redline "option", resulted in the identification of two options for incorporation into the final array of alternatives (**Figure 3-8**).

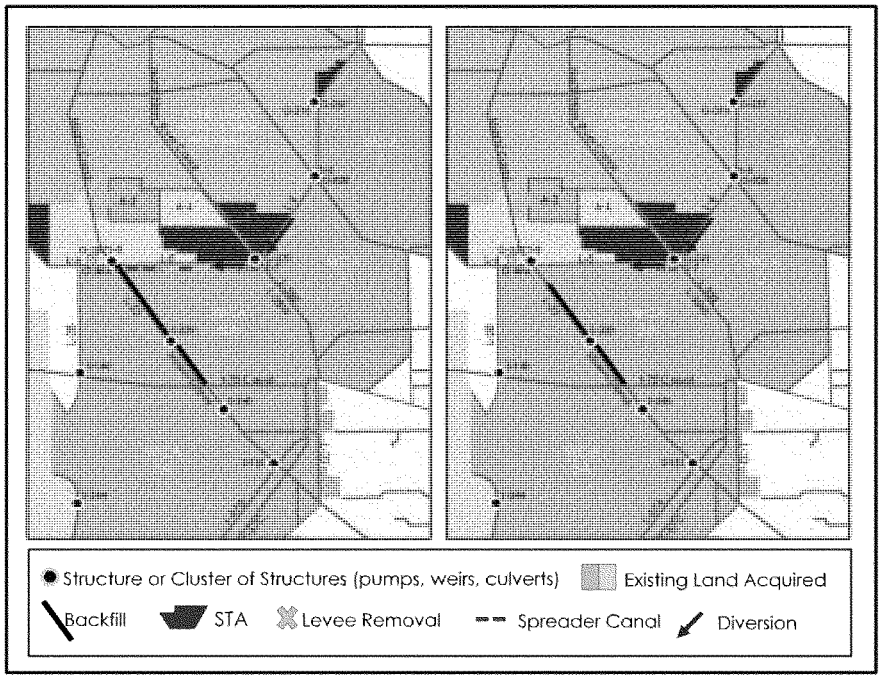


Figure 3-8. Two Options for Northern Distribution and Conveyance (Left Panel-Option 1) (Right Panel - Option 2)

Option 1: The detailed screening conducted for CEPP distribution and conveyance in northern WCA 3A, with additional preliminary conceptual design efforts, resulted in the identification of one highly functioning option for inclusion in the final array alternatives:

- Levee removal ~ 3 miles west of S-8 pump station (along the L-4) (HRF)
- Spreader canal ~ 3 mile east of S-8 pump station (S-8 to G-205) (HRF)
- Spreader canal 1.5 mile at G-206 (HRF)
- Full backfill of the Miami Canal from S-8 to I-75
- STA-2 outflow diverted to WCA 3A via the L-6 and L-5 canals (L-6 diversion)

Option 2: The second option identified for inclusion into a final array configuration resulted from stakeholder concerns. Option 1 includes a new spreader canal east of the S-8 pump station, parallel to L-5 and within WCA 3A. This area provides terrestrial refuge for deer on the L-4 levee during high water

events and provides recreational opportunities. The spreader canal construction, which is necessary to accommodate required pumped inflows from L-5, could also affect the wetlands within this section of northern WCA 3A. Stakeholders pointed out that, even without a spreader canal east of the S-8, water could still flow from the L-4 distribution canal located west of S-8 to the lower areas to the east, allowing for rehydration of areas both east and west of the Miami Canal. Therefore, an option that avoids constructing a new spreader canal and includes only an HRF west of the S-8 pump station was recommended to be considered in the final array. While the preliminary screening analysis (**Appendix E.2.2.1.3**) concluded that northern distribution solely in the west (the existing L-4 Canal is used to distribute water in this area) should not be further considered this option is a lower cost alternative to establishing desired hydroperiods in northern WCA 3A while avoiding impacts associated with a new canal in a terrestrial refuge area.

- Levee removal ~ 3 miles west of S-8 pump station (Along the L-4) (HRF)
- Full backfill of the Miami Canal from 1.5 miles south of S-8 to I-75
- STA-2 outflow diverted to WCA 3A via the L-6 and L-5 canals (L-6 diversion)

3.2.3 Screening of Southern Distribution and Conveyance (Blueline and Greenline)

Distribution and conveyance measures were formulated to meet CEPP project objectives by incrementally restoring hydropatterns and historic seasonal water flow through WCA 3A, WCA 3B, and ENP and to reverse the hydrological and ecological fragmentation caused by the L-67s and L-29 levees. Formulation of management measures began with the projected increase in the amount of treated water flowing into WCA 3A and the distribution across northern WCA 3A, identified by the North of Redline and South of the Redline screening. The distribution and conveyance configurations in southern WCA 3A, WCA 3B and ENP were sized to handle typical wet season flows to achieve marsh restoration targets within these areas.

The methods and steps used during screening of distribution and conveyance measures in southern WCA 3A, WCA 3B, and ENP are discussed further in the text that follows. See **Figure 3-9** and foldout Figure in back of this section.

CONVEYANCE AND DISTRIBUTION MEASURES/COMPONENTS/OPTIONS

Southern WCA 3A, WCA 3B, & ENP – Greenline/Blueline

PURPOSE

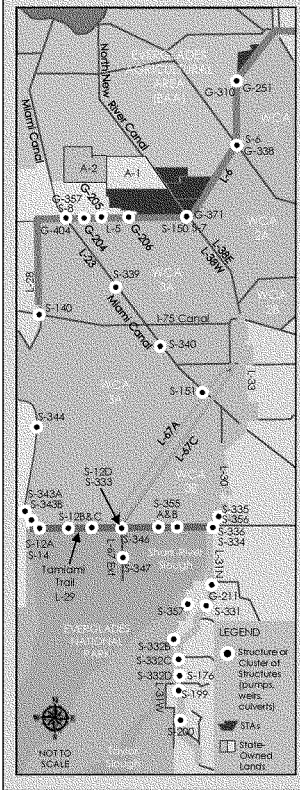
Incrementally restore hydropatterns, hydrologic connections, and historic seasonal water flow through WCA 3A, WCA-3B, and ENP ecosystem, and to reverse the ecosystem fragmentation caused by the L-67s and L-29.

CEPP OBJECTIVES

1 Restore seasonal hydroperiods & freshwater distribution to support a natural mosaic of wetland/upland habitat in Everglades system.

2 Improve sheetflow patterns and surface water depths and durations in the Everglades system to reduce soil subsidence, frequency of damaging fires, decline of tree islands, and decrease saltwater intrusion.

4 Restore more natural water level responses to rainfall to promote plant and animal diversity and habitat function.



1 SCREEN MANAGEMENT MEASURES

3.2.3.1

1. Compile measures from CERP efforts, Modified Water Deliveries to ENP Studies, Tamiami Trail Modifications Next Steps, Everglades Restoration Transition Plan (ERTP), tree island and ridge and slough habitat research, Working Group sponsored workshops, and PDT meetings
2. Determine consistency with CEPP objectives
3. Screen configurations of measures (sizes, combinations, locations) based on:
   - Environmental effectiveness
   - Maintenance needs
   - Cost

RESULT

WCA 3A TO WCA 3B CONVEYANCE AND DISTRIBUTION

- Levee Removal
- Levee Degradation/Gaps
- Levee/Berm Construction
- Weirs
- Gated Water Control Structures
- Culverts within Existing Levees

WCA 3A/3B TO ENP CONVEYANCE AND DISTRIBUTION

- Collection canal
- Elevate roadway
- Gated water control structures
- Weirs
- Pump stations
- Levee berm
- Operational changes
- Bridging
- Flow-through wetlands

2 LOCATE MANAGEMENT MEASURES

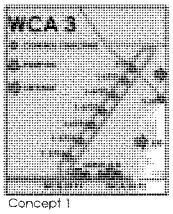
3.2.3.2

1. Configurations of retained management measures established by Working Group, stakeholders, and PDT members – evaluated on feasibility and effectiveness (meeting objectives and avoiding constraints)

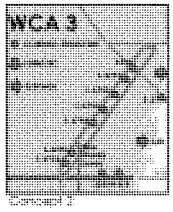
RESULT

2 configurations:

- Concept 1: multiple conveyance structures in L-67 and L-29 levees
- Concept 2: Similar conveyance structures plus a levee within WCA 3B near the Blue Shanty Canal to redirect water within WCA 3A and modify seepage out of WCA 3B



Concept 1



Concept 2

3 FORMULATE OPTIONS

3.2.3.3

1. Two flowways underwent iModel analysis – hydrologic modeling using operational targets (water depths and durations) to arrive at optimized combinations of structures and operations to best fit the targets
2. Highly functional features of the two flowways were assembled into 23 different "options" (locations and varying capacities)
3. Screening removed options that were:
   - very similar to each other
   - incompatible with future plans for Tamiami Trail construction

RESULT

10 options retained for further iModel analysis

4 EVALUATE OPTIONS

3.2.3.4

1. Multi-Criteria Decision Analysis (MCDA) & Cost-Effectiveness Evaluation for **10** options

LEVEL 1

- CEPP OBJECTIVES
- PERFORMANCE MEASURES:
  - Inundation (WCA 3A, 3B, & ENP)
  - Average ponding depth
  - Recession rate for gage 205 (healthy marl prairie habitat)

LEVEL 2

- OTHER ECOLOGICAL CONCERNS
- STAKEHOLDER CONCERNS:
  - Operational flexibility
  - Adaptability (robustness & future compatibility with future CERP increments)
  - Ecologic connectivity)

RESULT

4 options carried forward

3 cost-effective options + revised flowway option

4 OPTIONS

Option 1
- Increase S-333 to 3,000 cfs
- Unconstrained L-29 stage
- 750cfs centrally located structure on L-67A
- Gaps on L-67C Levee @ 750cfs structure

Option 2
- Increase S-333 to 3,000 cfs
- Unconstrained L-29 stage
- (2) 500 cfs and (1) 750cfs structure on L-67A
- Gaps on L-67C Levee @ structures
- New S-355C outflow structure (500 cfs) on L-29

Option 3
- Increase S-333 to 3,000 cfs
- Unconstrained L-29 stage
- (4) 500 cfs structures on L-67A
- Gaps on L-67C Levee @ structures
- (2) 500 cfs pumps on the L-29

Option 4
- Increase S-333 to 3,000 cfs
- Blue Shanty Levee L-67A to L-29
- Unconstrained L-29 stage
- (2) 500 cfs structures on L-67A inside Blue Shanty Flowway
- Degrade L-67C and L-29 in Flowway
- (1) 500 cfs structure north of Flowway
- Gap on L-67C Levee @ structure

Figure 3-9. Conveyance and Distribution Southern WCA 3A, WCA 3B, and ENP (Blueline and Greenline)

3.2.3.1 Screening of Southern Distribution and Conveyance Management Measures

Sources of information and ideas for the alignment, sizes, and operations of the management measures in the L-67A, L-67C, L-29, and L-30 levees (and their borrow canals), and Tamiami Trail included: CERP report (USACE 1999); Modified Water Deliveries to ENP Project (USACE 1992); Tamiami Trail Modifications Next Steps (National Park Service 2010); Everglades Restoration Transition Plan (USACE 2012c); research on tree islands and ridge and slough habitats; Working Group sponsored workshops; and CEPP PDT meetings. See **Appendix E.3.1** and **Appendix E.3.2** for detailed descriptions and screening rationale.

Management measures were organized by geographic region features and were screened with criteria that were established specifically for CEPP:

- **Effectiveness**: ability to meet objectives within constraints
- **Maintenance**: avoidance of costly and intensive management and maintenance
- **Environmental Effects**: avoidance of negative impacts

Seven management measures were evaluated and consequently one measures to convey water from WCA 3A to WCA 3B (pump stations) was screened from further consideration due to the effectiveness of meeting project objectives. Measures that were retained for consideration are in **Table 3-8**.

Table 3-8. Southern WCA 3A, 3B and ENP Management Measures Retained for Consideration

WCA 3A to WCA 3B: Distribution and Conveyance	WCA 3A/3B to ENP: Distribution and Conveyance
• Levee Removal (L-67A, L-67C) • Levee Degradation/Gaps(L-67A, L-67C) • Levee/Berm Construction (within WCA 3B) • Weirs (L-67A and L-67C) • Gated Water Control Structures • Culverts within Existing Levees	• Collection Canal (within WCA 3B) • Elevate Roadway/ Bridging (Tamiami Trail) • Gated Water Control Structures (S-333, L-29) • Weirs • Pump Stations • Levee/Berm Construction(within WCA 3B) • Operational Changes • Flow-through Wetlands

3.2.3.2 Locations of Southern Distribution and Conveyance Management Measures

Working Group workshop stakeholders and PDT members assembled dozens of combinations from the retained management measures. These combinations were methodically evaluated on the feasibility and effectiveness of meeting project objectives, and were subsequently screened to eliminate redundancies and grouped by common theme. Two primary concepts (**Figure 3-10**) were identified as a result of this evaluation. The first concept had multiple conveyance structures in the L-67A and L-29 levees (Concept 1), and the second (Concept 2) had a similar set of conveyance structures but also contained a new levee within WCA 3B (located near the Blue Shanty Canal) that redirects water flow within southwest WCA 3B and would change the patterns (rate and location) of seepage out of WCA 3B.

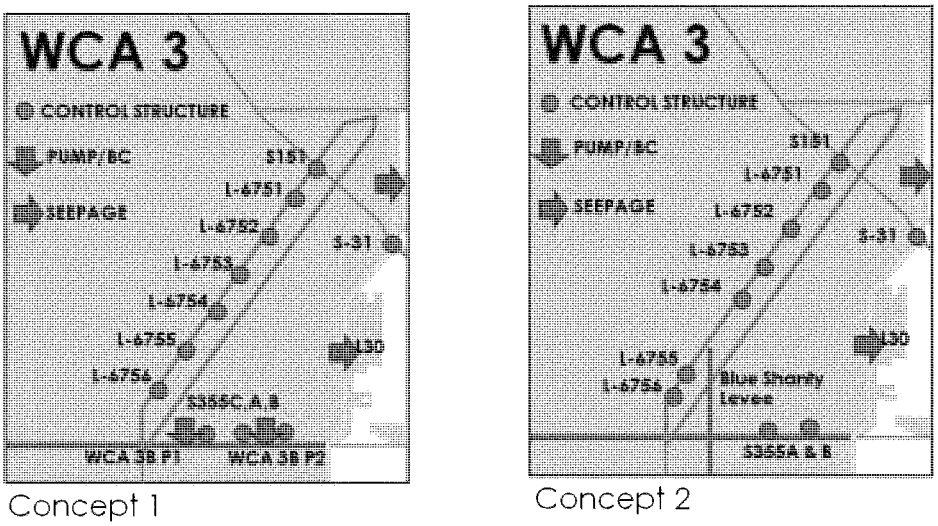


Figure 3-10. Two Primary Flowway Concepts for Distribution and Conveyance in Southern WCA 3A

These two concepts underwent analysis with the iModel screening tool. While the iModel tool emulates the hydrologic response characteristics of the RSM-GL model, unlike traditional hydrologic models, the iModel is "inverse" in that inputs to the iModel are operational targets (water depths and durations) and outputs are the optimized combination of structures and operations of structures that provide the overall "best" fit to the hydrologic targets. The iModel tests the need for individual structures and compares differences in achievement of performance. This tool is helpful to identify features and operations to undergo further investigation and is an efficient starting point for establishing the operations of features to be included in the RSM-GL evaluation of the final array. The iModel domain includes only WCA 3A, WCA 3B, and ENP, as well as WCAs 1 & 2; effects outside of the iModel domain, including the Lower East Coast, were not able to be assessed through iModel preliminary screening efforts.

3.2.3.3 Formulation of Options for Southern Distribution and Conveyance

The measures contained in the conceptual configurations (Concept 1 and Concept 2) were assembled into 23 combinations of differing locations and varying capacities based on the results of the initial iModel simulations and subsequent operational target refinements. Operational target refinements were conducted to ensure that project objectives and constraints were met. See **Appendix E 3.3** for description of the 23 options, operational target refinements, and screening details. Initial screening of the 23 combinations removed options that were not substantially different from each other, that included structures that were rarely used, or could not be implemented because they produced substantially different stages in adjacent areas.

Initial screening resulted in 10 options (**Appendix E**, **Table E.1.41**) that then underwent additional iModel analysis for performance toward full CERP restoration ecological targets (pre-drainage conditions).

3.2.3.4 Evaluation Criteria and Results of Options Analysis for Southern Distribution and Conveyance

Like previous options analyses, MCDA and a cost-effectiveness evaluation were used to evaluate the 10 options that resulted from the preliminary screening of southern distribution and conveyance measures. There were two levels of criteria evaluated (**Table 3-9**). Level 1 corresponded to the primary objectives of CEPP and Level 2 was used to ensure other important considerations were included in determination of what options were carried forward. See **Appendix E.3.4** and **Appendix E 3.5** for detailed criteria descriptions, evaluation tools used, scoring methodology and results.

Table 3-9. Level 1 and Level 2 Evaluation Criteria

Level 1 – Criteria Based on CEPP Objectives
• **Inundation:** average % time above ground surface elevation. Estimated for multiple locations throughout WCA 3A, WCA 3B, and ENP. • **Depth:** average ponding depth (ft) above ground surface elevation. Estimated for multiple locations throughout WCA 3A, WCA 3B, and ENP. • **Recession Rate**: estimated for location NP-205 within ENP. It is a key criterion for healthy marl prairie habitat which is less common and has a different target than ridge and slough habitat.
Level 2 – Other Important Considerations
• **Operational flexibility**: the speed, ease, efficiency of moving water to adjust to changing conditions such as storms or other real-time needs. • **Adaptability (Robustness and Future Compatibility):** Robustness was defined as the ability to function effectively in the face of variability and uncertainty of future events. Future compatibility is the efficiency of using the project configuration to complement future CEPP increments. • **Ecologic Connectivity:** qualitative criterion that evaluates increases in marsh connectivity directly associated with the removal of man-made barriers to flow.

3.2.3.4.1 Results of Level 1 and Level 2 Screening of Southern Distribution and Conveyance Options

The MCDA and cost effectiveness evaluation resulted in the elimination of several non-cost effective options. Evaluations were based on model output, records and guidance on requirements that the options would entail (such as levels of maintenance that each would require), and the results and lessons learned from relevant projects and restoration efforts in the region. Options were screened out due to lesser abilities to support project objectives combined with higher expected costs, as explained in **Appendix E.3.4** and **E.3.5**. Screening identified three cost-effective groups of options with similar costs and MCDA rating, which are listed below further described in **Section 3.2.3.5**.

Group 1: The first cost-effective group (Option 1A) was the lowest cost option that also yielded the lowest benefit.

Group 2: The second cost-effective group (Options 3A1 and 3A2) contained two options that demonstrated similar performance with similar costs. Additionally, the controllable gravity structures in these options restore more natural flow of water through the ecosystem while at the same time minimize O&M costs, fossil fuel consumption, and carbon emissions.

Group 3: The final cost-effective group (Options 3B2, 3B3 and 10A) are the highest performing plans and also exhibit the highest cost.

3.2.3.5 Refinement of Southern Distribution and Conveyance Options

The analysis conducted for this screening of options did not have the precision required to determine that one particular option was far superior to another in the same grouping. Further examination of the infrastructure sizing and usage was warranted on the three groupings of cost effective options to identify recommendations for inclusion in the final array.

Group 1: There was substantial stakeholder concern about the completeness of this option (1A) since this option bypassed delivering water to WCA 3B, leaving that area subject to continued degradation. This option also fails to utilize S-355A and S-355B, the previously constructed WCA 3B outlet structures in the L-29 levee. Additionally, it was apparent from the model output that the S-333 structure at 2,000 cubic feet per second (cfs) was frequently reaching capacity and a larger capacity could provide greater benefits at a relatively small increase in cost.

This option was modified to efficiently size the new infrastructure and maximize the use of existing infrastructure, and add one additional structure to deliver water from WCA 3A to WCA 3B (**Table 3-10**).

Table 3-10. Group 1 Refined Option for Southern Distribution and Conveyance

Initial Option 1A	Refined Group 1: Option 1
• Increase S-333 to 2,000 cfs • Unconstrained L-29 stage	• Increase S-333 to 3,000 cfs • Unconstrained L-29 stage • 750cfs centrally located structure on the L-67A • Gaps on L-67C Levee @ 750cfs structure • Existing S-355 A&B

Group 2: The second group (**Table 3-11**) contained two options (Options 3A1 and 3A2) that demonstrated similar performance with similar costs. Additionally, the controllable gravity structures in these options restored more natural flow of water through the ecosystem while at the same time minimized O&M costs, fossil fuel consumption and carbon emissions.

Table 3-11. Group 2 Refined Option for Southern Distribution and Conveyance

Initial Option 3A1	Initial Option 3A 2	Refined Group 2: Option 2
• Increase S-333 to 2,000 cfs	• Increase S-333 to 2,000 cfs	• Increase S-333 to 3,000 cfs
• Unconstrained L-29 stage	• Unconstrained L-29 stage	• Unconstrained L-29 stage
• (3) 500 cfs structures on the L-67A	• (3)750 cfs structures on the L-67A	• (2) 500 cfs and (1) 750cfs structure on the L-67A
• Gaps on L-67C Levee @ structures	• Gaps on L-67C Levee @ structures	• Gaps on L-67C Levee @ structures
• S-355 existing A&B and new S-355C outflow structure on L-29	• S-355 existing A&B and new S-355C outflow structure on L-29	• S-355 existing A&B and new S-355C outflow structure (500 cfs) on L-29

Model output demonstrated that the S-333 structure was frequently reaching capacity and larger capacity could provide greater benefits at a relatively low increase in cost. The modeling output also demonstrated that while Option 3A2 performed marginally better than Option 3A1, only one of the three proposed L-67A structures was operating at 750 cfs. Therefore, the refined options could maximize benefits and minimize costs with two 500 cfs structures and one 750 cfs structure.

Group 3: The final group (**Table 3-12**) contained the highest performing options (Options 3B2, 3B3, and 10A) and also exhibited the highest cost. An option from this grouping is recommended for inclusion in the final array because of the high degree of benefits achieved, despite stakeholder concern over having pumps operating to move water out of WCA 3B. Consistent with the first two groups, model output demonstrated that the S-333 structure frequently reached capacity and larger capacity could provide substantially greater benefits at a relatively low increase in cost.

Table 3-12. Group 3 Refined Option for Southern Distribution and Conveyance

Initial Option 3B 2	Initial Option 3B 3	Initial Option 10A	Refined Group 3: Option 3
• Increase S-333 to 2,000 cfs	• Increase S-333 to 2,000 cfs	• Increase S-333 to 2,000 cfs	• Increase S-333 to 3,000 cfs
• Unconstrained L-29 stage	• Unconstrained L-29 stage	• Unconstrained L-29 stage	• Unconstrained L-29 stage
• (3)750 cfs L-67A structures	• (3)750 cfs L-67A structures	• (4)500 cfs L-67A structures	• (4) 500 cfs structures on L-67A
• Gaps on L-67C Levee @ structures	• Gaps on L-67C Levee @ structures	• Gaps on L-67C Levee @ structures	• Gaps on L-67C Levee @ structures
• S-355 existing A&B and new S-355C	• S-355 existing A&B and new S-355C	• S-355 existing A&B and new S-355C	• S-355 existing A&B
• (1) 1,000 cfs pump on L-29	• (1) 1,000 cfs pump on L-29	• (2) 500 cfs pumps on L-29	• (2) 500 cfs pumps on the L-29
• Unconstrained WCA 3B Seepage	• Constrained WCA 3B Seepage	• Unconstrained WCA 3B Seepage	• Unconstrained WCA 3B Seepage

Option 10A had four 500 cfs structures conveying water into WCA 3B and two 500 cfs pumps moving water out, while options 3B2 and 3B3 had three 750 cfs structures conveying water into WCA 3B and one 1,000 cfs pump moving water out. The greater number of smaller structures of Option 10A provided increased operational flexibility and potentially greater spatial distribution of flow across the landscape relative to Options 3B2 and 3B3. Thus the pump option will contain the number and sizes of structures from Option 10A. The location of the structures was refined based on evaluation of model results to be more similar to that of the options 3B2 and 3B3 than 10A.

Revisions to Non-Cost Effective Options: The non cost-effective options were eliminated from further consideration through the iModel screening evaluations. However, major conceptual revisions (**Table 3-13**) were identified to Option 4A, B, and C (the Blue Shanty Flowway Options) that could bring the costs down substantially and increase the benefits to a level that is commensurate with the highest performing grouping. These options correspond to the Concept 2 (**Figure 3-10**) and provide a flowway through WCA 3B via the use of a new levee. These options provided the greatest improvement in ENP ridge and slough habitat, which warranted the consideration of a major conceptual revision to achieve the environmentally preferred level of benefits.

Table 3-13. Features in the Refined Group from Non-Cost Effective Options

Initial Option 4A	Initial Option 4B	Initial Option 4C	Refined Group 4 : Option 4
• Increase S-333 to 2,000 cfs	• Increase S-333 to 2,000 cfs	• Increase S-333 to 2,000 cfs	• Increase S-333 to 3,000 cfs
• Unconstrained L-29 stage	• Unconstrained L-29 stage	• Unconstrained L-29 stage	• Blue Shanty Levee L-67A to L-29 combined with a divide structure in the L-29 canal east of the terminus of the
• Blue Shanty Levee L-	• Blue Shanty Levee L-	• Blue Shanty Levee L-	

Initial Option 4A	Initial Option 4B	Initial Option 4C	Refined Group 4 : Option 4
67A to L-29 • (2) 500 cfs structures on L-67A inside Blue Shanty Flowway • Degrade L-67C and L-29 in Blue Shanty Flowway • (4) 500 cfs structure north of Blue Shanty Flowway • Gaps on L-67C Levee @ structures north of Flowway • Blue Shanty Levee in ENP	67A to L-29 • (2) 500 cfs structures on L-67A inside Blue Shanty Flowway • Degrade L-67C and L-29 in Blue Shanty Flowway • (1) 500 cfs structure north of Blue Shanty Flowway • Gaps on L-67C Levee @ structures north of Flowway • Blue Shanty Levee in ENP	67A to L-29 • (2) 500 cfs structures on L-67A inside Blue Shanty Flowway • Degrade L-67C and L-29 in Blue Shanty Flowway • Blue Shanty Levee in ENP	Blue Shanty Levee • Unconstrained L-29 stage • (2) 500 cfs structures on L-67A inside Blue Shanty Flowway • Degrade L-67C in Blue Shanty Flowway • Degrade L-29 in Blue Shanty Flowway • (1) 500 cfs structure north of Blue Shanty Flowway • Gaps on L-67C Levee @ structures north of Flowway

The Blue Shanty Flowway (i.e. new levee in WCA 3B /L-29 degrade) options were initially envisioned to minimize requirements needed to raise eastern Tamiami Trail and was expected to likely train water into central Shark River Slough which could lead to increased benefits in ENP. Upon further investigation, in the absence of raising Tamiami Trail east of the Blue Shanty Flowway, CEPP would be required to construct a levee inside ENP to protect eastern Tamiami Trail from high water impacts. In order to maintain consistency with the other options that were modeled, the Blue Shanty Flowway concept was altered to reflect full Tamiami Trail raising east of the flowway, consistent with the authorized TTNS Project, thereby removing the need for a levee in ENP. It is expected that the modified concept would avoid the adverse effects the Blue Shanty Levee caused to the marl prairie areas in ENP.

The Blue Shanty Flowway negates the need for additional seepage management features north of Tamiami Trail along the L-30 (eastern side of WCA 3B). Without the new WCA 3B levee, additional seepage management features would be required to protect against increased flooding risk to the adjacent Lower East Coast areas that would result from holding WCA 3B stages higher to promote significant wet season gravity outflows to the L-29 Canal. When considering the overall cost of the alternatives, this cost of this option will more closely reflect the other alternatives that are required to include seepage management features north of Tamiami Trail.

3.2.3.6 Southern Distribution and Conveyance Conclusion

Four options for southern distribution and conveyance are retained for incorporation into alternatives. The four options include incremental increases in the number of operable structures to deliver water from WCA 3A to WCA 3B across the L-67A levee and some degree of removal of L-67C levee. The first option has one structure in the L-67A levee and one gap in the L-67C levee. The second option has three structures and three gaps in the L-67A. The third option has four structures and four gaps. Similar to the second option, the fourth option also has three structures in the L-67A levee and complete removal of several miles of the L-67C levee; however, includes the north-south Blue Shanty Levee within WCA 3B combined with a divide structure in the L-29 canal east of the terminus of the Blue Shanty Levee,.

The four options also differ in the means by which water is conveyed out of WCA 3B into ENP across the L-29 Levee : option 1 relies on the existing 2 S-355s (gravity spillways), option 2 uses additional gravity flow structures, option 3 uses additional pumps, and option 4 removes approximately 4 miles of the L-29

Levee. All four options rely on the Tamiami Trail bridges to convey water from the L-29 canal to northeast ENP.

3.2.4 Screening of Seepage Management (Yellowline)

Seepage management features are located along the eastern boundary of the Everglades at the interface of the natural ecosystem and the agricultural and urban centers of Miami. See **Figure 3-11** and foldout Figure in back of this section. The focus of seepage management is on ground water that moves east through the protective levees and porous underground aquifer. Seepage management measures ensure that the seepage that crosses the levees can be effectively managed by the infrastructure east of the East Coast Protective Levee to achieve the objectives of the project. The objective of seepage management measures is to reduce water loss out of the natural system. Seepage management measures must also meet the project constraints to not reduce the level of service for flood protection and to maintain existing water supplies for adjacent agricultural and urban areas immediately east within the Lower East Coast Service Areas (LECSA) and Biscayne Bay, which could potentially be affected by restored water levels in the Everglades.

SEEPAGE MANAGEMENT MEASURES/COMPONENTS/OPTIONS

PURPOSE

Seepage management measures reduce water loss out of the natural system and reduce the flood risk to agricultural and urban areas

CEPP OBJECTIVES

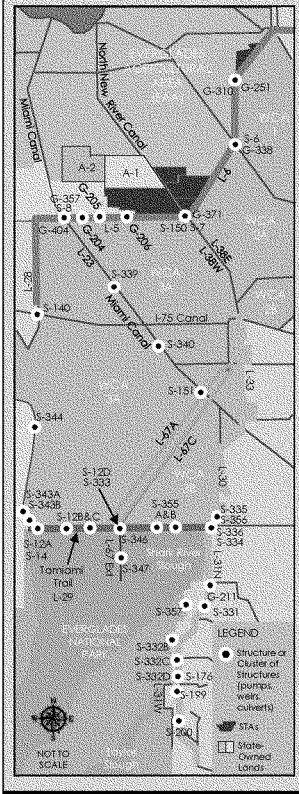
3 Reduce water loss out of natural system to promote appropriate dry season recession rates for wildlife utilization.

6 Increase availability of water supply

CEPP CONSTRAINTS

Avoid any reduction in level of service for flood protection.

Provide replacement sources of water of comparable quantity and quality for existing legal users for reductions caused by the project



1 SCREEN MANAGEMENT MEASURES 3.2.4.1

1. Canvass CERP efforts for measures and identify new measures
2. Determine consistency with CEPP objectives and constraints
3. Screen & optimize configurations of measures (sizes, locations, combinations) based on:
   - Flooding impacts
   - Effectiveness
   - Land available
   - Cost

RESULT

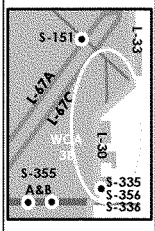
- New Pump Stations
- Raised Canal Stages
- New Canals
- Divide Structure
- Operational Changes
- Relocate /Operate Existing Pumps
- In-Ground Seepage Barrier
- Step-Down Levee

2 LOCATE MANAGEMENT MEASURES 3.2.4.2

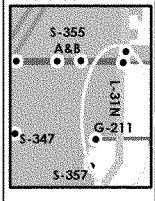
1. Seepage management location is directly related to the spatial distribution and quantity of water delivered across the L-67 levees and Tamiami Trail

RESULT

- North of Tamiami Trail



- South of Tamiami Trail



3 FORMULATE OPTIONS 3.2.4.3

1. **Sensitivity modeling** using several quantities of new water and existing facilities to predict locations and volumes of seepage
2. **Sensitivity modeling** of five sets of management measures to assess performance trends and effectiveness
   - Seepage Barrier | S-335 to S-334
   - Seepage Barrier Pennsuco to G-211
   - Convey Discharges to Coastal Canals + Utilize North and South Detention areas
   - Distributed pump scenario
   - Hydraulic Ridge + Pennsuco Pump

Critera

Quantity of water seepage into the LEC Canal Stage Groundwater Stage Structure Flow through Coastal Structures

RESULT

Each set of measures had some level of success in reducing seepage and retaining water within the natural areas

4 EVALUATE OPTIONS 3.2.4.4

1. Further evaluation of modeling results

Criteria:

- Adaptability
- Fuel consumption
- Land requirements and costs
- O&M costs

RESULT

Four seepage Management measures to be included in final alternatives:

- Increase S-356 to 1,000cfs
- Full depth seepage barrier between S-335 and S-334
- Partial depth seepage barrier
- 250 cfs seepage return pumps on L-31N

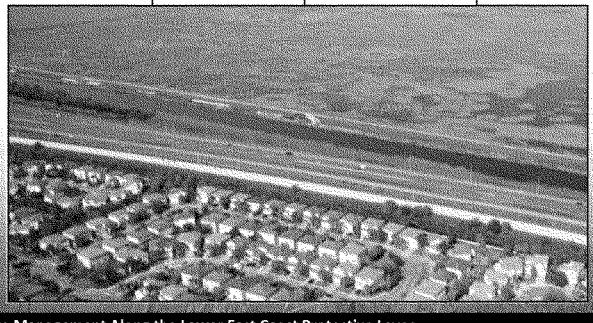


Figure 3-11. Seepage Management Along the Lower East Coast Protective Levee

3.2.4.1 Screening of Management Measures for Seepage Management

Several seepage management options were modeled and the results were used to inform development of the final array. The process followed similar steps used throughout CEPP screening and formulation, including: identifying and screening viable management measures, identifying combinations of those management measures that would provide the most informative model output, and using the output and information gathered in PDT discussions to determine feasible options for seepage management. A structured MCDA approach was not used for evaluating the results of the seepage management options.

A large compilation of measures previously suggested for other Everglades projects during PDT and stakeholder interactions and other measures suggested for CEPP based on professional judgment and experience were considered.

Initial screening criteria included:

- **Flooding impacts**: potential to cause adverse inundation in surrounding area
- **Effectiveness**: ability of the measure to achieve the seepage control desired
- **Costs:** efficiency and acceptability of high capital cost
- **Land availability:** sufficient or suitable property for construction and operation

The initial screening eliminated flood attenuation reservoirs, groundwater wells, lined canals and recharge basins. See **Appendix E.4.1** and **Appendix E.4.2** for detailed descriptions of management measures. **Table 3-14** lists the retained management measures.

Table 3-14. Results of Initial Screening of Management Measures

Seepage Management Measures	
• New Pump Stations • Raised Canal Stages • New Canals • Step-Down Levee (Blue Shanty Levee Divide Structure (L-29 Canal)	• Operational Changes • Relocate /Operate Existing Pumps • In-Ground Seepage Barrier • Detention Areas

3.2.4.2 Locations of Seepage Management Measures

The siting of the seepage management measures is directly related to the spatial distribution, directionality, and quantity of water being conveyed across the L-67s and Tamiami Trail. The conveyance options that increase the water depth in WCA 3B require increased seepage control over what currently exists to manage seepage north of Tamiami Trail. All conveyance and seepage options increase the water depth in ENP and will require some degree of seepage control south of Tamiami Trail. The Blue Shanty Levee combined with a divide structure in the L-29 was carried forward as an effective WCA 3B measure.

3.2.4.3 Formulation of Seepage Management Options

Two iterations of RSM-GL screening modeling were conducted to test the effectiveness of seepage management measure configurations. The highest flow and stage scenarios (upper bookend identified during the Greenline evaluations) were used as modeling baseline for the Yellowline seepage management configuration modeling. Information gained from testing against this upper bookend provided support in identifying configurations that minimize potential impacts on water supply and flood control.

Round 1: The first round of RSM-GL seepage screening modeling developed several quantities of additional water to northeast ENP to quantify changes to the total and event-based quantities of seepage and to characterize the performance of the S-356 pump station and other existing facilities in response to the increased water in ENP. The S-356 is an existing temporary 500 cfs pump station that was constructed under the MWD project, although the pump has not been operated pending completion of the MWD project. During formulation, there was a desire to modify or improve upon this pump station to identify if efficiency and cost savings could be realized by using an existing structure.

Round 2: The second round of screening modeling gathered information about the effectiveness of the proposed management measures from the refined list of measures described above. The goal was to assess the effectiveness of the management measures. The Yellowline sensitivity runs were performed on the five options in **Table 3-15** to examine performance trends for the various infrastructure and operational changes. These trends were used to help identify seepage management measures to include in the final alternatives. The configurations were evaluated to determine trend differences in hydrologic performance between the configuration and that of the existing condition for the following criteria:

- Quantity of water seepage into the LEC
- Canal Stage
- Groundwater stage
- Structure flow through coastal structures

Table 3-15. Seepage Management Options

Option	Description
YL1 - Seepage Barrier S-335 to S-334	• Full depth* seepage barrier S-335 to S-334 • Extend barrier a short distance south of Tamiami Trail (1 RSM cell) • S-356@1000 cfs
YL2 - Seepage Barrier Pennsuco to G-211	• Partial depth** seepage barrier ~35 ft deep • L-30 and L-31N to 8 ½ sq mile • S-356@1000 cfs
YL3 - Convey Discharges to Coastal Canals + Utilize North and South Detention areas	• Utilize coastal canals + existing detention areas • Utilize G-211 and S-331 to convey water supply and flood releases south • Convey water through C-1W @ S-338, C-102 @ S-194, C-103 @ S-196 during dry season • Convey water toward 332s during wet season
YL4 - Distributed pump scenario	• Distributed pumping: series of 100 cfs pumps along L-30, L-31N • S-356@500 cfs
YL5 - Hydraulic Ridge + Pennsuco Pump	• Hydraulic Ridge + Pennsuco Pump • ~ 1/2 mile wide impoundment area in ENP fed by S-356 @500 cfs and new pump @500 cfs • Pennsuco stage higher, and maintain an improved DBLEV canal • Pump near south end of Pennsuco
** "Full depth" seepage barrier – a barrier that terminates in the uppermost Tamiami Formation, restricting groundwater flow through the entire Biscayne Aquifer* *** "Partial depth" seepage barrier – a barrier that terminates above Tamiami Formation, restricting groundwater flow through the upper Biscayne Aquifer.*	

3.2.4.4 Seepage Management Conclusion

Overall, most of the measures had some level of success, highlighting that there are multiple ways to approach seepage management. One notable exception was identified that a seepage wall that is too long or penetrates too deeply may permanently adversely impact water supply performance and does not achieve the necessary balance between seepage management and replenishing well fields. Cost-effectiveness and screening against other criteria (O&M costs, adaptability to changing and uncertain future conditions, fossil fuel consumption, and other important stakeholder preferences) became key drivers of decision-making.

The seepage management measures retained from the above options include:

- Increase S-356 to 1,000 cfs
- Full depth seepage barrier between S-335 and S-334
- Partial depth seepage barrier
- 250 cfs seepage return pumps on L-31N
- Utilize G-211 and S-331 to convey water supply and flood releases south
- Convey water through C-1W @ S-338, C-102 @ S-194, C-103 @ S-196 during dry season
- Blue Shanty Levee and L-29 Divide Structure

These retained seepage management measures were then incrementally built upon and combined with the options identified through the other screening phases to identify the final array of alternatives. Uncertainties remained about which configuration of these management measures would perform optimally and meet requirements of the Savings Clause when combined with the other options. In order to mitigate this uncertainty, further information will be gathered during subsequent analysis that will allow for the refinement of the sizes, lengths, and capacities of the proposed seepage management measures.

3.3 FORMULATION OF THE FINAL ARRAY OF ALTERNATIVES

A key tenet of CEPP formulation is the interdependency of project components; therefore, the storage and treatment (i.e. water budget), distribution and conveyance, and seepage management components are not standalone features and, while formulated from a spatial perspective, do not function separately from the remaining portions of CEPP. Benefits are realized south of the storage and treatment facilities through redistribution and conveyance of the existing and "new" water made available. Likewise, the design of the seepage management features is highly dependent on the spatial distribution, directionality, and quantity of water that is moving into and through WCA 3A, WCA 3B, and ENP for restoration of natural habitat within these specific areas.

Combining the options identified through the plan formulation screening resulted in four alternatives to be considered in the final array. These alternatives are formulated to incrementally build off each other in terms of infrastructure required. Alt 1 required the least infrastructure and the other alternatives include more. Please see **the foldout Figure at the end of Section 4** for the proposed final array of alternatives. This section provides a synopsis of how the screening results were compiled into the final array.

3.3.1 Storage and Treatment - North of the Redline Options

The screening conducted for CEPP storage and treatment options, to deliver "new" water to the Everglades, resulted in the identification of one highly functioning option for inclusion in the final array

of alternatives (**Alts 1, 2, 3, and 4**). This configuration includes a 14,000 acre FEB on the A-2 footprint that operates in a mutually beneficial, integrated fashion with the State Restoration Strategies (water quality compliance remedy) on the A-1 footprint.

3.3.2 Northern Distribution and Conveyance – South of the Redline Options

The screening analysis identified two distribution and conveyance options in Northern WCA 3A to be combined with the other interdependent options. As previously described, the area east of the S-8 provides terrestrial refuge for deer on the L-5 levee during high water events and provides recreational access to northern WCA 3A. The option that avoids spreader canal construction in this area and minimizes costs, while still providing benefits to the greater ecosystem was recommended to be included as the minimal sized alternative in the final array (**Alt 1**).

Alt 1:

- Levee removal ~ 3 miles west of S-8 pump station (HRF)
- Full backfill of the Miami Canal from 1.5 miles south of S-8 to I-75
- Diversion of STA 2 flows to WCA 3A

One option was identified that reasonably maximizes project benefits in Northern WCA 3A. This option was included in the other alternatives in the final array (**Alts 2, 3, and 4**).

Alts 2, 3, and 4:

- Levee removal ~ 3 miles west of S-8 pump station (HRF)
- Spreader canal ~ 3 mile east of S-8 pump station (HRF)
- Spreader canal 1.5 mile at G-206 (HRF)
- Full backfill of the Miami Canal from S-8 to I-75
- Diversion of STA 2 flows to WCA 3A

3.3.3 Southern Distribution and Conveyance – Greenline and Blueline Options

The screening conducted for CEPP distribution and conveyance in Southern WCA 3A, WCA 3B, and ENP resulted in 4 groupings of alternatives to be incorporated into the final array.

First Grouping: The recommendation was to incorporate this option which maximized the use of existing infrastructure while providing moderate ecosystem benefits in the minimally sized alternative in the final array (**Alt 1**).

Alt 1

- Increase S-333 to 3,000 cfs
- One centrally located 750 cfs controlled structure on the L-67A
- Gaps on L-67C Levee @ structures
- Existing S-355 A&B
- Unconstrained L-29 stage

Second Grouping: The recommendation was to incorporate this option in the second alternative of the final array to rely on passive structure flows (**Alt 2**). This alternative would increase the passive inflow and outflow structures of WCA 3B over **Alt 1**.

Alt 2

- Increase S-333 to 3,000cfs
- Two 500cfs and one 750cfs controlled structures on the L-67A
- Gaps on L-67C Levee @ structures
- S-355 existing A&B and new S-355C outflow structure on L-29
- Unconstrained L-29 stage

Third Grouping: - The recommendation was to incorporate this option in the third alternative of the final array (**Alt 3**). These alternatives would increase the passive inflow structure capacity over Alt 2 and incorporate pump stations to move water out of WCA 3B.

Alt 3

- Increase S-333 to 3,000cfs
- (4) 500cfs controlled structures on L-67A
- Gaps on L-67C Levee @ structures
- S-355 existing A&B on L-29
- Two 500cfs pumps on the L-29
- Unconstrained L-29 stage

Fourth Grouping: The recommendation was to include the fourth grouping in the final array (**Alt 4**). This alternative builds off Alt 2 infrastructure with the addition of the Blue-Shanty Flow levee and degrading of the L-29 levee within the flowway in lieu of the additional outflow structure on the L-29.

Alt 4

- Increase S-333 to 3,000cfs
- Blue Shanty Levee L-67A to L-29 and divide structure in L-29 east of the Blue Shanty Levee terminus
- Unconstrained L-29 stage
- (2) 500cfs controlled structures on L-67A inside Blue Shanty Flowway
- Degrade L-67C in Blue Shanty Flowway
- Degrade L-29 in Blue Shanty Flowway
- 500cfs structure north of Blue Shanty Flowway

3.3.4 Seepage Management – Yellowline (Lower East Coast)

The different Greenline options carried forward into the final array have varying degrees and means of water being delivered into WCA 3B but all alternatives increase the stages in ENP. Uncertainties remained about which configuration of these management measures would perform optimally and meet requirements of the Savings Clause when combined with the other options. In order to mitigate this uncertainty, further analysis of the final array will allow for the refinement of the sizes, lengths, and capacities of the proposed management measures.

A commonality among all alternatives in the final array (**Alts 1, 2, 3, and 4**) is to increase the existing S-356 pump station to 1,000 cfs to capture seepage out of the natural system. The central location of the S-356 provides opportunities to manage seepage from both WCA 3B and ENP.

The distribution and conveyance options identified in **Alt 1** (minimal alternative) limit the amount of water entering WCA 3B so minimal seepage management infrastructure is required to handle WCA 3B seepage for this alternative. This alternative assumes only using pumps along L-31N to handle seepage out of WCA 3B and ENP. The configuration determined through screening to be further analyzed contains two distributed (northern and southern) 250 cfs pumps on the L-31N.

Alts 2 and 3 both increase the flow into WCA 3B and require seepage management infrastructure. These alternatives include full depth penetrating seepage barrier between S-335 and S-334, which is the most transmissive area due to the porous nature of the limestone. These alternatives also rely on the S-356 pump station to return excessive seepage. Continuing with the incremental approach to seepage management; **Alt 2** also includes a distributed pump configuration, but the northern pump location is substituted for a partial depth seepage barrier extending 2 miles south of Tamiami Trail, which is supplemented with the southern 250 cfs pump. **Alt 3** substitutes the southern pump for an additional 3 miles of partial depth seepage barrier (5 total miles).

The Blue Shanty Flowway levee in WCA 3B and the 1,000 cfs S-356 pump station negates the need for additional seepage management infrastructure in WCA 3B. **Alt 4** therefore contains no additional seepage infrastructure north of Tamiami Trail. South of Tamiami Trail this alternative incorporates the same infrastructure as **Alt 3**.

3.4 ELIMINATION OF A NON-INCREMENTAL APPROACH TO RESTORATION

The CERP provides a framework of components needed to achieve a practicable level of restoration of the Everglades. Each of the identified alternatives for CEPP has adopted the National Academy of Sciences' recommendation to use incremental adaptive restoration in fulfilling the comprehensive solution, and is therefore recommending an increment of several CERP components. Additionally as part of the CEPP formulation effort, CERP recommended plan components as described in the Restudy, related to the central Everglades, were also examined on the feasibility and efficiency of constructing complete elements of the following two CERP components for this increment of CEPP.

- **Everglades Agricultural Storage Reservoirs (Component G)**: 360,000 ac-ft of storage in the EAA
- **Decompartmentalization and Sheetflow Enhancement (Components AA and QQ):** complete Miami Canal backfill within WCA 3A and WCA 3B, distribution of conveyance features along the entire length of the L-67A levee, removal of the L-67C and L-29 levees, and seepage management

CEPP screening resulted in a 14,000 acre FEB identified as the sole option to include in the final array of alternatives. Larger storage capacity was examined, including up to 360,000 acre feet (12 ft reservoir); however, the deep reservoir storage was not brought forward due to unacceptable cost levels associated with the large increase in both storage and treatment capacity required to provide greater delivery of water to the Everglades. The four alternatives identified include incremental increases in the number of operable structures to deliver water from WCA 3A to WCA 3B across the L-67A levee and some degree of removal of L-67C levee. The alternatives differed in the means of moving water out of WCA 3B into ENP across the levee – gravity flow structures, pumps, or an increment of L-29 levee removal.

A CERP-like plan for CEPP would be based on the FEB in the EAA because of the reasons described above and would also include many CERP decompartmentalization components including: full backfill of the Miami Canal within WCA 3A, maximum distribution of the inflow structures along the L-67A (6 structures), removal of the L-67C levee, and full degradation of the eastern L-29 levee along WCA 3B. This plan could provide the opportunity to move more water through the system than was modeled during the screening effort given the increase in WCA 3B outlet capacity provided by full L-29 levee removal. This plan represents the most complete decompartmentalization consistent with the plan envisioned for CERP.

However, this plan would have to include extensive seepage management along the L-30 and L-31N levees; it would include a seepage barrier along the length of these levees. There is a great deal of uncertainty regarding the full seepage wall functionality and the associated risk to public water supply. Uncertainty about the sufficiency of the water budget available in this increment of CEPP and the potential adverse effects to the natural resources within WCA 3B during the dry season with complete removal of L-29 also pose significant concerns regarding this plan. Additionally, Miami Canal backfilling south of I-75 was demonstrated to provide negligible benefits with the identified water budget and modeling assumptions. The risk and uncertainty associated with the CERP-like plan was determined by the PDT and stakeholders to be unacceptable for this increment of CEPP, but was recommended to be further examined during potential subsequent planning efforts. This analysis supported the conclusion of using an incremental approach to restoration.

3.5 IDENTIFICATION OF THE FINAL ARRAY

Section 3.3 presented and assigned options for storage and treatment, northern conveyance and distribution, southern conveyance and distribution, and seepage management that that were combined into four alternatives. Representatives of the Miccosukee Tribe of Indians of Florida have also requested that CEPP consider levee gapping and backfilling of the L-28 levee and canal to re-connect WCA 3A to the Tribal lands located west of the L-28 Levee and south of I-75. This was analyzed as part of Alt 1. Alts 1, 2, 3, and 4 were identified to be further investigated as viable alternatives of the final array. The features of Alts 1 through 4 are listed and illustrated in **Figure 3-12**.

Figure 3-12. Final Array of Alternatives

CENTRAL EVERGLADES PLANNING PROJECT (CEPP) SPATIAL PERSPECTIVE

North of the Redline
- Combination of features to increase water deliveries downstream and improve estuarine benefits

South of the Redline
- Features and their locations to best restore sheetflow in northern Water Conservation Area 3A

Greenline/Blueline
- Features to best restore sheetflow through southern WCA-3A and 3B
- Configuration of conveyance features to best restore flows to Everglades National Park

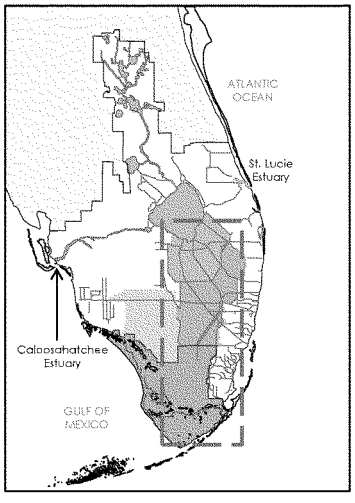
Yellowline
- Features to best compliment rest of project and manage seepage to the eastern urban area without impacting the water supply

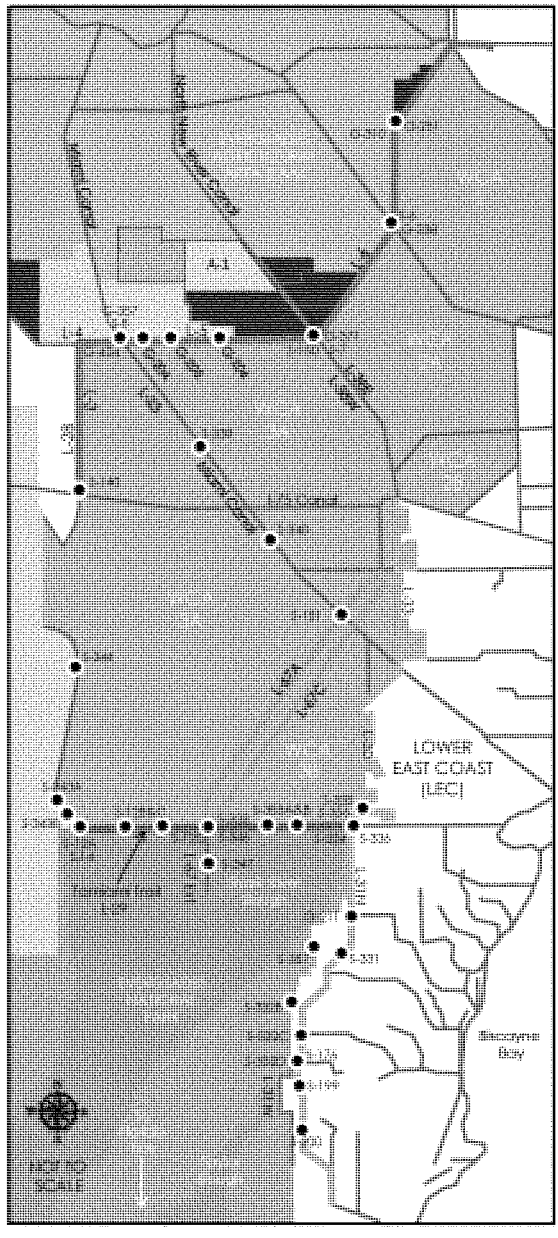
LEGEND
- Structure or Cluster of Structures (pumps, weirs, culverts)
- STAs
- State-owned Land

Future Without Project Conditions – Other Related Projects and Operations:

Projects (Non-CERP&CERP)
1. Modified Water Deliveries to ENP Components: Tamiami Trail Modifications (1-mile eastern bridge); 8.5 SMA;
2. C-111 South Dade (contracts 8 & 9)
3. Kissimmee River Restoration
4. SFWMD Restoration Strategies (Central Flow Path)
5. DOT Tamiami Trail Modifications (5.5 miles of bridges)
6. CERP Indian River Lagoon
7. CERP Picayune Strand Restoration
8. CERP Site 1 Impoundment
9. CERP Broward County Water Preserve Areas
10. CERP C-43 West Basin Storage Reservoir
11. CERP C-111 Spreader Canal Western Project

Operations
- Everglades Restoration Transition Plan (ERTP) 2012
- L-29 Canal Maximum Operational Limit
- G-3273 Constraint





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4.0 EVALUTION AND COMPARISON OF ALTERNATIVE PLANS

Please open the foldout figure at the end of this section to reference while reading.

Upon identification of the final array of alternatives, each alternative was evaluated for its effects on the environment (ecological and social benefits). See **Section 5** for details. The alternatives were compared using the Principles and Guidelines criteria (Completeness, Acceptability, Efficiency and Effectiveness). Project benefits were quantified using project specific performance measures, planning level costs were calculated for each alternative plan, and an analysis was conducted using Cost Effectiveness and Incremental Cost Analysis (CE/ICA) to identify alternatives that maximize environmental benefits compared to costs. The alternatives were also compared using the system of accounts (National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED) and Other Social Effects (OSE)). The evaluation and comparison resulted in the identification of the National Ecosystem Restoration (NER) plan and the recommended plan.

4.1 PRINCIPLES AND GUIDELINES EVALUATION CRITERIA

Principles and Guidelines criteria:

- **Effectiveness:** Extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities (Evaluated in **Section 4.1.1**)
- **Acceptability:** Workability and viability of the alternative plan with respect to acceptance by State and local entities and the public and compatibility with existing laws, regulations, and public policies (Evaluated in **Section 4.1.2**)
- **Completeness:** Extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects (Evaluated in **Section 4.1.3**)
- **Efficiency:** CE/ICA identified plans that maximize environmental benefits compared to costs (Evaluated in **Section 4.2**)

4.1.1 Effectiveness

An effective alternative alleviates the specified problems and achieves the specified opportunities for the Central Everglades Planning Project (CEPP). Because CEPP problems and opportunities drove the development of planning objectives (see **Section 1** of the report), effectiveness was evaluated by how well the alternatives achieved the planning objectives. **Table 4-1** presents how each alternative performed with respect to each objective. Additional details on hydrologic and ecological performance can be found in **Section 5.1, Appendix C.2.1**, and **Appendix G**. Additional details on hydrologic performance can be found in **Appendix A**.

Table 4-1. Summary Comparison of Alternatives in Effectiveness of Meeting the Planning Objectives of CEPP

Future Without (FWO) Project Condition	Alt 1 (S-333)	Alt 2 (Gravity)	Alt 3 (Pumps)	Alt 4 (Flowway)
Objective: Restore seasonal hydroperiods and freshwater distribution to support a **natural mosaic of wetland and upland habitat** in the Everglades System.				
Ridge and slough is the most common habitat in the Greater Everglades. The slough vegetation performance measure provides a measure of the suitability of hydrologic conditions for two key species of slough vegetation. All alternatives improve hydrologic conditions that support a more natural habitat mosaic. They increase continuous hydroperiods, reduce dry downs and improve average wet season and dry season depths. Performance for slough vegetation between alternatives varies by 1-4 percent, depending on location. All alternatives are closest to the targets in southern Water Conservation Area (WCA) 3A and Everglades National Park (ENP). The degree of freshwater distribution varies depending on the spatial extent and location of distribution features, with Alternative 1 containing the least distribution infrastructure and Alternative 4 the greatest.				
(Performance Measure for Slough Vegetation, 0-100 scale, target is 100)				
33 to 37 in zones north of I-75; 39 to 79 in zones south of I-75 and northern ENP	64 to 68 north 60 to 81 south	61 to 66 north; 60 to 81 south	61 to 66 north; 62 to 83 south	61 to 67 north 58 to 83 south
Objective: Improve sheetflow patterns and surface water depths/durations in the Everglades in order to **reduce soil subsidence, frequency of damaging peat fires**, decline of tree islands, and salt water intrusion.				
Before drainage, the Everglades probably remained wet nearly all years, with minimum slough water levels remaining at 0.5 to 1.0 feet (ft) above ground. Peat cores reveal little evidence of major fires. The Central and Southern Florida (C&SF) Project substantially altered hydrology. Construction of the Miami, North New River and Hillsboro Canals substantially lowered water levels, drying out the peat, reducing soil accretion, and increasing soil loss through oxidation and sever peat fires. Each alternative includes infrastructure that increases sheetflow and water depths across the WCA 3A via hydropattern restoration features and Miami Canal backfilling. Alternatives additionally improve surface water depths and durations through the introduction of additional water made available by the flowage equalization basin (FEB) and the redistribution of stormwater treatment area (STA) 2 discharges with the L-6 diversion operations. All alternatives reduce the risk of soil oxidation and peat fires relative to the FWO. All alternatives perform similarly to each other. Alternatives increase the amount of time that water levels are above the ground surface and do this for a larger portion of the project area relative to the FWO. Alternatives reduce risk of soil oxidation and fire more in the northern zones than in the southern zones.				
(Performance measure for Soil Oxidation, 0-100 scale, target is 100)				
26 to 63 in zones north of I-75; 50 to 100 in zones south of I-75 and northern ENP	85 to 100 north; 77 to 100 south	82 to 100 north; 77 to 100 south	81 to 100 north; 84 to 100 south	83 to 100 north; 86 to 100 south
Objective: Improve the quality of oyster and submerged aquatic vegetation (SAV) habitat in the Northern Estuaries (St Lucie Estuary (SLE) and Caloosahatchee (Cal) Estuary).				
High volume discharges from Lake Okeechobee can result in rapid decreases in salinity. Sustained exposure to reduced salinity produces adverse effects on oyster reefs, juvenile marine fish, sea grass beds, and other submerged aquatic vegetation in the Northern Estuaries. Reducing the frequency and magnitude of the high volume discharges improves salinity conditions in these estuaries thereby improving the quality of oyster and SAV habitat. All alternatives reduce high volume discharges to the Northern Estuaries. All alternatives perform equally, because they are dependent on the operations of the FEB, STA 2, STA 3/4, and Lake Okeechobee and contain the same features and operations. The CEPP alternatives reduce the moderately high lake inflow and estuary discharge events by diverting flow to the south, to the storage and treatment facilities, and reducing flows that would have otherwise gone to the estuaries. The largest lake inflow and estuary discharge events far exceed the combined available storage and treatment capacity in the A-1 and A-2 FEBs, STA 3/4, and STA 2, and as a result, the CEPP				

Future Without (FWO) Project Condition	Alt 1 (S-333)	Alt 2 (Gravity)	Alt 3 (Pumps)	Alt 4 (Flowway)
alternatives do not substantially reduce the frequency of extreme high flows to the Northern Estuaries.				
(Number of months of high flow and of extreme high flows, fewer is better)				
High flows: SLE - 54 months; Cal- 81 months Extreme high flows: SLE - 31 months; Cal – 33 months	High flows: SLE - 35 months; Cal- 68 months; Extreme high flows: SLE – 28 months; Cal – 31 months			
Objective: **Reduce water loss** (seepage) out of the natural system to promote appropriate dry season recession rates for wildlife utilization.				
Without management of seepage, a large portion of the new water delivered to the system would seep across and under the eastern perimeter levees, reducing the desired hydroperiod and water depth changes that produce the ecosystem benefits of the project alternatives. All alternatives include seepage management features that reduce water loss out of the natural system compared to water loss if no seepage management feature were included. While all the alternatives are effective in reducing seepage out of the natural system and consequently promoting more appropriate dry season recession rates for wildlife, they differ in the amount and spatial distribution of seepage to the east, where increased seepage may increase the risk of flooding in urban and agricultural areas, and decreased seepage may reduce water supply for municipal and agricultural uses and Biscayne Bay. None of the alternatives fully balance ecosystem benefits with potential adverse effects to water supply and/or flood control performance. The recommended plan will be modified to reduce seepage management infrastructure and/or improve operations in order to avoid impacts to water supply within the Lower East Coast Service Area (LECSA) and Biscayne Bay, while simultaneously reducing overall project costs.				
No change in seepage	All alternatives retain more water in the natural system than the FWO			
Objective: Restore more **natural water level responses to rainfall** to promote plant and animal diversity and habitat function.				
The target dry season recession rate in WCA 3A is approximately 0.05 ft per week from January 1 to June 1 (or onset of the wet season). This equates to a net stage difference of approximately 1.0 ft. Recession rates that are too slow prevent the gradual concentration of small fish and amphibian prey species into smaller, higher concentration areas where wading birds and other predators can catch them – the fish and other prey stay widely dispersed. Recession rates that are too fast lead to dry downs before the end of the dry season and eliminate the small fish and amphibians prey base. Rapid recession rates also may harm vegetation communities which are critical to nesting success of several bird species. All alternatives performed better than the FWO, with more weeks in the target and moderate recession rate zones, and fewer weeks in the lowest zone (recession rate too fast or too slow). All alternatives performed similar to each other. All alternatives improve hydrologic connectivity through backfilling of the Miami Canal. Alt 4 additionally improves hydrologic connectivity between WCA 3B and Northeast Shark River Slough (NESRS), but also reduces connectivity within WCA 3B. All alternatives incorporate rain-driven operations for WCA 3 and ENP to incorporate more natural water level responses to rainfall thereby improving more natural predator – prey relationships.				
(Dry season recession rate in WCA 3A (strive for 0.05 ft/week from Jan 1 to Jun 1)).				
115 of 880 weeks within 0.05 of target rate	143 of 880 weeks within 0.05 of target rate	142 of 880 weeks within 0.05 of target rate	144 of 880 weeks within 0.05 of target rate	148 of 880 weeks within 0.05 of target rate
Objective: Increase availability of **water supply**.				
Constraint: Ensure plan does not impact existing legal users water supply availability				
Increasing agricultural water availability for the Lake Okeechobee Service Area (LOSA), and increasing municipal/industrial water supply in the LECSA 2 (Broward County) and 3 (Miami-Dade County) is a desired				

Future Without (FWO) Project Condition	Alt 1 (S-333)	Alt 2 (Gravity)	Alt 3 (Pumps)	Alt 4 (Flowway)
outcome of CEPP. As the purpose of the Comprehensive Everglades Restoration Program (CERP) and CEPP is to restore, preserve, and protect the south Florida ecosystem while providing for other water-related needs of the region, the target was established to make additional water available without reducing the natural system benefits justifying the project. There is also a legal requirement to evaluate impacts on legal water users, and provide replacement sources of water of comparable quantity and quality if any adverse impacts are identified. All alternatives performed the same for the LOSA, since they depend on the operations of the FEB, STA 3/4, and Lake Okeechobee, and all alternatives contain the same operations for these features. The alternatives had less water supply cutback volumes than the FWO during 7 of the 8 years with the highest water supply cutback volumes (excluding 1981). Seepage management features and operations included in all alternatives may reduce water supply for municipal and agricultural users within the LECSAs and Biscayne Bay, and consequently all alternatives in the final array were not effective at increasing the availability of water supply. However, the identified NER plan will be modified to, at a minimum, meet project constraints by reducing the L-31N seepage management infrastructure and optimize regional operations in order to avoid impacts to water supply. Potential for adverse impacts on water supply in LECSA and Biscayne Bay is greater for Alts 3 and 4 than for Alts 1 and 2.				

4.1.2 Acceptability

An acceptable alternative plan is workable and viable with respect to acceptance by State and local entities and the public and compatible with existing laws, regulations, and public policies. Positive and negative attributes of project features and effects were characterized and documented in the following table. **Table 4-2** presents a description of specific concerns that have been raised regarding acceptability of alternative components by project component.

Table 4-2. Stakeholder Acceptability of Alternative Components by Region (Red, Green, and Yellow Line)

FEB, STA and Lake Okeechobee Operations
All Alternatives Concerns: FEB access and recreational opportunities should be provided Provide deep water refugia to support fish and wildlife during dry periods Limited additional water supply afforded by the project Limited additional benefits to the Northern Estuaries
Hydropattern Restoration Feature (HRF) and Miami Canal
All Alternatives Concerns: Potential effects on upland wildlife from changes in water depths in northern WCA 3A sawgrass areas Increased closure of WCA 3A to public access for hunting Cattail expansion along spreader canal inflow locations Sufficient deep water refugia to support fish and wildlife during dry periods Conflicting concerns about impacts to Miami Canal spoil mounds • Pro: Removing spoil mounds removes an impediment to flow • Con: Removing spoil mounds also removes refuge for terrestrial mammals Conflicting concerns about leaving the Miami Canal open south of I-75 • Pro: Filling in the Miami Canal removes an unnatural disturbance in WCA 3A • Con: Filling in the Miami Canal impacts prime fishing opportunities in south Florida
Alternatives 2, 3 and 4: • Pro: Capability for operational flexibility to reduce fire risk • Pro: Fishing in HRF to offset impacts due to Miami Canal backfilling (boat ramps) • Con: Fewer WCA 3A benefits than Alt 1, yet more costly • Con: Greater impact on recreational hunting access than Alt 1
WCA 3B Flow
Alt 1: • Pro: Least expensive • Con: Provides minimal sheetflow in WCA 3B, does not remove barriers to flow
Alt 2: • Pro: Low operations and maintenance costs for spillways compared to pumps • Con: Surface water flow does not go south, and lack of flow through WCA 3B, does not remove barriers to flow • Con: Concerns regarding modifications to agricultural ditches as collectors to aid flow of water out of WCA 3B
Alt 3: • Pro: Allows greater flow through WCA 3B than Alts 1, 2 and 4 • Con: Increased costs (construction, operations and maintenance) associated with extensive pumping • Con: Does not increase ecological connectivity
Alt 4: • Pro: Provides southerly flow direction consistent with landscape patterns in a portion of WCA 3B • Pro: Removal of part of L-29 Levee creates greatest ecological connectivity between WCA 3B and NESRS • Con: Building a new levee is not removing barriers to flow and levee would be a long term landscape feature • Con: Does not provide flow to the majority of WCA 3B • Con: The lack of control of releases from western WCA 3B could exacerbate dry downs or reverse flow situations
Seepage Management
Alt 1: • Pro: Utilized coastal canals to deliver water to Biscayne Bay • Con: Point source discharge rather than distributed flow due to pumping directly to eastern ENP along L-31N
Alt 2: • Pro: Utilized coastal canals to deliver water to Biscayne Bay • Con: Point source discharge rather than distributed flow due to pumping directly to eastern ENP along L-31N • Con: Increased capital and operations and maintenance costs associated with pumping • Con: Potential adverse impacts on water supply in LECSA with seepage management barrier options
Alt 3: • Pro: Utilized coastal canals to deliver water to Biscayne Bay • Con: Water quality concerns for infrastructure returning seepage directly to ENP • Con: Potential adverse impacts on water supply in LECSA and Biscayne Bay from longer and deeper barriers
Alt 4:

- Pro: Utilized coastal canals to deliver water to Biscayne Bay
- Con: Potential adverse impacts on water supply in LECSA and Biscayne Bay from longer barrier

Some of the stakeholder concerns listed in **Table 4-2** are also legal and policy concerns, particularly potential adverse effects to water supply and Biscayne Bay deliveries. For any of the alternatives, these legal and policy concerns could be reduced by refining the operations of the seepage management features.

Alts 1, 2, and 4 have similar levels of acceptability. All have a combination of concerns. Alt 3 is less acceptable since it has a higher reliance on pump stations and the associated operational and maintenance, repair, replacement and rehabilitation (OMRR&R) costs compared to the other alternatives.

4.1.3 Completeness

A complete alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the plan's effects.

Components in CEPP are interdependent features that necessitated formulation from a systems approach. The components in the central part of the Everglades are hydrologically connected from Lake Okeechobee to Florida Bay, and rely on one another for both inflows and outflows. These interdependencies required system-wide plan formulation from a spatial perspective to optimize structural and operational components, rather than formulating separable components that may not be compatible or complete for the cumulative watershed. Consequently, no alternative is complete unless all of the identified operations and infrastructure are included. In order to maintain completeness and meet constraints during construction, a strategic implementation sequencing and adaptive management plan will be required for any alternative suggested as the recommended plan.

In addition to the interdependent completeness of the components in the alternatives, there are both CERP and non-CERP activities that will be required to realize benefits are achieved and constraints are met.

- All alternatives in the final array depend on non-CERP activities:
  - Modified Water Deliveries
  - Tamiami Trail Next Steps – 2.6 mile Western Bridge and Road Raising
  - State of Florida – Restoration Strategies Water Quality Infrastructure
  - C-111 South Dade – North Detention Area Completion
- All alternatives in the final array depend on CERP activities:
  - Broward County Water Preserve Area
  - Indian River Lagoon-South Project
  - C-43 Western Basin Storage Reservoir Project
- All alternatives in the final array depend upon updates to C&SF Water Control Manuals, including revisions to the Lake Okeechobee Regulation Schedule (LORS) as needed

4.2 EFFICIENCY ANALYSIS: ENVIRONMENTAL BENEFITS AND COSTS OF ALTERNATIVE PLANS

The CEPP recommended plan is justified by the environmental benefits derived by the south Florida ecosystem; however, a comparison of the benefits and costs of alternative plans is also conducted to ensure that a selected alternative is efficiently producing the environmental benefits. The measurement of efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating the

specified problems and realizing the specified opportunities, consistent with protecting the nation's environment.

The CE/ICA is used to evaluate and compare the production efficiency of alternatives. This identifies the plans that reasonably maximize ecosystem restoration, a key criterion to select the NER plan. Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every level of output considered. Alternative plans are compared to identify those that would produce greater levels of output at the same cost or lesser cost than other alternative plans. Alternative plans identified through this comparison are the cost effective alternative plans. Cost effective plans are then compared by examining the additional (incremental) costs for the additional (incremental) amounts of output produced by successively larger cost effective plans. The plans with the lowest incremental costs per unit of output for successively larger levels of output are the best buy plans. The results of these calculations and comparisons of costs and outputs between alternative plans provide a basis for addressing the decision question "Is it worth it?" i.e., are the additional outputs worth the costs incurred to achieve them?

The CE/ICA analysis follows guidance from the U.S. Army Corps of Engineers (USACE) , Engineering Regulation (ER) 1105-2-100, Appendix E, para. E-36. Costs are based initially on a planning level estimate and benefits are based on the habitat unit (HU) evaluation. As per this guidance, CE/ICA analysis compares the alternative plans' average annual costs against the appropriate average annual HU estimates. The average annual outputs are calculated as the difference between with-plan and without-plan conditions over the period of analysis (through year 2072).

4.2.1 Costs of Final Array of Alternative Plans

Costs represent the difference between conditions without any plan (the "base condition" or "without project condition") and with a plan or alternative. For purposes of this report and analysis, NED costs (as defined by Federal and USACE policy) are expressed in 2014 price levels. Costs of a plan represent the value of goods and services required to implement and operate/maintain the plan. The cost estimate for the alternatives includes construction, lands, easements, right-of-ways, relocation (LERR), preconstruction engineering and design (PED), construction management, and OMRR&R, and was developed through engineering design and cost estimation, and real estate appraisal efforts.

4.2.1.1 Overview of the Planning Level Cost Estimating Tool

A Planning Level Cost Estimating Tool has been developed and designed by the South Florida Water Management District (SFWMD) to enable a "Planning Level" Construction Cost Estimate for reservoirs, STA's and canals. The construction costs included in the planning level estimate include PED, engineering during construction (EDC) and construction management supervisions and administration (SA).

The costs generated by this tool are screening level relative costs, not absolute costs. These costs should only be used to compare the costs of alternatives relative to one another and are not to be used as the detailed costs for construction. These costs were developed using historical costs from SFWMD constructed projects. This cost estimating tool can be used to generate simple cost estimate comparisons between specific features, components and configurations. The tool takes into account soil conditions such as muck, sand, and clay, as well as local impacts such as the construction or removal of roads, bridges, transmission lines, railroads, rail yards, railroad bridges, housing, farms, telemetry, etc. This tool does not take into account potential cost savings when some features can serve more than one purpose or function.

4.2.1.2 Overview of Real Estate Costs

A detailed analysis of the real estate requirements of the final array was completed. Each parcel required for construction or restoration activities was identified, characterized, and a value estimate was calculated. The real estate was valued in fee, however, lesser estates and interests in land could be considered.

All of the alternatives had the same land requirements for the storage and treatment features. 14,521 acres in the A-2 Compartment were valued at SFWMD actual acquisition costs since these lands were purchased with both Federal Farm Bill funds and SFWMD funds. 145.5 acres (90.93 acres owned by the State of Florida and 54.57 acres owned by SFWMD) were required for the new feeder canal leading from the Miami Canal on the west running east to the A-2 Compartment. These lands were valued at an estimated fair market value.

Alt 1 included a feature at the L-28 triangle which required additional lands, and accounts for the real estate difference between Alt 1 and the other alternatives. Lands were required for construction of pump stations, and other structures within WCA 3A and 3B. These lands were not assigned a value as they were provided for the prior C&SF Project.

4.2.1.3 Average Annual Costs

The timing of a plan's costs is important. Construction and other initial implementation costs cannot simply be added to periodically recurring costs for project operation, maintenance and monitoring if meaningful and direct comparisons of the costs of the different alternatives are to be made. A common practice of equating sums of money across time with their equivalent at an earlier point in time is the process known as discounting. Through this mathematical process, which involves the use of an interest rate (or discount rate) officially prescribed by Federal policy for use in water resource planning analysis (set at 3.5% at the time of the evaluation), the cost time streams for the alternative plans were mathematically translated into an equivalent time basis value. There is some uncertainty as to how any of the alternatives would be implemented. It is recognized that any of the plans would likely be implemented over a considerable length of time. For purposes of this evaluation, construction costs are assumed to incur on an equal monthly basis during the implementation of the alternative plans and would be implemented with no fiscal appropriation constraints.

ER 1105-2-100 requires that interest during construction (IDC) be computed, which represents the opportunity cost of capital incurred during the construction period. IDC was computed for PED costs from the middle of the month in which the expenditures were incurred until the first of the month following the estimated construction completion date, and assumed a 5 year unconstrained construction timeline. IDC was computed for both real estate and construction costs. IDC was computed for the total real estate cost starting from the month prior to construction commencing. The total first cost is the sum of construction and other capital cost, such as real estate and pre-construction. The total project investment is the first cost plus IDC. **Table 4-3** summarizes the total investment cost and average annual costs of each alternative plan.

Table 4-3. Planning Level Construction and Investment Cost of Alternative Plans

	Summary of Costs for CEPP Alternative Plans*			
	Alt 1	Alt 2	Alt 3	Alt 4
Cost Component				
Construction Features	$1,855,000,000	$2,174,000,000	$2,282,000,000	$2,147,000,000
Lands	$41,000,000	$39,000,000	$39,000,000	$39,000,000
Total First Cost	**$1,896,000,000**	**$2,213,000,000**	**$2,321,000,000**	**$2,186,000,000**
Interest During Construction				
Construction	$141,000,000	$165,000,000	$174,000,000	$163,000,000
Lands	$4,000,000	$4,000,000	$4,000,000	$4,000,000
Total Interest During Construction	**$145,000,000**	**$169,000,000**	**$178,000,000**	**$167,000,000**
Total Project Investment	**$2,041,000,000**	**$2,382,000,000**	**$2,499,000,000**	**$2,353,000,000**
Average Annual Cost				
Interest & Amortization	$87,000,000	$101,600,000	$106,500,000	$100,300,000
OMRR&R	$5,500,000	$6,400,000	$6,900,000	$6,500,000
Average Annual Cost	**$92,500,000**	**$108,000,000**	**$113,400,000**	**$106,800,000**

*NER annual costs are based on a 50-year period of analysis. Costs do not include costs of recreation features.
*Costs are planning level costs and do not coincide exactly with the detailed costs of the recommended plan presented in other sections of the report.
* Computation of the detailed estimate for the recommended plan is based on additional engineering and design.
* Contingency used in planning level costs was 82% due to the high level of uncertainty in the design of alternatives

4.2.2 Ecological Evaluation (Habitat Units)

The CEPP devised a project specific tool, referred to as the CEPP planning model to evaluate alternatives within the CEPP project area. The primary areas evaluated included the St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary, WCAs 3A and 3B, ENP, and Florida Bay. HUs were not calculated for Lake Okeechobee or Biscayne Bay, since the performance of these areas were considered a constraint during formulation. The CEPP planning model is a Microsoft (MS) Excel spreadsheet that utilizes project performance measures to derive a HU score that represents the ecological performance achieved by each alternative. The complete description of the model, equations and calculations, and further information pertaining to the alternative evaluation is described in **Appendix G**.

The CEPP planning model was used to aggregate the results of project performance measures. Each of the performance measures for the CEPP planning effort was derived from those approved for use in CERP by Restoration, Coordination and Verification (RECOVER). Eight performance measures were identified (**Table 4-4**). Performance measures were developed from the Northern Estuaries, Greater Everglades Ridge and Slough, and Florida Bay Conceptual Ecological Models (CEMs) (Barnes 2005, Ogden 2005a, Rudnick et al. 2005, Sime 2005). CEMs, as used in the Everglades restoration program, are non-quantitative planning tools that identify the major anthropogenic drivers and stressors on natural systems, the ecological effects of these stressors, and the best biological attributes or indicators of these ecological responses (Ogden et al. 2005b). These CEMs have been extensively peer reviewed and

provide the framework for the planning and assessment of the CERP. Each performance measure has a predictive metric and targets based on hydrologic requirements necessary to meet empirical or theoretical ecological thresholds. Detailed estimates of hydrology across the 41-year period of record (January 1965 – December 2005) generated by the RSM-BN (for the Northern Estuaries) and the RSM-GL (for the Greater Everglades (WCA 3 and ENP) and Florida Bay) were used to calculate performance measure scores.

Table 4-4. Performance Measures Used to Quantify Plan Benefits

Region	Performance Measure (PM)	Description
Northern Estuaries	**Caloosahatchee Estuary** • PM 6.1 Low Flow Targets • PM 6.2 High Flow Targets **St. Lucie Estuary** • PM 7.1 Low Flow Targets • PM 7.2 High flow Targets	Measure of the frequency of flows correlated to downstream estuarine salinities favorable to marine fish, shellfish, oyster and SAV.
Greater Everglades (WCA 3 and ENP)	**Hydrologic Surrogate for Soil Oxidation** • PM 3.1 Drought Intensity Index	Measure of cumulative drought intensity as an indicator of peat oxidation and risk of fire.
	Inundation Duration: Ridge and Slough Landscape • PM 1.1 Percent Period of Record of Inundation	Measure of the frequency and duration of marsh inundation.
	Number and Duration of Dry Events: Shark River Slough • PM 4.1 Number of Dry Events • PM 4.2 Duration of Dry Events • PM 4.3 Percent Period of Record of Dry Events	Measure of the number of times and mean duration of periods when water levels drop below ground.
	Sheet flow in the Ridge and Slough Landscape • PM 2.1 Timing of Sheetflow • PM 2.2 Continuity of Sheetflow • PM 2.3 Distribution of Sheetflow	Measure of the agreement of seasonal timing of flows with pre-drainage timing and of the spatial uniformity of sheet flow across the landscape.
	Slough Vegetation Suitability • PM 5.1 Hydroperiod • PM 5.2 Dry down • PM 5.3 Dry Season Depth • PM 5.4 Wet Season Depth	Measure of hydrologic conditions favorable to two species (white water lily and spikerush) indicative of Everglades sloughs.
Florida Bay	**Salinity in Florida Bay** • PM 8.1 Dry Season Regime Overlap • PM 8.2 Wet Season Regime Overlap • PM 8.3 Dry Season High Salinity • PM 8.4 Wet Season High Salinity	Measure of temporal-seasonal agreement between predicted salinity regimes in Florida Bay and pre-drainage salinity targets.

Performance measure scores are displayed as a function of restoration potential or achievement of the target with the minimum value of zero representing a fully degraded ecosystem and a maximum value of 100 representing the restoration target. Habitat suitability indices associated with each performance measure are then summed and applied to the total spatial extent (acres) for each of the 17 zones (**Figure 4-1** through **Figure 4-4**) to produce HUs. HU results for the existing conditions baseline (ECB), the FWO project condition, and the alternatives are displayed in **Table 4-5**.

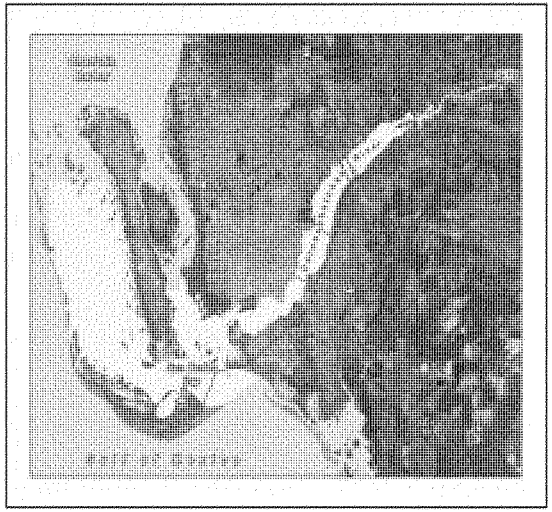


Figure 4-1. Zones for Habitat Suitability within the Caloosahatchee Estuary

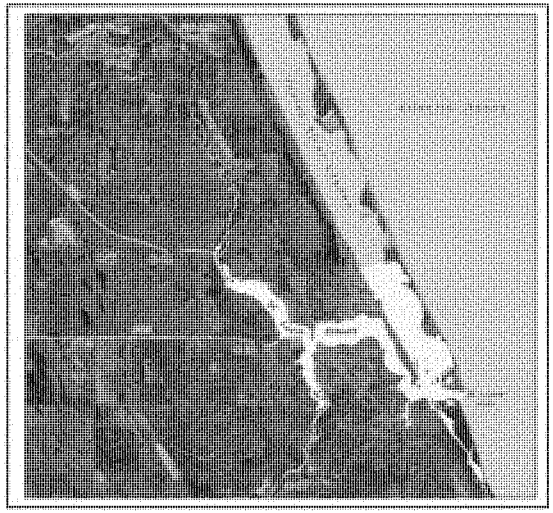


Figure 4-2. Zones for Habitat Suitability within the St. Lucie Estuary

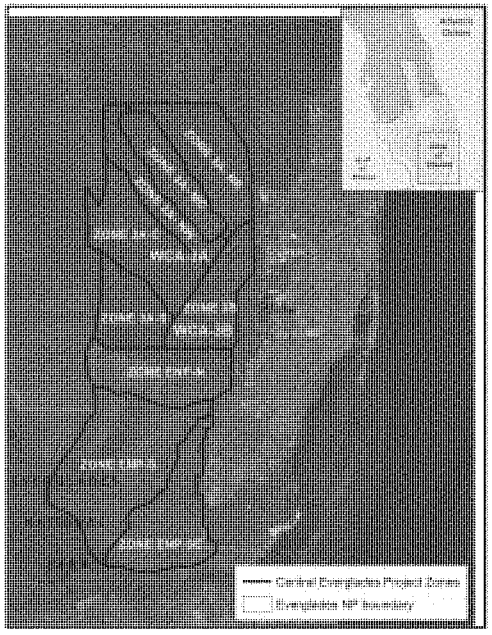


Figure 4-3. Zones for Habitat Suitability within WCA 3 and ENP

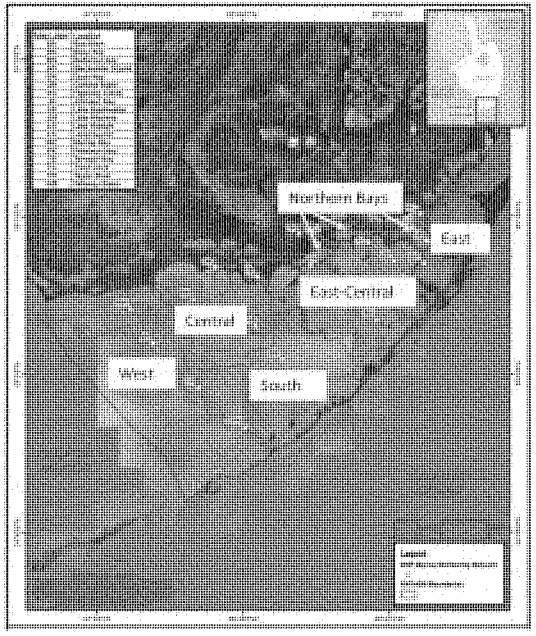


Figure 4-4. Zones for Habitat Suitability within Florida Bay

Table 4-5. Total Habitat Units for each Alternative Condition

Project Region (Zone)	ECB*	FWO**	Alt 1**	Alt 2**	Alt 3**	Alt 4**
Caloosahatchee Estuary (CE-1)	2,839	34,070	39,038	39,038	39,038	39,038
St Lucie Estuary (SE-1)	2,099	2,399	4,798	4,798	4,798	4,798
Total Northern Estuaries	**4,938**	**36,469**	**43,836**	**43,836**	**43,836**	**43,836**
Northeast WCA 3A (3A-NE)	44,451	29,634	96,311	96,311	96,311	96,311
WCA 3A Miami Canal (3A-MC)	32,847	27,373	57,874	57,092	56,310	57,092
Northwest WCA 3A (3A-NW)	30,970	30,266	54,902	53,494	53,494	53,494
Central WCA 3A (3A-C)	108,414	105,669	109,786	109,786	109,786	109,786
Southern WCA 3A (3A-S)	69,247	68,423	68,423	67,598	67,598	68,423
WCA 3B (3B)	55,697	48,842	58,268	59,125	57,411	54,840
Northern ENP (ENP-N)	57,557	55,054	102,601	101,350	103,852	102,601
Southern ENP (ENP-S)	124,068	126,454	169,400	169,400	176,558	188,488
Southeast ENP (ENP-SE)	79,711	81,062	82,413	82,413	82,413	83,764
Total Greater Everglades (WCA 3 and ENP)	**602,962**	**572,777**	**799,978**	**796,569**	**803,733**	**814,799**
Florida Bay West (FB-W)	23,693	20,534	42,647	42,647	47,386	52,124
Florida Bay Central (FB-C)	9,025	8,205	15,589	14,769	17,230	17,230
Florida Bay South (FB-S)	16,614	14,659	30,296	29,318	33,228	35,182
Florida Bay East Central (FB-EC)	21,984	20,225	36,933	36,933	42,209	46,606
Florida Bay North Bay (FB-NB)	2,154	2,028	2,661	2,661	2,788	2,915
Florida Bay East (FB-E)	9,440	8,685	10,573	10,573	10,950	10,950
Total Florida Bay	**82,910**	**74,336**	**138,699**	**136,901**	**153,791**	**165,007**
Total All Regions	**690,810**	**683,582**	**982,513**	**977,306**	**1,001,360**	**1,023,642**

* HU values for the ECB represent those calculated in the year 2010.

** HU values for the FWO and Alts 1 through 4 are calculated for the full ecological response time.

There are substantial benefits within the Blue Shanty flowway in WCA 3B that are not captured in the HU calculations. The CEPP planning model uses an indicator region that falls outside the Blue Shanty flowway; however, the hydrology within the flowway would more closely resemble southern WCA 3A, potentially leading to an underrepresentation of benefits for Alt 4.

4.2.2.1 Average Annual Habitat Units

The average annual outputs were calculated as the difference between the with-plan and without plan conditions over the period of analysis (through year 2072). The base year for the period of economic analysis for CEPP is the year 2022. The average annual HU lift is calculated as subtracting the FWO project HUs from the future with project HUs for each year and averaging over the 50 period of analysis. The anticipated time it will take to realize the benefits is necessary to calculate the average annual lift associated with each alternative.

Natural ecosystems are complex, dynamic systems and the exact functional form of the relationship among variables is rarely if ever known. South Florida ecosystems have been subject to extensive

research and monitoring, and credible estimates of response times can be predicted based on how key ecosystem components have responded to varying hydrologic conditions. The rate at which CEPP benefits accrue over various time intervals, depending on the region, were estimated using these inferences. Linear interpolation was used as a simple method for inferring the rate at which benefits would accrue between those time intervals for each of the three regions of the project area for both the FWO and future with project conditions.

Greater Everglades (WCA 3 and ENP)

An ecological response time for the Greater Everglades was estimated based on the ability of CEPP to improve conditions for aquatic and herbaceous vegetation communities, periphyton, piscivorus fish, aquatic prey base organisms, and hydroecological reshaping of ridges and tree islands. The ecological response time was estimated to be approximately 75-100 years until full impact would be realized, with a large percentage of benefits accruing earlier as identified in **Table 4-6**.

Table 4-6. Ecological Response Time for Greater Everglades (WCA 3 and ENP)

Percentage of Benefit Achieved Over Time for the Greater Everglades				
0-2 Years*	**2-5 Years**	**5-10 Years**	**25-50 Years**	**75-100 Years**
50%	70%	80%	90%	100%

*Base year is 2022

Figure 4-5 graphically displays the ecological response time in the Greater Everglades for each alternative condition. As previously discussed, the period of analysis for CEPP extends 50 years out from the base year (2022) and consequently a greater degree of the full impact of the CEPP alternatives is captured by extending the period of analysis past the traditional CERP 2050 end year.

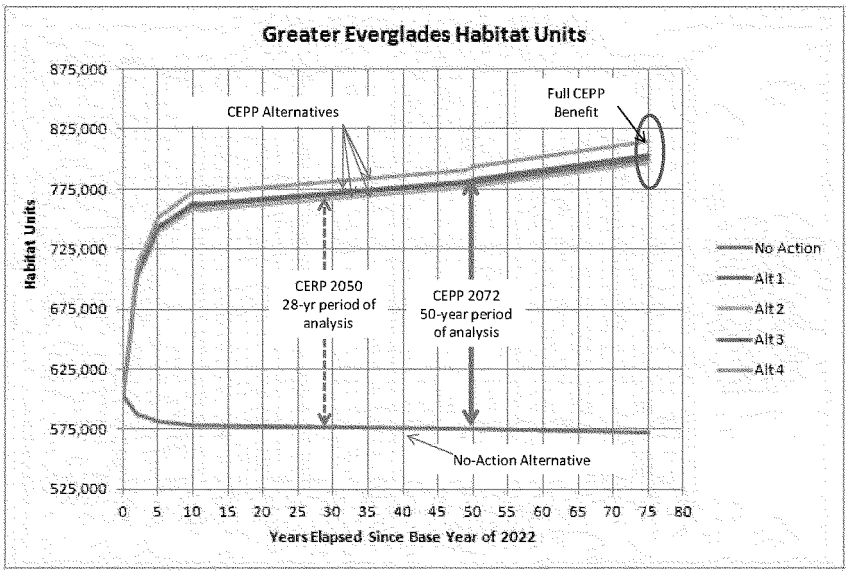


Figure 4-5. Habitat Units through Time for Alternative Conditions in Reaction to Ecological Response Times

Florida Bay

An ecological response time for Florida Bay was estimated based on the ability of CEPP to improve conditions for phytoplankton, zooplankton, seagrass, and large and small invertebrates. The ecological response time was estimated to be approximately 15-25 years until full impact would be realized, with a large percentage of benefits accruing earlier as identified in **Table 4-7**.

Table 4-7. Ecological Response Time for Florida Bay

Percentage of Benefits Achieved Over Time for Florida Bay				
0-2 years	2-5 years	5-10 years	10-15 years	15-25 years
40%	80%	90%	95%	100%

*Base year is 2022.

Northern Estuaries

An ecological response time for the Northern Estuaries was estimated based on the expected response time of oysters and submerged aquatic vegetation to improved salinities. The ecological response time was estimated to be approximately 6 years until full impact would be realized.

Table 4-8 includes the average annual lift when taking into account the ecological response times of each of the three regions described above.

Table 4-8. Average Annual Habitat Unit Lift

	No Action	Alt 1	Alt 2	Alt 3	Alt 4
St Lucie Estuary					
Average Annual Habitat Units	2,378	4,612	4,612	4,612	4,612
Average Annual Habitat Unit Lift		2,234	2,234	2,234	2,234
Caloosahatchee Estuary					
Average Annual Habitat Units	31,918	36,543	36,543	36,543	36,543
Average Annual Habitat Unit Lift		4,625	4,625	4,625	4,625
Greater Everglades (WCA 3 and ENP)					
Average Annual Habitat Units	578,991	759,417	756,087	761,503	769,866
Average Annual Habitat Unit Lift		180,426	177,096	182,512	190,875
Florida Bay					
Average Annual Habitat Units	75,047	133,510	131,877	147,218	157,406
Average Annual Habitat Unit Lift		58,463	56,830	72,171	82,359
Total Average Annual Habitat Unit Lift		245,748	240,785	261,542	280,093

4.2.3 Cost Effectiveness Incremental Cost Analysis

Sometimes it is difficult to summarize the results of CE/ICA when the analyses are performed separately on HUs for distinct species, communities or geographic areas. This phenomenon often occurs simply because different management measures or alternative plans have different functions, provide different types of output, and provide benefits to different biological communities. This is the case for the CEPP plans, in which certain features or alternatives provide greater benefits to Florida Bay and ENP, while other alternatives provide greater benefits for northern WCA 3A and WCA 3B.

Costs and benefits for each geographic area (Northern Estuaries, Greater Everglades (WCA 3A and ENP) and Florida Bay were examined both independently and combined. However, a combined HU score summing all geographic areas of the study area, while not appropriately representing the significance of each geographic area, provides a valuable cumulative analysis for determining the plan that best meets the needs of the entire watershed; for this reason, the combined HU were used to ensure a cost effective solution is identified.

For the incremental cost analysis, only the cost effective plans are arrayed by increasing output to show changes in cost (marginal cost) and changes in output (marginal output) of each cost effective alternative plan compared to the without plan condition. The plan with the lowest incremental costs per unit of output of all plans is the first best buy plan. All larger cost effective plans are compared to the first best buy plan in terms of increases in cost and increases in output. The alternative plan with the lowest incremental cost per unit of output for all cost effective plans larger than the first best buy plan is the second best buy plan. In summary, CE/ICA was performed using the following four spatial metrics to represent various ecosystem outputs of the CEPP alternatives:

1. System-Wide HU Score
2. Northern Estuaries alone
3. Greater Everglades (WCA 3A and ENP) alone
4. Florida Bay alone

4.2.3.1 Cost Effectiveness Incremental Cost Analysis – Total System-Wide Outputs

As can be seen in the following table (**Table 4-9**), both Alts 1 and 4 are identified as being cost effective for the aggregated system-wide HUs. Alts 2 and 3 are both more costly than Alt 4 and provide fewer overall HUs, and these alternatives are not cost effective for the production of system-wide HUs.

Table 4-9. Results of Cost Effectiveness Analysis for Total System-Wide Performance

	Alt 1	Alt 2	Alt 3	Alt 4
Average Annual Cost	**$92,500,000**	**$108,000,000**	**$113,400,000**	**$106,800,000**
Northern Estuaries	6,859	6,859	6,859	6,859
Greater Everglades (WCA 3 and ENP)	180,426	177,096	182,512	190,875
Florida Bay	58,463	56,830	72,171	82,359
Average Annual System Wide HUs	245,748	240,785	261,542	280,094
Average Annual Cost/Average Annual Habitat Units	$376	$449	$434	$381
Cost Effective	YES			YES

Notes: Values for alternatives are differences between "Without" plan and "With" plan on an average annual basis. Alternatives are arranged by increasing costs.

Table 4-10 shows that there are two best buy plans for the combined system-wide HU production, Alts 1 and 4. Alt 1 has the lowest cost per unit of output of any of the alternatives ($376 per combined HU produced). The next best alternative in terms of average cost per combined HU is Alt 4 ($381). Alt 4 provides an increment of 34,346 additional average annual HUs produced over Alt 1 at an incremental cost of over $14,300,000 (incremental cost of $416 per HU). Alt 4 provides approximately 14% greater benefits for a cost increase of 15%.

Table 4-10. Results of Incremental Cost Analysis

	Average Annual Cost	Average Annual Habitat Units	Cost Per Average Annual Habitat Units	Incremental Average Annual Cost Increase	Incremental Average Annual Habitat Unit Increase	Incremental Average Annual Cost/ Average Annual Habitat Unit
Alt 1	$92,500,000	245,748	$376	$92,500,000	245,748	$376
Alt 4	$106,800,000	280,093	$381	$14,300,000	34,345	$416

4.2.3.2 Efficiency Analysis

Following the results of the system-wide CE/ICA analysis, a more detailed examination of alternative components following the spatial perspective would:

- Provide insight into the efficiency of specific components,
- Provide logic and opportunity to modify alternatives to maximize benefits while minimizing costs
- Identify information that would support selection of a more expensive cost effective plan (will help identify if the additional benefit is worth the additional cost)

Northern Estuaries

No component refinements resulted from the efficiency analysis of the Northern Estuaries. The benefits accruing to the Northern Estuaries are realized primarily due to the construction of the FEB and Lake Okeechobee operations. However, it should be noted that without the project components in the Greater Everglades and corresponding seepage management features, benefits to the estuaries will not be realized. All alternatives included the same infrastructure and cost ($765 million) relating to the FEB and operations, and so there is no difference in benefits between alternatives for the Northern Estuaries.

Greater Everglades - WCA 3A

The components providing benefits to Northern WCA 3A include the HRF and Miami Canal infrastructure needed to distribute the water delivered from the upstream FEBs and STAs. The HRF is the primary difference between Alt 1 (HRF west of the S-8 pump station) and Alts 2, 3 and 4 (HRF both west and east of the S-8 pump station).

As can be noted in **Table 4-11**, Alt 1 was the highest performing alternative for WCA 3A, with little overall difference between alternatives. Alt 1 also had the least amount of infrastructure, and consequently the lowest costs to achieve the benefits in WCA 3A. There is minimal spread in benefits between the alternatives (~2% difference) with a large cost difference (~25%).

The main difference in benefits among the alternatives occurs in the northern zones of WCA 3A (3A-NE, 3A-MC and 3A-NW). As the available water flows south, the hydrology and associated ecological benefits equilibrate across the system regardless of where the water entered northern WCA 3A, as noted by the equal benefits occurring in the central zone (3A-C). The minor differences among alternatives in southern WCA 3A are attributed to differences in infrastructure in delivering water from WCA 3A to WCA 3B and/or ENP.

Table 4-11. Capital Costs and Habitat Unit Lift per Alternative for WCA 3A

Zone	Alt 1	Alt 2	Alt 3	Alt 4
Capital Cost	$520,000,000		$650,000,000	
3A-NE	66,677	66,677	66,677	66,677
3A-MC	30,501	29,719	28,937	29,719
3A-NW	24,636	23,228	23,228	23,228
3A-C	4,117	4,117	4,117	4,117
3A-S	0	-825	-825	0
Total WCA 3A	**125,931**	**122,916**	**122,134**	**123,741**

*Note: Benefits in this table are lift over the FWO and are not annualized; costs are non-annualized planning level construction costs that were used in the calculation of the project first cost

The HRF and Miami Canal infrastructure included in Alt 1 are the features that most efficiently minimize costs while providing greater benefits than the other alternatives. Consequently, Alts 2, 3 and 4 were recommended to be modified to include the HRF and Miami Canal infrastructure (and associated costs) contained in Alt 1.

Greater Everglades - WCA 3B and ENP

No infrastructure modifications were recommended to be made to any of the alternatives. However, it is recognized that operational changes to the L-67 structures could provide greater benefits to WCA 3B

and the recommended plan should further investigate the operational changes during the creation of the draft operations plan.

4.3 SUMMARY OF OUTPUTS FOR THE PRINCIPLES AND GUIDELINES EVALUATION CRITERIA

Based on the information included in the preceding descriptions of the Principles and Guidelines evaluation criteria, the following table (**Table 4-12**) rates each plan on the ability of each plan to meet the specified criteria (Ø not applicable; ≠ does not meet; + partially meets; ++ fully meets). Both Alt 1 and 4 are rated as highly functional, with Alt 4 rated slightly higher than Alt 1. **Section 4.1.1** showed that all alternatives were similar in their effectiveness, with Alt 4 more effective than the others. **Section 4.1.2** showed that the alternatives had similar acceptability, with Alt 3 slightly less acceptable than the others. **Section 4.1.3** showed that all alternatives have the same completeness since all alternatives depend on implementation of the same set of CERP and non-CERP projects. **Section 4.2.1** showed that Alts 1 and 4 were cost effective while the other two alternatives were not cost effective.

Table 4-12. Principles and Guidelines Evaluation Criteria

Evaluation Criteria	FWO	Alt 1	Alt 2	Alt 3	Alt 4
Effectiveness (Section 4.1.1)	≠	+	+	+	++
Acceptability (Section 4.1.2)	≠	+	+	≠	+
Completeness (Section 4.1.3)	Ø	+	+	+	+
Efficiency (Section 4.2.1)	Ø	++	≠	≠	++

4.4 RECOVER SYSTEM WIDE EVALUATION

CERP's interagency science group (RECOVER) conducted a broad-scale evaluation of ecological effects of Alts 1 through 4 on Lake Okeechobee, the Everglades, and the related estuaries, as required in the Programmatic Regulations. The scope of the review covers all areas expected to be improved by CERP, beyond the boundaries expected to be improved by CEPP, and includes a broad range of evaluation tools, performance measures, and best professional judgment that reach beyond the tools and expertise of the traditional USACE planning process. The tools and professional backgrounds of the reviewers represented decades of experience studying and modeling the ecology of south Florida. The purpose of the review is three-fold: to provide insight into whether some alternatives performed better ecologically than others, to indicate whether alternatives may lead to unintended ecological conditions, and to investigate for unintended effects beyond CEPP's boundaries that could potentially contradict CERP on a regional scale.

Key Findings:

- All areas that CEPP intends to improve can be improved by the proposed alternatives. These include the Northern Estuaries, the Greater Everglades, and the southern coastal systems.
- The CEPP planning team's intent was to remain within the existing water schedule for Lake Okeechobee and thereby not impact the Lake's ecology. Modeling indicated that there are periods where the Lake's water level is held approximately 6 to 12 inches higher than ECB or FWO levels, while remaining within the current schedule. The higher water events are expected to be rare enough to avoid significant ecological effects.
- Modeling of the hydrology, salinity, and associated ecology of the St. Lucie and Caloosahatchee Estuaries, referred to collectively as the Northern Estuaries, showed a small reduction in fresh water discharges from Lake Okeechobee to the Northern Estuaries. Although the difference was

not statistically significant, RECOVER concurred that the change is 'in the right direction' for reducing peak flow events. Ecological projections for oysters and seagrasses, key species in the estuaries, indicated improvements with CEPP implementation. Modeling indicated less fresh water entering the St. Lucie Estuary during low-flow times, when small amounts of fresh water are needed. CEPP operations and future increments of CERP should remain aware of the need for small amounts of base flow into the estuaries during drier times. Future operations of the Indian River Lagoon-South project can be optimized to help provide these base flows.

- In the Greater Everglades, all CEPP alternatives provide significant improvement towards restoration, compared to the FWO. All alternatives showed improved ecological performance for fish, wading birds, and apple snails in northern and central WCA 3A and Shark River Slough. Improved hydroperiods and sheetflow in WCA 3A, WCA 3B, and ENP result in less soil oxidation, which promotes peat accretion necessary to rebuild the complex mosaic of habitats across the landscape. There are some differences among the alternatives based on where and how the water will be distributed, e.g., Alt 1 may provide sheetflow to a larger area in WCA 3A, while Alts 3 and 4 provide more water to Shark River Slough and the southern marl prairies, improving conditions for fish, wading birds, alligators, tree islands and ridge and slough habitat. Overall, Alt 4 appears to make the most 'efficient' use of the water CEPP is adding to the Everglades according to the surface flow vectors, sheetflow information, and wading bird, small fish performance measure outputs. Concerns were expressed about the Blue Shanty Levee in Alt 4 potentially limiting restoration of WCA 3B in the future. Suggestions were made to not include the Blue Shanty Levee or move it eastward from the Blue Shanty Canal location initially identified for Alt 4 in order to align with the eastern end of the 2.6 mile Tamiami Trail Next Steps bridge span opening, avoid potential impacts from levee construction to tree islands located along the Blue Shanty Canal alignment, and to follow the landscape directionality to the northern intersection of the levee with the L-67A Levee. Given these concerns, and consistent with the CERP Programmatic Regulations Section 385.31, adaptive management will be employed to inform decisions and coordination regarding WCA 3B based on results and knowledge gained as CEPP structures are completed and operated. For example, water flow and restoration effects from the first CEPP structure installed in the L67s will help to determine the true need for, best use of, and best placement of other L67 structures and the Blue Shanty Levee. The role of adaptive management in informing steps in WCA 3B is discussed in **Section 6** and in **Annex D Part 1**. A preference was also expressed to use passive structures rather than pumps in order to lower operations/maintenance and increase the natural aspects of Everglades restoration.
- The Southern Coastal Systems are estuaries on the southern end of Florida, which require fresh water inputs to reduce salinity levels and maintain ecologically favorable brackish conditions. All CEPP alternatives showed decreased salinity compared to the FWO in Florida Bay, with associated ecological improvements for key species such as sea trout, pink shrimp, and crocodiles. Alt 4, which yielded more flow through Shark River Slough, improves estuarine salinity conditions over the other alternatives. The differences among alternatives were much less than the differences between each alternative and the FWO. Based on the hydrologic connections between Shark River Slough and the southwest coastal areas of Florida, there is high likelihood that the southwest coastal areas will experience significant ecological benefits from any CEPP alternative; however, these could not be quantified to be added to CEPP evaluations due to the lack of salinity and ecological models in that area of the estuaries. Biscayne Bay may have reduced fresh water flows in the dry season compared to ECB and FWO in the area of CERP's Biscayne Bay Coastal Wetlands Project and Biscayne National Park, which

could have adverse ecological effects. This will require additional investigation during operational refinement of the recommended plan.

- Overall, it appears that the alternatives that provide the most water to ENP provide the least volume to Biscayne National Park, and vice versa, almost certainly due to the type of seepage management and operational protocols employed. This will be addressed in the Savings Clause and Assurances analyses and will continue to be addressed with adaptive management during CEPP's implementation and operation.
- There was consensus that proceeding with an adaptive management approach can further increase the benefits of CEPP and positively influence the implementation of CEPP in sensitive areas. Adaptive management provides a means to learn during implementation and operations, improves delivery of benefits, and can minimize impacts, and therefore adaptive management is a significant source of ecological risk buy-down for CEPP.

4.5 SUMMARY OF OUTPUTS FOR THE FOUR ACCOUNTS

Upon identification of the final array of alternatives, each alternative plan and the FWO were evaluated and compared to identify the expected effects on the environment, the economy, society, and how well each plan met project objectives and avoided constraints.

4.5.1 National Economic Development

NED benefits are defined as increases in the economic value of the goods and services that result directly from a project. These are benefits that occur as a direct result of the project and are national in perspective. Benefit categories considered by the analysis include recreation, water supply, and flood control. These three categories represent important national considerations; however, the primary formulation of CEPP is ecosystem restoration.

While selecting a plan is predicated on the degree and significance of environmental restoration efforts, the health of the environment has a correlation with economic and social well being. The environmental restoration efforts of CEPP are expected to improve conditions in the Northern Estuaries, central Everglades and Florida Bay, which will lead to both direct and indirect economic benefits to commercial fisheries, property value, tax revenue, tourism and other significant economic sectors. It is recognized that further actions are needed to achieve the restoration envisioned in CERP that will have a direct correlation to the economic and social well being of south Florida.

Water supply is a stated objective of CERP and CEPP; however, no water supply improvements were realized during the initial formulation of Alts 1-4. Through operational refinements and optimization of the recommended plan, further consideration to identify additional water availability for LOSA and the LEC was undertaken. Recreation benefit quantification is necessary because those benefits would be used to justify costs of construction of proposed recreation features. Flood control is a constraint of the project, and while no additional benefits are realized, the alternatives successfully maintained the level of service for flood protection. No impacts to Lake Okeechobee navigation will be realized with the implementation of any alternative.

4.5.2 Environmental Quality

The EQ account is used to present non-monetary effects on ecological, cultural, and aesthetic resources including the positive and adverse effects of ecosystem restoration plans. The EQ outputs for this project are displayed in **Section 5**, and as HUs that were assessed for cost effectiveness and incremental cost analysis in **Section 4.2**.

4.5.3 Regional Economic Development

All alternatives are anticipated to provide RED benefits. In particular, the construction of any recommended features would have a beneficial effect on employment and demand for local goods and services during the construction period. In addition, if recreational features are included it is anticipated that some lasting benefits would accrue to the area as a result of additional recreational use and the associated economic activity.

The expenditures are related to construction activities and the employment that will occur when the expenditures are executed (**Table 4-13**). The total jobs created are based on State-wide impacts of construction expenditures and estimated using 15.3 jobs per $1 million spent and was developed using the impact analysis for planning (IMPLAN) input/output software. Impacts may vary depending on when construction funding is expended.

Table 4-13. Jobs Generated from CEPP Expenditures: Employment Created by Construction Expenditures

Alt 1	Alt 2	Alt 3	Alt 4
21,800	25,600	26,900	25,300

4.5.4 Other Social Effects

Potential areas of social effects have been assessed as part of the study process. The key areas analyzed to date are summarized below. Relatively similar impacts would be anticipated for all alternatives.

Prime and Unique Farmland: The majority of land within the project area is ridge and slough, sawgrass marsh, coastal wetlands and nearshore/open bay habitat with minimal potential for reduction in unique farmland. All project lands are State owned. Coordination is ongoing with the United States Department of Agriculture (USDA) and National Resources Conservation Service (NRCS) to meet the requirements of the Farmland Protection Policy Act. When detailed design information that locates each of the plan components is completed, it can then be determined how many acres of unique farmland would be affected by the Project. The Everglades Agricultural Area (EAA) area proposed for conversion to a FEB is prime and unique farmland and represents the greatest adverse impact on this resource.

Environmental Justice: *Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires the Federal Government to achieve environmental justice by identifying and addressing high, adverse and disproportionate effects of its activities on minority and low-income populations. It requires the analysis of information such as the race, national origin and income level for areas expected to be impacted by environmental laws, regulations and policies. It also requires Federal agencies to identify the need to ensure the protection of populations relying on subsistence consumption of fish and wildlife, through analysis of information on such consumption patterns and the communication of associated risks to the public. CEPP would provide benefits to quality of life by improving the estuarine environment and contribute to hydrological and water quality improvements in the historic Everglades. The project would improve the quality of human life by providing improved estuarine conditions for fish and wildlife. It would translate into aesthetic and economic benefits for sport fishing and other recreational communities. No homeowners would be displaced by the project.

The CEPP project does not present any environmental impacts that are high, adverse and disproportionate to low income, minority, or Tribal populations. The activity does not (a) exclude

persons from participation in, (b) deny persons the benefits of, or (c) subject persons to discrimination because of their race, color, or national origin. The activity would not impact "subsistence consumption of fish and wildlife." Through the public participation process of the outreach and National Environmental Policy Act (NEPA) scoping, no high or adverse impacts were identified. There was sufficient public input to feel confident that scoping was successful and that the breadth of the potential impacts were communicated and understood by the public. Environmental Impacts to Tribal populations are discussed in **Section 5.3**.

Protection of Children: Executive *Order 13045, Protection of Children from Environmental Health Risks and Safety Risks*, requires each Federal agency to "identify and assess environmental risks and safety risks [that] may disproportionately affect children and ensure that its "policies, programs, activities, and standards address disproportionate risks to children that results from environmental health risks or safety risks." The proposed project will not result in environmental health risks or safety risks that may have a disproportionate affect on children. Children will not be in the vicinity of any of the construction operations and activities should not have an impact on children.

Safety/Health: All alternatives would be designed to dam safety requirements. All alternatives would maintain the WCA 3A Zone A regulation schedule, the LORS management bands, and the level of service for flood protection in the LEC.

Community Cohesion: Community cohesion would not change. No additional land purchase is proposed. No real estate relocations of residences are proposed.

Recreation: All alternatives would reduce fishing opportunities in the backfilled portion of the Miami Canal. All alternatives include an FEB which adds 15,000 acres of recreational opportunities. No alternatives impact fishing access in the L-67A. Alts 2, 3 and 4 would lead to greater impact on recreational terrestrial mammal hunting than Alt 1 due to the HRF location.

4.6 IDENTIFICATION OF THE NATIONAL ECOSYSTEM RESTORATION PLAN

The overarching goal of CEPP is the environmental restoration of an Everglades ecosystem considered to be of both national and international significance. An alternative plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, is identified as the NER. Selecting the NER plan requires careful consideration of the plan that meets planning objectives and constraints and reasonably maximizes environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness. In accordance with USACE guidance, the selected plan must be shown to be cost effective and justified to achieve the desired level of output (ER-1105-2-100 **Appendix E, paragraph E-41**).

4.6.1 Modification of the Final Array and Identification of the National Ecosystem Restoration Plan

Resulting from the efficiency analysis (**Section 4.3.2.1**), HRF and Miami Canal infrastructure modifications were recommended to Alts 2, 3 and 4, to match the infrastructure proposed in Alt 1, and the descriptor "M" was added to the title to represent the modification. This modification included only incorporating a HRF west of the S-8 pump station, and leaving the northern most portion of the Miami Canal open conveyance.

Modifications to the HRF and Miami Canal infrastructure for Alts 2M, 3M, and 4M, resulted in cost reductions of $176,000,000 (when accounting for additional PED and S/A savings) for these alternatives (**Table 4-14**). Since there was no significant difference between alternatives for the area influenced by the HRF and Miami Canal backfill, benefits were not recalculated and consequently, these alternatives were not re-modeled. Alt 1 and Alt 4M are cost effective for the revised system-wide evaluation, and Alts 2M and 3M are not cost effective since they cost more than Alt 4M yet provide fewer benefits. The original Alts 2, 3 and 4 would no longer be cost effective since the costs of the modified alternatives decreased while the benefits were unchanged.

Table 4-14. Modified Alternative Construction, Real Estate and OMRR&R Cost

	Alt 1	Alt 2M	Alt 3M	Alt 4M
Construction Costs	$1,854,000,000	$1,998,000,000	$2,106,000,000	$1,971,000,000
Real Estate	$41,000,000	$39,000,000	$39,000,000	$39,000,000
Total First Cost	**$1,895,000,000**	**$2,037,000,000**	**$2,145,000,000**	**$2,010,000,000**
Total Project Investment*	**$2,041,000,000**	**$2,193,000,000**	**$2,309,000,000**	**$2,164,000,000**
OMRR&R	$5,500,000	$6,400,000	$6,900,000	$6,500,000
Average Annual Cost	**$92,500,000**	**$99,900,000**	**$105,300,000**	**$98,800,000**
System-Wide Average Annual Habitat Unit Lift	245,748	240,785	261,542	280,094
Average Annual Cost/Average Annual Habitat Unit	$376	$415	$403	$353
Cost Effective	YES			YES
Best Buy				YES

*Total project investment includes interest during construction

The Institute for Water Resources (IWR) Planning Suite was used to conduct a CE/ICA on the modified alternatives. The results of the efficiency analysis (CE/ICA) demonstrate that Alt 1 and Alt 4M are viable for implementation since they are both cost effective alternatives. Alt 4M is the lowest cost per HU alternative at producing system-wide benefits, and is therefore the only best buy alternative. While an incremental cost analysis is traditionally only conducted for "best buy" alternatives, an incremental analysis was conducted (**Table 4-16**) to display the substantial reduction in the incremental cost per HU lift of Alt 4M when compared to Alt 1. Alt 4M provides an increment of 34,346 additional average annual HUs produced over Alt 1 at an incremental average annual cost of over $6,300,000 (incremental cost of $183 per HU). Alt 4M increases benefits over Alt 1 by 14% while only increasing average annual costs by 7%.

Table 4-15. Results of Incremental Cost Analysis

	Average Annual Cost	Average Annual Habitat Units	Cost Per Average Annual Habitat Units	Incremental Average Annual Cost Increase	Incremental Average Annual Habitat Unit Increase	Incremental Average Annual Cost/ Average Annual Habitat Unit
Alt 1	$92,500,000	245,748	$376	$92,500,000	245,748	$376
Alt 4M	$98,800,000	280,094	$353	$6,300,000	34,346	$183

From an efficiency perspective, this assessment provides significant justification for identifying Alt 4M as the NER Plan. The updated cost effectiveness evaluation of the modified alternatives demonstrated that Alt 4M is the most efficient and effective at meeting project objectives, while improving acceptability by reducing impacts on recreational access in Northern WCA 3A.

4.6.2 Operational Refinements of the National Ecosystem Restoration Plan

The results of the NER analysis identified Alt 4M infrastructure as providing the greatest overall benefits with the least cost per HU; however, the evaluation identified the need to revise the operations of Alt 4M to ensure the project savings clause constraints are met, minimize localized adverse ecological effects, and identify additional opportunities to provide for other water related needs. Three modeling scenarios were conducted to identify project effects resulting from operational changes.

Alt 4R: The first refinement, Alt 4R, focused on operation changes to avoid potential impacts to water supply levels of service in the LOSA and LEC. Refinements included alleviating potential ecological impacts from lowered water depths in WCA 2B by retaining a small portion of the water in WCA 2B that Alt 4M had diverted to WCA 3A. Increases in low flow events to the St. Lucie Estuary, minimized reductions in freshwater flows to Biscayne Bay, and improved water depths in eastern WCA 3B for purposes of improving environmental conditions were also considered.

Alt 4R changed assumptions from Alt 4M by including:

- St Lucie Reservoir (C-44) backflow to Lake Okeechobee
- Made additional minor class limit adjustments to Lake Okeechobee inflow and climate forecasts to reduce the magnitude of allowable discharges from the Lake to re-balance Lake Okeechobee, water supply, and Northern Estuary objectives
- Reduced the frequency and magnitude of CEPP L-6 Diversion operations in Alt4R relative to Alts 1 through 4
- Increased utilization of S-144, S-145 and S-146 relative to the S-11s
- Increased seepage out of eastern ENP
- Increased discharges into WCA3B and reduced utilization of the S-12s
- Updated modeling for proposed L-4 degrade length (2.9 miles) and simulation of proposed new pump station on the L-4 Canal (S-630)

The Alt 4R refinement resulted in an alternative that lessened concerns over meeting constraints yet there remained room for improvement in LOSA water supply and the spatial distribution of groundwater and canal discharges in the LEC to provide greater confidence in meeting legal requirements of the savings clause. This alternative did not fully address the low flow events to the St. Lucie Estuary nor did it identify additional opportunities for other water related needs. Alt 4R maintains the majority of the system benefit identified for Alt 4M in the final array evaluation and demonstrates a substantial hydrologic improvement over the baselines; however, Alt 4R represented a 6% decrease in overall project benefits due to competing demands for the allocation of water in the regional system.

Alt 4R1: The second refinement, Alt 4R1, was performed to determine if water supply cutbacks for the LOSA could be further reduced and if increases in the LEC public water supply over the FWO project condition could be met while maintaining the natural system performance realized from the adjustments that were made for Alt 4R. The PWS demands utilized in the alternative are based on per capita demand increases proportional to Florida's Bureau of Economic and Business Research (BEBR) medium population projections.

Alt 4R1 changed assumptions from Alt 4M by including:

- Increased public water supply demand for LECSA 2 from 277 million gallons per day (MGD) to 295 MGD
- Increased public water supply demand for LECSA 3 from 412 MGD to 465 MGD
- Reduced Regulation Schedule releases within the assumed flexibility of LORS 2008
- Operational updates to CERP's Indian River Lagoon-South project, consistent with recent SFWMD reservations work; this provides low-flow salinity discharges to help meet St. Lucie estuary targets
- Operational updates to the Broward Water Preserve Areas project were incorporated to better represent that project's intent in the modeling representation
- Refinement of backflows from C-44 reservoir to Lake Okeechobee to send more water during low Lake stage events
- Updated modeling for proposed L-4 degrade length (2.9 miles) and simulation of proposed new pump station on the L-4 Canal (S-630)

Alt 4R1 was successful in delivering additional water supply to LECSA 2 and LECSA 3 while maintaining the benefits identified for Alt 4R, but caused potentially adverse impacts by reducing freshwater flows to Biscayne Bay. Additionally, the higher rate of increased pumpage was found to cause groundwater drawdown in the vicinity of regional canals which could lead to increased saltwater intrusion and potential impacts to local wetlands. These negative effects compelled further operational refinement, and Alt 4R1 was removed from further consideration.

Alt 4R2: The third refinement, Alt 4R2 was also performed to determine if increases in LEC public water supply (over FWO project conditions) could be met while maintaining the natural system performance realized from the adjustments that were made for Alt 4R without the negative effects to LEC groundwater and Biscayne Bay that Alt 4R1 realized. This refinement limited the increase in public water supply deliveries by reducing the demand in the model.

Alt 4R2 included the same Alt 4R infrastructure but changed assumptions from Alt 4M by including:

- Revised public water supply demand for LECSA 2 from 277 MGD to 289 MGD
- Revised public water supply demand for LECSA 3 from 412 MGD to 417 MGD
- Reduced Regulation Schedule releases within the assumed flexibility of LORS 2008
- Operational updates to CERP's Indian River Lagoon-South project, consistent with recent SFWMD reservations rules; this provides low-flow salinity discharges to help meet St. Lucie estuary targets
- Operational updates to the Broward Water Preserve Areas project were incorporated to better represent that project's intent in the modeling representation
- Enabled backflows from C-44 reservoir to Lake Okeechobee to send more water during low Lake stage events
- Updated modeling for proposed L-4 degrade length (2.9 miles) and simulation of proposed new pump station on the L-4 Canal (S-630)

Alt 4R2 was successful in making available an additional 12 MGD to LECSA 2 and 5 MGD to LECSA 3 public water supply, maintaining FWO freshwater flows to Biscayne Bay, and slightly improving the HUs over Alt 4R (**Table 4-16**). Alt 4R2 also provided approximately 210,000 acre-feet average annual flow to the Everglades system, which is almost 6 kac-ft more than Alt 4R.

Table 4-16. Habitat Unit Results for Alt 4R and 4R2

Project Region (Zone)	Habitat Units			
	ECB*	FWO**	Alt 4R**	Alt 4R2**
Caloosahatchee Estuary (CE-1)	2,839	34,070	39,038	39,038
St. Lucie Estuary (SE-1)	2,099	2,399	5,098	8,247
Total Northern Estuaries	**4,938**	**36,469**	**44,136**	**47,285**
Northeast WCA 3A (3A-NE)	44,451	29,634	92,606	91,372
WCA 3A Miami Canal (3A-MC)	32,847	27,373	54,746	54,746
Northwest WCA 3A (3A-NW)	30,970	30,266	54,198	54,198
Central WCA 3A (3A-C)	108,414	105,669	109,786	111,159
Southern WCA 3A (3A-S)	69,247	68,423	68,423	68,423
WCA 3B (3B)	55,697	48,842	58,268	59,125
Northern ENP (ENP-N)	57,557	55,054	98,847	98,847
Southern ENP (ENP-S)	124,068	126,454	169,400	169,400
Southeast ENP (ENP-SE)	79,711	81,062	85,116	83,764
Total Greater Everglades (WCA 3 and ENP)	**602,962**	**572,777**	**791,390**	**791,034**
Florida Bay West (FB-W)	23,693	20,534	39,488	41,068
Florida Bay Central (FB-C)	9,025	8,205	13,948	14,769
Florida Bay South (FB-S)	16,614	14,659	27,364	28,341
Florida Bay East Central (FB-EC)	21,984	20,225	33,416	34,295
Florida Bay North Bay (FB-NB)	2,154	2,028	2,534	2,661
Florida Bay East (FB-E)	9,440	8,685	9,818	9,818
Total Florida Bay	**82,910**	**74,336**	**126,568**	**130,952**
Total All Regions	**690,810**	**683,582**	**962,094**	**969,271**

* HU values for the ECB represent those calculated in the year 2010.

** HU values for the FWO and Alts 4R and 4R2 are calculated for the full ecological response time.

The costs of 4R and 4R2 are equal, yet Alt 4R2 provides slightly improved environmental benefits, and better meets the project objective of increasing public water supply opportunities and alleviates concerns over meeting constraints of the project.

4.6.3 Identifying the Recommended Plan

The operational refinements ecosystem benefits analysis indicate a reduction in alternative performance (approximately 6%) for Alt 4R and 4R2 when incorporating the operational refinements, compared to Alt 4 and Alt 4M. This reduction in benefits is a direct result of meeting project constraints. A similar reduction in benefit trends is expected for any of the alternatives in the final array if the operational modifications required to ensure legal requirements were being met were similarly applied. Alt 4R2 would remain the only best buy alternative and consequently the NER plan.

Although Alts 1, 2M and 3M were not re-modeled, there is reasonable confidence that the performance trends observed moving from Alt 4M to Alt 4R and Alt 4R2 would also be observed in re-modeled versions of the other alternatives. This assertion is based on the fact that in order to honor the identified constraints from a water budget perspective, some of the water that is sent to WCA 3A, WCA 3B and ENP in the first three alternatives would need to be sent to WCA 2A, WCA 2B and the LEC. This redirection of water would provide enough water in the WCA 2 and LEC system (as well as the downstream Biscayne Bay) to ensure adequate performance in these regions, but would mean that less water was entering or being retained in areas where project benefits are quantified. Some of the benefit quantified by having additional water in the WCA 3 and ENP system in Alts 1, 2M and 3M would be reduced. The level of reduction in benefit across the alternatives would be expected to be somewhat proportional to their identified lift, but even if the first three alternatives only realized a 2% reduction in benefits as opposed to the 6% realized in Alt 4R2, Alt 4R2 would still be a cost effective alternative and fulfill the requirements for justifying a recommended plan as described in WRDA 2000.

There are also substantial benefits that Alt 4R2 exhibits in the Blue Shanty flowway that are not captured in the HU calculation, yet are significant and compelling reasons for identifying Alt 4R2 as the recommended plan and are further described in **Section 3.2** and **Appendix G, Section G.2**.

Alt 4R2 (**Figure 4-6**) is being recommended for the following reasons:

- Best performing operational refinement of the NER plan.
- Meets the legal requirement for maintaining flood protection in the LEC.
- With adjustments to LORS releases (including class limit adjustments), the recommended plan maintains water availability for existing users in the LOSA, and increases available water supply (17 MGD) in the LEC, while maintaining FWO flows to Biscayne Bay.
- Meets Seminole Tribe of Florida's compacts.
- The flowway generated by the Blue Shanty Levee in Alt 4R2 would increase flows through western WCA 3B (**Appendix G, Figure G-36**) while maintaining protective water depths in eastern WCA 3B. Alt 4R2 best achieves the goal of re-establishing hydrologic and ecologic connectivity of WCA 3A, WCA 3B, and ENP by degrading the L-67 C and L-29 Levees west of the Blue Shanty Levee. Long, continuous and uninterrupted patterns of sheetflow from north to south are a defining characteristic of the Everglades. The flowway restores sheetflow consistent with the landscape patterns of the natural system.

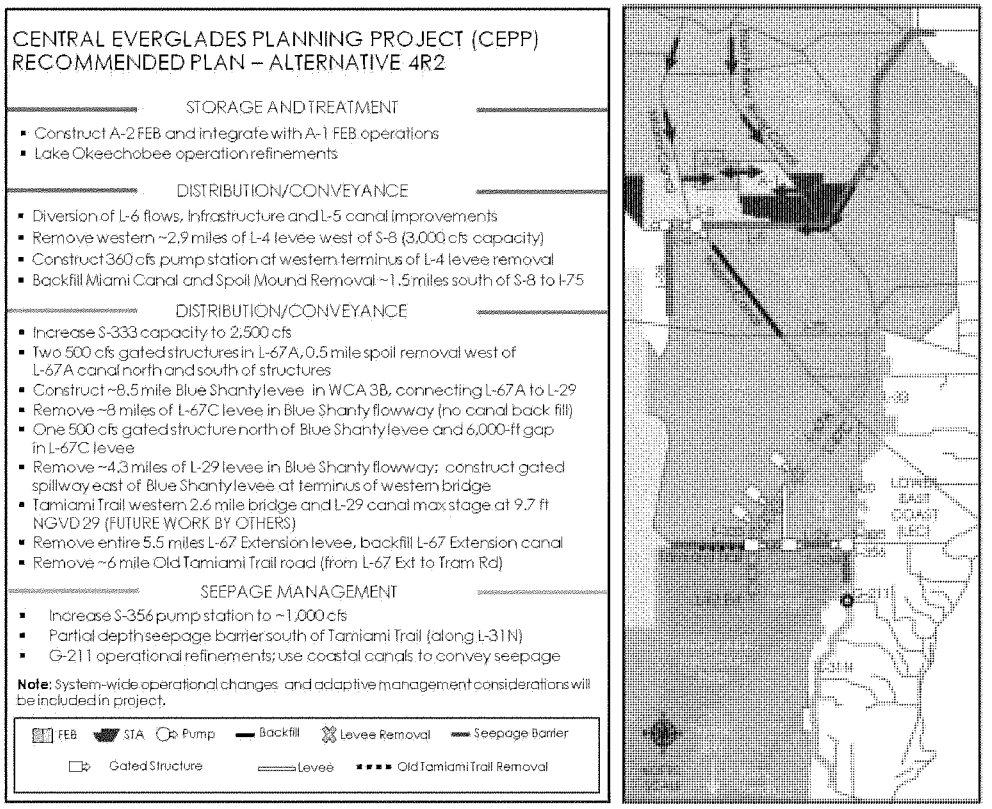
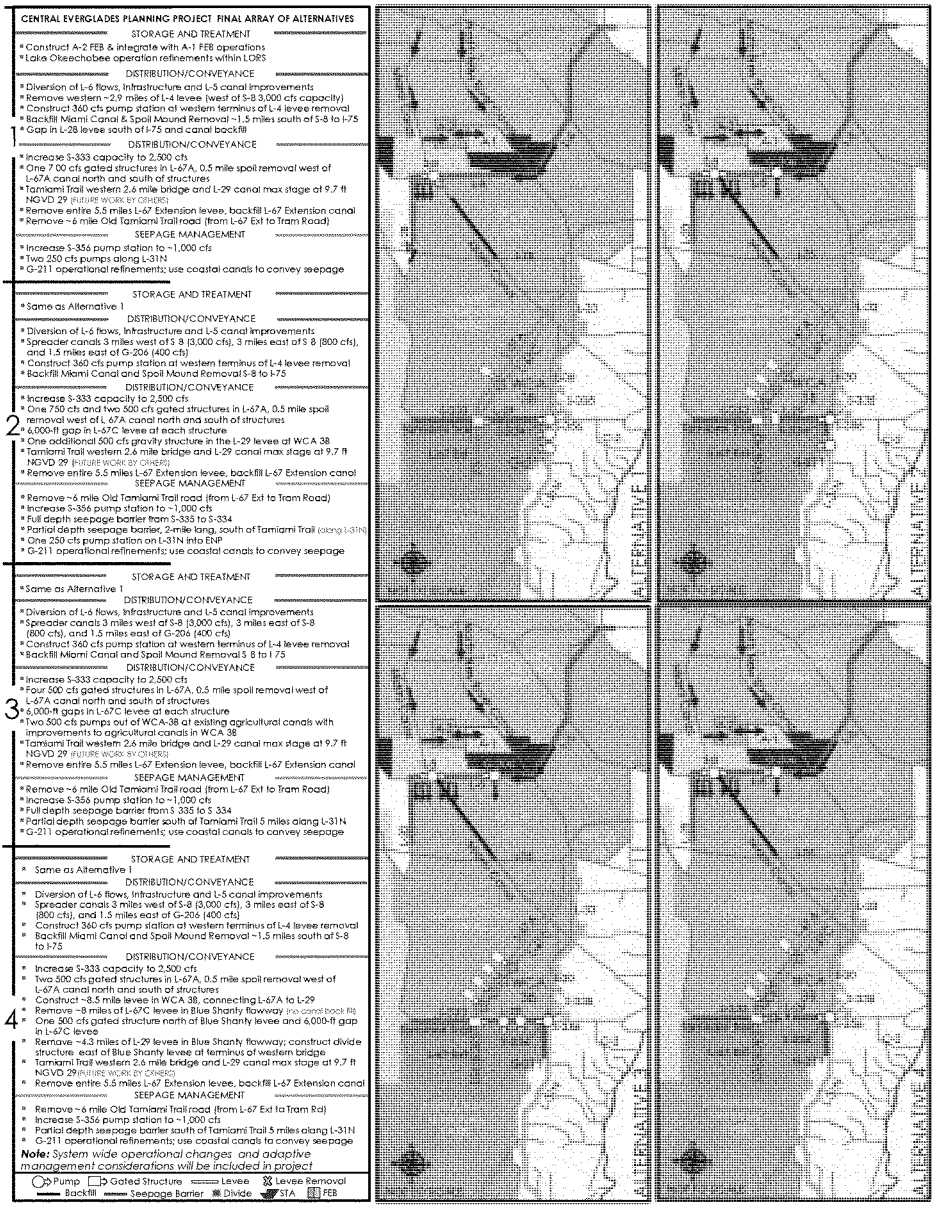


Figure 4-6. The CEPP Recommended Plan


CENTRAL EVERGLADES PLANNING PROJECT FINAL ARRAY OF ALTERNATIVES
STORAGE AND TREATMENT
* Construct A-2 FEB & integrate with A-1 FEB operations
* Lake Okeechobee operation refinements within LORS
DISTRIBUTION/CONVEYANCE
* Diversion of L-6 flows, Infrastructure and L-5 canal improvements
* Remove western ~2.9 miles of L-4 levee (west of S-8 3,000 cfs capacity)
* Construct 360 cfs pump station at western terminus of L-4 levee removal
* Backfill Miami Canal & Spoil Mound Removal ~1.5 miles south of S-8 to I-75
* Gap in L-28 levee south of I-75 and canal backfill
1
DISTRIBUTION/CONVEYANCE
* Increase S-333 capacity to 2,500 cfs
* One 7 00 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A canal north and south of structures
* Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft NGVD 29 (FUTURE WORK BY OTHERS)
* Remove entire 5.5 miles L-67 Extension levee, backfill L-67 Extension canal
* Remove ~6 mile Old Tamiami Trail road (from L-67 Ext to Tram Road)
SEEPAGE MANAGEMENT
* Increase S-356 pump station to ~1,000 cfs
* Two 250 cfs pumps along L-31N
* G-211 operational refinements; use coastal canals to convey seepage
STORAGE AND TREATMENT
* Same as Alternative 1
DISTRIBUTION/CONVEYANCE
* Diversion of L-6 flows, Infrastructure and L-5 canal improvements
* Spreader canals 3 miles west of S 8 (3,000 cfs), 3 miles east of S 8 (800 cfs), and 1.5 miles east of G-206 (400 cfs)
* Construct 360 cfs pump station at western terminus of L-4 levee removal
* Backfill Miami Canal and Spoil Mound Removal S-8 to I-75
DISTRIBUTION/CONVEYANCE
* Increase S-333 capacity to 2,500 cfs
* One 750 cfs and two 500 cfs gated structures in L-67A, 0.5 mile spoil
2 removal west of L 67A canal north and south of structures
* 6,000-ft gap in L-67C levee at each structure
* One additional 500 cfs gravity structure in the L-29 levee at WCA 3B
* Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft NGVD 29 (FUTURE WORK BY OTHERS)
* Remove entire 5.5 miles L-67 Extension levee, backfill L-67 Extension canal
SEEPAGE MANAGEMENT
* Remove ~6 mile Old Tamiami Trail road (from L-67 Ext to Tram Road)
* Increase S-356 pump station to ~1,000 cfs
* Full depth seepage barrier from S-335 to S-334
* Partial depth seepage barrier, 2-mile long, south of Tamiami Trail (along L-31N)
* One 250 cfs pump station on L-31N into ENP
* G-211 operational refinements; use coastal canals to convey seepage
STORAGE AND TREATMENT
* Same as Alternative 1
DISTRIBUTION/CONVEYANCE
* Diversion of L-6 flows, Infrastructure and L-5 canal improvements
* Spreader canals 3 miles west of S-8 (3,000 cfs), 3 miles east of S-8 (800 cfs), and 1.5 miles east of G-206 (400 cfs)
* Construct 360 cfs pump station at western terminus of L-4 levee removal
* Backfill Miami Canal and Spoil Mound Removal S 8 to I 75
DISTRIBUTION/CONVEYANCE
* Increase S-333 capacity to 2,500 cfs
* Four 500 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A canal north and south of structures
3 * 6,000-ft gaps in L-67C levee at each structure
* Two 500 cfs pumps out of WCA-3B at existing agricultural canals with improvements to agricultural canals in WCA 3B
* Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft NGVD 29 (FUTURE WORK BY OTHERS)
* Remove entire 5.5 miles L-67 Extension levee, backfill L-67 Extension canal
SEEPAGE MANAGEMENT
* Remove ~6 mile Old Tamiami Trail road (from L-67 Ext to Tram Road)
* Increase S-356 pump station to ~1,000 cfs
* Full depth seepage barrier from S 335 to S 334
* Partial depth seepage barrier south of Tamiami Trail 5 miles along L-31N
* G-211 operational refinements; use coastal canals to convey seepage
STORAGE AND TREATMENT
* Same as Alternative 1
DISTRIBUTION/CONVEYANCE
* Diversion of L-6 flows, Infrastructure and L-5 canal improvements
* Spreader canals 3 miles west of S-8 (3,000 cfs), 3 miles east of S-8 (800 cfs), and 1.5 miles east of G-206 (400 cfs)
* Construct 360 cfs pump station at western terminus of L-4 levee removal
* Backfill Miami Canal and Spoil Mound Removal ~1.5 miles south of S-8 to I-75
DISTRIBUTION/CONVEYANCE
* Increase S-333 capacity to 2,500 cfs
* Two 500 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A canal north and south of structures
* Construct ~8.5 mile levee in WCA 3B, connecting L-67A to L-29
4 * Remove ~8 miles of L-67C levee in Blue Shanty flowway (no canal back fill)
* One 500 cfs gated structure north of Blue Shanty levee and 6,000-ft gap in L-67C levee
* Remove ~4.3 miles of L-29 levee in Blue Shanty flowway; construct divide structure east of Blue Shanty levee at terminus of western bridge
* Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft NGVD 29 (FUTURE WORK BY OTHERS)
* Remove entire 5.5 miles L-67 Extension levee, backfill L-67 Extension canal
SEEPAGE MANAGEMENT
* Remove ~6 mile Old Tamiami Trail road (from L-67 Ext to Tram Rd)
* Increase S-356 pump station to ~1,000 cfs
* Partial depth seepage barrier south of Tamiami Trail 5 miles along L-31N
* G-211 operational refinements; use coastal canals to convey seepage
Note: System wide operational changes and adaptive management considerations will be included in project
Pump
Gated Structure
Levee
Levee Removal
Backfill
Seepage Barrier
Divide
STA
FEB
ALTERNATIVE
ALTERNATIVE
ALTERNATIVE
ALTERNATIVE

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5.0 EFFECT OF THE FINAL ARRAY OF ALTERNATIVES AND THE RECOMMENDED PLAN

5.1 EFFECTS OF THE FINAL ARRAY OF ALTERNATIVES

This assessment of environmental effects evaluates the anticipated environmental effects of the alternative actions described in **Section 3.0** and **Section 4.0**. Since the final array of alternatives contained a no action alternative (for consistency of the report the **No Action Alternative** is referred to as the **Future Without [FWO]** for the remainder of the report), the other four action alternatives were compared to and evaluated against the FWO to describe changes to existing conditions with implementation of each Central Everglades Planning Project (CEPP) action alternative. These potential effects are summarized within this section. Details regarding effects are provided within this section and full details are discussed in **Appendix C.2.1**.
For this analysis, intensity was rated as follows:

Negligible-effect to the resource or discipline is barely perceptible and not measurable and con-fined to a small area
Minor-effect to the resource or discipline is perceptible and measurable and is localized
Moderate-effect is clearly detectable and could have appreciable effect on the resource or discipline; or the effect is perceptible and measurable throughout the project area
Major-effect would have a substantial, highly noticeable influence on the resource or discipline on a regional scale

Duration: The duration of the effects in this analysis is defined as follows:

Short term-when effects last less than one year
Long term-effects that last longer than one year
No duration – no effect

5.1.1 Climate

Implementation of any of the CEPP alternatives would have a short-term, negligible and less than significant effect on climate within the action area. Minor, localized effects to microclimate may occur under all CEPP action alternatives as a result of redistribution of water and shifts in vegetation. Potential effects may include increases in evapotranspiration, increases in localized rainfall and temperature changes.

5.1.2 Geology and Soils

On the A-2 FEB footprint, with all the action alternatives, there would be short-term, minor and less than significant geologic effects within the project area from the removal of surface cover (i.e. vegetation and soil), potential removal of caprock using blasting, and removal of limestone to obtain material for construction of levees, canals and roads. All action alternatives would result in conversion of relatively flat, uniform agricultural lands to a FEB (4 feet maximum operating depth) with exterior levees up to 10 feet above existing grade). Improved hydroperiods and sheetflow in WCA 3A, WCA 3B, and ENP reduce soil oxidation, which promotes peat accretion necessary to rebuild the complex mosaic of habitats across the landscape. All action alternatives show an increase in inundation duration over FWO that will significantly decrease soil oxidation, subsidence and peat fires. All action alternatives improved hydrologic conditions in northern WCA 3A in comparison to the FWO by increasing stages and extending hydroperiods within the area. All action alternatives improved hydrologic conditions in northern and southern ENP (Zones ENP-N and ENP-S) in comparison to the FWO by significantly increasing depths and extending hydroperiods in Northeast Shark River Slough (NESRS) (**Table G-14,** and

Table G-15). Consistent with other regions of the Greater Everglades, alternatives scored significantly higher than the FWO in terms of meeting the desired targets for measures of inundation duration, drought intensity, and slough vegetation suitability. Within southern ENP, Alts 3 and 4 produced slightly greater depths, compared to Alts 1 and 2, as depicted by the normalized weekly stage duration curve for Indicator Region 130 (**Figure G-23**). Alt 4 produced slightly greater depths than Alt 3. Alt 4 generally produced improved inundation patterns in southern ENP. Alt 4 improved the number and duration of dry events in NESRS relative to the remaining alternatives at several of the IRs in Zone ENP-S (**Table G-17**). Improved inundation patterns in southern ENP resulted in better suitability for slough vegetation for Alt 4 (**Figure G-24**). In summary, increases in inundation duration throughout the Greater Everglades, particularly within northern WCA 3A and ENP would enable soil conservation through reduction in soil oxidation and fire frequency, and promotion of peat accretion.

5.1.3 Vegetation

Negligible, short-term and less than significant adverse effects to vegetation within Lake Okeechobee, the Northern Estuaries, and the Everglades Agricultural Area (EAA) are anticipated due to implementation of any of the alternatives. As compared with FWO, all CEPP action alternatives show a slight performance improvement within the Northern Estuaries as indicated by fewer high volume flow months, providing a minor beneficial effect. Reduction in high flows and accompanying flow velocities would result in lower suspended solids, color and colored dissolved organic matter, thereby allowing greater light penetration to promote growth of submerged aquatic vegetation (SAV). Refer to **Appendix C.2.1** for a detailed comparison of potential effects to vegetation.

Due to changes in the quantity, quality, distribution, and timing of water entering the Greater Everglades ecosystem, moderate, long-term and significant effects on wetland hydrology and vegetation would potentially occur under each alternative. The primary factors influencing the distribution of dominant freshwater wetland plant species of the Everglades are soil type, soil depth, and hydrological regime (FWS 1999). All four action alternatives improved hydroperiods and sheetflow in WCA 2A, WCA 3A, WCA 3B, and ENP which result in reduced soil oxidation and promoting of peat accretion necessary to rebuild the complex mosaic of habitats across the landscape. All four action alternative provide moderate improvements in hydroperiods in WCA 2A compared to FWO. However, all action alternatives had a moderate, long-term adverse effect in WCA 2B by significantly decreasing stages compared to FWO. In the L-28 Triangle, all action alternatives showed an improvement in hydroperiod over FWO, with Alt 1 having greater improvement than Alts 2-4. Differences among alternatives were found within northern WCA 3A, WCA 3B and southern ENP. These differences may be attributed to the location of project features and varied spatial distribution of water across the landscape. For example, Alt 1 includes a 3 mile spreader canal west of S-8 that provides the greatest improvements in northwestern WCA 3A. In comparison, Alts 3 and 4 provide more water to SRS and the southern marl prairies, improving conditions for tree islands and ridge and slough habitat within ENP and salinity within Florida Bay. Alt 1 performed slightly better than Alts 2, 3, and 4 in northern WCA 3A.

Implementation of any of the CEPP action alternatives is expected to rehydrate much of northern WCA 3A by redistributing treated STA discharges from the L-4 and L-5 Canals north of WCA 3A in a manner that promotes sheetflow and by removing the drainage effects associated with the Miami Canal. Variation in the spatial distribution of inflows into northern WCA 3A and backfill of the Miami Canal did not significantly influence performance among alternatives. Resumption of sheetflow and related patterns of hydroperiod extension and increased water depths will significantly help to restore and sustain the microtopography, directionality, and spatial extent of ridges and sloughs and improve the health of three islands in the ridge and slough landscape. All alternatives provide a major, long-term,

beneficial effect through the backfilling of the Miami Canal. Although none of the alternatives would provide the necessary inundation pattern for complete slough vegetation restoration, all action alternatives act to rehydrate northern WCA 3A, promoting peat accretion, reducing the potential for high intensity fires and promoting transition from upland to wetland vegetation.

Alternative performance varied greatly within WCA 3B due to structural and operational variations among alternatives with respect to construction of conveyance features within L-67 A, L-67 C and L-29 levees, along with associated levee removal or levee gaps. Alt 2 scored the highest in terms of meeting the desired performance measure targets within this area, followed by Alts 1, 3 and 4 respectively. All action alternatives provide a long-term, minor beneficial effect through improved hydrologic conditions in WCA 3B in comparison to FWO by increasing stages and extending hydroperiods within the area as measured by the RECOVER Slough Vegetation Performance Measure (refer to **Appendix G, Figure G-19**). Increases in stages and hydroperiods would promote wetland vegetation transition, through contraction of sawgrass marshes and expansion of wet prairies, and in deeper water areas, sloughs. Plant species diversity would also likely increase in WCA 3B with species composition in wet prairies determined largely by peat depth and substrate type (Powers 2005). Submerged aquatic plants are commonly associated with sloughs, providing structure for growth of periphyton, the main source of primary production (the production of organic compounds from atmospheric or aquatic carbon dioxide) within the freshwater Everglades (Gunderson 1994; Powers 2005).

Although none of the alternatives met the desired dry and wet season water depths for slough vegetation in WCA 3B, Alt 2 improved inundation patterns within WCA 3B and slightly improved conditions for slough vegetation relative to Alts 3, 1, and 4 by increasing water depths in both the wet and dry season (refer to **Appendix G, Figure G-18** and **Figure G-19)**. The increased ability of Alt 2 to rehydrate WCA 3B and further increase hydroperiods, especially relative to Alt 4, may come at a potential loss of tree islands. The potential moderate adverse effect is greatest for Alt 2 and Alt 3 because a third of the population of tree islands in WCA 3B are only 0.7-1.1 feet above the surrounding sloughs. When water depths on tree islands exceed one foot for greater than 120 days, even the most water tolerant species are affected (Wu et al. 2002).

Implementation of any of the CEPP action alternatives is expected to rehydrate much of NESRS by redistributing flows from WCA 3A and WCA 3B to ENP and provide a moderate, long-term, beneficial effect. Resumption of sheetflow and related patterns of hydroperiod extension will significantly help to restore pre-drainage patterns of water depths and the complex mosaic of Everglades' vegetation communities. As compared with FWO, all action alternatives produced significantly greater depths and inundation durations (refer to **Appendix G, Figure G-21** and **Figure G-22**). Within northern ENP, alternative performance was similar with reduction in the number of dry events within SRS and extending average hydroperiods by 35 to 90 days depending upon location; this would reduce soil oxidation, decrease fire potential, promote peat accretion, and aid in restoration of historic wetland communities. Within southern ENP, Alts 3 and 4 produced slightly greater water depths as compared with Alts 2, 1 and FWO (refer to **Appendix G, Figure G-23**). Inundation patterns improved with Alt 4 in southern ENP resulting in better suitability for slough vegetation, providing a minor beneficial effect. Although none of the alternatives met the desired dry and wet season water depths for slough vegetation in southern ENP. Alt 4 slightly improved conditions for slough vegetation relative to Alts 1, 2, and 3 by increasing water depths in both the wet and dry season within this region.

Rehydration within northern WCA 3A, new point source discharges of water into WCA 3B and increased discharges at S-333 have the potential to mobilize nutrients within the water column, thereby negatively

affecting water quality. The overall change in phosphorus loads in most areas is expected to be minor and vegetation shifts driven by water quality should be localized. Phosphorus loadings alter the Everglades plant communities through increased plant productivity, tissue phosphorus storage, soil phosphorus enrichment and shifts in plant species composition (Chaing et al. 2000). Substantial vegetation changes may result from elevated phosphorus concentrations. Water quality within the CEPP project area will continue to be monitored following implementation, as described in **Annex D**, to determine any associated changes.

Mangrove communities and seagrass beds associated with Florida Bay may likely show a minor, long-term and less than significant benefit under all alternatives from an increase in freshwater input resulting in decreased salinities. Mangrove communities and seagrass beds associated with Biscayne Bay under Alt2 is the only alternative that may likely show a minor benefit from an increase in freshwater input resulting in decreased salinities. Alts 1, 3, and 4 are likely to have negligible to minor adverse effects.

Non-native and invasive plant infestations in the action area may be exacerbated by soil disturbance, increased nutrients and hydrological modification. Construction and hydrological modification under each alternative may potentially influence the growth of non-native plant species and have a minor adverse effect. Refer to **Appendix C, Section C.2.4** for additional invasive species information.

5.1.4 Threatened and Endangered Species

Federally threatened, endangered, and candidate species that may occur within the study area include: Florida panther (*Puma concolor coryi*), Florida population of West Indian Manatee (Florida manatee) (*Trichechus manatus*) and its critical habitat, Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) and its critical habitat, Everglade snail kite (*Rostrhamus sociablis plumbeus*) and its critical habitat, Northern crested caracara (*Caracara cheriway*), piping plover (*Charadrius melodus*), red-cockaded woodpecker (*Picoides borealis*), roseate tern (*Sterna dougallii dougallii*), wood stork (*Mycteria americana*), American alligator (*Alligator mississippiensis*), Florida bonneted bat (*Eumops floridanus*), American crocodile (*Crocodylus acutus*) and its critical habitat, Eastern indigo snake (*Drymarchon corais couperi*), Miami black-headed snake (*Tantilla oolitica*), Schaus swallowtail butterfly (*Heraclides aristodemus ponceanus*), Miami blue butterfly (*Cyclargus thomasi bethunebakeri*), Florida leafwing butterfly (*Anaea troglodyta floridalis*), Bartram's hairstreak butterfly (*Strymon acis bartrami),* Stock Island tree snail (*Orthalicus reses* [not incl. *nesodryas*]), crenulate lead-plant (*Amorpha crenulata*), Cape Sable thoroughwort (*Chromolaena frustrata*) deltoid spurge (*Chamaesyce deltoidea* ssp. *deltoidea*), Garber's spurge (*Chamaesyce garberii*), Okeechobee gourd (*Cucurbita okeechobeensis* ssp. *okeechobeenis*), Small's milkpea (*Galactia smallii*), tiny polygala (*Polygala smallii*), smalltooth sawfish (*Pristis pectinata*) and its critical habitat, Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and its critical habitat, blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), green sea turtle (*Chelonia mydas*), hawksbill sea turtle (*Eretmochelys imbricata*), leatherback sea turtle (*Dermochelys coriacea*), Kemp's ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), Johnson's seagrass (*Halophila johnsonii*) and its critical habitat, elkhorn coral (*Acropora palmata*) and its critical habitat, and staghorn coral (*Acropora cervicornis*) and its critical habitat.

Threatened and endangered species that the Corps anticipated that the project may affect were compared to the FWO and all action alternatives with their potential effects summarized in **Table 5.1-1**. Further details on the life history of each species and their effects determinations can be found in the Biological Assessments in **Annex A**. For a more detailed analysis, please refer to **Appendix C.2.1**.

Table 5.1-1. Effects of Alts 1 though 4 on Threatened and Endangered Species

Threatened and Endangered Species (Please refer to Biological Assessment (Annex A) for further details on life history of each species.)					
Species	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Everglade Snail Kite and it's critical habitat	WCA 3A would continue to suffer from loss of sheet flow and over drying within northern WCA 3A, WCA 3B and ENP. If water levels become too low and food resources become too scarce, adults will abandon their nest sites and young. Southern WCA 3A would continue to experience extended hydroperiods due to ponding along the L-67a and L-29. High water levels and extended hydroperiods have resulted in vegetation shifts within WCA 3A, degrading Everglade snail kite critical habitat.	Rehydration and vegetation shifts within northern WCA 3A, WCA 3B and increased hydroperiods within ENP would increase suitable habitat for apple snails, thereby increasing spatial extent of suitable foraging opportunities for snail kites providing a moderate and significant beneficial effect. Based on this single metric, in WCA 3B, Alt 4 performed the best overall, followed by Alts 3, 1, and 2 respectively. All alternatives may affect Everglade snail kite critical habitat.			
Cape Sable Seaside Sparrow (Hydroperiod and Nesting condition) and it's critical habitat	Hydroperiods would remain the same. Hydroperiods for the western population (CSSS- A) would remain too wet preventing successful nesting, while eastern populations would remain too dry which can cause adverse habitat change from unseasonable fire frequencies. Nesting: Number of dry nesting days would remain the same, which is marginal in CSSS-A, but generally suitable over the rest of sparrow habitat.	Implementation of any alternative, with currently defined operations, has the potential to provide a major adverse affect and significant and unavoidable effect on hydroperiods within the marl prairies adjacent to NESRS. Longer hydroperiods than the FWO are predicted within CSSS-E and southern portions of CSSS-A. Hydroperiods within northern CSSS-A are slightly reduced over the FWO, providing slightly better, but overall too wet conditions for marl prairie habitat and nesting CSSS. Alt 2 is slightly better performing overall, followed by Alts 1, 3, and 4. Nesting: Nesting condition (or number of dry nesting days) proved to be a less sensitive metric than hydroperiod. Minor improvements were seen in northern CSSS-A and CSSS-F while performance was reduced in southern CSSS-A and E. Alts 1 and 2 were slightly better performing than Alts 3 or 4. All alternatives may adversely affect CSSS critical habitat.			
Wood Stork	Western and southern WCA 3A and ENP would continue to suffer from loss of freshwater flows, shorter hydroperiods, and increased saltwater intrusion.	In northeastern and western 3A, Alt 1 performed best with appropriate foraging depths during the dry season. Implementation is expected to provide moderate beneficial and significant effects for improved conditions for wood storks throughout much of the Greater Everglades. Overall, Alts 3 and 4 perform better in comparison with Alts 1 and 2.			
Eastern Indigo Snake	Maintenance of current water levels would not affect upland habitat.	Loss of 14, 000 acres of upland habitat within the FEB provides a major adverse effect and a significant and unavoidable effect. Potential loss of upland habitat due to backfilling the Miami Canal in WCA 3A.			

Threatened and Endangered Species (Please refer to Biological Assessment (Annex A) for further details on life history of each species.)					
Species	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
American Alligator (similarity of appearance to the American Crocodile)	Drainage of peripheral wetlands and increasing salinity in mangrove wetlands limits the occurrence of alligators to canals and deeper slough habitats.	All action alternatives provide minor beneficial effects on habitat suitability for American alligator, with Alt 4 performing the best.			
American Crocodile and it's critical habitat	Salinity fluctuations due to lack of freshwater flow would continue to reduce habitat suitability for American crocodile.	All action alternatives provide minor beneficial effects and improve habitat suitability for American crocodile, with Alt 4 performing the best. All alternatives may affect, but are not likely to adversely affect, critical habitat for the American crocodile.			
Manatee and it's critical habitat	Freshwater high volume flows into the Northern Estuaries would continue to degrade seagrasses. Salinity fluctuations in Florida Bay and southern estuaries would continue, potentially reducing quality sea grasses for foraging.	Reduction in high volume discharge events from Lake Okeechobee to the Northern Estuaries would reduce stress on seagrass beds, thereby increasing foraging potential for manatee within this region and provide minor beneficial effects to the manatee and its critical habitat. Increased flows to Florida Bay and southwest coastal estuaries would improve salinity, thereby reducing stress on seagrasses important to foraging manatees and provide minor beneficial effects to the manatee and its critical habitat. All alternative may affect, but are not likely to adversely affect designated critical habitat for the Florida manatee.			
Panther	Maintenance of current water levels would not affect upland habitat.	Loss of 14, 000 acres of upland habitat due to FEB provides a minor adverse effect. Potential loss of upland habitat due to backfilling the Miami Canal in WCA 3A. However, increases in forage base due to hydrological improvements provide a minor beneficial effect.			
Smalltooth Sawfish and its critical habitat	In the absence of land-based water storage facilities disruptions caused by flood control regulatory freshwater releases would continue to cause extreme salinity fluctuations in the northern estuaries; while current water management operations have caused in an inland migration of saline conditions in groundwater and surface waters and prolonged dry season conditions in the southern estuaries resulting in an escalation of salinities unsuitable for estuarine biota.	All of the alternatives have the potential to provide a minor beneficial effect to the smalltooth sawfish and its critical habitat by reducing the volume of high level flows from Lake Okeechobee to the Caloosahatchee River thereby improving the overall salinity regime throughout the Caloosahatchee estuary; and by improving freshwater delivery to coastal wetlands and downstream estuaries in ENP and Florida Bay, subsequently reducing the duration and occurrence of hypersaline conditions.			

Threatened and Endangered Species (Please refer to Biological Assessment (Annex A) for further details on life history of each species.)					
Species	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Green Sea Turtle, Hawksbill Sea Turtle, Leatherback Sea Turtle, Kemp's Ridley Sea Turtle, Loggerhead Sea Turtle	Current water management operations and possibly sea level change have caused in an inland migration of saline conditions in groundwater and surface waters and prolonged dry season conditions in the southern estuaries resulting in an escalation of salinities unsuitable for estuarine biota.	The increased freshwater flows may alter seagrass species composition but should have a negligible and less than significant effect on the overall biomass available for sea turtle feeding habits.			

5.1.5 State Listed Species

The CEPP project area contains habitat suitable for the presence, nesting, and/or foraging of 16 State-listed threatened and endangered species and 18 species of special concern. Threatened and endangered animal species include the Big Cypress fox squirrel (*Sciurus niger avicennia*), Florida mastiff bat (*Eumops glaucinus floridanus*), Florida black bear (*ursus americanus floridanus*), Everglades mink (*Mustela vison evergladensis*), Florida sandhill crane (*Grus canadensis pratensis*), snowy plover (*Charadrius alexandrius*), Southeastern American kestrel (*Falco sparveriuspaulus*), least tern (*Sterna antillarum*), white-crowned pigeon (*Columba leucocephalus*), and Miami black-headed snake (*Tantilla oolitica*). Species of special concern include the Florida mouse (*Podomys floridanus*), Shermans fox squirrel (*Sciurus niger shermani*), American oystercatcher (*Haematopus palliates*), brown pelican (*Pelecanus occidentalis*), black skimmer (*Rynchops niger*), burrowing owl (*Athene cunicularia*), limpkin (*Aramus guarauna*), reddish egret (*Egretta rufescens*), snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), white ibis (*Eudocimus albus*), roseate spoonbill (*Platalea ajaja*), osprey (*Pandion haliaetus*), mangrove rivulus (*Kryptolebias marmoratus*), mangrove gambusia (*Gambusia rhizophorae*), gopher tortoise (*Gopherus polyphemus*), and the Florida tree snail (*Liguus fasciatus*).

Threatened and endangered plant species include the pine-pink orchid, which frequents the edges of the farm roads just above wetland elevation; the lattice-vein fern which is found occasionally in the forested wetlands; Eaton's spikemoss, and Wright's flowering fern, both found in the Frog Pond natural area; along with the Mexican vanilla plant and Schizaea tropical fern located on tree islands in the upper Southern Glades region.

While small foraging or nesting areas utilized by many of these animal species may be affected by this project, Alts 1-4 are not likely to adversely affect protected State species and have a less than significant and short-term effect on protected State species. Impacts to wading bird species will be similar to those affecting the wood stork. Subtle changes in water quality can also support the prey base so that net effects on forage availability can be variable. Overall, negligible adverse impacts are anticipated to State listed species as a result of this project. For a more detailed analysis, please refer to **Appendix C.2.1.**

5.1.6 Wildlife

A comparison of FWO and CEPP alternatives and their potential effects on wildlife within the CEPP action area are summarized below. For a more detailed analysis, please refer to **Appendix C.2.1.4.** Fur-

ther details on the effects of the alternatives can be found in the Fish and Wildlife Coordination Act Report in **Annex A.**

Effects on State and Federally listed species are described in further detail in **Section C.2.1.4**. Changes in water quality also have the potential to affect prey forage base by altering vegetation composition or structure. Elevated nutrient concentrations in surface water have adversely affected the prey forage base in some portions of the Everglades Protection Area by altering the dominant vegetation coverage from sawgrass to cattails. Nutrient concentrations may be reduced as a result of CEPP and other projects over the next 50 years. Lower nutrient discharges should slow or halt the expansion of cattail acreage which should result in maintained or improved prey forage base over the long-term. Water quality will continue to be monitored under CEPP, and potential effects are largely uncertain at this time.

5.1.6.1 Invertebrates

Short-term, negligible and less than significant effects to the invertebrate community within Lake Okeechobee or EAA are anticipated under any CEPP action alternative. As compared with FWO, all CEPP action alternatives show a minor beneficial effect with performance improvement within the Northern Estuaries as indicated by fewer high volume flow months. Reductions in high volume discharges and salinity fluctuations would likely benefit oysters within the Northern Estuaries. In the St. Lucie Estuary a minor adverse effect is expected due to increases in low flow violations during the dry season. Recent oyster monitoring data during extended dry conditions in the area has shown an increase in oyster disease related to the duration and severity of high salinity conditions. Although these extreme dry spells are rare in the St. Lucie Estuary, supplemental flows during dry times may be warranted and have been accounted for in the IRLS water reservation process.

Within the Greater Everglades aquatic invertebrates would rapidly colonize newly re-hydrated areas with implementation of any alternative providing a long-term, moderate and significant beneficial effect, directly benefitting aquatic invertebrates within the action area. Increase in stages and hydroperiods within WCA 2, northern WCA 3A, WCA 3B, and ENP would promote wetland vegetation transition, increasing periphyton. Periphyton is a primary component of invertebrate diets, including apple snails. In addition to the potential for increased foraging opportunities, changes in vegetation resulting in expansion of wet prairie and increases in emergent vegetation would also provide habitat structure critical for apple snail aerial respiration and egg deposition (Turner 1996; Darby et al. 1999).

Crayfish are important components within the Everglades food web, serving as primary dietary components of higher trophic level species including fish, amphibians, alligators, wading birds, and mammals such as raccoons and river otters (Kushlan and Kushlan 1979). Increases in hydroperiod associated with implementation of any alternative would likely increase crayfish density within northern WCA 3A, WCA 3B, and ENP, particularly within the marl prairies. All action alternatives, especially Alts 4 and 3, would increase hydroperiods within this region resulting in significantly increased native crayfish productivity having a long-term, moderate beneficial effect.

Invertebrate populations associated with Florida Bay may likely show a long-term, minor beneficial effect under all alternatives from an increase in freshwater input resulting in decreased salinities. Invertebrate populations and seagrass beds associated with Biscayne Bay under Alt 2 may likely show a minor beneficial effect from an increase in freshwater input resulting in decreased salinities. Alts 1, 3, and 4 are likely to have a negligible or minor adverse effect.

5.1.6.2 Fish

Implementation of any alternative is expected to significantly improve conditions for fish species throughout much of the Greater Everglades and have a long-term, moderate beneficial effect. The largest percent gains in daily average fish density were predicted within northern WCA 3A and NESRS. In these areas fish densities increased in excess of 30%, with extremes over 80%. Other areas within SRS also experienced appreciable gains in fish density due to increased flows. In comparison, all action alternatives resulted in lower fish densities within WCA 3A along L-67A. Regional percent changes in fish densities were highest in SRS (16-23%) and southern marl prairies (17-31%) as compared with FWO, with Alts 3 and 4 exhibiting the largest percent increases. Taylor Slough experienced negligible positive changes (<1%) (Catano and Trexler 2013).

Introduction or expansion of non-native fish species due to changes in water distribution and increased connectivity within WCA 3A, WCA 3B, and ENP is likely to occur; however, the extent of invasion is uncertain at this time providing a minor adverse effect. In contrast to FWO, new access points will be created under each alternative, with the highest connectivity achieved under Alts 3 and 4. Alt 1 would provide the fewest new access points, thus limiting the potential for spread of invasive and or exotic fish species as compared with the other action alternatives. Additional analysis of invasive and exotic fish can be found in **Section 5.1.17**.

Fish populations associated with Florida Bay may likely show a long-term, minor beneficial effect under all alternatives from an increase in freshwater input resulting in decreased salinities. Fish populations and seagrass beds associated with Biscayne Bay under Alt2 may likely show a minor beneficial effect from an increase in freshwater input and decreased salinities. Alts 1, 3, and 4 are likely to show a negligible or minor adverse effect.

5.1.6.3 Amphibians and Reptiles

Long-term, minor beneficial effects to the amphibian and reptile communities are anticipated under each alternative. All action alternatives showed improved conditions for amphibians within WCA 3 and ENP as compared with FWO. Rehydration within previously dry areas within northern WCA 3A would increase spatial extent of suitable habitat for aquatic amphibian species in this area. Similarly, increased hydroperiods within ENP would also benefit aquatic amphibian species. As hydrology improves within WCA 3 and ENP it is expected that amphibian species richness will also change. However, declines in some amphibian species will be offset by favorable habitat conditions for other species. Increase in forage prey availability (i.e. crayfish and other invertebrates, fish) in areas rehydrated by CEPP implementation will also directly benefit amphibian and reptile species.

5.1.6.4 Birds

The freshwater wetlands of the Everglades are noted for their abundance and diversity of colonial wading birds. Nesting and foraging activities of resident bird species are anticipated to show a long-term, moderate and significant beneficial effect with implementation of any CEPP alternative. Impacts to the Cape Sable seaside sparrow, snail kite, and wood stork are further discussed in **Appendix C.2.1**, **Section C.2.1.5**, and **Annex A**. Changes in water quality also have the potential to affect birds through alteration of vegetation composition or structure or impacts to their forage base. Water quality will continue to be monitored under CEPP and potential effects are uncertain at this time.

As predicted by the Trophic Hypothesis (RECOVER 2004), an increase in density of small fishes will directly benefit higher trophic level predators such as wading birds. Therefore, it is predicted that the alternatives that provide the greatest benefit to small fishes as described in **Section C.1.3** will also

perform best overall for wading birds. Crayfish are a particularly important forage resource for nesting white ibis (*Eudocimus albus*). Appropriate foraging conditions and crayfish densities within core foraging areas of nesting wading bird colonies can reduce foraging flight distance, thereby enhancing overall body condition. As indicated in **Section C.1.1**, increases in hydroperiod associated with implementation of any CEPP action alternative would likely increase crayfish density within northern WCA 3A, WCA 3B and ENP, particularly within the marl prairies. Historically, the short hydroperiod wetlands within ENP have been important for wood stork foraging during the pre-breeding season with wood storks shifting to longer hydroperiod wetlands as the dry season progresses. Hydrological patterns that produce a maximum number of patches with high prey availability (i.e. high water levels at the end of the wet season and low water levels at the end of the dry season) are necessary for high reproductive outputs (Gawlik 2002; Gawlik et al. 2004). Depending upon the elevation and microtopography throughout WCA 3 and ENP, implementation of any of the CEPP action alternatives would produce a variety of wetland habitats that would support prey densities conducive to successful wading bird foraging and nesting.

5.1.6.5 Mammals

As compared with FWO, potential long-term, minor beneficial effects to mammals within CEPP action area are anticipated with implementation of any CEPP alternative. Small mammals including raccoons and river otters would benefit from increased crayfish and small prey fish biomass. The increase in water availability and rehydration within northern WCA 3A, WCA 3B, and ENP under all action alternatives will likely benefit Everglades mink (*Mustela vison evergladensis*) as a result of increased forage with Alts 4 and 3 providing the greatest improvements within ENP.

CEPP implementation may negatively affect some mammals dependent upon upland habitat. Due to increased water flow and changes in water distribution it is anticipated that overdrained areas in northern WCA 3A will be rehydrated, triggering a vegetation transition from upland to wetland habitat. Although mammals occurring within the action area are adapted to the naturally fluctuating water levels in the Everglades, there is an increased potential for this vegetation transition to have a short-term significant, adverse, and unavoidable effect on some mammals using upland habitat. This is a particular concern for deer populations within northern WCA 3A that utilize tree islands. However, as discussed in **Section C.2.1.4.4**, no significant effects on tree islands within WCA 3A and ENP are anticipated to occur under any alternative; but, lower elevation tree islands within WCA 3B may be adversely affected by CEPP implementation, with Alts 2 and 3 resulting in the greatest potential impact. Deer populations that utilize the lower elevation tree islands within WCA 3B may suffer from habitat loss. In addition, deer that utilize levees slated for removal (L-67C, L-29, and L-67 Extension) also have the potential to be negatively affected. Loss of these levees may be offset by the construction of the Blue Shanty Levee in WCA 3B. Deer are highly mobile and will migrate to find suitable habitat. No significant negative effects on mammals in the remainder of the CEPP action area are anticipated under any of the alternative.

5.1.7 Essential Fish Habitat

The Caloosahatchee and St. Lucie estuaries will continue to be subjected to high-level freshwater discharges during the wet season, causing salinities to drop below preferred ranges for estuarine biota which could negatively impact species utilizing essential fish habitat in the FWO. Alts 1 through 4 perform similarly in the Northern Estuaries and have the potential to reduce the frequency and volume of high level flows from Lake Okeechobee to the Caloosahatchee River Estuary and the St. Lucie Estuary; thus reducing the potential for impacts to estuarine and nearshore biota associated with essential fish habitat, providing a minor beneficial effect.

For the Southern Estuaries, current operations in the project area have resulted in an inland migration of saline conditions in both groundwater and surface waters. This has caused the expansion of moderate to high salinity zones and has diminished the spatial extent of freshwater wetland habitats in the project area. Under the FWO, less water will be available to contribute to the existing water budget necessary to realize estuarine and nearshore habitat restoration potential. The proposed project components would improve freshwater delivery to coastal wetlands and adjacent estuaries, providing a minor beneficial effect. Implementation of the project would redistribute flow to salt water wetlands and nearshore bay areas and result in favorable changes to salinity levels. These changes may affect essential fish habitat, although the impacts to the aquatic resources are anticipated to be beneficial. Alt 2 performs the best overall for southeastern Biscayne Bay while providing the least restoration benefits to Florida Bay. In contrast, Alt 4 provides the best benefits to Florida Bay, with Alt 3 second. With the increase in benefits to Florida Bay however, Alts 3 and 4 suggest a reduction in hydration within the northern Biscayne Bay. There is no effect for any of the alternatives in Lake Okeechobee, EAA, or the Greater Everglades. A detailed analysis of the Essential Fish Habitat can be found in the National Marine Fisheries Service Biological Assessment (**Annex A**) and in **Appendix C.4.33.6.8.1**.

5.1.8 Hydrology

A summary of the anticipated long-term hydrologic effects of the alternative actions, which were described in **Section 3**, is presented in **Table 5.1-2**. Comprehensive discussion of the anticipated long-term hydrologic effects of the alternative actions is provided in **Section C.2.1.7** of **Appendix C.2.1**. Alts 1 through 4 are compared to the FWO; similarly, the hydrologic effects of the FWO are described based on comparison to the Existing Condition Baseline (ECB). The summary of regional hydrologic differences includes quantitative comparisons between the ECB and FWO and between the FWO and Alts 1 through 4 based on the Regional Simulation Model (RSM)-BN and RSM-GL CEPP modeling representations of these baselines and alternatives. The determination of the directionality of the long-term hydrologic change (improvements and/or adverse hydrologic change) within each specified geographic region is principally based on the results of the ecological evaluation, which are described in **Section 4.2.2**.

Table 5.1-2. Effects of Alts 1 through 4 on Hydrology

Geographic Region	Alt	Hydrologic Effects
Lake Okeechobee	FWO	Moderate hydrologic change, with improvements from reducing the frequency of high lake stages and adverse effect from increasing the frequency of low lake stages. Significant stage reduction of 0.1-0.5 feet for the upper 75% of the stage duration curve. Number of days with stages above 16 feet NGVD is reduced from 870 to 696 during the 1965-2005 period of simulation.
	All Alts	Moderate hydrologic change, with improvements from reducing the frequency of low lake stages and adverse effect from increasing the frequency of high lake stages. Significant stage increase by 0.2-0.4 feet for the upper 60% of the stage duration curve, excluding extreme wet hydrologic conditions. Number of days with stages above 16 feet NGVD is increased from 696 to 1096 during the 1965-2005 period of simulation.
Northern Estuaries	FWO	Caloosahatchee Estuary: Major improvement. Mean monthly flows above 2800 cfs and above 4500 cfs are reduced by 13 and 10 months, respectively (14% and 23% reductions, respectively). Mean monthly flows less than 450 cfs are reduced by 89 months (77%). St. Lucie Estuary: Major improvement. Mean monthly flows above 2000 cfs and above 3000 cfs are reduced by 10 and 12 months, respectively (11% and 28% reductions, respectively).
	All Alts	Caloosahatchee Estuary. Moderate improvement. Mean monthly flows above 2800 cfs and 4500 cfs are reduced by 13 and 2 months, respectively (16% and 6% reductions,

Geographic Region	Alt	Hydrologic Effects
		respectively). St. Lucie Estuary. Major hydrologic change, with improvements for high volume discharges and adverse effect for low volume discharges. Mean monthly flows above 2000 cfs and above 3000 cfs are reduced by 22 and 3 months, respectively (26% and 10% reductions, respectively). Mean monthly flows less than 350 cfs are increased by 30 months (33%).
Greater Everglades: WCA-2A and WCA-2B	FWO	WCA-2A (2A-17): Minor adverse effect. Stages are increased by 0.1-0.2 feet under all hydrologic conditions. WCA-2B (2B-Y): Moderate improvement. Stages within WCA-2B are significantly increased by 0.25-0.50 feet under nearly all hydrologic conditions, excluding extreme wet conditions.
	All Alts	WCA-2A (2A-17): Moderate improvement. Stages are decreased by 0.1-0.3 feet under all hydrologic conditions. WCA-2B (2B-Y): Major adverse effect. Stages are decreased by 0.50-0.75 feet under nearly all hydrologic conditions, excluding extreme wet conditions.
Greater Everglades: WCA 3A and WCA 3B	FWO	a) L-28 Triangle: Negligible effect. b) Northwest WCA 3A (3A-NW): Negligible effect. Stages slightly increased during the wettest 20% of conditions. c) Northeast WCA 3A (3A-NE): Minor to Moderate adverse effect. Stages are decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. d) East-Central WCA 3A (3A-3): Minor to Moderate adverse effect. Stages are generally decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. e) Central WCA 3A (3A-4): Minor to Moderate adverse effect. Stages are generally decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. f) Southern WCA 3A (3A-28): Moderate adverse effect. Stages are generally decreased by 0.2-0.3 feet, with no significant change during extreme wet or extreme dry conditions. g) WCA 3B (Site 71): Minor to Moderate adverse effect. Stages are decreased by 0.1-0.2 feet during normal to dry conditions.
	Alt 1	a) L-28 Triangle: Moderate to major improvement. Stages within the Triangle are increased by 0.2-0.5 feet during nearly all hydrologic conditions, excluding the driest 25% of hydrologic conditions. b) Northwest WCA 3A (3A-NW): Major improvement. Stages are increased by 0.6-0.8 feet. c) Northeast WCA 3A (3A-NE): Major improvement. Stages increased by 0.4-0.7 feet, with no significant change during extreme wet conditions and a slight increase in stage for extreme dry conditions. d) East-Central WCA 3A (3A-3): Major improvement. Stages are increased by 0.2-0.6 feet, with no significant change during the wettest 20% of conditions. e) Central WCA 3A (3A-4): Minor to Moderate improvement. Stages are increased by 0.1-0.2 feet during average to dry conditions, with a slight stage reduction during the wettest 10% of conditions and no significant change during extreme dry conditions. f) Southern WCA 3A (3A-28): Minor improvement. Stages are decreased by 0.1-0.2 feet during the wettest 5% of conditions and slightly decreased during normal to dry conditions. g) WCA 3B (Site 71): Minor to Moderate improvement. Stages are increased by 0.1-0.2 feet during the wettest 10% of conditions and during normal to dry conditions.
	Alt 2	a) L-28 Triangle. Minor improvement. Stages increased by 0.1-0.2 feet during normal to dry conditions.

Geographic Region	Alt	Hydrologic Effects
		b) Northwest WCA 3A (3A-NW): Major improvement. Stages are increased by 0.5-0.7 feet. c) Northeast WCA 3A (3A-NE): Major improvement. Stages increased by 0.5-0.8 feet, with no significant change during extreme wet conditions and a slight increase in stage for extreme dry conditions. d) East-Central WCA 3A (3A-3): Same as Alt 1. e) Central WCA 3A (3A-4): Same as Alt 1. f) Southern WCA 3A (3A-28): Minor adverse effect. Stages are decreased by 0.1-0.2 feet during the wettest 5% of conditions and decreased by 0.1-0.2 feet during wet, normal, and dry conditions. g) WCA 3B (Site 71): Major improvement. Stages significantly increased by 0.3-0.5 feet under all conditions.
	Alt 3	a) L-28 Triangle: Same as Alt 2. b) Northwest WCA 3A (3A-NW): Same as Alt 2. c) Northeast WCA 3A (3A-NE): Same as Alt 2. d) East-Central WCA 3A (3A-3): Same as Alt 1. e) Central WCA 3A (3A-4): Same as Alt 1. f) Southern WCA 3A (3A-28): Minor adverse effect. Stages decreased by 0.1-0.2 feet during the wettest 5% of conditions and decreased 0.1-0.2 feet during normal to dry conditions. g) WCA 3B (Site 71): Major improvement. Stages are significantly increased by 0.2-0.3 feet during the wettest 10% of conditions and during normal to dry conditions.
	Alt 4	a) L-28 Triangle: Same as Alt 2. b) Northwest WCA 3A (3A-NW): Same as Alt 2. c) Northeast WCA 3A (3A-NE): Same as Alt 2. d) East-Central WCA 3A (3A-3): Same as Alt 1. e) Central WCA 3A (3A-4): Same as Alt 1. f) Southern WCA 3A (3A-28): Same as Alt 1. g) WCA 3B (Site 71): Minor to Moderate improvement. Stages are slightly increased during the wettest 10% of conditions and increased by 0.1-0.2 feet during normal to dry conditions.
Greater Everglades: ENP	FWO	a) Northwest ENP (NP-201): Minor improvement. Stages are increased by 0.1-0.2 feet during normal to dry conditions. b) Northeast ENP (NESRS-2): Minor adverse effect. Stages are slightly reduced during normal to dry conditions. c) Central ENP (P-33): Negligible effect. d) Taylor Slough: Minor to Moderate improvement. Stages are increased by 0.1-0.3 feet during nearly all hydrologic conditions.
	Alt 1	a) Northwest ENP (NP-201): Moderate to Major adverse effect. Stages are decreased by 0.1-0.4 feet under all hydrologic conditions. b) Northeast ENP (NESRS-2): Major improvement. Stages are increased by 0.7-1.0 under all hydrologic conditions. c) Central ENP (P-33): Major improvement. Stages are increased by 0.2-0.6 feet under all hydrologic conditions. d) Taylor Slough: Minor improvement. Stages are slightly increased by approximately 0.1 feet during the wettest 20% of hydrologic conditions.
	Alt 2	a) Northwest ENP (NP-201): Moderate adverse effect. Stages are slightly decreased during wet conditions, slightly increased during normal conditions, and decreased by 0.1-0.3 feet under normal to dry conditions. b) Northeast ENP (NESRS-2): Same as Alt 1. c) Central ENP (P-33): Same as Alt 1.

Geographic Region	Alt	Hydrologic Effects
		d) Taylor Slough: Same as Alt 1.
	Alt 3	a) Northwest ENP (NP-201): Same as Alt 2. b) Northeast ENP (NESRS-2): Same as Alt 1. c) Central ENP (P-33): Same as Alt 1. d) Taylor Slough: Same as Alt 1.
	Alt 4	a) Northwest ENP (NP-201): Minor to Moderate adverse effect. Stages are slightly decreased during extreme wet conditions, increased by 0.1-0.2 feet during normal conditions, and decreased by 0.1-0.2 feet under normal to dry conditions. b) Northeast ENP (NESRS-2): Same as Alt 1. c) Central ENP (P-33): Same as Alt 1. d) Taylor Slough: Minor adverse effect. Stages are slightly decreased by 0.1 feet during the wettest 30% of hydrologic conditions.
Southern Estuaries	FWO	a) Biscayne Bay: Moderate improvement. Average annual canal discharges to northern Biscayne Bay (S-27, S-28, and S-29) are increased by 66,000 acre-feet (66 kAF; 19%). b) Florida Bay: Moderate adverse effect. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are decreased by 14 kAF (5%).
	Alt 1	a) Biscayne Bay: Moderate adverse effect. Combined total average annual canal discharges to central and southern Biscayne Bay (S-336, S-338, S-194, S-196, S-197) are reduced by 23-24 kAF (21%). b) Florida Bay: Minor improvement. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are increased by 7 kAF (3%).
	Alt 2	a) Biscayne Bay: Minor to Moderate adverse effect. Combined total average annual canal discharges to central and southern Biscayne Bay are reduced by 23-24 kAF (21-22%). Average annual canal discharges to northern Biscayne Bay are increased by 14 kAF (3%). b) Florida Bay: Same as Alt 1.
	Alt 3 &4	a) Biscayne Bay: Moderate to Major adverse effect. Combined total average annual canal discharges to central and southern Biscayne Bay are reduced by 37-44 kAF (34-40%). b) Florida Bay: Moderate improvement. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are increased by 9-10 kAF (4%).

5.1.9 Water Quality

The assessment of project impacts to water quality is summarized in **Table 5.1-3** below. The detailed analyses are found in **Appendix C.1**, **Appendix C.2.1**, and **Appendix C.2.2** as well as **Annex F**.

Table 5.1-3. Effects of Alts 1 through 4 on Water Quality

Geographic Regions	Alts	Water Quality
Lake Okeechobee	FWO	WQ is expected to improve relative to present conditions as the result of implementation of Total Maximum Daily Loads (TMDLs), and implementing the associated BMAPs for the basins discharging to the lake.
	All Alts	Relative to FWO, no significant change to lake water quality is expected; however, additional backflow into the lake at S-308 increases the phosphorus load slightly. Changes in phosphorus loads will be addressed holistically throughout the watershed via the Florida Department of Environmental Protection's Lake Okeechobee Basin Management Action Plan (BMAP) process (Section 403.067, Florida Statutes). The BMAP is a currently under development via a public stakeholder driven process.
Northern Estuaries	FWO	Number of low salinity events reduced for both Caloosahatchee and St. Lucie relative to baseline conditions. Number of high salinity events reduced for the Caloosahatchee

Geographic Regions	Alts	Water Quality
		Estuary and St. Lucie Estuary. Improved nutrient and dissolved oxygen conditions expected to result from reduced high flow events from Lake Okeechobee, improved Lake Okeechobee nutrient levels, and improved estuary basin runoff quality.
	All Alts	Relative to FWO, number of low and high salinity events for Caloosahatchee is reduced. Number of high flow events reduced in St. Lucie, however, the number of low flow events increased. Improved nutrient and dissolved oxygen conditions expected to result from reduced high flow events from Lake Okeechobee, improved Lake Okeechobee nutrient levels, and improved estuary basin runoff quality due to implementation of TMDLs for nutrients.
EAA	FWO	Relative to existing conditions improvement in nutrient concentrations due to implementation of additional storm water treatment areas (STAs). Slight reduction in sulfate due to additional removal in STAs as well as expected reduction in future farming activities due to Restoration Strategies Implementation and reduced flow. Dynamic Model for Stormwater Treatment Areas (DMSTA) water quality modeling indicates that SFWMD's Restoration Strategies Program is expected to result in compliance with the 2012 water quality-based effluent limits (WQBEL) for total phosphorus. The Restoration Strategies plan is scheduled for completion in 2029.
	All Alts	Relative to FWO condition, integration of the A2 FEB with the State of Florida's A1 FEB, STA 3/4 and STA2 allows for the delivery of restoration flows. The DMSTA water quality model prediction shows compliance with the WQBEL. CEPP plan increases flows through the Central flow path, but it also provides increased FEB storage. Based on DMSTA modeling, the additional FEB storage provided in the central flow path by CEPP, in combination with the A-1 FEB, STA-2, and STA-3/4, is sufficient to handle the additional CEPP flows (approximately 215 kac-ft/yr) and still achieve the WQBEL.
Greater Everglades	FWO	Relative to baseline conditions, expect reduction in nutrient concentrations entering Everglades Protection Area due to implementation of new STAs in EAA. Reduced sulfate load expected as a result of reduced flows and reduction of farming activities in Restoration Strategy project lands. Relative to baseline conditions, increased frequency of meeting the water quality 1991 Settlement Agreement compliance requirements for Loxahatchee, and Shark River Slough. This is a result of construction of additional STAs in the EAA and S9 Basin as well as further progress on implementation of nutrient BMPs in developed areas adjacent to the Everglades. Mercury load available for methylation is likely to increase as a result of increased offshore Hg atmospheric load. This will be moderated somewhat by the implementation of FDEP Total Hg TMDL and new EPA Clean Air Act standards for emissions of Hg.
	Alt 1 & 4	WCA 3A: Backfilling of northern portion of Miami Canal and re-direction of water into the northern marsh areas will result in greater uptake of nutrients and sulfate in northern WCA 3A. Increased flows and new flow patterns may result in increased water column phosphorus concentrations at one or more TP rule stations; however, this should have minimal impact on TP rule compliance. Reduced incidence of dry out of the northern marsh should limit peat oxidation and nutrient re-mobilization. Lower phosphorus and sulfate concentrations should occur in southern WCA 3A. Redistribution of flows into the northern marsh and away from the Miami Canal will result in a change in locations of methylmercury "hotspots" identified as areas where methylmercury concentrations are high in fish. WCA 3B: Reduction in dry out events relative to FWO will result in reduced peat oxidation

Geographic Regions	Alts	Water Quality
		/ re-mobilization of nutrients. Additional flows into WCA 3B through the S-631 structure may result in increased water column phosphorus concentrations at one or more TP rule stations; however, this should have minimal impact on TP rule compliance. ENP: It is uncertain how changes in flow distributions proposed under CEPP will impact compliance with Appendix A of the 1991 Settlement Agreement. Over the long-term, distributing the flow over the northern WCA-3A marsh, reducing short-circuiting down the canals to ENP, adding more flow from the lake that is treated to the WQBEL, and distributing these flows over the marsh should result in improvements by lowering the flow weighted mean total phosphorous concentration entering the Park. In the short-term, to address the uncertainty in compliance with Appendix A, the Technical Oversight Committee (TOC) is currently reviewing applicability of the current Appendix A compliance methodology for a restored ecosystem. Relative to FWO, no changes to Settlement Agreement compliance for Loxahatchee and Taylor Slough are expected.
Southern Estuaries	FWO	Base salinity conditions in Florida Bay are poor - current or FWO conditions are far from the restoration target. Relative to baseline condition, slight reduction in salinities in nearshore zones. Nutrient loading from upland areas not expected to change significantly relative to baseline conditions.
	All Alts	Improved salinity conditions relative to FWO condition. With-project mean salinity moves closer to the target with a 2 psu decrease in the bay's central zone and an average salinity decrease of 1.5 psu among all bay zones for wet and dry seasons. While this appears to be a small change, this grand mean of salinity improvement (over a simulated 36 year period) is still a major step toward the restoration target.

5.1.10 Air Quality

Comparison of the FWO and alternatives is summarized in **Table 5.1-4.** A detailed analysis of project impacts on air quality compliance and to emissions of CO_2 is provided in **Appendix C.2.1.**

Table 5.1-4. Effects of Alts 1 through 4 on Air Quality

Air Quality					
Geographic Regions	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Lake Okeechobee --- Northern Estuaries	Relative to existing conditions baseline, population growth in area expected to increase air pollution; however, air quality compliance is expected.	Negligible and less than significant effect relative to FWO condition.			
EAA	No change in compliance with Air Quality Standards is expected relative to baseline condition.	Negligible and less than significant effect in air quality compliance. Reduction in farming equipment use on A-2 FEB lands in FWO condition will be offset by increase in air pollutants from pump stations. Particulate loading should be reduced since sugar cane cultivation no longer done on FEB lands and thus annual burning during harvesting will no longer be done. Conversion of A-2 FEB lands from agriculture will result in decrease in CO_2 emissions due to annual burning and an increase in CO_2 capture through peat soil accretion.			

Air Quality					
Geographic Regions	FWO	Alt 1	Alt 2	Alt 3	Alt 4
Greater Everglades	Increased LEC development will result in air quality degradation relative to baseline conditions. Enforcement of CAA should limit impacts.	Minor beneficial effect with decrease in drying event severity relative to FWO condition should result in reduced fire incidence within wetlands which should improve air quality. Rehydration of wetlands expected to result in increased CO_2 sequestration through peat accretion.			
Southern Estuaries	No change				

5.1.11 Hazardous, Toxic and Radioactive Waste

A summary comparison of Hazardous, Toxic, and Radioactive Waste (HTRW) is in **Table 5.1-5**. The expanded HTRW assessment is found in **Appendix C.1**. HTRW reports and correspondence are found in **Annex H**. The residual agricultural chemical policy assessment is found in **Appendix C.2.2**.

Table 5.1-5. Effects of Alts 1 through 4 on HTRW

HTRW					
Geographic Regions	FWO	Alt 1	Alt 2	Alt 3	Alt 4
Lake Okeechobee	Increased development within basin may result in increase in new HTRW sites while existing ones should continue to be remediated.				
Northern Estuaries	Increased development within Caloosahatchee and St. Lucie basins may result in new HTRW sites while existing ones should continue to be remediated.				
EAA	A-2 FEB lands continue to be farmed which may result in new HTRW releases on these lands as well as additional pesticide application to cultivated areas.	A-2 FEB lands converted to wetlands so potential for new HTRW or pesticide application to soils is reduced relative to FWO condition.			
Greater Everglades	FDEP identified HTRW sites are remediated and new sites are documented and eventually remediated. Potential for illegal waste disposal remains high.				
Southern Estuaries	FDEP identified HTRW sites are remediated and new sites are documented and eventually remediated.				

5.1.12 Noise

All action alternatives would result in minor and short-term increases in noise during construction as compared with the FWO and a less than significant effect. All action alternatives include additional pump stations which would result in long-term, localized increases in noise. Alt 3 would have the greatest effect with the addition of 5 pump stations.

5.1.13 Aesthetics

In the Northern Estuaries, the action alternatives would increase the aesthetic value due to decreased high flow events and provide a long-term, minor beneficial effect. Reductions in high volume discharges to the estuaries would result in lower suspended solids, increased water clarity and improvements to the salinity envelopes that maintain healthy SAV beds. These benefits could also lead to an increase in wildlife viewing opportunities. With the EAA, wetland vegetation is anticipated to colonize the A-2 FEB, increasing wildlife utilization and opportunities for wildlife viewing within the area, providing a long-term, major beneficial and significant effect. In the Greater Everglades, Alts 3 and 4 had a greater effect on aesthetics as compared with Alts 1, 2, and FWO due to the addition of two pump stations along the L-29 levee in Alt 3 and the construction of a new levee (Blue Shanty Levee) in Alt 4. The action alterna-

tives would result in temporary, short-term, minor effects to aesthetics during construction of all features. The action alternatives show a long-term, major beneficial and significant effect with an increase in aesthetic value over the FWO due to restoration of hydropatterns and sheetflow throughout the project area. The restoration of sheetflow provides additional habitat for native plants and animals and increased opportunities for wildlife viewing. Restoration of flows within Florida Bay and the southwestern coastal estuaries would reduce extreme salinity ranges and improve habitat within these regions, increasing potential opportunities for wildlife viewing providing a long-term, minor beneficial effect.

5.1.14 Land Use

All of the land in consideration for CEPP is in public ownership. Land being converted from agricultural production to wetlands within the A-2 FEB accounts for the only significant long-term, land use change.

5.1.14.1 Wetlands

Effects on wetlands and uplands are summarized for the final array of alternatives in **Table 5.1-6**. The action alternatives show a long-term, major beneficial and significant effect with an increase in wetland/upland habitat and wetland function over FWO with minor differences between alternatives. The differences stem from different project features (lengths of backfilling, gaps, number of structures, etc) as detailed below. While there is a long-term, minor adverse effect due to the construction of some features, most notably the Blue Shanty Levee in WCA 3B, the construction of other features, the degradation of levees, and the backfilling of canals) reconnects and adds wetland acreage and provides the needed topography for sheetflow to restore the natural system. Also, shifting approximately 14,000 acres of former agricultural land (currently classified as agriculture land cover and wetland soils) to a higher quality wetland within the A-2 FEB increases the quality of the existing wetland habitat as well as the functionality. The WCA 3B flowway achieves a central goal of Comprehensive Everglades Restoration Plan (CERP) and of CEPP: restoration of continuous sheet-flow, over long distances, and in the original flow directionality. If the new levee is not constructed and water stages are not raised substantially within WCA 3B, then significant southward movement of water into NESRS from WCA 3B cannot be achieved by gravity flow alone due to higher wet season stages in the L-29 Canal associated with the implementation of the TTNS Project implementation; it must instead be driven by pumps. These pumps in turn would require additional dredging of former remnant agricultural ditches within southern WCA 3B to create expanded intake canals. The disturbance footprint would potentially be similar to that of the new levee. Focusing instead on Alt 4, we note that creation of the new levee enables the removal of a similar length of existing levee (L-67C). A detailed description of the differences in wetland/upland acres is provided in **Appendix C.2.1**. In addition to the long-term benefit of increased wetland/upland acres, the wetland function increases as well due to backfilling the Miami Canal and the restoration of sheetflow across WCA 3A and 3B into ENP. The initial construction may have a temporary, short-term adverse affect on the wetland function in the construction areas, but once the project is complete, all alternatives would increase wetland function based on the acres of wetlands gained.

Table 5.1-6. Effects of Alts 1 through 4 on Wetlands (acres)

Project Feature	FWO Acres of Wetland Gain (Loss)	Alt 1 Acres of Wetland Gain (Loss)	Alt 2 Acres of Wetland Gain (Loss)	Alt 3 Acres of Wetland Gain (Loss)	Alt 4 Acres of Wetland Gain (Loss)
L-4 Degrade	0	35	35	35	35
Miami Canal Backfill	0	417	469	469	469
Miami Canal Spoil Mounds	0	45	49	49	49
L-67A Culverts	0	(4.5)	(13.5)	(18)	(13.5)
L-67C Gaps	0	9	27	36	9
L-67C Flow Way Degrade	0	0	0	0	49
L-29 Degrade	0	0	0	0	32
Blue Shanty Levee	0	0	0	0	(84)
L-67 Extension Backfill	0	29	104	104	104
Old Tamiami Trail Road Degrade	0	0	0	0	0
Total Net Change	0	**531**	**671**	**675**	**650**

5.1.14.2 Agriculture

Modest expansion in overall agricultural acreage, along with a very slight rise in water use, is expected in the study area within FWO as compared to the existing condition. Agricultural acreage declines slightly in Miami-Dade County, primarily due to urbanization. Broward County and Palm Beach County's Coastal sub-basin expect a slight increase. Irrigated acreage in the EAA remains stable since it is fully developed and permitted. The number of acres cultivated in any given year is driven by market forces and cultivation practices such as rotating crops (SFWMD Draft LEC Water Supply Plan, 2013).

The entire CEPP project area consists of lands currently under public ownership; however, the A-2 footprint is currently under lease for sugarcane production. For all action alternatives the A-2 FEB footprint of agriculture land will be converted into an FEB. The A-2 footprint will continue to be farmed in the FWO.

As described in **Section 5.1.8**, short-term, negligible and less than significant changes were noted for water stages within the South Dade Conveyance System; therefore no effects on agriculture within this region are anticipated. Coordination with the United States Department of Agriculture (USDA) and National Resources Conservation Service (NRCS) to meet the requirements of the Farmland Protection Policy Act, is ongoing. When detailed design information that locates each of the plan components is completed, it can then be determined how many acres of unique farmland would be affected by the Project. See **Appendix C.4.12** for more information.

5.1.15 Socioeconomics

5.1.15.1 Population

The CEPP study area population is expected to increase by 18 percent from 2010 to 2030 with Palm Beach and Miami-Dade counties attracting the greatest number of new residents. Monroe County is expected to experience a small reduction in permanent residents over the next 20 years. When aggregated, the total population is projected to increase by 1 million people. This is a slower rate of

growth than projected previously in CERP planning efforts. Population projections are not anticipated to differ between the FWO and alternative conditions.

Congress enacted the 1996 Federal Agriculture Improvement and Reform Act (Farm Bill) and provided funds on April 4, 1996 (Public Law 104-127, 110 Statue 1022). Under Section 390 of the Farm Bill, the Secretary of the Interior was authorized to use funds made available to conduct restoration activities in the Everglades ecosystem in south Florida, including but not limited to the acquisition of real property and interests in real property located within the Everglades ecosystem. The Farm Bill provided that the Secretary of the Interior could transfer funds to the USACE, the State of Florida, or the SFWMD to conduct the aforementioned restoration activities. The A-2 site was purchased with Farm Bill monies. The loss of agricultural production in the A-2 FEB and potential effects on socioeconomic conditions and low income/minority populations were addressed during the land acquisition. CEPP does not present any environmental impacts that are high, adverse and disproportionate to low income, or minority populations.

There will be no impacts to Lake Okeechobee commercial navigation with this project. The hydrologic modeling conducted for all CEPP alternatives to optimize system-wide performance incorporated the current Regulation Schedule management bands of the 2008 LORS. The hydrologic modeling of the CEPP alternatives included proposed revisions to the 2008 LORS flow chart guidance of maximum allowable discharges, which are dependent on the following criteria:

- Class limits for Lake Okeechobee inflow and climate forecasts, including tributary hydrologic conditions, seasonal climate outlook, and multi-seasonal climate outlook
- Stage level, as delineated by the Regulation Schedule management bands
- Stage trends (whether water levels are receding or ascending)

Most of the 2008 LORS refinements applied in the CEPP modeling lie within the bounds of the operational limits and flexibility available in the current 2008 LORS, with the exception of the adjustments made to the class limits for the Lake Okeechobee inflow and climate forecasts. Under some hydrologic conditions, the class limit adjustments made to the Lake Okeechobee inflow and climate forecasts reduced the magnitude of allowable discharges from the Lake, thereby resulting in storage of additional water in the Lake in order to optimize system-wide performance and ensure compliance with Savings Clause requirements. However, these class limit changes represent a change in the flow chart guidance that extends beyond the inherent flexibility in the current 2008 LORS. Additional information and documentation of the CEPP recommended plan modeling assumptions for Lake Okeechobee operations are found in the **Appendix A**. The authorized C&SF project depths for Lake Okeechobee navigation are based on 12.56 ft NGVD.

5.1.15.2 Socioeconomics: Water Supply and Flood Control

A summary of the anticipated long-term effects on water supply and flood control of the alternative actions is presented in **Table 5.1-7**. Alts 1 through 4 are compared to the FWO; similarly, the water supply and flood control effects of the FWO are described based on comparison to the ECB. The summary of regional performance differences (**Table 5.1-7**) includes quantitative comparisons between the ECB and FWO and between the FWO and Alts 1 through 4 based on the RSM-BN and RSM-GL CEPP modeling representations of these baselines and alternatives. The period of simulation (1965-2005) used for the CEPP hydrologic modeling encompasses a wide range of historical climatologic and meteorologic conditions that are representative of south Florida hydrology. This analysis period includes

several moderate wet and moderate dry periods, as well as less frequent and potentially more impactful periods of both extreme high rainfall and extreme drought conditions.

Table 5.1-7. Effects of Alts 1 through 4 on Water Supply and Flood Control

Geographic Region	Alts	Water Supply and Flood Control
Lake Okeechobee	FWO	Moderate adverse effect. Compared to the ECB, mean annual Everglades Agricultural Area (EAA) water supply demands not met are increased from 7% to 8%. Lake Okeechobee Service Area (LOSA) water supply cutback percentage is increased for 3 of the 8 years with the largest water supply cutbacks.
	All Alts	Minor improvement. Compared to the FWO, mean annual EAA water supply demands not met are decreased from 8% to 7%. LOSA water supply cutback percentage is increased for 1 of the 8 years with the largest water supply cutbacks.
Greater Everglades	FWO	Major flood control improvement. Compared to the ECB, the frequency of WCA 3A stages within Zone A of the Regulation Schedule is significantly reduced from 32% to 18% of the 1965-2005 period of simulation.
	All Alts	Moderate flood control improvement. Compared to the FWO, the frequency of WCA 3A stages within Zone A of the Regulation Schedule is moderately increased from 18% to 20-22% of the 1965-2005 period of simulation. Stages within the wettest 10% of hydrologic conditions, however, are generally reduced by 0.2-0.3 feet.
Lower East Coast Service Area 1 (Palm Beach)	FWO	Moderate adverse effect. 3 additional water years with 3 or more consecutive months with restrictions, which result from lower Lake Okeechobee stages and not local groundwater conditions. Local groundwater stages east of WCA 1 reduced by 0.2-0.5 feet for the driest 10% of hydrologic conditions. Local groundwater stages south of the Site 1 CERP project reduced by 0.2 feet for normal to dry conditions and by up to 1.0 feet during extreme dry conditions.
	All Alts	Minor improvement. 1 fewer water years with 3 or more consecutive months with restrictions. No significant changes to local groundwater stages.
Lower East Coast Service Area 2 (Broward)	FWO	Minor adverse effect. 1 additional water year with 3 or more consecutive months with restrictions which results from lower Lake Okeechobee stages and not local groundwater conditions. Local groundwater stages slightly reduced for the driest 10% of hydrologic conditions.
	All Alts	Minor adverse effect. No change in the number of water years with 3 or more consecutive months with restrictions. No significant changes to local groundwater stages which are prevalent through normal to dry hydrologic conditions. Reduced stages are indicated during the driest 5-10% of hydrologic conditions for some monitoring gages located east of WCA-2A and WCA-2B.
Lower East Coast Service Area 3 (Miami-Dade)	FWO	Moderate to major adverse effects. a) 3 additional water years with 3 or more consecutive months with restrictions, which result from lower Lake Okeechobee stages and not local groundwater conditions. b) L-30 canal stages are reduced by 0.2-0.4 feet for normal to extreme dry conditions. c) L-31N canal stages are slightly reduced by 0.1-0.2 feet for extreme dry conditions. Slight increase to flood control stages within the wettest 10% of hydrologic conditions. d) C-111 canal stages between S-176 and S-18C are generally lowered by 0.2-0.5 feet for normal to extreme dry conditions.

Geographic Region	Alts	Water Supply and Flood Control
	Alt 1	Moderate improvement, with no anticipated adverse effect. a) Decrease of 2 water years with 3 or more consecutive months with restrictions. b) L-30 canal stages are generally increased by 0.2-0.4 feet for normal to extreme dry conditions (similar to existing condition baseline). General moderate reduction of 0.2 feet to flood control stages within the wettest 10% of hydrologic conditions. c) L-31N canal stages are increased by 0.3-0.5 feet for dry conditions. Significant reduction to flood control stages within the wettest 5% of hydrologic conditions d) No significant change to C-111 canal stages between S-176 and S-177 and increase by 0.2 feet between S-177 and S-18C during normal hydrologic conditions.
	Alt 2	Moderate to significant change, with general improvements for water supply and flood control; potential increased flood control risk along L-30 (to the adjacent Pennsuco wetlands, adjacent Miccosukee Tribe reservation, and Miami-Dade urban areas located several miles east of the Pennsuco) during normal to wet conditions and potential increased water supply risk along L-31N during normal to dry conditions. a) Decrease of 2 water years with 3 or more consecutive months with restrictions. b) L-30 canal stages are generally increased by 0.3-1.0 feet for normal to extreme dry conditions. General moderate reduction of 0.3 feet in flood control stages within the wettest 10% of hydrologic conditions. c) L-31N canal stages are lowered by 0.2-0.3 feet for normal to dry conditions. Significant reduction in flood control stages within the wettest 5% of hydrologic conditions. d) Same as Alt 1 for C-111 canal stages.
	Alt 3	Moderate change, with general improvements for water supply and flood control; potential increased water supply risk along L-31N during normal to dry conditions. a) Decrease of 2 water years with 3 or more consecutive months with restrictions. b) L-30 canal stages are generally increased by 0.3-0.7 feet for normal to extreme dry conditions. General moderate reduction of 0.2 feet in flood control stages within the wettest 10% of hydrologic conditions. c) L-31N canal stages are lowered by 0.2-0.3 feet for wet, normal, and dry conditions. Significant reduction to flood control stages within the wettest 5% of hydrologic conditions. d) Same as Alt 1 for C-111 canal stages.
	Alt 4	Moderate change, with general improvements for water supply and flood control; potential increased water supply risk along L-31N during normal to dry conditions. e) Decrease of 2 water years with 3 or more consecutive months with restrictions. a) L-30 canal stages are generally increased by 0.1-0.2 feet for normal to extreme dry conditions. General moderate reduction of 0.2 feet in flood control stages within the wettest 10% of hydrologic conditions. b) L-31N canal stages are lowered by 0.2-0.3 feet for wet, normal, dry, and extreme dry conditions. Significant reduction in flood control stages within the wettest 5% of hydrologic conditions. c) Same as Alt 1 for C-111 canal stages.

5.1.15.3 Recreation

Alternative effects on recreation are presented in **Table 5.1-8** with additional details provided in **Appendix C.2.1.15**. **Table 5.1-9**, **Table 5.1-10**, and provide information on when the Florida Fish and Wildlife Commission (FWC) considers closures in the Everglades and Francis S. Taylor Wildlife Management Areas (EWMA) due to high or low water stages. Comprising WCAs 2A, 2B, 3A, and 3B, the EWMA totals 671,831 acres, or 82% of the WCAs in south Florida and roughly 30% of the remaining Everglades landscape south of the EAA. A closure event for these tables is one or more consecutive days when high or low water criteria are met based on the two gauge average for WCA 3A-2 and WCA 3A-3.

Table 5.1-8. Effects of Alts 1 through 4 on Recreation

Recreation		
Geographic Regions	**FWO**	**With Project Conditions**
Lake Okeechobee	No effect	Negligible and less than significant effects for Alts 1-4. There will be no impacts to recreational navigation with this project.
Northern Estuaries	No effect	Reductions in high flows to the estuaries resulting from Alts 1-4 would provide minor and less than significant beneficial effects by enhancing utilization of estuaries by fish and subsequently improve related recreational opportunities such as fishing, boating and kayaking.
EAA	Currently no recreation exists on A-2 parcel.	The FEB feature included in Alt 1-4 will add 14,000 acres of recreational opportunities and facilities, providing a minor and less than significant beneficial effect.
Greater Everglades	Minimal effect on recreational fishing. No effect on hiking, biking and camping. Degraded wetlands and aesthetic values could impact wildlife viewing and nature study. Peat loss to oxidation and fire would degrade current habitat further and impact hunting opportunities.	Alts 1-4's improved hydrology will enhance wildlife populations through improved survival and reproduction, subsequently resulting in a minor and less than significant beneficial effect for outdoor recreation opportunities. Proposed facilities will enhance the public's ability to access into and within the Greater Everglades. Increased hydration in the very northern WCA 3A areas that have been drier may have a short-term significant, adverse and unavoidable effect on hunting (deer, hog, and rabbit). Conversely, a long term major significant benefit occurs due to increased fire protection for the peat soils, thus diminishing the potential for loss of this same area. Of the three alternatives, Alt 1 has the least negative effect on northern WCA 3A mammal hunting opportunities. For Alts 1, 2 and 3 in the northern dry areas public access is often limited to track vehicles; rehydration will increase public access through improved conditions favorable to airboats. Access for recreational fishing by power boats will have a major adverse and significant effect through backfilling of the Miami Canal between S-8 and I-75. This affects 14 of the 33 miles of the Miami Canal in the WCA 3. Fishing opportunities throughout the Greater Everglades will have a major beneficial effect by the improvements in boat access and the addition of access points around the proposed structures. Improved trailheads for access and designation of blue and greenway trails will be positive. Alt 4's Blue Shanty Levee will bisect L67C. Recreational fishing by prop boat to the northern end of L67C canal would continue to be available from a new public boat ramp located in the northern end of L67C at the S151, providing a minor beneficial effect. Also at the S151 a new public boat ramp will allow access into the northern 5 miles of the Miami Canal south of S151 not previously served by a public boat ramp. The Blue Shanty Levee will have an airboat crossing at full height so as to not bisect the airboat use within WCA3B. The removal of a segment of the L-29 levee will create a marsh connection between WCA 3B and the L-29 Canal and enhance fishing. A boat ramp will be added near S333 to provide access to the L-29 Canal so the L-29 divide structure (S-355W) does not prevent boat access. The L-29 divide structure will also serve as a pedestrian and vehicle access to the remaining eastern L-29 Levee. The Blue Shanty Levee will serve as a reroute connection for greenways

Recreation		
Geographic Regions	**FWO**	**With Project Conditions**
		trail users when the L-29 levee segment is removed, to ensure contiguous connection east to west between S333 and S334.
Southern Estuaries	No effect	Access to the Southern Estuaries would not change based on CEPP, however, increase in flows to Florida Bay would enhance fish populations and subsequently significantly improve related recreational opportunities such as fishing, boating and kayaking, providing a minor beneficial effect.

Table 5.1-9. Closures over the Period of Record (POR) in the EWMA for the ECB, FWO and Alts 1 through 4

Alt	High Stage Closures over POR (2 Gauge avg. > 11.6' ft)			Fire Closures over POR (2 gauge avg. <= 9.30' ft)			Total High Water and Low Water Closures			
	Closure Days	Closure Events	Avg. Closure Duration (Days)	Closure Days	Closure Events	Avg. Closure Duration (Days)	Closure Days	Closure Events	Avg. Closure Duration (Days)	% of POR-Closure
ECB	511	15	34.1	599	19	31.5	1,110	34	32.6	7.4%
FWO	441	12	36.8	677	21	32.2	1,118	33	33.9	7.5%
Alt 1	635	19	33.4	230	7	32.9	865	26	33.3	5.8%
Alt 2	610	18	33.9	247	5	49.4	857	23	37.3	5.7%
Alt 3	589	18	32.7	247	5	49.4	836	23	36.3	5.6%
Alt 4	613	16	38.3	246	5	49.2	859	21	40.9	5.7%

Notes:

* 2 Gauge avg. is based on cells WCA 3A-2 and WCA 3A-3.
*3A-2 & 3A-3 average ground surface elevation = 9.66 ft NGVD (closure thresholds are indicated in Table 5.1-9)

Table 5.1-10. High Water Event Changes from the FWO for Alts 1 through 4 in the EWMA for each Month of the Year

Month	ECB	FWO	Alt 1	Alt 2	Alt 3	Alt 4	Month
1	0	0	0	0	0	0	1
2	1	0	2	2	1	2	2
3	0	0	1	0	0	0	3
4	0	0	0	0	0	0	4
5	0	0	0	0	0	0	5
6	0	0	3	3	3	3	6
7	2	0	3	2	2	1	7
8	0	0	1	1	1	1	8
9	0	0	-1	-1	-1	-1	9
10	0	0	-2	-1	-2	-2	10
11	0	0	0	0	1	0	11
12	0	0	0	0	1	0	12
Total	3	0	7	6	6	4	Total

Table 5.1-11. High Water Events for the ECB, FWO, and Alts 1 through 4 in the EWMA for each Month of the Year

Month	ECB	FWO	Alt 1	Alt 2	Alt 3	Alt 4	Month
1	0	0	0	0	0	0	1
2	1	0	2	2	1	2	2
3	1	1	2	1	1	1	3
4	0	0	0	0	0	0	4
5	0	0	0	0	0	0	5
6	2	2	5	5	5	5	6
7	3	1	4	3	3	2	7
8	0	0	1	1	1	1	8
9	2	2	1	1	1	1	9
10	5	5	3	4	3	3	10
11	1	1	1	1	2	1	11
12	0	0	0	0	1	0	12
Total	15	12	19	18	18	16	Total

5.1.16 Cultural Resources

Alternatives 1 through 4 effects to cultural resources are presented in **Table 5.1-12.** Criteria used to evaluate the alternatives are found in **Section 5.1**. A description of full preliminary analysis, background information and descriptions of terms are presented in **Appendix C.2 (Section C.2.1.17)**.

In conjunction with the National Historic Preservation Act (NHPA), formal consultation was initiated with the Seminole Tribe of Florida's Tribal Historic Preservation Office (THPO); the Miccosukee Tribe of Indians of Florida's NAGPRA Representative; the Florida State Historic Preservation Office (SHPO); Everglades National Park's, Chief of Cultural Resources; and the Florida Bureau of Archaeological Research (**Appendix C.5**). During formal consultation, a number of conclusions were drawn: (1). It was determined that additional surveys were needed to identify cultural resources within specific areas of potential effect, (2). It was decided that as the CEPP project progressed, additional surveys may be needed, specifically during the PED phase, when feature designs were finalized and construction staging areas were determined, and (3). Section 106 compliance with the NHPA would be conducted separately from NEPA and would not be completed during the current feasibility phase of the project, however would be complete prior to construction of each feature.

Under the NEPA process (Section 40CFR1501.2(d) (2)), formal consultation regarding cultural resources has been completed and is final for the CEPP feasibility study. For consideration under the NHPA, determinations of potential effects and mitigation of those effects on cultural resources listed in **Table 5.1-12** are preliminary and should not be considered final. As required under the NHPA, further Section 106 (36 CFR Part 800) consultation is required and will be completed during the PED phase. The CEPP is currently in compliance with the procedural requirements of the NHPA and will remain in compliance with the NHPA pre and post construction.

Avoidance of adverse effects to cultural resources is the Corps preference, therefore, throughout the planning process for CEPP, the project archaeologist, engineers, and plan formulators have worked closely to determine alternatives and features of alternatives that reduce or eliminate impacts to cultural resources. Pursuant to 36 CFR 800.1, where possible, the project design will be modified to avoid impacting significant historic properties and culturally significant sites. Where avoidance is not possible, other mitigation measures will be considered, which could include but are not limited to data

recovery excavations. The mitigation measures will be developed in consultation with SHPO, tribal groups and other interested parties as established in implementing regulations for Section 106 of the NHPA.

The use of the term cultural resources includes historic properties that are eligible or potentially eligible for NRHP listing, and culturally significant sites. For definitions of terms see **Section 10**.

Table 5.1-12. Effects of Alts 1 through 4 on Cultural Resources

Cultural Resources (Please refer to Cultural Resources in Appendix C.2.1 for further details)					
Geographic Regions	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Lake Okeechobee	No effect on cultural resources.				
Northern Estuaries	No effect on cultural resource.				
EAA, including Associated Canals and Structures	Long-term adverse effect on cultural resources 8PB16039 and 8PB16040.	Major long-term adverse effects on cultural resources sites 8PB16039 and 8PM16040. Mitigation of effects for historic property 8PB16039 potentially reduced to no effect. Mitigation of effects for culturally significant site 8PB16040 is unknown.			
L-4 Spreader Feature	No effect on cultural resources.	The L-4 (8BD5098) is not significant, therefore no effect on cultural resources.			
S-8 Pump Station Complex	No effect on cultural resources.	Unknown effects on historic property 8BD5092. More work needed to determine NRHP eligibility. If applicable, mitigation could potentially reduce effects.			
L-5 Deepening/Widening and Spreader Feature	No effect on cultural resources.		The L-5 (8BD5099) is not significant, therefore no effect. Potential major long term effects on cultural resources 8BD4836-4838. Mitigation could potentially reduce effects In addition to being historically significant, all three sites contain material deemed culturally sensitive to both tribes		
L-6 Deepening/Widening	No effect on cultural resources.	Unknown – assessment needed for the L-6 levee and associated canal. If applicable, mitigation could potentially reduce effects.			
Miami Canal	No effect on cultural resources.	Major long-term adverse effect on historic properties 8PB4840/8BD5097. Mitigation could potentially reduce effects.			
L-67A Levee and Canal	No effect on cultural resources.	Potentially major to moderate long-term adverse effect to sites with cultural significance to members of the Miccosukee Tribe of Indians of Florida. If unable to avoid, mitigation unknown. The L-67A (8BD5100) is not significant. No effect on historic properties.			
L-67C Levee and Canal	No effect on cultural resources.				

Cultural Resources (Please refer to Cultural Resources in Appendix C.2.1 for further details)					
Geographic Regions	**FW0**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
L-29 Levee	No effect on cultural resources.		Major long-term adverse effect on sites culturally significant to the Miccosukee Tribe of Indians of Florida and that are potential historic properties. Potential mitigation could reduce effect.		
New Levee (L-67D) within WCA3B and Flow Way (Blue Shanty Flow Way)	No effect on cultural resources.				Potentially major adverse effect on cultural resources / Unknown - survey needed. Mitigation could reduce effect.
S-333 Pump Station	No effect on cultural resources.				
Old Tamiami Trail	No effect on cultural resources.				
L-67 Ext. Levee and Canal	No effect on cultural resources.				
L-31N Levee	No effect on cultural resources.	Potentially major long-term adverse effect on site 8DA2104. Potentially mitigation could reduce effect.			
S-356 Pump Station	No effect on cultural resources.				
L-28 Levee and Canal	No effect on cultural resources.	Unknown - survey needed.	No effect on cultural resources		
G-211 Operational Refinements	No effect on cultural resources.				
S-334 to S335 Seepage Barrier	No effect on cultural resources.				
Draft Preliminary Operations Plan	Unknown overall effects to cultural resources. Approximately 350 cultural resources sites including five districts, two traditional cultural properties, multiple culturally significant properties and one World Heritage site (ENP) within APE for CEPP. ERTP investigations are projected to be completed ca. 2016.[1] Mitigation unknown.				

[1] ERTP cultural resources investigations specified through the Corps' executed Programmatic Agreement dated August 2012, to identify effect (if any) to subsurface cultural resources material caused by fluctuating water will be completed ca. 2016. This information, including other updated research available at the time, will be utilized in advance of CEPP to determine additional mitigation needs (if any) for effects of fluctuating water on subsurface cultural resources materials above and beyond those already mitigated for ERTP or as required by other actions.

5.1.17 Invasive Species

All action alternatives have the potential and likelihood for establishment and spread of non-native invasive and native nuisance species. A summary of comparisons is in **Table 5.1-13**. A more detailed description of the effects of each feature is provided in **Appendix C.2.1.18**. Proposed restoration activities may have a minor to major effect on the ecosystem drivers that directly or indirectly influence the spread of non-native species. These factors may affect invasive species positively or negatively,

depending on the unique characteristics of individual species and the environmental conditions for a given biological invasion (Doren et al. 2009). Disturbed areas resulting from construction are likely to become established with non-native invasive and native nuisance species. New flows created by operations of the proposed features may serve as vectors to spread invasive and native nuisance species into new areas. The large number of existing and potential invasive plant and animal species and the often incomplete knowledge of invasive mechanisms for each species create moderate to high uncertainty in this evaluation. Long-term monitoring in an adaptive management framework is critical to ensure efficient management of the most threatening non-native invasive species in the restoration footprint. Proposed management activities to address invasive species are provided in **Annex G**.

Table 5.1-13. Effects of Alts 1 through 4 on Invasive Species

Invasive Species					
Feature	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Lake Okeechobee and Northern Estuaries	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species; Invasion pathway to/from lake and estuaries.				
A-2 Flow Equalization Basin	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species Vegetation management challenges in downstream STA's from continued stormwater pulses.	Moderate to major increase in Invasive and nuisance plant and fish species FEB; Management options limited to mitigating impacts to FEB operations; Potential invasion pathway to WCAs			
Diversion of L-6 Flows and L-5 Improvements	Negligible effect on invasive and nuisance vegetation and non-native fish species, continue to persist at baseline levels.	Negligible to moderate reduction of SAV; Minor to moderate habitat improvement for non-native tropical fish species.			
L-4/L-5 Spreader Canal and Levee Degradation	Moderate to major recruitment of existing invasive species in WCA 3A. O&M of canal/levee minimize colonization of certain invasive species.	Minor reduction in recruitment of some invasive and nuisance species; Moderate to major expansion of obligate wetland invasive species in spreader canal and south of spreader canal; Spreader canal is a potential invasion pathway for aquatic species; Portions of remaining levee are habitat for Burmese pythons.			
L-28 Degradation and Backfill	Negligible effects to actively managed invasive and nuisance species, continue to persist in adjacent natural areas at baseline levels or decrease; Moderate expansion of uncontrolled species; O&M of canal levee will minimize colonization of certain invasive species.	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Moderate to major expansion of uncontrolled species; Lack of O&M on remaining levee will promote colonization of certain invasive species.			

Invasive Species					
Feature	**FWO**	**Alt 1**	**Alt 2**	**Alt 3**	**Alt 4**
Increase Capacity of S-333	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Invasion pathway for aquatic invasive species downstream.				
L-67A Gated Structures / Spoil Removal and L-67C Degradation	Negligible effects to actively managed invasive and nuisance species, continue to persist or decrease; Moderate expansion of uncontrolled species; Invasion pathway for aquatic invasive species downstream.	New invasion pathway for aquatic plant and animal species between WCA 3A and 3B; Moderate to major expansion of cattail downstream of structures; plant and animal habitat reduced by spoil removal. Isolated remnants of L-67C will create invasive plant and animal habitat.			
Outflow Structures out of WCA 3B	Invasive and nuisance species persist, negligible effects; barriers for water surface connectivity are present.	New invasion pathway for aquatic plant and animal species between WCA 3B and ENP. Potential for minor to moderate expansion of species.			
L-67 Extension Levee Degrade/Backfill	Invasive and nuisance species persist on levee and in canal, negligible effects; continued cattail expansion west of L-67 Extension.	Minor to moderate reduction in habitat for some invasive plants, fish and reptiles by levee removal and canal backfill; Improved habitat for obligate wetland invasive species, minor to moderate expansion of species.			
G-211 Operational Modifications / Coastal Canals Conveyance	Negligible effects on actively managed invasive and nuisance species, continue to persist or decrease; Minor expansion of uncontrolled species; Invasion pathway for aquatic invasive species downstream.				
Increase S-356 Capacity to 1,000 cfs	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Negligible reduction in invasive plant recruitment, minor to moderate improved conditions for obligate wetland invasive species, and potential expansion of cattail in northern ENP.			
Miami Backfill S-8 to I-75	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Alt 1: 1.5 miles of invasive plant and animal habitat persists; spoil mound removal/canal backfill reduces habitat for some invasive species, minor to moderate effects; Tree islands vulnerable to invasive plant and animal colonization, minor to moderate effects; Moderate to major expansion of obligate wetland invasive species in backfill area. Alts 2-4: mound removal/canal backfill- minor reduction of habitat for some invasive species; Tree islands vulnerable to invasive plant and animal colonization; Minor to moderate expansion of obligate wetland invasive species in backfill area.			

Invasive Species					
Feature	FWO	Alt 1	Alt 2	Alt 3	Alt 4
Build North South Levee in WCA 3B	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Alts 1-3 same as FWO. Alt 4: Moderate to major potential for increased invasive species due to levee construction; Increased cattail along levee in WCA 3B.			
L-29 degradation	Invasive and nuisance species persist; Invasion pathway for aquatic invasive species into ENP.	Alts 1-3: Same as FWO. Alt 4: New invasion pathway for aquatic plant and animal species between L-29 and WCA 3B, possible minor to major expansion.			
Divide Structure on L-29	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Alts 1-3: Same as FWO. Alt 4: Increased O&M management of aquatic invasive and nuisance plants, minor to moderate effects.			
Penetrating Seepage Barrier	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Alt 1: Same as FWO Alt 2: Minor reduction in invasive plant recruitment; minor improved conditions for obligate wetland invasive species. Alts 3-4: Moderate reduction in invasive plant recruitment; minor to moderately improved conditions for obligate wetland invasive species.			
L-31N - New Pump Stations	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species.	Alts 1-2: New invasion pathway for aquatic plant and animal species from L-31N to ENP; Minor reduction in invasive plant recruitment; Minor improved conditions for obligate wetland invasive species; Potential expansion of cattail in ENP. Alts 3-4: Same as FWO.			

5.2 EFFECTS OF THE RECOMMENDED PLAN

Analysis of Alternatives 1-4 identified Alt 4 as cost effective and the National Ecosystem Restoration (NER) plan to be carried forward for further analysis. This assessment of environmental effects evaluates the anticipated environmental effects of the Alts 4R and 4R2 described in **Section 4.0**. The evaluation of Alts 1 through 4 identified the need to revise the operations of Alt 4 to ensure the project savings clause constraints are met, to minimize localized adverse ecological effects, and to identify additional opportunities to provide for other water related needs. Alt 4 was initially refined with operational changes to avoid potential impacts to water supply levels of service in the LOSA and LEC, resulting in Alt 4R. Alt 4R was then refined further to determine if water supply cutbacks to the LOSA could be further reduced and to determine the quantity of additional LECSA 2 and LECSA 3 public water supply able to be provided while maintaining the natural system performance realized for Alt 4R. Due to these changes in operations, Alts 4R and 4R2 were no longer comparable to Alts 1-4. Because they are not comparable, they were separated and placed in different matrices. Alts 4R and 4R2 were compared to and evaluated against the FWO (No Action Alternative under NEPA) to describe changes to existing conditions with implementation of each Central Everglades Planning Project (CEPP) action alternative. These potential effects are summarized within this section. Details regarding significant or non significant effects are provided within this section and full details are discussed in **Appendix C.2.2**. The same definitions described in Section 5.1 were used to evaluate the context, intensity, duration, and cumulative nature of impacts associated with Alts 4R and 4R2.

The CEPP PIR report documentation and the complete set of RSM-BN and RSM-GL hydrologic model performance measure output comparing the ECB baseline, the FWO baseline, Alt 4R, and Alt 4R2 is posted on the Everglades Plan public web site for the CERP:
http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

Final CEPP hydrologic modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files, and documentation. CEPP modeling products in MMS can be accessed directly at the MMS project page through the Everglades Plan public web site:
http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

5.2.1 Climate

Features of Alts 4R and 4R2 are the same. Implementation of Alts 4R and 4R2 would have short-term, negligible and less than significant effects on climate within the action area. Minor, localized effects to microclimate may occur as a result of redistribution of water and shifts in vegetation. Potential effects may include localized increases in evapotranspiration, increases in localized rainfall, and temperature changes.

5.2.2 Geology and Soils

Features of Alts 4R and 4R2 are the same. On the A-2 FEB footprint, Alt 4R and Alt 4R2 would result in conversion of relatively flat, uniform agricultural lands to an FEB (4 feet maximum operating depth) with exterior levees up to 10 feet above existing grade. Alts 4R and 4R2 show an increase in inundation duration over the FWO that will significantly decrease soil oxidation, subsidence and peat fires in WCA 3A, providing a minor, long-term, beneficial effect. Alts 4R and 4R2 improve hydrologic conditions in northern WCA 3A in comparison to FWO by increasing stages and extending hydroperiods within the area (**Table G-22** and **Table G-24**). Inundation duration for Alt 4R ranged from 76% of the period of record (POR) to 96% of the POR in northern ENP (Zone ENP-N) and from 91% to 93% in southern ENP. Inundation duration for FWO within this same region varied from 78% to 83% of the POR in northern

ENP and from 86% to 91% in southern ENP. Alts 4R and 4R2 produced significantly deeper depths than the FWO as depicted by the normalized weekly stage duration curve for IRs 129 (**Figure G-38**) and IR 130 (**Figure G-39**); example IRs for northern and southern ENP. Alts 4R and 4R2 also consistently reduced the frequency and duration of dry events in NESRS in comparison to the FWO (**Table G-31**).

5.2.3 Vegetation

Long-term, negligible and less than significant effects on vegetation within Lake Okeechobee, the Northern Estuaries, and EAA are anticipated due to implementation of Alts 4R and 4R2. As compared with FWO, Alts 4R and 4R2 show a slight performance improvement within the Northern Estuaries as indicated by fewer high volume flow months. Reduction in high flows and accompanying flow velocities would result in lower suspended solid loading and decreased concentration of colored dissolved organic matter, thereby allowing greater light penetration to promote growth of submerged aquatic vegetation (SAV). Refer to **Appendix C.2.2** for a detailed comparison of potential effects to vegetation.

Due to changes in the quantity, quality, distribution and timing of water entering the Greater Everglades ecosystem, long-term, significant and moderate effects on wetland hydrology and vegetation would potentially occur with implementation of Alts 4R and 4R2. Alts 4R and 4R2 include features to distribute water through spreader canals in the L-4 across northern 3A and backfill portions of the Miami Canal north of Interstate 75, thereby increasing hydroperiods and depths within this area. CEPP implementation of Alts 4R and 4R2 would act to rehydrate WCA 2 and northern WCA 3A promoting peat accretion, reducing the potential for high intensity fires and promoting transition from upland to wetland vegetation. Alts 4R and 4R2 provide moderate improvements in hydroperiods in WCA 2A compared to FWO. However, Alt 4R had a moderate adverse effect in WCA 2B by significantly decreasing stages compared to FWO, while Alt 4R2 had a minor to moderate adverse effect compared to FWO. In the L-28 Triangle, Alts 4R and 4R2 showed an improvement in hydroperiod over FWO. As compared to Alt 4R, Alt 4R2 produced slightly lower depths during average hydrologic conditions in northeastern WCA 3A. Observed depths for Alt 4R2 in northeastern WCA 3A may be more conducive to shorter hydroperiods sawgrass marshes relative to Alt 4R.

Vegetation and patterning in the central portion of WCA 3A resembles pre-drainage conditions most closely and represents some of the best examples of remnant Everglades habitat in south Florida. These areas remain largely unaffected by Alts 4R and 4R2 with a negligible effect. Increases in depth within central WCA 3A were not as significant as increases in observed depths in northern WCA 3A; however maintenance of existing conditions within this region of the project area is desirable as ridge and slough habitat is well conserved.

The routing of flows through the marsh will likely result in the expansion of cattail vegetation in areas experiencing higher nutrient loads, particularly in the northern portion of WCA 3A, providing a minor adverse effect. Conversely, some areas directly adjacent to the Miami Canal will experience lower flows and nutrient loads under Alts 4R and 4R2 in comparison to the FWO condition. In southern WCA 3A, high water levels during the wet season are important in maintaining quality wet prairie and emergent slough habitat (FWS 2010). However, prolonged high water levels (i.e. during both wet and dry season) and extended hydroperiods have resulted in vegetation shifts within southern WCA-3A, negatively impacting tree islands and fragmenting sawgrass ridges, resulting in the loss of historic landscape patterning. Neither Alt 4R, Alt 4R2, or FWO would provide significant benefits to southern WCA 3A through reduction in high water levels or duration, therefore, significant shifts in vegetation are not anticipated within this region, providing a negligible effect.

Alts 4R and 4R2 include conveyance features and levee removal within L-67A and C, thereby providing new point source discharges of water into WCA 3B. However, it is anticipated that Broward County Water Preserve Areas (BCWPA) CERP Project would be constructed prior to CEPP implementation, thereby reducing discharges from S-9 into L-67A. Currently, total phosphorous (TP) within L-67A ranges between 10 and 20 psu, depending upon the time of year. With completion of the BCWPA CERP Project, it is anticipated that TP loading within L-67A will be greatly reduced and therefore minor adverse effects to vegetation due to changes in water quality are anticipated within WCA 3B. Cattail expansion will be monitored as outlined within **Annex D**. Tree islands contain extraordinarily high levels of TP in their soil suggesting that they may play a major role in the biogeochemical cycles of nutrients in the Everglades (Sah 2004; Troxler and Childers 2010; Troxler et al. 2009; Wetzel 2002; Wetzel et al. 2009, 2011). Wetzel et al. (2011) found that soil TP levels within WCA 3A and WCA 3B tree islands were approximately 4 times higher than the surrounding marsh TP levels. Tree islands within WCA 3B may help to capture and focus nutrients, assisting to minimize potential effects on sawgrass and wet prairie communities within this region (Wetzel et al. 2011).

Flows through SRS under current system compartmentalization and water management practices are greatly reduced when compared with pre-drainage conditions. The result has been lower wet season depths and more frequent and severe dry downs in sloughs and reduction in extent of shallow water edges. Over-drainage in the peripheral wetlands along the eastern flank of NESRS has resulted in shifts in community composition, invasion by exotic woody species, and increased susceptibility to fire. Implementation of CEPP is expected to rehydrate much of NESRS by providing a means for redistributing flows from WCA 3A and WCA 3B to ENP, providing minor beneficial effects. Resumption of sheetflow and related patterns of hydroperiod extension will significantly help to restore pre-drainage patterns of water depths and the complex mosaic of Everglades' vegetation communities.

As compared with the FWO, Alts 4R and 4R2 produced significantly higher depths and inundation durations (refer to **Appendix G**, **Figure G-38** and **Figure G-39**). Within northern ENP, performance of Alts 4R and 4R2 was similar with each alternative reducing the number of dry events within SRS and extending average hydroperiods by 35 to 90 days depending upon location. Reduction in the number and duration of dry events and extended hydroperiods will reduce soil oxidation, decrease fire potential, promote peat accretion and aid in restoration of historic wetland vegetation communities, providing minor beneficial effects. Improved inundation patterns produced by Alts 4R and 4R2 in northern ENP resulted in better suitability for slough vegetation. Although none of the alternatives met the desired dry and wet season water depths for slough vegetation in northern ENP, Alts 4R and 4R2 would provide minor benefits as compared with the FWO by increasing water depths in both the wet and dry season within this region. As compared to Alt 4R, Alt 4R2 produced slightly lower depths during average hydrologic conditions in southeastern ENP and slightly decreased overland flow through Taylor Slough.

Alts 4R and 4R2 include increasing capacity at S-333 from 1350 cfs to 2500 cfs. With an increase in S-333 flow, there would be a potential increase in total phosphorus loading entering NESRS. The Everglades, a phosphorus-limited system, historically received most inputs of phosphorus through rainfall, with average TP concentrations of less than 0.01 milligrams per liter (mg/L) (McCormick et al. 1996, Newman et al. 2004). However, more recently, areas within ENP, including NESRS, have been exposed to TP concentrations at or in excess of 0.10 mg/L (SFWMD 2010). These concentrations and any additional inputs resulting from implementation of any of Alt 4R or 4R2 (refer to **Section 5.2.9**, Water Quality for details), have the potential to result in vegetation changes within NESRS. Vegetation that can assimilate nutrients directly from the water column appears to be the most sensitive to nutrient enrichment and include periphyton and floating-leaved plants, such as spatterdock and water lily (Chaing et al. 2000;

Newman et al. 2004). Chaing et al, 2000 demonstrated that the periphyton-*Utricularia* complex may be quite sensitive to increased phosphorus, as illustrated by the disappearance of this complex from enriched study plots after the third year. Potential effects on vegetation and species community composition within NESRS and ENP cannot fully be determined at this time. Water quality within the CEPP action area will continue to be monitored, as described in **Annex D**, to determine any associated changes.

Mangrove communities and seagrass beds associated with Florida Bay may likely show a significant and minor beneficial effect under all Alts 4R and 4R2 from an increase in freshwater input resulting in decreased salinities. Invertebrate populations and seagrass beds associated with southern Biscayne Bay under Alt4R2 may likely show a beneficial effect from an increase in freshwater input resulting in decreased salinities. Alts4R is likely to show a minor adverse effect due to greatly decreased freshwater input to Biscayne Bay.

Construction and hydrological modification under Alts 4R and 4R2 may likely influence the spread and establishment of invasive and native nuisance plant species within the CEPP action area and have a minor adverse effect. Refer to **Section 5.2.23** and **Appendix C.2.2.18** for additional information.

5.2.4 Threatened and Endangered Species

Threatened and endangered species anticipated to be affected by the project are discussed below. Other species are discussed further in **Appendix C.2.2.4** and within the Biological Assessment in **Annex A**. The Corps entered formal consultation with USFWS on the Everglade snail kite (*Rostrhamus sociablis plumbeus*), and its designated critical habitat, Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), (CSSS) and its designated critical habitat, wood stork (*Mycteria americana*) and eastern indigo snake (*Drymarchon corais couperi*). A Programmatic Biological Opinion (BO) was received from USFWS on April 9, 2014, which clearly states that further consultation will be needed when more specific project details are finalized during PED. While this document does not authorize incidental take of three endangered avian species (CSSS, snail kite, and wood stork), it does describe the anticipated effects based on current information. Upon completing ESA Section 7 consultation for each PPA, USACE will undertake the agreed-to avoidance and minimization measures and implementing terms and conditions (TCs). When USACE is closer to constructing phases of CEPP that will affect listed species, FWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable reasonable and prudent measures (RPMs) and TCs.

The preliminary conclusion is that the proposed project is not likely to jeopardize the continued existence of the species listed above and are not likely to adversely modify critical habitat, where designated. The USFWS Progammatic Biological Opinion concurred on the Corps' determination of may affect, but not likely to adversely affect the Florida panther (*Puma concolor coryi*), West Indian manatee (*Trichechus manatus*), and its critical habitat, American crocodile (*Crocodylus acutus*) and its critical habitat, deltoid spurge (*Chamaesyce deltoidea* ssp. *deltoidea*), Garber's spurge (*Chamaesyce garberii*), Small's milkpea (*Galactia smallii*), and tiny polygala (*Polygala smallii*). Furthermore, the USFWS concurred with all the "No Effect" determinations made by the Corps in regard to the applicable threatened or endangered species that are found in the action area. The National Marine Fisheries Service (NMFS) provided a Programmatic Biological Opinion for the Comprehensive Everglades Restoration Plan to the Corps on 17 December 2013 and concurred with the "No Effect" determinations for CEPP for the species under their purview.

5.2.4.1 American Alligator

A keystone species within the Everglades ecosystem, the American alligator (*Alligator mississippiensis*) is dependent on spatial and temporal patterns of water fluctuations that affect courtship and mating, nesting, and habitat use (Brandt and Mazzotti, 2000). Due to rehydration and decreased salinity of previously drained areas, particularly in northern WCA 3A, WCA 3B, and ENP, it is anticipated that implementation of CEPP Alts 4R and 4R2 would significantly improve alligator habitat suitability as compared with the FWO and provide a minor beneficial effect. Alligator habitat suitability for Alts 4R and 4R2 trend similarly; differences between alternatives within the project area are negligible. Major adverse effects on alligators that utilize the Miami Canal would occur due to its backfilling. However, these effects are expected to be short-term as alligators will expand into other areas of suitable habitat created as a result of CEPP implementation.

5.2.4.2 American Crocodile

A Habitat Suitability Index (HSI) for juvenile American crocodiles (*Crocodylus acutus*) was used to predict potential effects of the alternatives. The crocodile growth and survival index used in this analysis is one of the components of a crocodile HSI that characterizes suitable habitat for crocodiles based on habitat, location of known nest sites, salinity, and prey biomass. Results from applying the salinity data into the juvenile crocodile HSI is shown in **Figure C.2.2-47**. The plot shows the lift (Alts 4R and 4R2 minus FWO) of an index of juvenile crocodile growth and survival at sites along the northern Florida Bay shoreline for all years of the model runs. For the four sites with the highest predicted growth and survival, Alt 4R2 improves habitat suitability for juvenile crocodiles, providing a minor beneficial effect to crocodiles and their critical habitat.

5.2.4.3 Everglade snail kite

The snail kite has a highly specialized diet typically composed of apple snails, which are found in palustrine, emergent, long-hydroperiod wetlands. As a result, the snail kite's survival is directly dependent on the hydrology and water quality of its habitat (FWS 1999). As compared to FWO, rehydration and vegetation shifts within northern WCA 3A and increased hydroperiods within WCA 3B and ENP would increase habitat suitable for apple snails, thereby increasing the spatial extent of suitable foraging opportunities for snail kites, providing a significant and moderate beneficial effect. The number of years that Alts 4R and 4R2 fell within USFWS recommended depth ranges substantially increased from FWO, therefore increasing habitat suitability for snail kites (See **Table C.2.2-1 in C.2.2.4.1** or **Annex A**). Designated Everglade snail kite critical habitat would also be improved with increased sheetflow to WCAs and ENP. There would be no effect on Everglade snail kite designated critical habitat within Lake Okeechobee, WCA 1, or WCA 2 because CEPP is redirecting approximately 210,000 acre feet of additional water that currently flows into the St. Lucie and Caloosahatchee Estuaries to the historical southerly flow path south through FEBs and existing STAs.

5.2.4.4 Cape Sable Seaside Sparrow (Nesting Condition and Hydroperiod)

Implementation of Alts 4R and 4R2 has the potential to have a significant and unavoidable adverse effect on hydroperiods within the marl prairies adjacent to SRS. The Programmatic Biological Opinion located in Annex A addresses the required monitoring and recovery projects to reduce the impact. Modeling indicates an increase in hydroperiod within CSSS-E and southern portions of CSSS-A (refer to **Appendix C.2.2.4.2,** T**able C.2.2-7**). However, hydroperiods within northern CSSS-A are slightly reduced as compared with FWO, providing slightly better, but overall, too wet conditions for marl prairie habitat and nesting CSSS. Minor habitat improvements were seen in CSSS-F. A detailed analysis is provided in **Appendix C.2.2.4.2**. While there are slight improvements to critical habitat areas in CSSS-A, CSSS-F, and CSSS-B (some metrics), other areas show an adverse affect.

5.2.4.5 Wood stork

An analysis of wood stork foraging potential was performed to predict improvements to foraging habitat with CEPP implementation (South Florida Natural Resources Center 2013). Results from this analysis indicate that Alts 4R and 4R2 provide the greatest benefit over FWO within northern WCA 3A (CEPP zones 3A-NE and 3A-MC) and provide a moderate beneficial effect. The Beerens (2013) model showed improvement in stork habitat conditions in NESRS with Alts 4R and 4R2. When suitability scores are compared for FWO and Alts 4R and 4R2, (refer to **Appendix C.2.2.4.3**, **Figure C.2.2-38**) the magnitude of the scores is very similar, however, Alts 4R and 4R2 maintain a higher score for somewhat longer into the season. Historically, the short hydroperiod wetlands within ENP have been important for wood stork foraging during the pre-breeding season with wood storks shifting to longer hydroperiod wetlands as the dry season progresses. Hydrological patterns that produce a maximum number of patches with high prey availability (i.e. high water levels at the end of the wet season and low water levels at the end of the dry season) are necessary for high reproductive outputs (Gawlik 2002; Gawlik et al. 2004). Depending upon the elevation and microtopography throughout WCA 3 and ENP, implementation of CEPP Alt 4R2 would produce a variety of wetland habitats that would support prey densities conducive to successful wading bird foraging and nesting, providing a moderate beneficial effect. A detailed analysis is provided in **Appendix C.2.2.4.3**.

5.2.4.6 Eastern Indigo snake

Since Eastern indigo snakes occur primarily in upland areas, their presence within the Greater Everglades portion of the project area is somewhat limited, however, they have a high probability of occurrence within the proposed A-2 FEB site and as a result of construction of the A-2 FEB are likely to be displaced, thereby removing approximately 14,000 acres of potential habitat, a major adverse effect and a significant and unavoidable effect. The hydrologic effects of Alts 4R and 4R2 are expected to benefit existing or historic wetlands, which is what the FEB historically was. Once the Miami Canal is backfilled, created tree islands will be constructed, which would potentially provide habitat for the indigo snakes, perhaps offsetting the increased hydroperiods within WCA 3.

5.2.4.7 Florida manatee

As compared to FWO, Alts 4R and 4R2 would decrease damaging high volume flows to the Northern Estuaries, providing minor beneficial effects to manatees and their critical habitat. Decreased salinities within the Northern Estuaries that reduce stress on SAV and promote increases in seagrass shoots have the potential to increase foraging opportunities for manatees in this region. Similarly, increased freshwater flows to Florida Bay and the southwestern coastal estuaries would result in lowered salinity levels that better encompass seagrass salinity tolerance ranges. This lower-salinity effect would also increase foraging opportunities for manatees. Alt 4R2 would provide increased flows to Florida Bay and the southwestern coastal estuaries, improving salinities, therefore benefitting Florida manatee as compared with the FWO and providing minor beneficial effects to manatees and their critical habitat. Refer to **Section C.2.1.4.6** for further information.

5.2.4.8 Florida Panther

Alts 4R and 4R2 have the potential to have a minor adverse effect on both the Primary and Secondary Zones for Florida panther habitat. Construction of the 14,000 acre FEB within the A-2 parcel in EAA would result in conversion of upland habitat that could be potentially used by Florida panther to transverse the area to wetland habitat, thereby eliminating potential habitat within the panther secondary zone in this region. In addition, since potentially suitable habitat occurs within the action area, increased water deliveries under Alts 4R and 4R2 to ENP could have a minor adverse effect on

Florida panther habitat. However, as lands within the CEPP project area become restored to their more historic natural values, the improved forage base would result in greater use by the Florida panther utilizing these areas, providing a minor beneficial long-term effect.

5.2.4.9 Smalltooth Sawfish

The smalltooth sawfish resides in the Caloosahatchee River and adjacent Charlotte Harbor estuaries; and has the potential to be found in the southern estuaries where juveniles could potentially occur and feed in red mangrove wetlands. Alts 4R and 4R2 have the potential to provide a minor beneficial effect to the smalltooth sawfish and their critical habitat by reducing excessive freshwater flows and improving the salinity regime throughout the Caloosahatchee estuary; and by increasing freshwater flows into the coastal wetlands adjoining Florida Bay, subsequently reducing the duration and occurrence of hypersaline conditions.

5.2.4.10 Green Sea Turtle

Green sea turtles live in tropical and subtropical waters. Although green sea turtles are expected to be found foraging in nearshore seagrass habitats within Florida Bay, the increased freshwater flows associated with Alts 4R and 4R2 may alter seagrass species composition but should have a negligible and less than significant effect on the overall biomass available for sea turtle feeding habits. Additionally, no green sea turtles would attempt to utilize areas for nesting purposes since there is no suitable habitat for nesting in the project area.

5.2.4.11 Hawksbill Sea Turtle

The hawksbill lives in tropical and sub-tropical waters of the Atlantic, Pacific, and Indian Oceans. Although hawksbill sea turtles are expected to be found foraging near hardbottom habitats within Florida Bay, the increased freshwater flows associated with Alts 4R and 4R2 may reduce nearshore salinity concentrations but should have a negligible and less than significant effect on sponges or other food sources utilized by this species. Additionally, no hawksbill sea turtles would attempt to utilize areas for nesting purposes since there is no suitable habitat for nesting in the project area.

5.2.4.12 Leatherback Sea Turtle

The leatherback lives in tropical and sub-tropical waters. Habitat requirements for juvenile and post-hatchling leatherbacks are virtually unknown. Although leatherback turtles are expected to be found foraging in nearshore habitats within Florida Bay, the increased freshwater flows associated with the Alts 4R and 4R2 may reduce nearshore salinity concentrations but should have a negligible and less than significant effect on jellyfishes or other food sources utilized by this species. Additionally, no leatherback sea turtles would attempt to utilize areas for nesting purposes since there is no suitable habitat for nesting in the project area.

5.2.4.13 Kemp's Ridley Sea Turtle

This species is a shallow water benthic feeder consuming mainly algae and crabs. Although Kemp's ridley sea turtles could be found foraging in nearshore habitats within Florida Bay, this species is not expected to be found within the direct area of influence associated with CEPP.

5.2.4.14 Loggerhead Sea Turtle

Loggerhead sea turtles inhabit the continental shelves and estuarine environments along the margins of the Atlantic, Pacific, and Indian Oceans. Although loggerhead sea turtles are expected to be found foraging in nearshore habitats within Florida Bay, the increased freshwater flows associated with Alts 4R and 4R2 may reduce nearshore salinity concentrations but should have a negligible and less than

significant effect on crustaceans, mollusks or other invertebrate food sources utilized by this species. Additionally, no loggerhead sea turtles would attempt to utilize areas for nesting purposes since there is no suitable habitat for nesting in the project area.

5.2.5 State Listed Species

The CEPP project area contains habitat suitable for the presence, nesting, and/or foraging of 16 State listed threatened and endangered species and 18 species of special concern. Threatened and endangered animal species include the Big Cypress fox squirrel (*Sciurus niger avicennia*), Florida mastiff bat (*Eumops glaucinus floridanus*), Florida black bear (*ursus americanus floridanus*), Everglades mink (*Mustela vison evergladensis*), Florida sandhill crane (*Grus canadensis pratensis*), snowy plover (*Charadrius alexandrius*), Southeastern American kestrel (*Falco sparveriuspaulus*), least tern (*Sterna antillarum*), white-crowned pigeon (*Columba leucocephalus*), and Miami black-headed snake (*Tantilla oolitica*). Species of special concern include the Florida mouse (*Podomys floridanus*), Shermans fox squirrel (*Sciurus niger shermani*), American oystercatcher (*Haematopus palliates*), brown pelican (*Pelecanus occidentalis*), black skimmer (*Rynchops niger*), burrowing owl (*Athene cunicularia*), limpkin (*Aramus guarauna*), reddish egret (*Egretta rufescens*), snowy egret (*Egretta thula*), little blue heron (*Egretta caerulea*), tricolored heron (*Egretta tricolor*), white ibis (*Eudocimus albus*), roseate spoonbill (*Platalea ajaja*), osprey (*Pandion haliaetus*), mangrove rivulus (*Kryptolebias marmoratus*), mangrove gambusia (*Gambusia rhizophorae*), gopher tortoise (*Gopherus polyphemus*), and the Florida tree snail (*Liguus fasciatus*).

Threatened and endangered plant species include the pine-pink orchid, which frequents the edges of the farm roads just above wetland elevation; the lattice-vein fern which is found occasionally in the forested wetlands; Eaton's spikemoss, and Wright's flowering fern, both found in the Frog Pond natural area; along with the Mexican vanilla plant and Schizaea tropical fern located on tree islands in the upper Southern Glades region.

While small foraging or nesting areas utilized by many of these animal species may be affected by this project, Alts 4R are 4R2 should have long-term, negligible and less than significant adverse effects on protected State species. Impacts to wading bird species will be similar to those affecting the wood stork. Subtle changes in water quality can also support the prey base so that net effects on forage availability can be variable. Overall, no long-term, adverse impacts are anticipated to State listed species as a result of this project. For a more detailed analysis, please refer to **Appendix C.2.2**.

5.2.6 Wildlife

A comparison of FWO and Alts 4R and 4R2 and their potential effects on wildlife within the CEPP action area are summarized below. Effects on State and Federally listed species are described in further detail in **Appendix C.2.2** and **Section C.2.2.5** and **Annex A**. Further details on the effects of the alternatives can be found in the Fish and Wildlife Coordination Act Report in **Annex A.** Changes in water quality also have the potential to affect prey forage base through altering of vegetation composition or structure. Water quality will continue to be monitored under CEPP; potential effects are largely uncertain at this time.

5.2.6.1 Invertebrates

Long-term, negligible and less than significant effects to the invertebrate community within Lake Okeechobee or EAA are anticipated under Alts 4R and 4R2. As compared with FWO, Alts 4R and 4R2 show a long-term, minor beneficial effect with performance improvement within the Northern Estuaries

as indicated by fewer high volume flow months. Reductions in high volume discharges and salinity fluctuations would likely benefit oysters within the Northern Estuaries.

Within the Greater Everglades aquatic invertebrates would rapidly colonize newly re-hydrated areas with implementation of Alts 4R and 4R2 providing a long-term, significant and moderate beneficial effect, directly benefitting aquatic invertebrates within the action area. Increases in stages and hydroperiods within WCA 2, northern WCA 3A, WCA 3B and ENP would promote wetland vegetation transition through contraction of sawgrass marshes and expansion of wet prairies, and in deeper regions, sloughs. Submerged aquatic plants are commonly associated with sloughs providing structure for growth of periphyton, the main source of primary production within the freshwater Everglades (Gunderson 1994; Powers 2005). Periphyton is a primary component of invertebrate diets, including apple snails. In addition to the potential for increased foraging opportunities, changes in vegetation resulting in expansion of wet prairie and increases in emergent vegetation would also provide habitat structure critical for apple snail aerial respiration and egg deposition (Turner 1996; Darby et al. 1999).

Crayfish are important components within the Everglades food web, serving as primary dietary components of higher trophic level species including fish, amphibians, alligators, wading birds and mammals such as raccoons and river otters (Kushlan and Kushlan 1979). Increases in hydroperiod associated with Alts 4R and 4R2 would likely significantly increase crayfish density within northern WCA 3A, WCA 3B, and ENP, particularly within the marl prairies. Research by Acosta (2001) revealed that crayfish productivity would increase substantially if hydroperiods within the marl prairie wetlands were extended by 3 to 4 months. Although Alts 4R and 4R2 would not extend hydroperiods within the marl prairies by 3 to 4 months, CEPP implementation would increase hydroperiods within this region resulting in increased native crayfish productivity having a long-term, moderate beneficial effect.

Invertebrate populations associated with Florida Bay may show a minor beneficial effect under Alts 4R and 4R2 from an increase in freshwater input resulting in decreased salinities. Invertebrate populations and seagrass beds associated with Biscayne Bay under Alt4R2 may show a long-term, minor beneficial effect from an increase in freshwater input resulting in decreased salinities. Alts4R is likely to show a major adverse effect due to greatly decreased freshwater input. A detailed analysis is provided in **Appendix C.2.2.5.1**.

5.2.6.2 Fish

Implementation of Alts 4R and 4R2 are expected to significantly improve conditions for fish species throughout much of the Greater Everglades and have a long-term, moderate beneficial effect. It is predicted that with implementation of Alt 4R and 4R2, the largest percent gains in daily average fish density would occur within northern WCA 3A and NESRS due to rehydration. Other areas within Shark River Slough are also expected to experience appreciable gains in fish density due to increased flows. It is also expected that regional percent changes in fish densities would be highest in SRS and southern marl prairies (17-31%) for Alt 4R and that Taylor Slough and Florida Bay would also be expected to experience positive changes as compared with FWO (Catano and Trexler 2013). Alt 4R predicted approximately 5% higher biomass than Alt 4R2 in SRS and the southern marl prairies. Long-term decreases in fish density, or negligible changes (3%), were predicted for Alts 4R and 4R2 in WCA 2A and the area of WCA 3A along the L-67 A canal. Negligible differences between Alts 4R and 4R2 were predicted in most other regions.

Fish populations associated with Florida Bay may show a long-term, minor beneficial effect under all Alts 4R and 4R2 from an increase in freshwater input resulting in decreased salinities. Invertebrate

populations and seagrass beds associated with Biscayne Bay under Alt4R2 may show a long-term, minor beneficial effect from an increase in freshwater input resulting in decreased salinities. Alts4R is likely to show a minor adverse effect due to greatly decreased freshwater input. A detailed analysis is provided in **Appendix C.2.2.5.2**.

Introduction or expansion of non-native fish species due to changes in water distribution and increased connectivity within WCA 3A, WCA 3B and ENP is likely to occur; however, the extent of invasion is uncertain at this time providing a minor adverse effect. In contrast to FWO, new access points will be created under CEPP.

5.2.6.3 Amphibians and Reptiles

Long-term, moderate and significant beneficial effects on amphibian and reptile communities are anticipated with CEPP implementation. Alts 4R and 4R2 showed improved conditions for amphibians within WCA 3 and ENP as compared with FWO. Rehydration within previously dry areas within northern WCA 3A would increase spatial extent of suitable habitat for aquatic amphibian species in this area. Similarly, increased hydroperiods within ENP would also benefit aquatic amphibian species. As hydrology improves within WCA 3A, WCA 3B and ENP, it is expected that amphibian species richness will also change. However, declines in some amphibian species will be offset by favorable habitat conditions for other species. Increase in forage prey availability (i.e. crayfish and other invertebrates, fish) in areas rehydrated by CEPP implementation will also directly benefit amphibian and reptiles species.

5.2.6.4 Birds

The freshwater wetlands of the Everglades are noted for their abundance and diversity of colonial wading birds. Nesting and foraging activities of resident bird species are anticipated to show a long-term, moderate beneficial effect with the implementation of Alts 4R and 4R2. Impacts on the Cape Sable seaside sparrow, snail kite, wading birds and shore bird species are further discussed in **Section 5.2.4** and **Appendix C.2.2.4**. Changes in water quality also have the potential to affect birds through alteration of vegetation composition or structure or impacts to their forage base. Water quality will continue to be monitored under CEPP and potential effects are largely uncertain at this time.

As predicted by the Trophic Hypothesis (RECOVER 2004) an increase in density of small fishes will directly benefit higher trophic level predators such as wading birds. Therefore, it is predicted that Alts 4R and 4R2 that provide a long-term, moderate and significant beneficial effect to small fishes as described in **Section 5.2.6.2** and **Appendix C.2.2.5.2**, will also perform well overall for wading birds. Crayfish are a particularly important forage resource for nesting white ibis (*Eudocimus albus*). Appropriate foraging conditions and crayfish densities within core foraging areas of nesting wading birds colonies can reduce foraging flight distance, thereby enhancing overall body condition. As indicated in **Section C.2.2.5.1**, increases in hydroperiod associated with implementation of Alts 4R and 4R2 would likely increase crayfish density within northern WCA 3A, WCA 3B, and ENP, particularly within the marl prairies. Depending upon the elevation and microtopography throughout WCA 3 and ENP, implementation of Alts 4R and 4R2 would produce a variety of wetland habitats that would support prey densities conducive to successful wading bird foraging and nesting.

5.2.6.5 Mammals

As compared with FWO, potential long-term, minor beneficial effects on mammals within the CEPP action area are anticipated with Alts 4R and 4R2. Small mammals including raccoons and river otters would benefit from increased crayfish and small prey fish biomass in rehydrated areas within northern

WCA 3A, WCA 3B and ENP. Effects on Federally listed species are described in further detail in **Section 5.2.4** and in **Section C.2.2.4** and within **Annex A**.

Anticipated benefits of Alts 4R and 4R2 include improving the quantity, timing, and distribution of water delivered to ENP. The increase in water availability and rehydration within northern WCA 3A, WCA 3B, and ENP under Alts 4R and 4R2 will likely benefit Everglades mink (*Mustela vison evergladensis*) as a result of increased prey availability (forage fish).

CEPP implementation, however, may negatively affect mammals dependent upon upland habitat in the short-term. As compared with the FWO, Alts 4R and 4R2 increased depths and resulting hydroperiods within northern WCA 3A. Due to increased water flow and changes in water distribution it is anticipated that overdrained areas in northern WCA 3A will be rehydrated, triggering a vegetation transition from upland to wetland habitat. Performance between Alts 4R and 4R2 was similar in northwestern WCA 3A; however Alt 4R2 showed slightly lower depths during average hydrologic conditions in northeastern WCA 3A. Although mammals occurring within the action area are adapted to the naturally fluctuating water levels in the Everglades, there is an increased potential for this vegetation transition to have a short-term significant, adverse and unavoidable effect on the mammals utilizing upland habitat. This is a particular concern for deer populations within northern WCA 3A that utilize tree islands. However, as discussed in **Appendix C.2.2.3.4.4**, no significant effects on tree islands within WCA 3A and ENP are anticipated to occur under Alts 4R and 4R2; however slightly lower water depths under Alt 4R2 relative to Alt 4R may be more favorable to deer populations in northeastern WCA 3A. Deer populations that utilize the lower elevation tree islands within WCA 3B may suffer from habitat loss, having a short-term significant, adverse and unavoidable effect. In addition, deer that utilize levees slated for removal (L-67A, L-29, and L-67 Extension) also may be adversely affected. Loss of these levees may be offset by the construction of the Blue Shanty Levee in WCA 3B. Deer are highly mobile and will migrate to find suitable habitat. No significant negative effects on mammals in the remainder of the CEPP action area are anticipated under Alts 4R and 4R2. Changes in water quality also have the potential to affect prey forage base through altering of vegetation composition or structure. Water quality will continue to be monitored under CEPP; potential effects are largely uncertain at this time.

5.2.7 Essential Fish Habitat

Alts 4R and 4R2 have the potential to reduce the frequency and volume of high level flows from Lake Okeechobee to the Caloosahatchee River Estuary and the St. Lucie Estuary; thus reducing the potential for adverse impacts on estuarine and nearshore biota associated with Essential Fish Habitat (EFH), providing a minor beneficial effect. This is a significant improvement for those estuarine systems compared to a FWO project scenario. Alts 4R and 4R2 would also improve freshwater delivery to coastal wetlands and downstream estuaries in Northern Biscayne Bay, ENP and Eastern Florida Bay, providing a minor beneficial effect. Model output indicates a minor beneficial effect on indicator species and estuarine habitats compared to a FWO scenario. Implementation of Alt 4R2 would increase freshwater flows to salt water wetlands and nearshore bay areas and result in favorable changes to salinity levels. These changes may affect EFH, although effects on the aquatic resources are anticipated to be significant and beneficial. The recommended plan will have no adverse effects on EFH in the northern estuaries of St. Lucie and Caloosahatchee; and the southern estuaries including Florida Bay and Biscayne Bay. A more detailed analysis of the EFH can be found in **Appendix C.2.2.6** and **Appendix C.4**.

5.2.8 Hydrology

A summary of the anticipated long-term hydrologic effects of Alt 4R and Alt 4R2, which were previously described in **Section 4.6.2**, is presented in **Table 5.2-1**. Comprehensive discussion of the anticipated

long-term hydrologic effects of Alt 4R and Alt 4R2 is provided in **Section C.2.2.7** of **Appendix C.2.2**. Alt 4R and Alt 4R2 are compared to the FWO; similarly, the hydrologic effects of the FWO are described based on comparison to the ECB. The summary of regional hydrologic differences includes quantitative comparisons between the ECB and FWO, the FWO and Alt 4R, and the FWO and Alt 4R2 based on the RSM-BN and RSM-GL CEPP modeling representations of these baselines and alternatives. The determination of the directionality of the long-term hydrologic change (improvements and/or adverse hydrologic change) within each specified geographic region is principally based on the results of the ecological evaluations, where available, which are described in **Section 4.6.2**. Alts 1 through 4 are separately compared to the FWO in **Section 5.1.8**.

Table 5.2-1. Environmental Effects of Alt 4R and Alt4R2 on Hydrology

Geographic Region	Alt	Hydrologic Effects
Lake Okeechobee	FWO	Moderate hydrologic change, with improvements from reducing the frequency of high lake stages and adverse effect from increasing the frequency of low lake stages. Significant stage reduction of 0.1-0.5 feet for the upper 75% of the stage duration curve. Number of days with stages above 16 feet NGVD is reduced from 870 to 696 during the 1965-2005 period of simulation.
	Alt 4R	Moderate hydrologic change, with improvements from reducing the frequency of low lake stages and adverse effect from increasing the frequency of high lake stages. Significant stage increase of 0.25-0.50 feet for the upper 60% of the stage duration curve, excluding extreme wet hydrologic conditions. Number of days with stages above 16 feet NGVD is increased from 696 to 1157 during the 1965-2005 period of simulation.
	Alt 4R2	Moderate hydrologic change, with improvements from reducing the frequency of low lake stages and adverse effect from increasing the frequency of high lake stages. Significant stage increase of 0.25-0.50 feet for the upper 70% of the stage duration curve, excluding extreme wet hydrologic conditions. Number of days with stages above 16 feet NGVD is increased from 696 to 1162 during the 1965-2005 period of simulation.
Northern Estuaries	FWO	Caloosahatchee Estuary: Major improvement. Mean monthly flows above 2800 cfs and above 4500 cfs are reduced by 13 and 10 months, respectively (14% and 23% reductions, respectively). Mean monthly flows less than 450 cfs are reduced by 89 months (77%). St. Lucie Estuary: Major improvement. Mean monthly flows above 2000 cfs and above 3000 cfs are reduced by 10 and 12 months, respectively (11% and 28% reductions, respectively).
	Alt 4R	Caloosahatchee Estuary: Moderate improvement. Mean monthly flows above 2800 cfs and 4500 cfs are reduced by 11 and 3 months, respectively (14% and 9% reductions, respectively). Mean monthly flows less than 450 cfs are reduced by 3 months (11%). St. Lucie Estuary: Moderate hydrologic change, with improvements for high volume discharges and adverse effect for low volume discharges. Mean monthly flows above 2000 cfs and 3000 cfs are reduced by 27 months and 5 months, respectively (32% and 16% reductions, respectively). Mean monthly flows less than 350 cfs are reduced by 2 months (2%).
	Alt 4R2	Caloosahatchee Estuary: Moderate improvement. Mean monthly flows above 2800 cfs and 4500 cfs are reduced by 11 months and 4 months, respectively (14% and 12% reductions, respectively. Mean monthly flows less than 450 cfs are reduced by 4 months (15%). St. Lucie Estuary: Moderate to significant improvement. Mean monthly flows above 2000 cfs and 3000 cfs are reduced by 29 months and 7 months, respectively (34% and 23% reductions, respectively). Mean monthly flows less than 350 cfs are reduced by 27 months (29%). Additional analysis for Savings Clause requirements is provided in **Annex B**.

Geographic Region	Alt	Hydrologic Effects
Greater Everglades: WCA 2A and WCA 2B	FWO	WCA-2A (2A-17): Minor adverse effect. Stages are increased by 0.1-0.2 feet under all hydrologic conditions. WCA-2B (2B-Y): Moderate improvement. Stages within WCA-2B are significantly increased by 0.25-0.50 feet under nearly all hydrologic conditions, excluding extreme wet conditions.
	Alt 4R	WCA-2A (2A-17): Moderate improvement. Stages are decreased by 0.1-0.3 feet under all hydrologic conditions. WCA-2B (2B-Y): Moderate adverse effect. Stages within WCA-2B are significantly decreased by 0.25-0.50 feet under nearly all hydrologic conditions, excluding extreme wet conditions.
	Alt 4R2	WCA-2A (2A-17): Same as Alt 4R. WCA-2B (2B-Y): Minor adverse effect. Stages within WCA 2B are slightly decreased by less than 0.10 feet for wet to normal conditions and stages are decreased by 0.25 feet during the driest 20 percent of the stage duration curve. Compared to the ECB, stages within WCA 2B are moderately improved with significant increases of 0.10 - 0.25 feet under nearly all hydrologic conditions, excluding extreme wet conditions.
Greater Everglades: WCA 3A and WCA 3B	FWO	a) L-28 Triangle: Negligible effect (note: based on comparison of updated IORBL1 to the updated 2012EC, due to error correction in RSM-GL modeling; refer to **Appendix C.2.2** for additional discussion). b) Northwest WCA 3A (3A-NW): Negligible effect. Stages slightly increased during the wettest 20% of conditions. c) Northeast WCA 3A (3A-NE): Minor to Moderate adverse effect. Stages are decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. d) East-Central WCA 3A (3A-3): Minor to Moderate adverse effect. Stages are generally decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. e) Central WCA 3A (3A-4): Minor to Moderate adverse effect. Stages are generally decreased by 0.1-0.2 feet, with no significant change during extreme wet or extreme dry conditions. f) Southern WCA 3A (3A-28): Moderate adverse effect. Stages are generally decreased by 0.2-0.3 feet, with no significant change during extreme wet or extreme dry conditions. g) WCA 3B (Site 71): Minor to Moderate adverse effect. Stages are decreased by 0.1-0.2 feet during normal to dry conditions.
	Alt 4R	a) L-28 Triangle: Minor improvement. Stages increased by 0.1-0.2 feet during all hydrologic conditions, excluding extreme wet conditions (note: based on comparison of updated IORBL1 to the updated 2012EC, due to error correction in RSM-GL modeling; refer to **Appendix C.2.2** for additional discussion). b) Northwest WCA-3A (3A-NW): Major improvement. Stages are generally significantly increased by 0.6-0.8 feet. c) Northeast WCA-3A (3A-NE): Major improvement. Stages are increased by 0.4-0.7 feet, with no significant change during extreme wet conditions and a slight increase in stage for extreme dry conditions. d) East-Central WCA-3A (3A-3): Major improvement. Stages are generally increased by 0.2-0.5 feet, with no significant change during the wettest 20% of conditions. e) Central WCA-3A (3A-4): Minor to moderate improvement. Stages are generally increased by 0.1-0.2 feet during average to dry conditions, with a slight depth reduction during the wettest 10% of conditions and no significant change during extreme dry conditions. f) Southern WCA-3A (3A-28): Minor improvement. Stages are decreased by 0.1-0.2 feet

Geographic Region	Alt	Hydrologic Effects
		during the wettest 5% of conditions and slightly decreased during normal to dry conditions. g) WCA-3B (Site 71): Moderate to major improvement. Stages are increased under all hydrologic conditions, including stage increases of 0.1 feet during the upper 20% of the stage duration curve (wet to extreme wet conditions), stage increases of 0.2-0.3 feet for normal to dry conditions, and a slight stage increase during extreme dry conditions.
	Alt 4R2	a) L-28 Triangle: Same as Alt 4R. b) Northwest WCA-3A (3A-NW): Same as Alt 4R. c) Northeast WCA-3A (3A-NE): Same as Alt 4R. d) East-Central WCA-3A (3A-3): Same as Alt 4R. e) Central WCA-3A (3A-4): Same as Alt 4R. f) Southern WCA-3A (3A-28): Same as Alt 4R. g) WCA-3B (Site 71): Same as Alt 4R.
Greater Everglades: ENP	FWO	a) Northwest ENP (NP-201): Minor improvement. Stages are increased by 0.1-0.2 feet during normal to dry conditions. b) Northeast ENP (NESRS-2): Minor adverse effect. Stages are slightly reduced during normal to dry conditions. c) Central ENP (P-33): Negligible effect. d) Taylor Slough: Minor to Moderate improvement. Stages are increased by 0.1-0.3 feet during nearly all hydrologic conditions.
	Alt 4R	a) Northwest ENP (NP-201): Minor to moderate adverse effect. Stages are significantly decreased by 0.1-0.3 feet under both wet and dry hydrologic conditions; stages are slightly increased or unchanged for normal hydrologic conditions between approximately 35% and 55% on the stage duration curve. b) Northeast ENP (NESRS-2): Major improvement. Stages are significantly increased by 0.5-0.9 feet under all hydrologic conditions. c) Central ENP (P-33): Major improvement. Stages are increased by 0.2-0.4 feet under all hydrologic conditions. d) Taylor Slough: Minor adverse effect. Stages are slightly decreased by approximately 0.1 feet during the wettest 20% of hydrologic conditions and slightly increased by 0.1-0.2 feet during normal to dry hydrologic conditions.
	Alt 4R2	a) Northwest ENP (NP-201): Same as Alt 4R. b) Northeast ENP (NESRS-2): Same as Alt 4R. c) Central ENP (P-33): Same as Alt 4R. d) Taylor Slough: Same as Alt 4R.
Southern Estuaries	FWO	a) Biscayne Bay: Moderate improvement. Average annual canal discharges to northern Biscayne Bay (S-27, S-28, and S-29) are increased by 66 kAF (19%). b) Florida Bay: Moderate adverse effect. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are decreased by 14 kAF (5%).
	Alt 4R	a) Biscayne Bay: Minor adverse effect. Combined total average annual canal discharges to central and southern Biscayne Bay (S-336, S-338, S-194, S-196, S-197) are

Geographic Region	Alt	Hydrologic Effects
		reduced by 9 kAF (8%). b) Florida Bay: Moderate improvement. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are increased by 27 kAF (11%).
	Alt 4R2	a) Biscayne Bay: Minor to moderate adverse effect. Combined total average annual canal discharges to central and southern Biscayne Bay are increased by 17 kAF (15%). Average annual canal discharges to northern Biscayne Bay are reduced by 46 kAF (11%). Additional analysis for Savings Clause requirements is provided in **Annex B**. b) Florida Bay: Moderate improvement. Combined average annual overland flows from Southern ENP to Florida Bay (Transect 23) are increased by 23 kAF (9%).

5.2.9 Water Quality

The assessment of project impacts to water quality are summarized in **Table 5.2-2** below. The detailed analyses are found in **Appendix C.2.1**, and **Appendix C.2.2** as well as **Annex F**.

Table 5.2-2. Environmental Effects of Alt 4R and 4R 2 on Water Quality

Water Quality		
Geographic Regions	FWO	Alt 4R and Alt 4R2
Lake Okeechobee	WQ is expected to improve relative to present conditions as the result of implementation of TMDLs, and implementing the associated BMAPs for the basins discharging to the lake.	Similar to FWO; slight changes to operations not expected to result in significant WQ impacts; however, additional backflow into the lake at S-308 increases the annual phosphorus load slightly. Changes in phosphorus loads will be addressed holistically throughout the watershed via the Florida Department of Environmental Protection's Lake Okeechobee Basin Management Action Plan (BMAP) process (Section 403.067, Florida Statutes). The BMAP is currently under development via a public stakeholder driven process.
Northern Estuaries	Number of low salinity events reduced for both Caloosahatchee and St. Lucie relative to baseline conditions. Number of high salinity events reduced for the Caloosahatchee Estuary. Improved nutrient and dissolved oxygen conditions expected to result from reduced high flow events from Lake Okeechobee, improved Lake Okeechobee nutrient levels, and improved estuary basin runoff quality from TMDL implementation.	Relative to FWO, number of low and high salinity events for Caloosahatchee and St. Lucie is reduced. Improved nutrient and dissolved oxygen conditions expected to result from reduced high flow events from Lake Okeechobee, improved Lake Okeechobee nutrient levels, and improved estuary basin runoff quality.
EAA	Relative to existing conditions there will be improvement in nutrient conditions due to implementation of water quality projects under the States Restoration Strategy Program to meet the WQBEL for STA discharges. See **Annex F** for details. Slight reduction in sulfate due to additional removal in STAs as well as potential reductions from reduced farming activities.	Use of A-2 FEB lands in project will slightly reduce total basin nutrient loads. Otherwise similar to FWO. CEPP plan increases flows through the Central Flow path, but it also provides increased FEB storage. Based on DMSTA modeling, the additional FEB storage provided in the central flow path by CEPP, in combination with the A-1 FEB, STA-2, and STA-3/4, is sufficient to handle the additional CEPP flows (approximately 210 kac-

Water Quality		
Geographic Regions	FWO	Alt 4R and Alt 4R2
	DMSTA water quality modeling indicates that SFWMD's Restoration Strategies Program is expected to result in compliance with the 2012 WQBEL for total phosphorus. The Restoration Strategies plan is scheduled for completion in 2029.	ft/yr) and still achieve the WQBEL. However, there are still uncertainties associated with treatment of CEPP flows using the existing conveyance features, STA facilities, and portion of A-1 FEB capacity. The CEPP adaptive management plan will address some of the uncertainties associated with operating the integrated A-1/A-2 FEB integrated system. It is expected that the A-2 FEB will accrete peat soils and capture carbon from the atmosphere.
Greater Everglades	Relative to baseline conditions, expect reduction in nutrient concentrations entering Everglades Protection Area due to implementation in the Restoration Strategies project in the EAA. Reduced sulfate load expected as a result of reduced flows and additional removal in additional removal from STA/FEB expansion. Relative to baseline conditions, increased frequency of meeting the 1991 Settlement Agreement water quality compliance requirements for Loxahatchee, Shark River Slough, and Taylor Slough. This is as result of construction of Restoration Strategies project features in the EAA constructed as part of Restoration Strategies, the stormwater features constructed in the S9 Basin as part of the Broward County Water Preserve Area project, as well as further progress on implementation of BMPs in developed areas adjacent to the Everglades. Mercury available for methylation is likely to increase as a result of increased Hg atmospheric load from international sources. This will be moderated somewhat due to the implementation of FDEP Total Hg TMDL and new EPA Clean Air Act standards for emissions of Hg.	WCA 3A: Backfilling of northern portion of Miami Canal and re-direction of water into the northern marsh areas will result in greater uptake of nutrients and sulfate in northern WCA 3A. Increased flows and new flow patterns may result in increased water column phosphorus concentrations at one or more TP rule stations in the short term. The effect on TP rule compliance is uncertain; though the impact is likely to be minimal in the long term. Reduced incidence of dry out of the northern marsh should limit peat oxidation and nutrient re-mobilization. Lower phosphorus and sulfate concentrations should occur in southern WCA 3A. Redistribution of flows into the northern marsh and away from the Miami Canal may result in a change in locations of methylmercury "hotspots" identified as areas where methylmercury concentrations in fish are high. It is expected that the sawgrass prairie communities north of Alligator Alley will have a higher probability of succession which suggests positive peat soil accretion and carbon capture from the atmosphere. WCA 3B: Reduction in dry out events relative to FWO will result in reduced peat oxidation / re-mobilization of nutrients. Additional flows into WCA 3B through the S-631 structure may result in increased water column phosphorus concentrations at one or more TP rule stations in the short term; however, this should have minimal impact on TP rule compliance in the long term. ENP: It is uncertain how changes in flow distributions proposed under CEPP will impact compliance with Appendix A of the 1991 Settlement Agreement. Over the long-term, distributing the flow over the northern WCA-3A marsh, reducing short-circuiting down the canals to ENP, adding more flow from the lake that is treated to the WQBEL, and distributing these

Water Quality		
Geographic Regions	FWO	Alt 4R and Alt 4R2
		flows over the marsh should result in improvements by lowering the flow weighted mean total phosphorous concentration entering the Park. In the short-term, to address the uncertainty in compliance with Appendix A, the Technical Oversight Committee (TOC) is reviewing applicability of the current Appendix A compliance methodology for a restored ecosystem. Relative to FWO, no change to Settlement Agreement compliance for Taylor Slough is expected.
Southern Estuaries	Base salinity conditions in Florida Bay are poor - current or FWO conditions are far from the restoration target Relative to baseline condition, slight reduction in salinities in nearshore zones. Nutrient loading from upland areas not expected to change significantly relative to baseline conditions.	Improved salinity conditions relative to FWO condition. With-project mean salinity moves closer to the target with a 2 psu decrease in the bay's central zone and an average salinity decrease of 1.5 psu among all bay zones for wet and dry seasons. While this appears to be a small change, this grand mean of salinity improvement (over a simulated 36 year period) is still a major step toward the restoration target.

5.2.10 Air Quality

The total increases in air pollutants are relatively minor in relation to the existing point and nonpoint and mobile source emissions in Palm Beach, Broward, and Miami-Dade Counties. Effects from project related emissions for Alts 4R and 4R2 during construction and during the operational phase of the CEPP project would not significantly impact air quality within the air shed. Short-term loadings of internal-combustion engine exhaust gasses are expected to be negligible and not pose a threat to workers or local populations. The G-370 and G-372 pumps presently have air quality emissions permits. These permits may need modification to account for the additional operations and emissions. The project is expected to reduce green house gas emissions by capturing carbon through peat soil accretion that is expected to occur as a result of wetland rehydration. An air quality permit will be obtained prior to the construction of the expanded S-356 pump station. Because the project is located within a designated attainment area, U.S. Environmental Protection Agency's general conformity rule to implement Section 176 (c) of the Clean Air Act does not apply, and a conformity statement should not be required. Detailed analysis on air quality impacts and green house gas emissions are presented in **Appendix C.2.2.10**.

5.2.11 Hazardous, Toxic and Radioactive Waste

Table 5.2-3. Environmental Effects of Alts 4R and 4R2 on HTRW

HTRW		
Geographic Regions	**FWO**	**Alt 4R and Alt 4R2**
Lake Okeechobee	Increased development within basin may result in new HTRW sites while existing ones should continue to be remediated.	Similar to FWO
Northern Estuaries	Increased development within Caloosahatchee and St. Lucie basins may result in new HTRW sites being identified while response actions are expected to continue at existing sites.	Similar to FWO
EAA	A2 FEB lands continue to be farmed which may result in new HTRW releases on these lands as well as additional pesticide application to cultivated areas.	A-2 FEB lands are converted to aquatic habitat. This will reduce the possibility of future HTRW release on these lands.
Greater Everglades	Response actions are completed on FDEP identified HTRW sites and new sites are documented and eventually remediated. Potential for illegal waste disposal remains high.	Similar to FWO
Southern Estuaries	Response actions are completed on FDEP identified HTRW sites and new sites are documented and eventually remediated.	Similar to FWO

5.2.12 Noise

Features of Alts 4R and 4R2 are the same. During construction of Alts 4R and 4R2 there would be minor and short-term increases in noise during construction and a less than significant effect. Alts 4R and 4R2 each include construction of two additional pump stations which would result in long-term, localized increases in noise in comparison to FWO.

5.2.13 Aesthetics

Features of Alts 4R and 4R2 are the same. Alts 4R and 4R2 show a significant increase in aesthetic value over the FWO due to restoration of hydropatterns and sheetflow throughout the project area and provide long-term, minor beneficial effects. The restoration of sheetflow would provide additional habitat for native plants and animals and increased opportunities for wildlife viewing. There would be temporary, short-term, localized effects to aesthetics during construction of all features. In the Northern Estuaries, Alts 4R and 4R2 would increase the long-term aesthetic value due to decreased high flow events. Reductions in high volume discharges to the estuaries would result in lower suspended solids, increased water clarity and the correct salinity envelope that maintain healthy SAV beds. These benefits could also lead to an increase in long-term wildlife viewing opportunities. With the EAA, wetland vegetation is anticipated to colonize the A-2 FEB increasing wildlife utilization and opportunities for wildlife viewing within the area. In the Greater Everglades, while there would be a short-term, minor adverse effect on aesthetics due to the construction of the Blue Shanty Levee, there would be a long-term beneficial effect with an increase in aesthetics due to the creation of sheet flow in the Blue Shanty flow way. Restoration of flows within Florida Bay and the southwestern coastal estuaries would improve habitat within these regions, thereby increasing opportunities for wildlife viewing as well as providing a potential for the reduction in red tide occurrences. A more detailed description of the potential effects is provided in **Appendix C.2.13.**

5.2.14 Land Use

The entire CEPP project area consists of lands currently under public ownership; however, the A-2 footprint is currently being leased and used for agricultural purposes.

5.2.14.1 Wetlands

Much of the future development within the study area is expected to occur on lands that were formerly in agricultural use. **Table 5.2-4** summarizes effects on wetlands and uplands for Alts 4R and 4R2. Alts 4R and 4R2 each show a long-term, significant and major beneficial effect with an increase of 625 acres of wetland/upland habitat over the FWO as well as an increase in wetland function. There are some minor, short-term, adverse effects due to the construction of some CEPP features, most notably the Blue Shanty Levee in WCA 3B. However, the construction of other features, including the degradation of levees and the backfilling of canals, reconnects and adds wetland acreage and provides the needed topography for sheetflow to restore the natural system. In addition to gains in wetlands, Alts 4R and 4R2 each shift approximately 13,800 acres of agricultural land use with wetland soils to a higher quality wetland with the construction of the A-2 FEB. The A-2 FEB would alter the land use from agriculture to an FEB that includes wetland habitat. The WCA 3B flow-way achieves a central goal of CERP and of CEPP: restoration of continuous sheet-flow, over long distances, and in the original flow directionality. The creation of a new levee in Alts 4R and 4R2 make it possible to remove a similar length of existing levee (L-67C). A detailed description of the differences in wetland/upland acres is provided in **Appendix C.2.2.16**

In addition to the benefit of increased wetland/upland acres, the wetland function increases as well due to backfilling the Miami Canal and the restoration of sheetflow across WCA 3A and 3B into ENP. The initial construction may have a short-term, temporary adverse affect on the wetland function in the construction areas, but once the project is complete, all alternatives would increase wetland function based on the acres of wetlands gained.

Table 5.2-4. Effects on Wetlands (acres) for Alts 4R and 4R2

Project Feature	Alt 4R Acres of Wetland Gain (Loss) over FWO	Alt 4R2 Acres of Wetland Gain (Loss) over FWO
L-4 Degrade	35	35
Miami Canal Backfill	417	417
Miami Canal Spoil Mounds	45	45
L-67A Culverts	(13.5)	(13.5)
L-67C Gaps	9	9
L-67C Flow Way Degrade	64	64
L-29 Degrade	46	46
Blue Shanty Levee	(113)	(113)
L-67 Extension Backfill	104	104
Old Tamiami Trail Road Degrade	31	31
Total Net Change	**625**	**625**

5.2.14.2 Agriculture

Fourteen thousand acres of public land currently leased for agricultural use will be converted into a FEB for both Alt 4R and Alt 4R2. As described in **Section 5.2.8**, negligible and less than significant changes were noted for water stages within the South Dade Conveyance System; therefore no indirect effects on

agriculture within this region are anticipated. All of the agricultural acreage is considered unique farmland (not subject to frost). Coordination with the United States Department of Agriculture (USDA) and National Resources Conservation Service (NRCS) to meet the requirements of the Farmland Protection Policy Act, is ongoing. When detailed design information that locates each of the plan components is completed, it can then be determined how many acres of unique farmland would be affected by the Project. See **Appendix C.4.12** for more information.

5.2.15 Socioeconomics

5.2.15.1 Population

The CEPP study area population is expected to increase by 18 percent from 2010 to 2030 with Palm Beach and Miami-Dade counties attracting the greatest number of new residents. Monroe County is expected to experience a small reduction in permanent residents over the next 20 years. When aggregated, the total population is projected to increase by 1 million people. This is a slower rate of growth than projected previously in CERP planning efforts. Population projections are not anticipated to differ between FWO, Alt 4R and Alt 4R2 conditions.

There will be no impacts to Lake Okeechobee commercial navigation with this project. Operational changes were incorporated into the hydrologic modeling conducted for Alt 4R2, in an effort to optimize CEPP system-wide performance within the existing flexibility of the 2008 LORS. More specifically, the hydrologic modeling of the CEPP alternatives included proposed revisions to the 2008 LORS decision tree outcome maximum allowable discharges dependant on the following criteria: Lake Okeechobee inflow and climate forecasts (class limits were modified for tributary hydrologic conditions, seasonal climate outlook, and multi-seasonal climate outlook), stage level (regulation zone), and stage trends (receding or ascending). While some refinements were made within the operational flexibility available in the 2008 LORS, consistent with the original modeling intent, the final operational assumptions ultimately extended beyond this flexibility due to adjustments made to the tributary/climatological classifications. Additional information and documentation of these assumptions can be found in **Appendix A**. The authorized C&SF project depths for Lake Okeechobee navigation are based on 12.56 feet NGVD. The number of days below this criteria was 4934 for the ECB/2012EC, 5323 for the FWO, 5327 for the IORBL1, and 4463 for ALT4R2. Comparison between the FWO/IORBL1 and the Alt 4R2 indicate reduced potential navigation impacts with the TSP. Of course, as discussed above, the Lake Okeechobee Regulation Schedule changes which are implicit in the analysis are not included as part of Alt 4R2.

5.2.15.2 Water Supply and Flood Control

A summary of the anticipated long-term effects on water supply and flood control of the FWO, Alt 4R, and Alt 4R2 is presented in **Table 5.2-5**. Alt 4R and Alt 4R2 are compared to the FWO; similarly, the effects of the FWO are described based on comparison to the ECB. The summary of regional performance differences includes quantitative comparisons between the CEPP ECB and the FWO, the FWO and Alt 4R, and the FWO and Alt 4R2 based on the RSM-BN and RSM-GL CEPP modeling representations of these baselines. The period of simulation (1965-2005) used for the CEPP hydrologic modeling encompasses a wide range of historical climatologic and meteorologic conditions that are representative of south Florida hydrology. This analysis period includes several moderate wet and moderate dry periods, as well as less frequent and potentially more impactful periods of both extreme high rainfall and extreme drought conditions. Alts 1 through 4 are separately compared to the FWO in **Section 5.1.15.2**. To address the Savings Clause requirements for CERP, **Annex B** includes a detailed and comprehensive analysis of potential long-term effects of the CEPP recommended plan (Alt 4R2), where applicable, to existing legal sources for water supply and/or the levels of service for flood protection.

Based on the period of simulation analysis for the recommended plan, the C&SF system modifications successfully maintained the pre-project levels of service for flood protection consistent with the requirements of the WRDA 2000 Savings Clause.

Table 5.2-5. Environmental Effects of Alt 4R and Alt4R2 on Water Supply and Flood Control

Geographic Region	Alts	Water Supply and Flood Control
Lake Okeechobee	FWO	Moderate adverse effect. Compared to the ECB, mean annual EAA water supply demands not met are increased from 7% to 8%. LOSA water supply cutback percentage is increased for 3 of the 8 years with the largest water supply cutbacks.
	Alt 4R	Minor improvement. Compared to the FWO, mean annual EAA water supply demands not met are decreased from 8% to 6%. LOSA water supply cutback percentage is increased for 2 of the 8 years with the largest water supply cutbacks.
	Alt 4R2	Minor to moderate improvement. Compared to the FWO, mean annual EAA water supply demands not met are decreased from 8% to 6%. LOSA water supply cutback percentage is increased for 1 of the 8 years with the largest water supply cutbacks.
Greater Everglades	FWO	Major flood control improvement. Compared to the ECB, the frequency of WCA-3A stages within Zone A of the Regulation Schedule is significantly reduced from 32% to 18% of the 1965-2005 period of simulation.
	Alt 4R	Moderate flood control improvement. Compared to the FWO, the frequency of WCA-3A stages within Zone A of the Regulation Schedule is moderately increased from 18% to 22% of the 1965-2005 period of simulation. Stages within the wettest 10% of hydrologic conditions, however, are generally reduced by 0.2-0.3 feet.
	Alt 4R2	Same as Alt 4R.
Lower East Coast Service Area 1 (Palm Beach)	FWO	Moderately adverse effect. 3 additional water years with 3 or more consecutive months with restrictions, which result from lower Lake Okeechobee stages and not local groundwater conditions. Local groundwater stages east of WCA-1 reduced by 0.2-0.5 feet for the driest 10% of hydrologic conditions. Local groundwater stages south of the Site 1 CERP project reduced by 0.2 feet for normal to dry conditions and by up to 1.0 feet during extreme dry conditions.
	Alt 4R	Minor improvement. 2 fewer water years with 3 or more consecutive months with restrictions. No significant changes to local groundwater stages.
	Alt 4R2	Same as Alt 4R.
Lower East Coast Service Area 2 (Broward)	FWO	Minor adverse effect. 1 additional water year with 3 or more consecutive months with restrictions which results from lower Lake Okeechobee stages and not local groundwater conditions. Local groundwater stages slightly reduced for the driest 10% of hydrologic conditions.
	Alt 4R	Minor adverse effect. No change in the number of water years with 3 or more consecutive months with restrictions. No significant changes to local groundwater stages which are prevalent through normal to dry hydrologic conditions. Reduced stages are indicated during the driest 5-10% of hydrologic conditions for some monitoring gages located east of WCA-2A and WCA-2B.
	Alt 4R2	Negligible. No change in the number of water years with 3 or more consecutive months with restrictions. No significant changes to local groundwater stages which are prevalent through normal to dry hydrologic conditions. An increased demand of 12 million gallons per day (MGD) is provided for LECSA 2.

Geographic Region	Alts	Water Supply and Flood Control
Lower East Coast Service Area 3 (Miami-Dade)	FWO	Moderate to major adverse effects. a) 3 additional water years with 3 or more consecutive months with restrictions, which result from lower Lake Okeechobee stages and not local groundwater conditions. b) L-30 canal stages are reduced by 0.2-0.4 feet for normal to extreme dry conditions. c) L-31N canal stages are slightly reduced by 0.1-0.2 feet for extreme dry conditions. Slight increase in flood control stages within the wettest 10% of hydrologic conditions. d) C-111 canal stages between S-176 and S-18C are generally lowered by 0.2-0.5 feet for normal to extreme dry conditions.
	Alt 4R	Moderate improvement for water supply and flood control, with no anticipated adverse effects. a) Decrease of 3 water years with 3 or more consecutive months with restrictions. b) L-30 Canal stages are increased by 0.1-0.6 feet for normal to extreme dry conditions; moderate reduction of 0.1-0.2 feet for flood control stages within the wettest 10% of hydrologic conditions, with no significant change observed for the upper 1% of the stage duration curve. c) L-31N canal stages are increased by 0.1-0.2 during dry conditions; significant reduction to flood control stages within the wettest 5% of hydrologic conditions. Reduced stages are indicated during the driest 5% of hydrologic conditions for areas east of L-31N and south of the 8.5 SMA. d) No significant change to C-111 canal stages between S-176 and S-18C during normal to dry hydrologic conditions, with a 0.1-0.2 ft increase during normal hydrologic conditions; no significant change for flood control stages within the upper 10% of the stage duration curve.
	Alt 4R2	Moderate improvement for water supply and flood control, with no anticipated adverse effects. a) Decrease of 3 water years with 3 or more consecutive months with restrictions. b) L-30 Canal stages: Same as Alt 4R. c) L-31N canal stages: Same as Alt 4R. d) C-111 canal stages between S-176 and S-18C: Same as Alt 4R. e) Minor increase to stages in the wettest 10% of the hydrologic conditions for areas immediately east of Pennsuco, with stage increases of less than 0.20 feet. f) An increased demand of 5 MGD is provided for LECSA 3.

5.2.15.3 Recreation

Effects of Alt 4R and 4R2 on recreation are presented in **Table 5.2-6** with additional details provided in **Appendix C.2.2.15**. **Table 5.2-7**, **Table 5.2-8** and **Table 5.2-9** provide information as on when the FWC considers closures in the EWMA due to high or low water stages. A closure event for these tables is one or more consecutive days when high or low water criteria are met based on the two gauge average for WCA 3A-2 and WCA 3A-3.

Table 5.2-6. Environmental Effects of Alts 4R and 4R2 on Recreation

Recreation		
Geographic Regions	**FWO**	**Alt 4R and Alt 4R2**
Lake Okeechobee	No Effect	No Effect. There is no impact to recreational navigation.
Northern Estuaries	No Effect	Reductions in extremely high flows to the estuaries that currently damage fisheries habitat would provide minor and less than significant beneficial effects by enhancing utilization of the estuaries by fish and subsequently improve related recreational opportunities such as fishing, boating and kayaking.
EAA	Currently no recreation exists on the project site.	The FEB feature will add approximately 14,000 acres of recreational opportunities and recreation features similar to those in the Greater Everglades, providing a minor and less than significant beneficial effect.
Greater Everglades	Recreational hunting and fishing would be affected little if at all. Hiking, Biking and Camping will not be affected directly. Any changes in recreation would be due to degraded quality of wetlands and the aesthetic values could decrease as wildlife viewing and nature study would be degraded.	Improved hydrology will enhance wildlife populations through improved survival and reproduction, subsequently resulting in a minor and less than significant beneficial effect for outdoor recreation opportunities. Proposed facilities will enhance the public's ability to access into and within the Greater Everglades. Increased hydration in the very northern WCA 3A areas that have been drier could have a short-term significant, adverse and unavoidable effect on hunting (deer, hog, and rabbit). Conversely, a long term major significant benefit occurs due to increased fire protection for the peat soils, thus diminishing the potential for loss of this same area. Alts 4R and 4R2 incorporate the least negative effect on Northern WCA 3A mammal hunting opportunities. In these northern dry areas public access is often limited to track vehicles; rehydration will increase public access through improved conditions favorable to airboats. Access for recreational fishing by power boat will have a major and adverse significant effect through backfilling the Miami Canal. This affects 14 of the 33 miles of the Miami Canal in the WCA 3. Fishing opportunities throughout the Greater Everglades will have a major beneficial effect by the improvements in boat access and the addition of access points around proposed structures. The removal of the L-29 levee will create a marsh connection to L-29 canal and enhance fishing in this canal. Improved trail heads for access and designation of blue and greenway trails will be positive. The Blue Shanty Levee will bisect L-67C. Recreational fishing by prop boat to the northern end of L67C canal would continue to be available from a new public boat ramp located in the northern end of L67C at the S151, providing a minor and less than significant beneficial effect. Also at the S151 a new public boat ramp will allow access into the northern 5 miles of the Miami Canal south of S151 not previously served by a public boat ramp. The Blue

Recreation		
Geographic Regions	**FWO**	**Alt 4R and Alt 4R2**
		Shanty levee will have an airboat crossing, at full height, so as to not bisect the airboat use within WCA 3B. A boat ramp will be added near S-333 to provide access to the L-29 canal so the L-29 divide structure does not prevent boat access. The L-29 divide structure will also serve as a pedestrian and vehicle access to the remaining L-29. The Blue Shanty Levee will serves as reroute connection for greenways trail users when the L-29 levee is removed to ensure contiguous connection east to west between S333 and S334.
Southern Estuaries	No Effect	Access to the Southern Estuaries would not change based on CEPP, however, increase in flows to Florida Bay would enhance fish populations and subsequently improve related recreational opportunities such as fishing, boating and kayaking, providing a minor beneficial effect.

Table 5.2-7. Closures Over the Period of Record in the EWMA for the ECB, FWO and Alts 4R and 4R2

Alt	High Stage Closures over POR (2 Gauge avg. > 11.6' ft)			Fire Closures over POR (2 gauge avg. <= 9.30' ft)			Total High Water and Low Water Closures			
	Closure Days	Closure Events	Avg. Closure Duration (Days)	Closure Days	Closure Events	Avg. Closure Duration (Days)	Closure Days	Closure Events	Avg. Closure Duration (Days)	% of POR-Closure
ECB	511	15	34.1	599	19	31.5	1,110	34	32.6	7.4%
FWO	441	12	36.8	677	21	32.2	1,118	33	33.9	7.5%
Alt 4R	605	17	35.6	353	12	29.4	958	29	33.0	6.4%
Alt 4R2	613	18	34.1	355	10	35.5	968	28	34.6	6.5%

Notes:

* 2 Gauge avg. is based on cells WCA 3A-2 and WCA 3A-3.

*3A-2 & 3A-3 average ground surface elevation = 9.66 ft NGVD (closure thresholds are indicated in Table 5.2.7)

Table 5.2-8. High Water Event Changes from the FWO for Alts 4R and 4R2 in the EWMA for each Month of the Year

Month	ECB	FWO	Alt 4R	Alt 4R2	Month
1	0	0	0	0	1
2	1	0	2	2	2
3	0	0	0	0	3
4	0	0	0	0	4
5	0	0	0	0	5
6	0	0	1	3	6
7	2	0	4	3	7
8	0	0	1	1	8
9	0	0	-1	-1	9
10	0	0	-2	-2	10
11	0	0	0	0	11
12	0	0	0	0	12
Total	3	0	5	6	Total

Table 5.2-9. High Water Events for the ECB, FWO, and Alts 4R and 4R2 in the EWMA for each Month of the Year

Month	ECB	FWO	Alt 4R	Alt 4R2	Month
1	0	0	0	0	1
2	1	0	2	2	2
3	1	1	1	1	3
4	0	0	0	0	4
5	0	0	0	0	5
6	2	2	3	5	6
7	3	1	5	4	7
8	0	0	1	1	8
9	2	2	1	1	9
10	5	5	3	3	10
11	1	1	1	1	11
12	0	0	0	0	12
Total	15	12	17	18	Total

5.2.16 Cultural Resources

Alternative 4R and 4R2 effects on cultural resources is presented in **Table 5.2-10.** Criteria used to evaluate the alternatives can be found in **Section 5.1**. A description of full preliminary analysis, background information and descriptions of terms are presented in **Appendix C.2.2.17**.

In conjunction with the National Historic Preservation Act (NHPA), formal consultation was initiated with the Seminole Tribe of Florida's Tribal Historic Preservation Office (THPO); the Miccosukee Tribe of Indians of Florida's NAGPRA Representative; the Florida State Historic Preservation Office (SHPO); Everglades National Park's, Chief of Cultural Resources; and the Florida Bureau of Archaeological Research. During formal consultation, a number of conclusions were drawn (**Appendix C.5**): (1) It was determined that additional surveys were needed to identify cultural resources within specific areas of potential effect. (2) It was decided that as the CEPP project progressed, additional surveys may be needed, specifically during the PED phase, when feature designs were finalized and construction staging areas were determined. (3) Section 106 compliance with the NHPA would be conducted separately from

NEPA and would not be completed during the current feasibility phase of the project, however would be complete prior to construction of each feature.

Under the NEPA process (Section 40CFR1501.2(d) (2)), formal consultation regarding cultural resources has been completed and is final for the CEPP feasibility study. For consideration under the NHPA, determinations of potential effects and mitigation of those effects on cultural resources listed in **Table 5.2-10.** are preliminary and should not be considered final. As required under the NHPA, further Section 106 (36 CFR Part 800) consultation is required and will be completed during the PED phase. The CEPP is currently in compliance with the procedural requirements of the NHPA and will remain in compliance with the NHPA pre and post construction.

Avoidance of adverse effects to cultural resources is the Corps preference, therefore, throughout the planning process for CEPP, the project archaeologist, engineers, and plan formulators have worked closely to determine alternatives and features of alternatives that reduce or eliminate impacts to cultural resources. Pursuant to NHPA implementing regulations, 36 CFR 800.1, where possible, the project design will be modified to avoid impacting significant historic properties and culturally significant sites. Where avoidance is not possible, other mitigation measures will be considered, which could include but are not limited to data recovery excavations. The mitigation measures will be developed in consultation with SHPO, tribal groups and other interested parties as established in implementing regulations for Section 106 of the NHPA.

For this document, the use of the term cultural resources includes historic properties eligible or potentially eligible for NRHP listing and culturally significant sites. For definitions of terms, see **Section 10**.

Table 5.2-10. Environmental Effects of Alt 4R and 4R2 on Cultural Resources

Cultural Resources (Please refer to Cultural Resource in Appendix C.2.2 for further details)		
Geographic Regions	**FWO**	**Alt 4R and Alt 4R2**
Lake Okeechobee	No effect on cultural resources.	
Northern Estuaries	No effect on cultural resources.	
EAA, including Associated Canals and Structures	If agricultural practices continue, long-term adverse effect on significant cultural resources sites 8PB16039 and 8PB16040.	Major long-term adverse effect on cultural resources sites 8PB16039 and 8PB16040. Mitigation of effects for historic property 8PB16039 potentially reduced. Mitigation of effects for culturally significant site 8PB16040 is unknown.
L-4 Spreader Feature	The L-4 (8BD5098) is not significant. No effect on cultural resources.	
S-8 Pump Complex	No effect on cultural resources.	Unknown - assessment needed for historic property 8BD5092. If applicable, mitigation could potentially reduce effects.
L-5 Deepening/Widening	The L-5 (8BD5099) is not significant. No effect on cultural resources.	
L-6 Deepening/Widening	No effect on cultural resources.	Unknown – assessment needed for the L-6 levee and associated canal. If applicable, potential mitigation could potentially reduce effects.

Cultural Resources (Please refer to Cultural Resource in Appendix C.2.2 for further details)		
Geographic Regions	**FWO**	**Alt 4R and Alt 4R2**
Miami Canal	No effect on cultural resources.	Major long-term adverse effects on historic properties 8PB4840/8BD5097. Mitigation could potentially reduce effect.
L-67A Levee and Canal	No effect on cultural resources.	Potentially major to moderate long-term adverse effect on sites with cultural significance to members of the Miccosukee Tribe of Indians of Florida. If unable to avoid, mitigation unknown. The L-67A (8BD5100) is not significant. No effect on historic properties.
L-67C Levee and Canal	No effect on cultural resources.	
L-29 Levee	No effect on cultural resources.	Major long-term adverse effect on sites culturally significant to the Miccosukee Tribe of Indians of Florida and that are potential historic properties. Potential mitigation could reduce effect.
S-333 Pump Station	No effect on cultural resources.	
New Levee(L-67D) within WCA 3B and Flow Way (Blue Shanty Flow Way)	No effect on cultural resources.	Potentially adverse effect to cultural resources/Unknown - survey needed. Mitigation unknown.
Old Tamiami Trail	No effect on cultural resources.	Major long-term adverse effect. Potential mitigation could reduce effect.
L-67 Ext. Levee	No effect on cultural resources.	
L-31N Levee	No effect on cultural resources.	Potentially major long-term adverse effect to site 8DA2104. Potential mitigation could reduce effect.
S-356 Pump Station	No effect on cultural resources.	
L-28 Levee and Canal	No effect on cultural resources.	Not Applicable
G-211 Operational Refinements	No effect on cultural resources.	
S-334 to S335 Seepage Barrier	No effect on cultural resources.	
Draft Preliminary Operations Plan	Unknown overall effects on cultural resources. Approximately 350 cultural resources sites including five districts, two traditional cultural properties, multiple culturally significant properties and one World Heritage site (ENP) within APE for CEPP. ERTP investigations are projected to be completed ca. 2016.[1] Mitigation unknown.	

[1] ERTP cultural resources investigations specified through the Corps' executed Programmatic Agreement dated August 2012, to identify effect (if any) to subsurface cultural resources material caused by fluctuating water will be completed ca. 2016. This information, including other updated research available at the time, will be utilized in advance of CEPP to determine additional mitigation needs (if any) for effects of fluctuating water on subsurface cultural resources materials above and beyond those already mitigated for ERTP or as required by other actions.

5.2.17 Invasive Species

Alt 4R has the potential and likelihood for establishment and spread of non-native invasive and native nuisance species (**Table 5.2-11**). Proposed restoration activities may affect ecosystem drivers that

directly or indirectly influence the invasiveness of non-native species. These factors may affect invasive species positively or negatively, depending on the unique characteristics of individual species and the environmental conditions for a given biological invasion (Doren et al. 2009). For example, shortened surface water drawdowns may reduce the recolonization rates of melaleuca in sawgrass marsh while increasing habitat suitability for Old World climbing fern in tree islands. Many of the areas where features are proposed are currently inhabited by non-native invasive and native nuisance species. Construction of the proposed features has the potential to spread the existing non-native invasive and native nuisance species on site as well as introduce new invasive species via contaminated equipment. Disturbed areas resulting from construction are likely to become established with non-native invasive and native nuisance species. New flows created by operations of the proposed features may serve as vectors to spread invasive and native nuisance species into new areas. The large number of existing and potential invasive plant and animal species and the often incomplete knowledge of invasive mechanisms for each species create moderate to high uncertainty in this evaluation. Long-term monitoring in an adaptive management framework is critical to ensure efficient management of the most threatening non-native invasive species in the restoration footprint. A more detailed description of the potential effects of each feature is provided in **Appendix C.2.2.18**.

Table 5.2-11. Environmental Effects of Alts 4R and 4R2 on Invasive Species

Invasive Species		
Feature	**FWO**	**Alt 4R and Alt 4R2**
Lake Okeechobee and Northern Estuaries	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species; Invasion pathway to/from lake and estuaries.	Same as FWO.
A-2 Flow Equalization Basin	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species; Invasion pathway to/from lake and estuaries. Vegetation management challenges in downstream STA's from continued stormwater pulses.	Moderate to major increase in invasive and nuisance plant and fish species thrive in FEB; Management options limited to mitigating impacts to FEB operations; Potential invasion pathway to WCA's.
Diversion of L-6 Flows and L-5 Improvements	Negligible effect on invasive and nuisance vegetation and non-native fish species, continue to persist at baseline levels.	Negligible to moderate reduction of SAV; Minor to moderate habitat improvement for non-native tropical fish species.
L-4/L-5 Spreader Canal and Levee Degradation	Moderate to major recruitment of existing invasive species in WCA 3A. OMRR&R of canal/levee minimize colonization of certain invasive species.	Minor reduction in recruitment of some invasive and nuisance species; Moderate to major expansion of obligate wetland invasive species in spreader canal and south of spreader canal; Spreader canal is a potential invasion pathway for aquatic species; Portions of remaining levee are habitat for Burmese pythons.

Invasive Species		
Feature	**FWO**	**Alt 4R and Alt 4R2**
L-28 Degradation and Backfill	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species; OMRR&R of canal levee will minimize colonization of certain invasive species.	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Moderate to major expansion of uncontrolled species; Lack of OMRR&R on remaining levee will promote colonization of certain invasive species.
Increase Capacity of S-333	Negligible effects on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Invasion pathway for aquatic invasive species downstream.	Same as FWO.
L-67A Gated Structures / Spoil Removal and L-67C Degradation	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species; Invasion pathway for aquatic invasive species downstream.	New invasion pathway for aquatic plant and animal species between WCA 3A and 3B; Moderate to major expansion of cattail downstream of structures; plant and animal habitat reduced by spoil removal. Isolated remnants of L-67C will create invasive plant and animal habitat.
Outflow Structures out of WCA 3B	Invasive and nuisance species persist, negligible effects; barriers for water surface connectivity are present.	New invasion pathway for aquatic plant and animal species between WCA 3B and ENP. Potential for minor to moderate expansion of species.
L-67 Extension Levee Degrade/Backfill	Invasive and nuisance species persist on levee and in canal, negligible effects; continued cattail expansion west of L-67 Extension.	Minor to moderate reduction in habitat for some invasive plants, fish and reptiles by levee removal and canal backfill; Improved habitat for obligate wetland invasive species, minor to moderate expansion of species.
G-211 Operational Modifications / Coastal Canals Conveyance	Negligible effects on actively managed invasive and nuisance species, continue to persist or decrease; Minor expansion of uncontrolled species; Invasion pathway for aquatic invasive species downstream.	Same as FWO.
Increase S-356 Capacity to 1,000 cfs	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Negligible reduction in invasive plant recruitment, minor to moderate improved conditions for obligate wetland invasive species, and potential expansion of cattail in northern ENP.
Miami Backfill S-8 to I-75	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Spoil mound removal/canal backfill reduces habitat for some invasive species, minor to moderate effects; Tree islands vulnerable to invasive plant and animal colonization, minor to moderate effects; Minor to moderate expansion of obligate wetland invasive species in backfill area.
Build North South Levee in WCA 3B	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Moderate to major potential increased invasive species due to levee construction; Increased cattail along levee in WCA 3B.

Invasive Species		
Feature	**FWO**	**Alt 4R and Alt 4R2**
L-29 degradation	Invasive and nuisance species persist; Invasion pathway for aquatic invasive species into ENP.	New invasion pathway for aquatic plant and animal species between L-29 and WCA 3B, possible minor to major expansion.
Divide Structure on L-29	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Increased OMRR&R management of aquatic invasive and nuisance plants, minor to moderate effects.
Remove Old Tamiami Trail	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Habitat removal for many established invasive plant and animal species, moderate effects; expansion of obligate wetland invasive species from canal into ENP, potential for minor to moderate effects.
Penetrating Seepage Barrier	Negligible effect on actively managed invasive and nuisance species, continue to persist at baseline levels or decrease; Minor to moderate expansion of uncontrolled species	Moderate reduction in invasive plant recruitment; improved conditions for obligate wetland invasive species.

5.3 EFFECTS ON NATIVE AMERICANS

The Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida rely upon the Everglades in its natural state to support their cultural, subsistence, and commercial activities. Portions of the Tribes' Federal Reservation lands are either partially situated or immediately adjacent to WCA 3A (**Figure C.1-18 in Appendix C.1.**). In addition, the Tribes hold easements and leases from the State of Florida over large portions of the WCA 3A. Subsistence activities for members of the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida include gathering of materials, hunting, trapping, frogging, and fishing; while the Miccosukee Tribes of Indians of Florida's commercial activities additionally include frogging, airboat and other guided tours, and providing recreational and tourism facilities within the Everglades.

5.3.1 Miccosukee Tribe of Indians of Florida

General background information on the Miccosukee Tribe is provided in **Section 2.6 Native Americans**. The changes in hydrology from the final array of alternatives for areas of interest to the Miccosukee Tribe are summarized in **Table S.1-2** and **Table 5.2-1** and described in more detail in **Appendix C.2.1** and **Appendix C.2.2** along with effects on species and other environmental effects.

Representatives for the Miccosukee Tribe of Indians have indicated that restoration of conditions in northwestern WCA 3 towards conditions presently observed in the central portion of WCA 3A, referred to as the South Grass, would be beneficial. Representatives of the Miccosukee Tribe of Indians also requested that CEPP consider levee gapping and backfilling of the L-28 levee and canal to re-connect WCA 3A to the Tribal lands located west of the L-28 Levee south of I-75. Several variable configurations of L-28 levee degrade and canal backfill were modeled during the screening phase of the CEPP and these results were shared with representatives of the Tribe to determine what configuration should be considered in more detail within the final array of alternatives. The Tribe's representatives indicated that application of the objectives and habitat performance metrics of CEPP for the greater Everglades were appropriate for the L-28 Triangle area.

All of the CEPP alternatives show marked improvement in hydroperiod and hydropatterns in northwestern WCA 3A. Resumption of sheetflow and related patterns of hydroperiod extension and increased water depths will significantly help to restore and sustain the micro-topography, directionality, and spatial extent of ridges and sloughs and to improve the health of tree islands in the ridge and slough landscape. Although none of the alternatives would provide the necessary inundation pattern for complete slough vegetation restoration, all action alternatives act to rehydrate northern WCA 3A, promoting peat accretion, reducing the potential for high intensity fires, and promoting transition from upland to wetland vegetation.

All CEPP alternatives result in similar patterns of rehydration within northern WCA 3A and all significantly decrease the amount of time when this region experiences dry out conditions. Gauge 3A-3 in northeastern WCA 3A, used to track droughts, indicates that with the FWO this area will continue to experience water levels below ground 25-30% of the time and that water depths will exceed three feet approximately 1-2% of the time. Tree islands are connected to the surrounding peat marshes via the roots of the trees. Although tree roots are still receiving water from wicking within the peat (unless the tree island is rocky), when the water table drops below these roots, the microclimate of these islands gets too dry and they can burn. All CEPP action alternatives create the hydrology necessary to restore tree islands and reduce the potential for devastating fires. Under all CEPP alternatives, the duration of water above marsh surface increases to 85-90% (10-15% below ground), but at the same time, tree island flooding stress (i.e., ponding depths greater than 3.0 ft) remained extremely rare and slightly reduced compared to the FWO. Rehydration of northern WCA 3A is expected to prevent further tree island degradation and peat fires, and set in motion trends to restore ridge-slough-island patterns. With all CEPP action alternatives, northern WCA 3A will no longer have extremely short hydroperiods. Instead, this area will have more spatially uniform hydroperiods that vary between 120 and 240 days.

Compared to the FWO, Alt 4R and Alt 4R2 stages immediately west of the L-28 Levee are increased by 0.1-0.2 feet under wet to normal hydrologic conditions and increased by 0.2-0.3 feet under normal to dry hydrologic conditions, with no significant change indicated for extreme wet or dry conditions. Stage increases are only observed for the RSM-GL cells located immediately west of the L-28 Levee, which correspond to approximately 1-2 miles west of L-28. Average annual hydroperiods for these cells within the Miccosukee Tribe of Indians of Florida's Alligator Alley Reservation, north of Interstate 75, are increased by 10 to 60 days with Alt 4R and Alt 4R2 (FWO hydroperiods range from 25-150 days), with no significant hydroperiod changed indicated for the 2-3 miles south of L-4 (FWO hydroperiods range from 0-15 days) .

Alt 1 included gapping of the mid-portion of the L-28 Levee and backfilling of the mid-section of the L-28 canal, south of I-75. By re-establishing a surface water hydrologic connection between WCA 3A and the L-28 Triangle, stages within the Triangle associated with Alt 1 were generally increased by 0.2-0.5 feet during nearly all hydrologic conditions, excluding the driest 25% of hydrologic conditions. However, this component was not brought forward into the recommended plan at the request of the representatives for Miccosukee Tribe of Indians of Florida. Although Alts 2 through 4 do not include modifications to the L-28 Levee or the adjacent canal, stages within the L-28 Triangle are slightly increased by 0.1-0.2 feet during normal to dry conditions, due to groundwater interactions with the down-gradient western WCA 3A marsh. Similarly, although Alt 4R and Alt 4R2 do not include modifications to the L-28 Levee or the adjacent canal, stages within the L-28 Triangle are slightly increased by 0.1-0.2 feet during nearly all hydrologic conditions, with no stage increases indicated during extreme wet hydrologic conditions.

The WCA 3 tributary basins include the C-139, Feeder Canal, L-28 Interceptor, and L-28 Gap (located within the Big Cypress National Preserve) basins, which encompasses approximately 440,000 acres located primarily in eastern Hendry County (**Figure 5-1**and **Figure 5-2**). These basins are collectively called the Western Basins because they are along the western edge of the Everglades. Generally, land within these basins have three classifications: 1) agricultural (vegetable, sugarcane, and citrus), 2) cow-calf operations, and 3) wetlands and native areas. Agricultural land dominates the C-139 and Feeder Canal basins. While the L-28 interceptor basin land use is split between wetlands and agricultural. The L-28 Gap Basin consists almost entirely (98 percent) of wetlands. Urban land classifications occupy 4 percent of the C-139 Basin. Overall, agricultural land uses and urban lands are projected to remain stable. A portion of the Miccosukee Tribe of Indians of Florida's Alligator Alley Miccosukee Reservation is located within the Western Basins (**Figure 5 - 2**) with water supply needs for its residents, agriculture and wetlands. Both water supply and water quality of stormwater runoff are challenges facing the development of the Western Basins.

Within central WCA 3A (3A-4), stages are generally increased by 0.1-0.2 feet during average to dry conditions, with a slight depth reduction during the wettest 10% of conditions and no significant change during extreme dry conditions for Alts 1 through 4; with Alt 4R and Alt 4R2, stages are generally increased by 0.1-0.2 feet during average to dry conditions, with a slight depth reduction during the wettest 10% of conditions and no significant change during extreme dry conditions.

Southern WCA 3A (3A-28) stages are decreased by 0.1-0.2 feet during the wettest 5% of conditions and slightly decreased during normal to dry conditions for Alts 1 and 4; for Alts 2 and 3, southern WCA 3A stages are decreased by 0.1-0.2 feet during the wettest 5% of conditions and decreased by 0.1-0.2 feet during wet, normal, and dry conditions; and for Alt 4R and Alt 4R2, stages are decreased by 0.1-0.2 feet during the wettest 5% of conditions and slightly decreased during normal to dry conditions. This information has been provided to representatives of the Tribe through PDT meetings and additional individual meetings with representatives of the Tribe.

The WCA 3B hydrologic effects, resultant from the water budget differences, vary significantly between the alternatives. At Site 71 for Alt 1, WCA 3B stages are increased by 0.1-0.2 feet during the wettest 10% of conditions and during normal to dry conditions, compared to the FWO; for Alt 2, stages are significantly increased by 0.3-0.5 feet under all hydrologic conditions; for Alt 3, stages are significantly increased by 0.2-0.3 feet during the wettest 10% of conditions and during normal to dry conditions; for Alt 4, stages are slightly increased during the wettest 10% of conditions and increased by 0.1-0.2 feet during normal to dry conditions; and for Alt 4R and Alt 4R2, stages are increased under all hydrologic conditions, including stage increases of 0.1 feet during the upper 20% of the stage duration curve, stage increases of 0.2-0.3 feet for normal to dry conditions, and a slight stage increase during extreme dry conditions. For Alt 4R2, the peak stage within the Blue Shanty flow-way is 9.70 feet NGVD and stages exceed 8.0 feet NGVD for approximately 45% of the period of simulation.

Two Native American family group settlements are located along the eastern section of the L-29 Canal, the Tigertail Camp and the Osceola Camp. The Tigertail Camp is located north of Tamiami Trail between the L-29 Canal and the L-29 Levee, approximately 0.75 miles east of S-355A and east of the proposed L-29 divide structure. Vehicle access is by means of unimproved roads adjacent to and on top of the L-29 Levee that intersect the Tamiami Trail at canal crossings at each end of the eastern section of the L-29 Canal (near S-333 and S-356). A pedestrian bridge crossing the canal connects a small parking area along the northern side of the highway to the Tigertail Camp. Elevation of the Tiger Tail Camp was

raised as part of the Modified Water Deliveries Project to elevation 12.5 ft-NGVD and is sufficient to protect this area from flooding with implementation of CEPP recommended plan (Alt4R2).

The Osceola Camp is located on the south side of the Tamiami Trail approximately one-half mile east of the S-333 structure, south of the proposed L-29 Levee degrade for the proposed Blue Shanty flow-way. Access is by vehicle directly from the highway. Peak simulated L-29 Canal stages (within the proposed WCA 3B flowway) for Alt 4R2 are 9.59 feet NGVD west of the proposed L-29 divide structure, with stages above 8.0 feet NGVD approximately 35% of the time compared to less than 2% for the FWO condition. East of the proposed L-29 divide structure, the peak simulated L-29 Canal stage is 9.50 feet NGVD, with stages above 8.0 feet NGVD approximately 20% of the time compared to less than 2% in the FWO condition. The current elevation of the Osceola Camp is not sufficient to prevent flooding of this area with implementation of the CEPP recommended plan, which relies upon implementation of the DOI Tamiami Trail Modifications: Next Steps project outlined in the Final Environmental Impact Statement November 2010, with a Record of Decision signed February 11, 2011. Implementation of the chosen alternative (6e) of the Tamiami Trail Modifications: Next Steps would require the Osceola Camp ground to be elevated to 12.5, with non-residential finished floor to 12.83 and residential finished floor to 13.5 feet NGVD. DOI will be responsible as part of the implementation of the Tamiami Trail Modifications: Next Steps to raise the Osceola Camp to the levels above expected flood levels.

Compared to the FWO, stages within northwest ENP (NP-201) which is the gage closest to the Miccosukee Tribe of Indians of Florida's Trail Reservation along Tamiami Trail are generally significantly decreased by 0.1-0.4 feet under all hydrologic conditions for Alt 1; For Alt 2 and Alt 3, NP-201 stages are slightly decreased during wet conditions, slightly increased during normal conditions, and decreased by 0.1-0.3 feet under normal to dry conditions; for Alt 4, NP-201 stages are slightly decreased during extreme wet conditions, increased by 0.1-0.2 feet during normal conditions, and decreased by 0.1-0.2 feet under normal to dry conditions; and for Alt 4R and Alt 4R2, stages within northwest ENP are generally significantly decreased by 0.1-0.3 feet under both wet and dry hydrologic conditions; stages are slightly increased or unchanged from the FWO for normal hydrologic conditions between approximately 35% and 55% on the stage duration curve. To the south and west, the NP-205 monitoring gage indicates a potentially significant stage decrease of 0.1-0.2 feet under all hydrologic conditions for all action alternatives, compared to the FWO.

Regarding the features of the final array of alternatives, the representatives for the Miccosukee Tribe of Indians of Florida has indicated that: 1) the reliance on additional bridging along the Tamiami Trail associated with the DOI Tamiami Trail Next Steps Project is not supported by the Tribe; 2) the additional pumps along the L-29 levee associated with Alt 3 would not be supported by the Tribe; 3) that construction of the Blue Shanty Levee associated with Alt 4, Alt 4R, and Alt 4R2 and the additional spreader canals along northern WCA-3A associated with Alts 2 - 4 seems counter-intuitive to goals of restoration to decompartmentalize the system. Additionally, the Tribe has indicated that none of the alternatives address their concerns regarding the quality of water entering the system at the S-140 pump station from the western basins. Tribal representatives have also reiterated the call for attention to the need for water to be returned to a natural sheetflow over the entire Everglades regions, including western Shark Valley Slough.

5.3.2 Seminole Tribe of Florida

General background information on the Seminole Tribe of Florida is provided in **Section 2.6**. The changes in hydrology from the final array of alternatives for areas of interest to the Seminole Tribe of

Florida are summarized in **Table 5.1-2** and **Table 5.2-1** and described in more detail in **Appendix C.2.1** and **Appendix C.2.2** along with effects on species and other environmental effects.

The Corps submitted a letter to the Chairman of the Seminole Tribe of Florida on December 7, 2011 outlining the scope of the CEPP requesting to meet with the Tribe routinely throughout the planning process and their participation on the Project Delivery Team to ensure any issues or concerns the Tribe may have are identified and to get their input regarding development of the plan (**Appendix C.3.1**). The scope of the planning effort was described and referenced development of the first increment of a subset of CERP project features that provide for storage, treatment and conveyance south of Lake Okeechobee, modifications to canals and levees within WCA 3 to re-distribute water flow, and seepage management features to retain water within the natural system. The components referenced were those CERP components that had been identified to accomplish these objectives, which included the Everglades Agricultural Area Storage Reservoir, Modified Holey Land Wildlife Management Area Operation Plan, Flow to Northwest and Central WCA 3A, Water Conservation Area 3A Decompartmentalization and Sheetflow Enhancement, Dade-Broward Levee/Pennsuco Wetlands, Bird Drive Recharge Area, L-31 N Improvements for Seepage Management and S-356 Structures, and Everglades Rain-Driven Operations. These CERP projects included project features within the EAA, WCA 3 and along L-31 north levee which comprises the eastern border of ENP. The figure included in the scoping letter outlined the area where potential effects would be considered which extended beyond the construction footprint of the CERP project components outlined in the scoping letter. The figure included the northeastern and southerly portions of the western basins which border the EAA and the northwest corner of WCA 3A as areas where potential effects would be considered.

The WCA 3 tributary basins include the C-139, Feeder Canal, L-28 Interceptor, and L-28 Gap (located within the Big Cypress National Preserve) basins, which encompasses approximately 440,000 acres located primarily in eastern Hendry County (**Figure 5-1** and **Figure 5-2**). These basins are collectively called the Western Basins because they are along the western edge of the Everglades. Generally, land within these basins have three classifications: 1) agricultural (vegetable, sugarcane, and citrus), 2) cow-calf operations, and 3) wetlands and native areas. Agricultural land dominates the C-139 and Feeder Canal basins. While the L-28 interceptor basin land use is split between wetlands and agricultural. The L-28 Gap Basin consists almost entirely (98 percent) of wetlands. Urban land classifications occupy 4 percent of the C-139 Basin. Overall, agricultural land uses and urban lands are projected to remain stable. A portion of the Seminole Tribe of Florida's Big Cypress Reservation is located within the Western Basins (**Figure 5 - 2**) with water supply needs for its residents, agriculture and wetlands. Both water supply and water quality of stormwater runoff are challenges facing the development of the Western Basins.

During the scoping phase of the CEPP study, representatives for the Seminole Tribe of Florida participating in the PDT meetings requested that CEPP consider opportunities to re-direct undesirable discharges from Lake Okeechobee to the Northern estuaries to the Western Basins for purposes of restoring natural areas within the Seminole Tribe of Florida's Big Cypress Reservation and the adjacent Big Cypress National Preserve. The Corps subsequently received a letter from the Seminole Tribe of Florida in July 2, 2012 expressing their concerns over reserving water necessary to support healthy ecosystems on the Seminole Tribe of Florida's Big Cypress Reservation and neighboring Big Cypress National Preserve not being included in the developing CEPP plan.

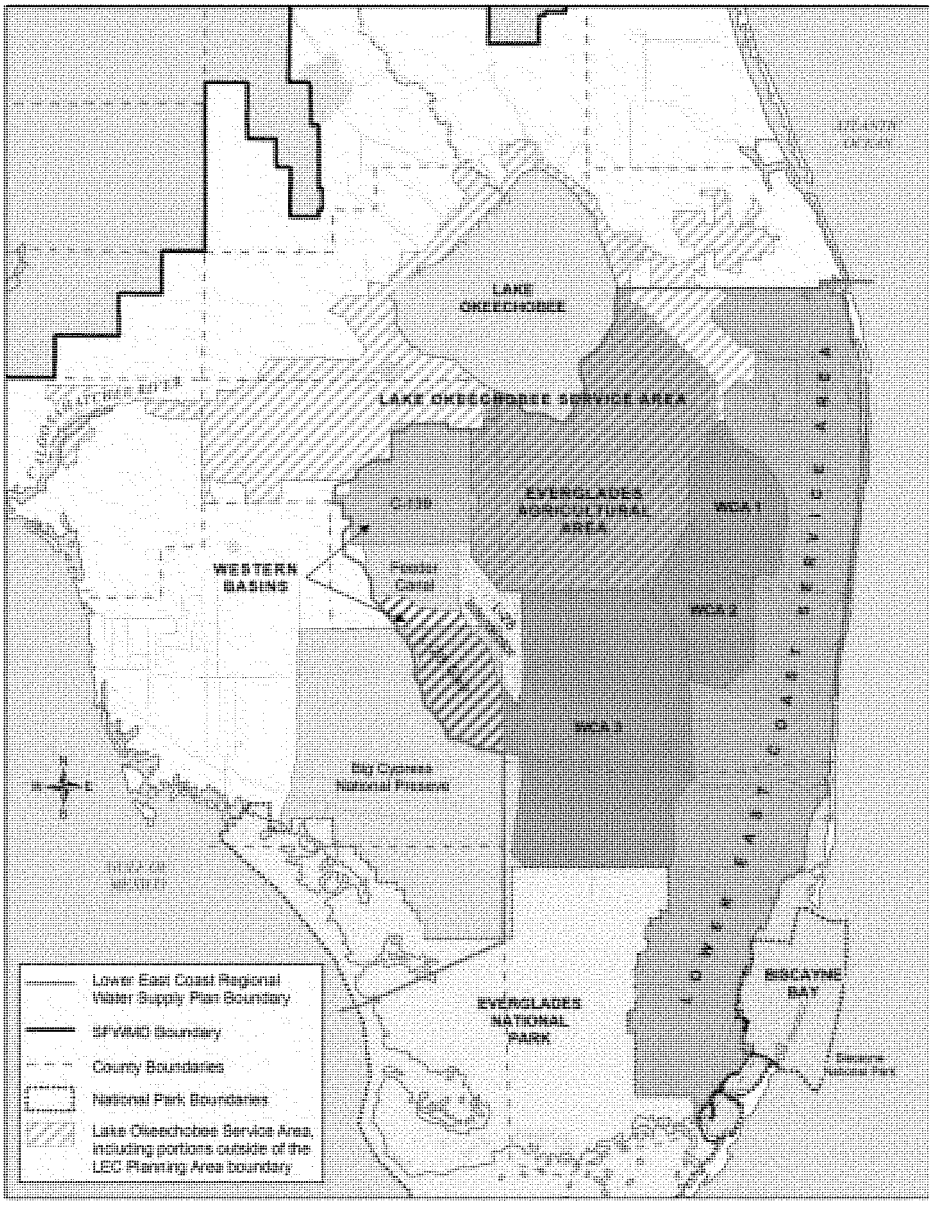

Figure 5-1. Everglades Agricultural Area, Western Basins and Surrounding Basins

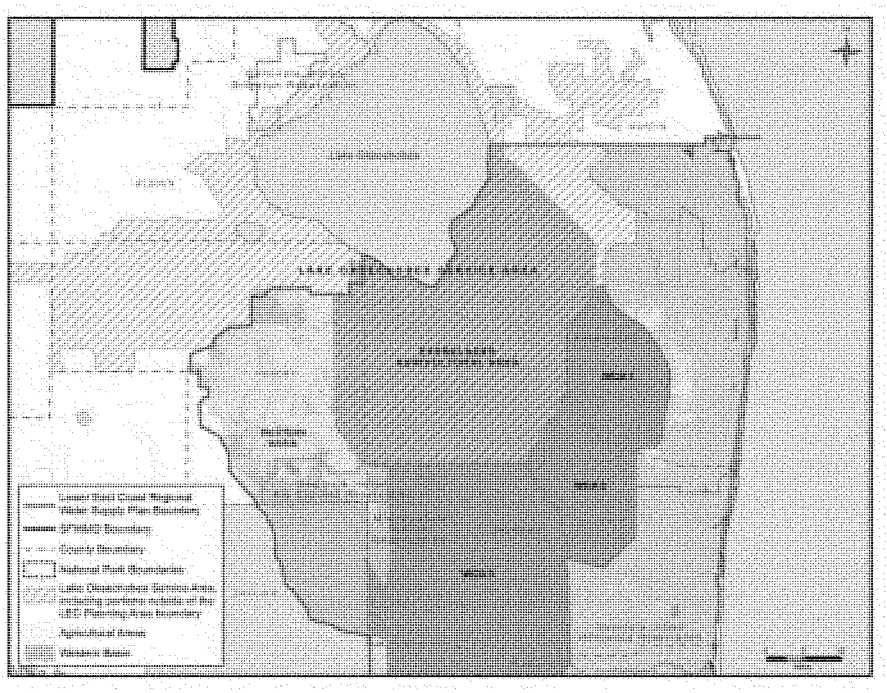

Figure 5-2. Western Basins Map Showing the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida Reservations

The Corps remains fully committed to ecosystem restoration and over the past several years has found success in doing so through continued engagement with key partners and stakeholders. The Seminole Tribe of Florida's interest in seeing the CEPP used as a planning vehicle to deliver the long-term hydrologic benefits is understandable. However, within the broader CERP, the current CEPP study cannot specifically address several restoration projects, to include the delivery of water to the Big Cypress Reservation. To support restoration, the CEPP study sought to identify a suite of projects that most effectively capitalized on existing data, knowledge, evaluation tools, previously constructed restoration features, land in Public ownership, and lands currently available. Implementing an incremental approach along with the continued gathering of critical scientific data and knowledge will certainly facilitate future studies and subsequent progress in restoration.

The Seminole Tribe of Florida issued a Minority View for inclusion in the South Florida Ecosystem Restoration Task Force 2012 Strategy and Biennial Report (http://www.sfrestore.org/documents/2012_sbr.pdf.) that represents the culmination of and seeks a response to, the Tribe's long standing concerns for natural systems in the western basins of the Everglades:

- adequate water supply for the environment in the western basins
- the lack of attention by Federal and State resource agencies on western basin conditions

The following is an excerpt from the Seminole Tribe of Florida's Minority View included in the South Florida Ecosystem Restoration Task Force 2012 Strategy and Biennial Report (http://www.sfrestore.org/documents/2012_sbr.pdf.):

> "In consideration of the 2012 South Florida Ecosystem Restoration Task Force Strategy and Biennial Report, the Seminole Tribe of Florida seeks to amend the report with the following note. As background, over the past six months, the Corps explained that CEPP projects would not be available to contribute to resolving challenging hydrology problems on the Big Cypress Reservation because the western basins have never been appropriately modeled to allow effective planning. The Tribe once again requests that the western basins be monitored and modeled. The Tribe seeks a response in the Task Force's strategy for how to address the western basins in the restoration of the South Florida Ecosystem."

A subset of Task Force member agencies has convened to discuss this issue and specific concerns raised by the Tribe:

- The Big Cypress Reservation Critical Project is not operating as intended;
- Natural areas in the reservation and downstream are experiencing negative ecological impacts, affecting core Tribal values;
- The CEPP does not address problems in the western basins;
- The Tribe's concerns are long standing and have not been addressed.

The Tribe reiterated their concerns with the hydrology and inadequate water supply for the environment in the western basins (C-139, Feeder Canal, L-28, and L-28 Gap) as more recently evidenced by the negative impact of low water levels on the Big Cypress Reservation Critical Project. Further, the Tribe re-emphasized the call for attention to the area as evidenced by the lack of monitoring, data, and models – a situation that prevents the Tribe, and everyone else, from being able to adequately assess the impacts of water resource management decisions on lands in the western basins.

The Tribe has expressed the importance of these concerns as factors affecting the traditional Seminole Tribe of Florida's cultural, and recreational activities, as well as commercial endeavors, which are dependent on a healthy Everglades ecosystem.

A subset of Task Force member agencies has convened to discuss this issue and other specific concerns raised by the Tribe. A mission statement has been drafted in support of the restoration of the Seminole Tribe of Florida's Big Cypress Reservation natural areas and adjacent portions of the Big Cypress National Preserve. Its purpose is to identify and recommend to the SFERTF opportunities to restore ecological and culturally utilized natural areas within the Big Cypress Reservation and adjacent portions of the Big Cypress National Preserve to support the designated uses of water bodies including wetlands

CEPP deliveries to northern WCA-3A will benefit the Tribe's hunting, fishing, trapping and frogging rights (1987 Tribe, SFWMD and State of Florida Settlement Agreement) along the approximate 14,720 acres on the NW corner of the WCA-3A. As a result of reduced freshwater inflow and drainage by the Miami Canal, northern WCA 3A is currently dominated largely by mono-specific sawgrass stands and lacks the diversity of communities found in central and portions of southern WCA 3A. Implementation of any of the CEPP action alternatives is expected to rehydrate much of northern WCA 3A by redistributing treated STA discharges from the L-4 and L-5 Canals north of WCA 3A in a manner that promotes natural

sheetflow and by removing the drainage effects associated with the Miami Canal. Compared to the FWO, Alt 4R and Alt 4R2 stages immediately west of the L-28 Levee are increased by 0.1-0.2 feet under wet to normal hydrologic conditions and increased by 0.2-0.3 feet under normal to dry hydrologic conditions, with no significant change indicated for extreme wet or dry conditions. Stage increases are only observed for the RSM-GL cells located immediately west of the L-28 Levee, which correspond to approximately 1-2 miles west of L-28. Average annual hydroperiods for the southernmost cells within the Seminole Tribe of Florida's Big Cypress Reservation are increased by 10 to 60 days with Alt 4R and Alt 4R2 (FWO hydroperiods range from 25-150 days), with no significant hydroperiod change indicated for the northernmost cells 2-3 miles south of L-4 (FWO hydroperiods range from 0-15 days) .

Resumption of sheetflow and related patterns of hydroperiod extension and increased water depths will significantly help to restore and sustain the micro-topography, directionality, and spatial extent of ridges and sloughs and improve the health of tree islands in the ridge and slough landscape. Although none of the alternatives would provide the necessary inundation pattern for complete slough vegetation restoration, all action alternatives act to rehydrate northern WCA 3A, promoting peat accretion, reducing the potential for high intensity fires and promoting transition from upland to wetland vegetation.

Representatives for the Seminole Tribe of Florida have indicated that none of the CEPP alternatives provide additional water to the Seminole Tribe of Florida's Big Cypress Reservation and therefore do not address the problems they have identified in the western basins.

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6.0 RECOMMENDED PLAN

Please open the foldout figure at the end of this section for reference while reading.

The Central Everglades Planning Project (CEPP) will begin to reverse over 100 years of human induced environmental degradation within the central portion of the globally significant Everglades ecosystem. Restored water depth, duration and distribution in Water Conservation Area (WCA) 3A, WCA 3B and Everglades National Park (ENP) will serve to recreate a landscape characteristic of a pre-drained system that will support a healthy mosaic of plant and animal life. The restored hydrology of the Everglades ecosystem will more closely resemble a natural occurring rainfall driven system with wet and dry cycles essential to flora and fauna propagation. Improved water depth and sheet-flowing distribution will begin to re-establish the unique ridge, slough and tree island micro-topography that once provided sustenance to the vast diversity of the species inhabiting the Everglades.

The recommended plan will benefit the Caloosahatchee and St. Lucie Estuaries by decreasing the number and severity of high volume regulatory flood control releases sent from Lake Okeechobee. This will be accomplished by redirecting approximately 210,000 acre-feet average per year of additional water to the historical southerly flow path south through flow equalization basins (FEBs) and existing stormwater treatment areas (STAs). The STAs reduce phosphorus concentrations in the water to meet required water quality standards. Rerouting this treated water south and redistributing it across the degraded L-4 Levee will facilitate hydropattern restoration in WCA 3A. This, in combination with Miami Canal backfilling and other CEPP components, is paramount to re-establishing a 500,000-acre flowing system through the northernmost extent of the remnant Everglades. The treated water will be distributed through WCA 3A to WCA 3B and ENP via new gated control structures and creation of the Blue Shanty flowway. The Blue Shanty flowway will restore continuous sheet-flow and re-connection of a portion of WCA 3B to ENP.

6.1 PLAN DESCRIPTION

6.1.1 Plan Features

The components of the recommended plan, Alternative (Alt) 4R2, are organized into four geographic areas: North of the Redline, South of the Redline, the Green/Blue lines and along the Yellowline.

I. **Everglades Agricultural Area (EAA)** (North of the Redline) includes construction and operations to divert, store and treat Lake Okeechobee regulatory releases.

Storage and treatment of new water will be possible with the construction of a 14,000 acre FEB and associated distribution features on the A-2 footprint that is operationally integrated with the State-owned and State-constructed A-1 FEB and existing STAs. The A-2 FEB will accept EAA runoff and a portion of the Lake Okeechobee water currently discharged to the estuaries. This Lake Okeechobee water will be diverted to the FEB when FEB/STAs and canals have capacity. The C-44 Reservoir also collects water that would go to the St. Lucie Estuary, and CEPP modifies operations of the reservoir to return a portion of this water back to Lake Okeechobee, from which water can be delivered to the FEB or used to provide water supply deliveries.

CEPP benefits gained from sending new water south from Lake Okeechobee are derived in part from operational refinements that can take place within the existing, inherent flexibility of the 2008 Lake Okeechobee Regulation Schedule (LORS), and in part with refinements that are beyond the schedule's current flexibility. Modifications to 2008 LORS will be required to optimally utilize the added storage capacity of the A-2 FEB to send the full 210,000 acre-feet per year of new water available in CEPP south

to the Everglades, while maintaining compliance with Savings Clause requirements for water supply and flood control performance levels.

The hydrologic modeling conducted for all CEPP alternatives to optimize system-wide performance incorporated the current Regulation Schedule management bands of the 2008 LORS. The hydrologic modeling of the CEPP alternatives included proposed revisions to the 2008 LORS flow chart guidance of maximum allowable discharges, which are dependent on the following criteria:

- Class limits for Lake Okeechobee inflow and climate forecasts, including tributary hydrologic conditions, seasonal climate outlook, and multi-seasonal climate outlook
- Stage level, as delineated by the Regulation Schedule management bands
- Stage trends (whether water levels are receding or ascending)

Most of the 2008 LORS refinements applied in the CEPP modeling lie within the bounds of the operational limits and flexibility available in the current 2008 LORS, with the exception of the adjustments made to the class limits for the Lake Okeechobee inflow and climate forecasts. Under some hydrologic conditions, the class limit adjustments made to the Lake Okeechobee inflow and climate forecasts reduced the magnitude of allowable discharges from the Lake, thereby resulting in storage of additional water in the Lake in order to optimize system-wide performance and ensure compliance with Savings Clause requirements. However, these class limit changes represent a change in the flow chart guidance that extends beyond the inherent flexibility in the current 2008 LORS. As detailed in **Section 6.8.2.1**, the recommended plan operations also expand on the 2008 LORS backflow operations to Lake Okeechobee through the following operational changes: (1) backflow to Lake Okeechobee from the C-44 Canal is allowed when S-308 is not open for regulatory discharge and the stage in Lake Okeechobee is below 14.5 feet (ft) National Geodetic Vertical Datum (NGVD) (no seasonal variability); and (2) discharges from the Indian River Lagoon-South Project C-44 Reservoir to the C-44 Canal are made when the stage in Lake Okeechobee is below the baseflow zone of the 2008 LORS schedule to provide an additional source of backflow water to Lake Okeechobee. Additional information and documentation of the recommended plan modeling assumptions for Lake Okeechobee operations are found in the **Appendix A**.

Independent of CEPP implementation, there is an expectation that revisions to the 2008 LORS will be needed following the implementation of other Comprehensive Everglades Restoration Plan (CERP) projects and Herbert Hoover Dike (HHD) infrastructure remediation. The U.S. Army Corps of Engineers (USACE) expects to operate under the 2008 LORS until there is a need for revisions due to the earlier of either of the following actions: (1) system-wide operating plan updates to accommodate CERP "Band 1" projects ("Band 1" projects are defined in **Section 2.5**), as described in **Section 6.1.3.2**, or (2) completion of sufficient HHD remediation for reaches 1, 2 and 3 and associated culvert improvements, as described in **Section 2.5.1**. When HHD remediation is completed and the HHD Dam Safety Action Classification (DSAC) Level 1 rating is lowered, higher maximum lake stages and increased frequency and duration of high lake stages may be possible to provide the additional storage capacity assumed with the recommended plan. The future LORS which may be developed in response to actions (1) and/or (2) is unknown at this time. It is anticipated that the need for modifications to the 2008 LORS will be initially triggered by non-CEPP actions and that these actions will occur earlier than implementation of CEPP. Therefore, the CEPP project implementation report (PIR) will not be the mechanism to propose or conduct the required National Environmental Policy Act (NEPA) evaluation of modifications to the LORS. However, depending on the ultimate outcome of these future LORS revisions, including the level of

inherent operational flexibility provided with these revisions, CEPP implementation may still require further LORS revisions to optimize system-wide performance and ensure compliance with Savings Clause requirements.

II. **WCA 2A and Northern WCA 3A** (South of the Redline) includes conveyance features to deliver and distribute existing flows and the redirected Lake Okeechobee water through WCA 3A.

Backfilling 13.5 miles of the Miami Canal between I-75 and 1.5 miles south of the S-8 pump station, and converting the L-4 Canal into a spreader canal by removing 2.9 miles of the southern L-4 Levee are the key features needed to ensure spatial distribution and flow directionality of the water entering WCA 3A.

Conveyance features to move water into and through the northwest portion of WCA 3A include: a gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal, a new gated spillway to deliver water from the remnant L-5 Canal to the western L-5 Canal (during L-6 diversion operations); a new gated spillway to deliver water from STA 3/4 to the S-7 pump station during peak discharge events (eastern flow route is not typically used during normal operations), including L-6 diversion operations; approximately 13.6 miles of conveyance improvements to the L-5 Canal; a new 360 cubic feet per second (cfs) pump station to move water within the L-4 Canal to maintain water supply deliveries to retain the existing functionality of STA-5 and STA-6 and maintain water supply to existing legal users, including the Seminole Tribe of Florida; and new gated culverts and an associated new canal to deliver water from the Miami Canal (downstream of S-8, which pulls water from the L-5 Canal) to the L-4 Canal, along with potential design modifications to the existing S-8 and G-404 pump stations.

The Miami Canal will be backfilled to approximately 1.5 ft below the peat surface of the adjacent marsh. Spoil mounds on the east and west side of the Miami Canal from S-8 to I-75 will be used as a source for Miami Canal backfill material. Refuge for mammals and other upland species will continue to be provided by the retention of 22 of the highest priority Florida Fish and Wildlife Conservation Commission (FWC) enhanced spoil mounds between S-339 (located approximately 10 miles south of S-339) to I-75 and the creation of additional upland landscape (constructed tree islands) approximately every mile along the entire reach of the backfilled Miami canal section (S-8 to I-75) where historic ridges or tree islands once existed. The constructed tree islands will block flow down the backfilled canal due to the tree island having a profile across the landscape that varies, or undulates, in elevation. Miami Canal constructed tree island design details will be determined during CEPP preconstruction, engineering and design (PED) phase. Tree island design, construction and planting will be coordinated with appropriate science team members with expertise in these topics to accomplish the restoration vision and intent of CEPP's canal backfilling and tree island construction. A diverse array of species will be planted, including trees, shrubs, and herbaceous species that are appropriate for these tree islands. Additional details are located in **Appendix A**.

III. **Southern WCA 3A, WCA 3B, and ENP** (Green/Blue Lines) includes conveyance features to deliver and distribute water from WCA 3A to WCA 3B and ENP.

A new Blue Shanty Levee extending from Tamiami Trail northward to the L-67A Levee will be constructed. This Blue Shanty Levee will divide WCA 3B into two subunits, a large eastern unit (3B-E) and a smaller western unit, the Blue Shanty flowway (3B-W). A new levee is the most efficient means to restore continuous southerly sheetflow through a practicable section of WCA 3B and alleviates concerns over effects on tree islands by maintaining lower water depths and stages in WCA 3B-E. The width of the 3B-W flowway is aligned to the width of the downstream 2.6-Mile Tamiami Trail Next Steps bridge,

optimizing the effectiveness of both the flowway and bridge. In the western unit, construction of two new gated control structures on the L-67A, removal of the L-67C and L-29 Levees within the flowway, and construction of a gated spillway in the L-29 Canal will enable continuous sheetflow of water to be delivered from WCA 3A through WCA 3B-W to ENP. A third gated control structure in the L-67A Levee and associated gap in the L-67C Levee, both outside the flowway, will improve the hydroperiod of the eastern unit of WCA 3B. Spoil mounds along the northwestern side of the L-67A Canal, in the proximity to the three new L-67A structures will also be removed to facilitate sheetflow connectivity with the WCA 3A marsh.

Increased outlet capability at the S-333 structure at the terminus of the L-67A Canal, removal of approximately 5.5 miles of the L-67 Extension Levee, and removal of approximately 6 miles of Old Tamiami Trail between the ENP Tram Road and the L-67 Extension Levee will facilitate additional deliveries of water from WCA 3A directly to ENP. Detailed design and construction of these features will minimize project footprints due to the nature of these environmentally sensitive areas.

IV. **Lower East Coast Protective Levee** (Yellowline) includes features primarily for seepage management, which are required to mitigate for increased seepage resulting from the additional flows into WCA 3B and ENP.

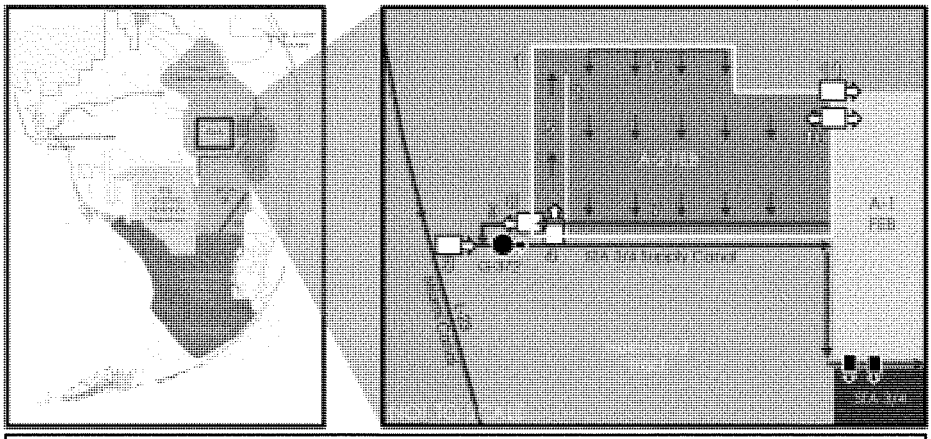
A newly constructed pump station with a combined capacity of 1,000 cfs will replace the existing temporary S-356 pump station, and a 4.2-mile partial depth seepage barrier will be built along the L-31N Levee south of Tamiami Trail.

There is an existing 2-mile seepage cutoff wall in the same vicinity that was constructed by a permittee as mitigation to offset authorized impacts under a Clean Water Act (CWA) Section 404 permit. There is a possibility that the same permittee may construct an additional 5- miles of seepage wall south of the 2-mile seepage wall, if permitted. Since the capability and effectiveness of the existing seepage wall to mitigate seepage losses from ENP remains under investigation, the recommended plan conservatively includes an approximately 4.2 mile long, 35 ft deep tapering seepage barrier in the event construction is necessary. There are remaining uncertainties about the effectiveness of the recommended plan's seepage cutoff wall in maintaining desired stages in marshes of ENP while maintaining flood protection and canal stages to the east without limiting water availability to water users and Biscayne Bay. Therefore, additional analysis of the CEPP seepage cutoff wall will be conducted as an early phase in PED. See **Section 6.10.1.2**, the Engineering Appendix (**Appendix A**), the analyses required by the Water Resources Development Act (WRDA) 2000 (**Annex B**), and the CEPP Adaptive Management Plan (**Annex D Part 1**) for more detail about the remaining uncertainties and suggested analysis to be completed to determine the need for and extent of a CEPP seepage cutoff barrier wall.

The specific feature locations of the recommended plan are shown in **Figure 6-1** through **Figure 6-4**. Also see the foldout **Figure** in the back of this section. Further details of features are available in **Appendix A**.

NORTH OF THE REDLINE

STORAGE AND TREATMENT/FLOW EQUALIZATION BASIN (FEB) – A2

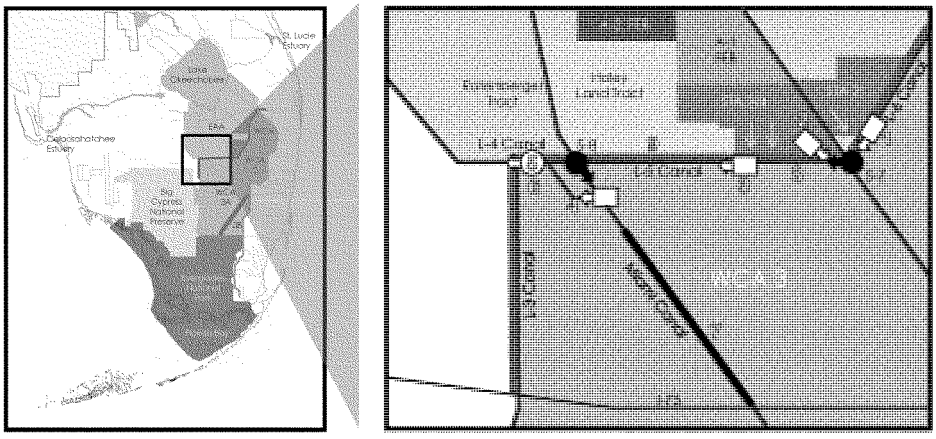


LEGEND: Pump | Gated Structure | Levee | Spreader Canal | Existing Structure

#	STRUCTURE	STRUCTURE/FEATURE TYPE	CFS	TECHNICAL NOTES
1	L-624	Levee		Perimeter Levee (~ 20 miles, 11.3 feet high, 14 feet wide, 3:1 side slope)
2	L-625	Levee		Interior levee (~ 4 miles, 11.3 feet high, 12 feet wide, 3:1 side slope)
3	S-623	Gated Spillway	3700	Delivers water from Miami Canal to existing G-372 pump station
4	S-624	Gated Sag Culvert (FEB inflow structure)	1550	Receives water from existing pump station G-372 via STA 3/4 Supply Canal and delivers it to C-624 FEB inflow canal
5	C-624	FEB Inflow Canal	1550	Conveys water from FEB inflow structure S-624 to FEB C-624 E spreader canal (length: ~ 4 miles)
6	C-624E	FEB Spreader Canal		Distributes FEB inflows across northern FEB; sheetflow within FEB is generally north to south (length: ~ 4 miles)
7	C-625E	FEB Collection Canal	400	Existing seepage canal for STA 3/4 Supply Canal, used to supplement FEB sheetflow during normal operating conditions
8	S-625	Gated Culverts (FEB discharge structure)	1550	Delivers water to FEB outflow canal (C-625W)
9	C-625W	FEB Outflow Canal	1550	FEB Outflow Canal is the extended seepage canal for the STA 3/4 Supply Canal; delivers water vio existing G-372 pump station to STA 3/4 for water quality treatment
10	S-628	Gated Culvert (FEB intake/discharge structure)	930	Delivers water in both directions between A-2 FEB and A-1 FEB for operational flexibility
11	S-627	Emergency Overflow weir	445	Location to be determined
A-2 FEB design also includes an exterior seepage collection system (not illustrated):				
	C-626	Seepage Canal	400	~ 11 miles
	S-626	Seepage Pump Station	500	Delivers seepage back into the FEB outflow canal C-625W

Figure 6-1. Recommended Plan Treatment and Storage Features and Location

SOUTH OF THE REDLINE
DISTRIBUTION AND CONVEYANCE

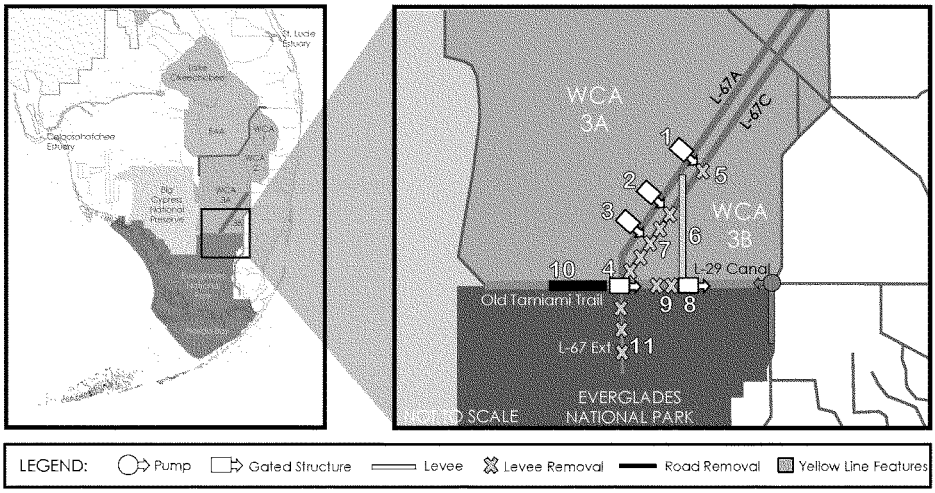


LEGEND: Pump | Gated Structure | Levee Removal | Existing Structure

#	STRUCTURE	STRUCTURE/FEATURE TYPE	CFS	TECHNICAL NOTES
1	S-620	Gated Culvert	500	Delivers water from L-6 Canal to L-5 Canal
2	S-621	Gated Spillway	2500	Closed to direct STA 3/4 discharges to western L-5 Canal during normal operations; controls water from STA 3 /4 to the existing S-7 pump station during peak events
3	S-622	Gated Spillway	500	Delivers water from east to west in L-5 Canal (replaces existing L-5 canal plug)
4	S-8A	Gated Culverts with Canal	3080 & 1020	Existing S-8 pump station delivers water from L-5 Canal to Miami Canal; S-8A delivers water from Miami Canal to L-4 Canal (3120 cfs) and remaining Miami Canal segment (1040 cfs); potential design modifications to the existing S-8/G-404 complex will be assessed during PED
5	S-630	Pump Station	360	Delivers water from L-4 Canal west to maintain existing water supply deliveries
6		L-4 Levee Removal		Removes ~2.9 miles of south L-4 Levee
7		Miami Canal Backfill with Tree Islands Mounds		Remove ~ 13.5 miles of Miami Canal , from 1.5 miles south of S-8 to I-75; tree island mounds create habitat and promote sheetflow in WCA-3A within the footprint of the former Miami Canal
8		L-5 Remnant Canal	500	Enlarging canal to expand capacity of L-5 Canal (between S-621 & S-622)
9		L-5 Canal	3000	Enlarging canal to expand capacity of L-5 Canal (between S-622 & S-8)

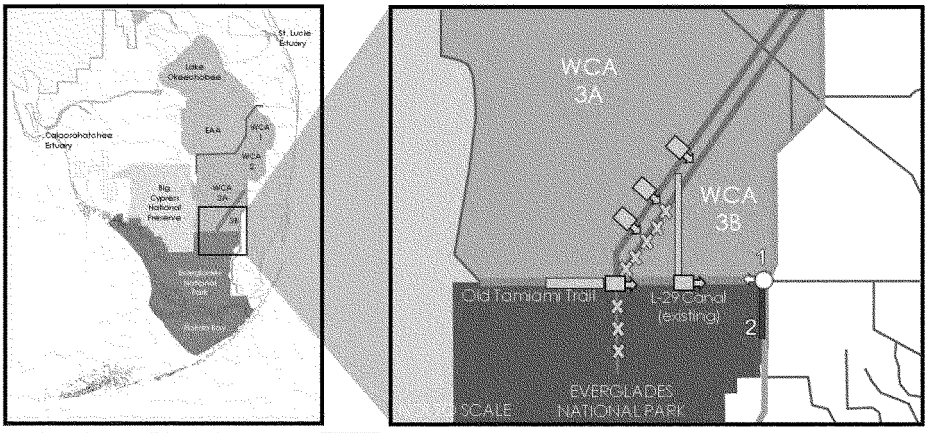
Figure 6-2. Recommended Plan Northern Conveyance and Distribution Features and Location

BLUE AND GREEN LINES
DISTRIBUTION AND CONVEYANCE



#	STRUCTURE	STRUCTURE/FEATURE TYPE	CFS	TECHNICAL NOTES
1	S-631	Gated Culvert	500	Delivers water from WCA 3A to 3B, east of L-67D Levee
2	S-632	Gated Culvert	500	Delivers water from WCA 3A to 3B, west of L-67D Levee
3	S-633	Gated Culvert	500	Delivers water from WCA 3A to 3B, west of L-67D Levee
4	S-333 (N)	Gated Spillway w/new canal	1150	Delivers water from L-67A Canal to L-29 Canal; supplements existing S-333 gated spillway
5		L-67C Levee Removal Gap		Gap, ~ 6000 feet (corresponding to S-631)
6	L-67D	Blue Shanty Levee		Levee, ~ 8.5 miles, connecting from L-67A to L-29 (6 feet high, 14-foot crest width, 3:1 side slopes)
7		L-67C Levee Removal		Complete removal of ~ 8 miles from New Blue Shanty Levee (L-67D)south to intersection of L-67A/L-67C; L-67C canal is not backfilled
8	S-355W	Gated Spillway	1230	Maintains water deliveries to eastern L-29 Canal
9		Levee Removal (L-29)		Removal of ~ 4.3 miles between L-67A and Blue Shanty Levee intersection with L-29 Levee
10		Removal of remnants of Old Tamiami Trail roadway		Removal of ~ 6 miles of roadway west of L-67 Extension
11		L-67 Extension Levee Removal and Canal Backfill)		Complete removal of ~ 5.5 miles of remaining L-67 Extension, including S-346 culvert

Figure 6-3. Recommended Plan Southern Distribution and Conveyance Features and Location



#	STRUCTURE	STRUCTURE/FEATURE TYPE	CFS	TECHNICAL NOTES
1	S-356	Pump Station	1000	Provides seepage management for WCA 3B and NESRS stages
2		Seepage Barrier Cutoff Wall		Soil cement bentonite (SCB) wall (~4.2 miles, 3 feet wide, 35 feet deep)

Figure 6-4. Recommended Plan Seepage Management Features and Location

6.1.2 Lands and Interests in Lands

The following real estate interests and lands identified below are needed to ensure the construction and operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) of CEPP is implemented. More details are provided in **Appendix D**.

6.1.2.1 A-2 Flowage Equalization Basin

Fee title will be required for the project footprint of the A-2 FEB. The A-2 FEB requires approximately 13,849 acres in Compartment A, of which approximately 13,839.44 acres were acquired in the Talisman exchange/acquisition. The remaining approximately 9.9 acres in the A-2 FEB were acquired by the South Florida Water Management District (SFWMD) using State funds. In March 1999, the "Talisman Exchange and Purchase and Sale Agreement" effected transactions in which certain landowners in the EAA would sell lands to, or exchange lands, with other landowners and the SFWMD in order for SFWMD to own contiguous parcels of land in the southern portion of the EAA for the purposes of Everglades restoration.

6.1.2.2 Flowage Equalization Basin Discharge Canal

The A-2 FEB Discharge Canal runs from the STA 3/4 supply canal to the southwest corner of the A-2 FEB. There are approximately 91.25 acres required for this canal. The canal runs along the southern portions of Sections 35 and 36, Township 46 South, Range 35 East. Approximately 57.02 acres are owned by the State of Florida and will be acquired by SFWMD, either through direct acquisition from the State (permanent canal easement) or by Supplemental Agreement (fee or permanent canal easement) with the State. The remaining 34.23 acres are owned by SFWMD and were acquired as part of the Talisman Exchange, with both Federal and State funds. Fee title will be the required estate for these lands. These lands are currently leased by either the State of Florida or the SFWMD to agricultural interests.

6.1.2.3 Water Conservation Areas 3A and 3B

SFWMD owns a variety of interests in WCA 3A and WCA 3B. These lands were previously acquired and certified for the Central and Southern Florida (C&SF) Project. The SFWMD owns fee title to approximately 134,280.95 acres, a perpetual flowage easement over approximately 300,343.52 acres (with the fee owned by the State of Florida), a perpetual flowage easement over approximately 70,612 acres (with the fee owned by private parties), canal or levee easement over approximately 11,598.84 acres and a perpetual easement for surface flowage rights over approximately 73,360 acres (with fee title owned by the State). Pursuant to the Seminole Indian Claims Settlement Act of 1987, the Seminole Tribe of Florida transferred property, including what is now referred to as WCA 3A, to the SFWMD while retaining traditional hunting, fishing, trapping, and frogging rights within this property. These subsistence rights are also extended to lands perpetually leased to the Miccosukee Tribe of Indians of Florida also in areas within WCA 3A pursuant a Settlement Agreement between the Miccosukee Tribe of Indians of Florida and the State of Florida, dated 15 March, 1982. The Corps also acknowledges that this area continues to hold cultural significance to both Federally recognized Tribes. All of these lands were provided as an item of local cooperation for the C&SF Project. The rights owned by SFWMD in WCA 3A and WCA 3B have been determined to be sufficient for CEPP project purposes. The SFWMD will recertify these lands to the Federal Government when required for construction or operations at no cost to CEPP.

6.1.2.4 S-356 Structure and L-31N Seepage Barrier

The S-356 structure will be constructed on lands within the right-of-way of existing L-29 Levee, which was previously acquired and provided as an item of local cooperation for the original C&SF Project. The seepage barrier wall will be constructed within the right-of-way of the L-31N Levee, which also was previously acquired and provided as an item of local cooperation for the original C&SF Project. SFWMD

owns sufficient interests (fee or a perpetual easement) in these lands for the construction of these project features. Where SFWMD owns a perpetual easement, either the State of Florida or private parties own the underlying fee title. SFWMD will not receive credit for the provision of these lands unless a greater interest is required and then only for the difference in value between the interest provided for the C&SF project and that required for CEPP. Additional analysis of the CEPP seepage cutoff wall will be conducted as an early phase in PED. See **Section 6.10.1.2**, the Engineering Appendix (**Appendix A**), the analyses required by WRDA 2000 (**Annex B**), and the CEPP Adaptive Management Plan (**Annex D Part 1**) for more detail about the remaining uncertainties and suggested analysis to be completed to determine the need for and extent of a CEPP seepage cutoff barrier wall.

6.1.2.5 Uniform Relocation Assistance Act, PL91-646 as amended

The appropriate relocation benefits were included as part of the Talisman Exchange/acquisition agreement for the land in the A-2 FEB and therefore these costs were not evaluated separately. Under P.L 91-646, as amended, there are no additional residential relocations and no business relocations associated with the implementation of this Project.

6.1.2.6 Facility/Utility Relocations

Florida Power and Light lines will have to be relocated or abandoned from the area within the A-2 FEB. Florida Power and Light, and Quest Communications lines will have to be relocated where the L-29 is being removed. The removal of Old Tamiami Trail will require relocation of the Florida Power and Light line.

6.1.3 Project Operations

The draft Project Operating Manual (POM) in **Annex C** includes operating criteria based on the Alt 4R2 hydrologic modeling assumptions and generally discusses the transitions to operations during the construction phase, the Operation, Testing & Monitoring Phase (OTMP), and the long-term Operations and Maintenance (O&M) phase. The POM assumes completion of all CEPP components. Modifications and/or revisions to the POM will occur during subsequent implementation phases. Development of the POM is an iterative process that will continue throughout the life of the project. The POM will be updated at periodic intervals during the detailed design, construction and operational testing and monitoring phases of the project. Refinements to the operating criteria in the POM will be made as more project design details, data, operational experience, and general information are gained during these project phases. It is also anticipated that once the POM is completed and the long-term operations and maintenance phase is underway, it may be necessary to revise the POM from time to time based on additional scientific information and implementation of CERP or non-CERP activities.

It is important to understand that the POM will develop over time as the details of the design of CEPP components are developed. The first draft is presented in this document with the recognition that multiple revisions and operational fine-tuning would occur over the life of the project. The operations discussed herein represent the start-up operational strategy, recognizing that constraints in the system may be removed over time due to the completion of many of the CEPP components as well as other CERP and non-CERP Projects. Refinements to the POM may also be needed in response to phased implementation of CEPP components. The draft POM is presented with the recognition that multiple revisions and operational refinements will occur over the life of the project, as described below in **Figure 6-5**. The USACE and SFWMD will share in the responsibilities for conducting water management operations during the OTMP.

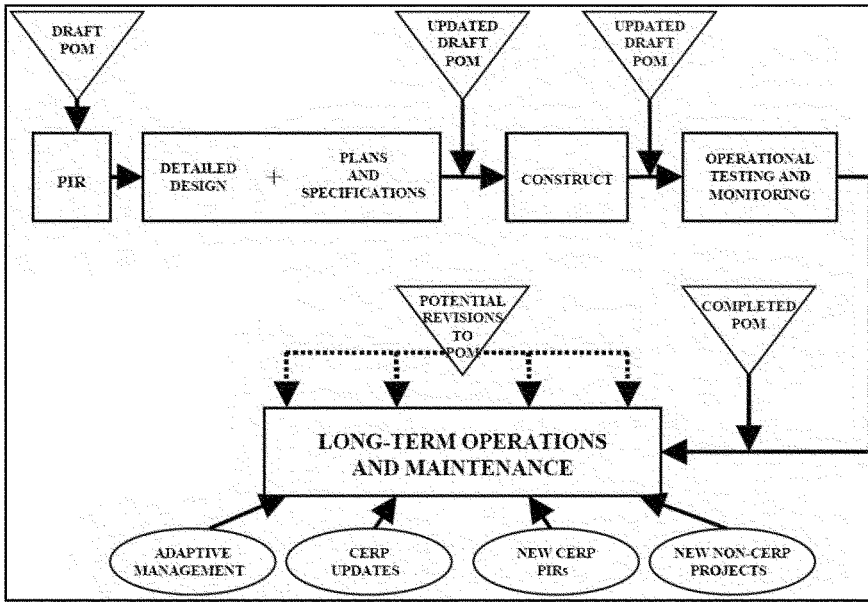


Figure 6-5. Evolution of the Project Operating Manual

6.1.3.1 Rain-Driven Operations

The CEPP proposes changes to the operation of WCA 3 to better mimic a natural delivery of water through the system in response to rainfall. Unlike regulation schedule-based operations, the Rain-Driven Operations (RDO) estimate inflows and outflows in response to weekly rainfall and Potential Evapotranspiration (PET) and target water deliveries so that the weekly stage at ten target locations (3ANW, 3A11, 3ASW, W2, 3A4, 3AS, 3ANE, 3A28, E4, 3A3) approach the corresponding weekly restoration targets. In addition to meeting these targets, the RDO aims at improved recession rates (measured in ft per week) in three range categories: excellent (0.03 to 0.06), acceptable (0 to 0.03 and 0.06 to 0.10) and unacceptable (> 0.10). The recession rate would be calculated as the difference between the current stage and the previous week's stage. The stage would be calculated as the average of three locations: 3A4, 3A28 and 3A3. The RDO employs a mechanism that resists the stage going into Zone A of the WCA 3A Interim Regulation Schedule. As part of a system-wide optimization, the WCA 3A RDO is constrained with the amount and timing of inflows upstream, and the restoration targets and constraints in WCA 3B and the ENP.

It is recognized that transitioning to RDO would likely be a lengthy and complex process for the USACE, but a necessary step to achieve the proposed restoration objectives within WCA 3A and ENP. The process for making this transition has not yet been developed, but it is envisioned for RDO to be phased in gradually as CEPP components become operational. RDO operations may also be considered by the USACE during future operational planning studies prior to CEPP, as appropriate. Initially, system operations would be conducted under the current Rainfall Plan, with modeling and testing of RDO to occur alongside the Rainfall Plan; development and limited testing of RDO modeling tools should be

initiated prior to this operational testing period. When RDO has been developed and approved for use, the USACE will fully implement it.

6.1.3.2 System Operating Manual Updates

Implementation of the CERP plan envisioned the need to create a System Operating Manual (currently the Master Water Control Manual is the primary governing document). This System Operating Manual would ensure that the operations of all projects, both CERP and non-CERP, are integrated within the C&SF system operations on order to achieve the authorized purposes of the C&SF Project and the individual CERP and non-CERP projects. The CEPP plan acknowledges that a revision to the current 2008 LORS, as well as the associated Volume 3 of the Master Water Control Manual – Lake Okeechobee and EAA) will be needed to integrate the features of CEPP as well as the HHD remediation, the Kissimmee River Restoration, and other CERP projects which are connected or adjacent to Lake Okeechobee.

Therefore, it is anticipated that modifications to the 2008 LORS would be triggered by actions other than CEPP implementation and the CEPP PIR will not be the mechanism to propose or conduct the required NEPA evaluation of modifications to the LORS. However, depending on the ultimate outcome of these future LORS revisions, including the level of inherent operational flexibility provided with these revisions, CEPP implementation may still require further LORS revisions to optimize system-wide performance and ensure compliance with Savings Clause requirements.

6.1.4 Adaptive Management and Monitoring

The CEPP Adaptive Management (AM) and Monitoring Plans (**Annex D**) identifies the monitoring information needed to inform CEPP implementation and to document restoration progress to agencies, the public, and Congress. The overall objective of the AM and Monitoring Plan is to focus resources on refinement of CEPP to fine-tune performance due to inevitable uncertainties, based on existing knowledge and knowledge that will be gained through monitoring and assessment.

CERP's interagency science group, the Restoration Coordination and Verification group (RECOVER) provided significant support in the development of CEPP's AM and Monitoring Plan, as did project delivery team (PDT) scientists, engineers, and water operators. Expertise included input from more than 10 agencies and both Tribes of south Florida, consisting collectively of decades if not centuries of scientific and operational knowledge of the Everglades, Lake Okeechobee, the Lower East Coast (LEC), and the estuaries. Using this knowledge, key questions were identified for analysis to inform CEPP design, implementation, and potential adjustments for optimizing project performance.

The CEPP AM and Monitoring Plans contain descriptions of monitoring that should address specific uncertainties identified during CEPP planning, required parameters such as water quality and water levels, and ecological features that track CEPP's progress toward success. The monitoring data will indicate CEPP's progress toward the objectives of CEPP, and CEPP's conformance to applicable legal requirements. The monitoring descriptions are found in detail in **Annex D Part 1 Sections D.1.3 – D.1.4** (pages 13 – 91) and in **Annex D Parts 2, 3, 4**. For each region of south Florida in the CEPP study area, the monitoring parameters, their value to CEPP, timeframe needed to see changes, measurement frequencies, decision criteria for triggering adaptive management options, and suggested adaptive management options are provided in the AM Plan text; the information is also summarized per region in **Tables D.1.3 – D.1.9**. Monitoring durations, which are specified in Annex D, are dependent on the intended use of the monitoring: regulatory monitoring will be continued as long as required by applicable regulations and the adaptive management and ecological success monitoring will continue up to 10 years, per WRDA 2007 Section 2039, in coordination with the phases of CEPP construction. See

Annex D Part 1 Section 1.5, "Implementation of CEPP Adaptive Management" for a description of the rolling implementation of the monitoring and the feedback that the data will provide to inform management decisions. The implementation is summarized in **Annex D Part 1 Section D.1.5**, in **Figures D.1.11 – D.1.17**, and in **Tables D.1.10 – D.1.15**.

Part 1 of the AM and Monitoring Plans (**Annex D**) is the CEPP AM Plan. A fundamental principle of AM is that a project can be adjusted to achieve higher performance toward the project's goals and objectives and to remain within its constraints. In AM the adjustments are based on a scientifically efficient and sound process of learning from data. These adjustments should be viewed as intelligently fine-tuning the project, the need for which is almost inevitable in large-scale, long-term restoration projects like CERP and CEPP. Given this fundamental principle of AM, the CEPP AM Plan provides suggestions for potential improvements and refinements of aspects of CEPP if necessary, called Adaptive Management Options (AM Options). The suggestions are based on current experience and knowledge and are not required actions, nor are they meant to limit agencies from considering other options. All of the AM Options are considered part of the recommended plan for authorization, although some would require more information about project footprint and performance in order to perform a full NEPA analysis, permitting, and agency coordination before they could be initiated. The AM Options are included in the CEPP cost estimates and described here per WRDA 2007 USACE implementation guidance (August 2009). The AM Options are not automatic; they are informed suggestions provided as part of the recommended plan that capture current knowledge of what may needed in the future to adjust and maximize performance as CEPP progresses. Additional options that are also considered part of the recommended plan but would not require as extensive additional analysis are listed in the CEPP AM Plan (**Annex D Part 1**) where they are summarized per CEPP region in **Tables D.1.3 – D.1.9**.

AM Option: Dig shallow S-355B Collector Canal Extension near the southern end of WCA 3B, east of the proposed Blue Shanty Levee, to increase flows southward out of this part of WCA 3B.
The shallow canal would connect to remnant agricultural ditches to allow them to act as collector canals in the portion of WCA 3B potentially most sensitive to transition of restoring longer hydroperiods. A different AM Option is proposed below for the western portion of WCA 3B, which is referred to as the Blue Shanty flowway. Environmental Considerations: USACE would need to perform an analysis in accordance with Section 404 (b)(1) guidelines for CEPP to perform this option; potential wetland impacts would need to be considered as well as potential nesting and foraging sites for snail kites in the area.

AM Option: Modify agricultural canals in the WCA 3B flowway, west of the proposed Blue Shanty Levee, to maximize sheetflow and hydroperiod objectives.
Remove spoil mounds and backfill the agricultural ditches (in order of priority) that run east-west and north-south in the portion of WCA 3B west of the Blue Shanty canal, a.k.a the Blue Shanty flowway. Environmental Considerations: USACE would need to perform an analysis in accordance with Section 404 (b)(1) guidelines for CEPP to perform this option; potential impacts to nesting and foraging sites for wading birds and snail kites would need to be considered.

AM Option: Extend Decompartmentalization Physical Model (DPM) Test 4 additional years.
Environmental Considerations: During previous Section 106 consultation on the DECOMP Physical Model (DPM), these features were not described to last over two years. Therefore, Section 106 consultation would need to be re-initiated for this feature as required by 36 CFR 800. Coordination with the Florida Department of Environmental Protection (FDEP) would be required.

AM Option: C-11 Extension gapping with 100-foot gaps north and south of the C-11 canal, created by pushing spoil into canal every 1000 ft.
Environmental Considerations: USACE would need to perform an analysis in accordance with Section 404 (b)(1) guidelines for CEPP if this AM action were to be employed. All necessary analysis and coordination would be completed prior to implementation of the action.

In addition to the AM Plan, **Annex D** contains the **Water Quality Monitoring Plan** (**Part 2**), **Hydrometeorological Monitoring Plan** (**Part 3**), and the **Ecological Monitoring Plan** (**Part 4**). These include regulatory monitoring associated with water quality and the U.S, Fish and Wildlife Service (FWS) Biological Opinion (BO), as well as hydrometeorological monitoring to inform system operations, and ecological success monitoring directly related to project objectives.

6.1.5 Invasive and Nuisance Species Management Plan

This plan has been developed in accordance with Executive Order (E.O.) 13112, entitled Invasive Species, signed 03 February 1999, the USACE Invasive Species Policy and CERP Guidance Memorandum 062.00 (CGM62), Invasive Species. The purpose of the Invasive and Nuisance Species Management Plan (INSMP) is to outline measures for preventing, controlling, reducing and monitoring invasive species within the CEPP footprint in order to achieve restoration benefits. To achieve these goals, the plan proposes to complete both initial and long-term invasive species management. The INSMP is a living document and will be updated throughout design, construction and OMRR&R. The INSMP is located in **Annex G**.

6.1.6 Recreation Plan Features

The proposed recreation facilities will increase access into the Greater Everglades and enhance users' opportunities and access within the marsh. Facilities include sufficient gravel parking with boat ramps and trailheads, dry vault toilets, shelters, primitive camping sites and Americans with Disabilities Act compliant fishing platforms, and are illustrated in **Figure 6-6** below.

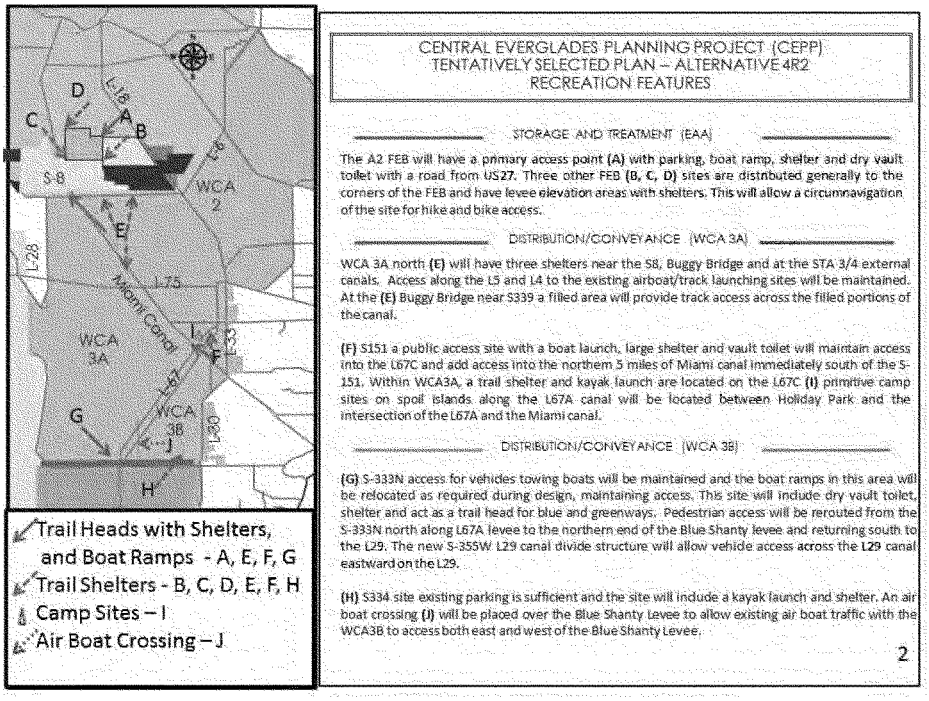


Figure 6-6. CEPP Recommended Plan Recreation Features

6.2 PLAN ACCOMPLISHMENTS

6.2.1 Environmental Benefits

The recommended plan provides significant benefits within the project area; beneficially affecting more than 1.5 million acres in the Caloosahatchee and St. Lucie Estuaries, the Greater Everglades, and Florida Bay. The recommended plan provides an increase of 246,590 average annual habitat units (HU) relative to the future without (FWO) project condition for the period of analysis based on the methodology that was used to quantify ecosystem benefits. The recommended plan would decrease high volume freshwater discharges from Lake Okeechobee that are currently sent to the Northern Estuaries. Additional water from Lake Okeechobee would be sent southward through canals of the EAA to the A-2 FEB. The A-2 FEB would provide storage capacity, attenuation of high flows, and limited pre-treatment prior to delivery of the redirected water to existing STAs, which would reduce phosphorus concentrations in the water to meet required water quality standards. The treated water would be distributed across the northwestern boundary of WCA 3A to flow through and help restore more natural quantity, timing and distribution of water to WCA 3A, WCA 3B, ENP, and Florida Bay. Several existing levees, canals, culverts, and pump stations would be constructed, modified, or removed to improve the flow of water through the system and provide for other water related needs.

The recommended plan addresses the need to restore ecosystem function in the Caloosahatchee and St. Lucie Estuaries by reducing the number and severity of events where undesirable amounts of freshwater

from Lake Okeechobee are discharged into the estuaries (**Figure 6-7** and **Figure 6-8**). Currently, many oyster and seagrass beds are stressed and have been reduced or eliminated from their former areas by extreme salinity fluctuations, increased turbidity and sedimentation, dredging, damage from boats, and nutrient enrichment, which causes algal blooms that in turn restrict light penetration. A reduction in the number of high volume freshwater discharges to the estuaries would help to reduce turbidity, sedimentation, and moderate unnatural changes in salinity that are extremely detrimental to estuarine communities. Reductions in turbidity and sedimentation would allow greater light penetration, promoting the growth of seagrass beds and would help lessen the problem of flushing oyster spat into outer areas of the estuaries that currently experience high salinity levels during the dry season resulting in increased predation and disease in the oyster population. Implementation of the recommended plan provides an increment of the benefits envisioned in CERP and builds upon those achieved in the Northern Estuaries with implementation of other CERP projects (i.e. C-43 West Basin Storage Reservoir and Indian River Lagoon South Project).

In June 2013, the CEPP base condition assumptions established for plan formulation were subsequently revisited and updated to represent the most current information for the analysis of Savings Clause requirements and Project-Specific Assurances (see **Section 6.8** and **Annex B**). The FWO project baseline was updated utilizing new information for the Initial Operating Regime Baseline (IORBL1). In the **Annex B** analysis, the potential effects of CEPP are analyzed through comparison of the with-project condition (recommended plan) to the without project condition (IORBL1). The revised IORBL1 updated the FWO to include the 2.6 mile western Tamiami Trail bridge proposed with the initial increment of the Department of Interior's (DOI) Tamiami Trail Next Steps Project (based on best available phased implementation information from DOI), operational updates to the CERP Indian River Lagoon-South project (based on best available information from the Indian River Lagoon-South project team), and operational refinements to the CERP Broward County Water Preserve Area project (to reduce excess discharges to tide via S-29, including accounting for the effects of the Lake Belt expansion assumed in the CEPP FWO condition). The FWO baseline was used to determine the National Ecosystem Restoration (NER) Plan. The IORBL1 represents the FWO baseline assumption for purposes of completing the CEPP assessments for the Savings Clause and Project Assurances. The IORBL1 updates incorporated the most current information and assumptions at the time of selection of the recommended plan. Compared to the FWO baseline, the updated IORBL1 baseline indicates significant hydrologic differences with respect to the Saint Lucie Estuary, with other portions of the CEPP project area performing similar to the FWO; inclusion of both the FWO and IORBL1 is provided in **Figure 6-8** to highlight performance differences.

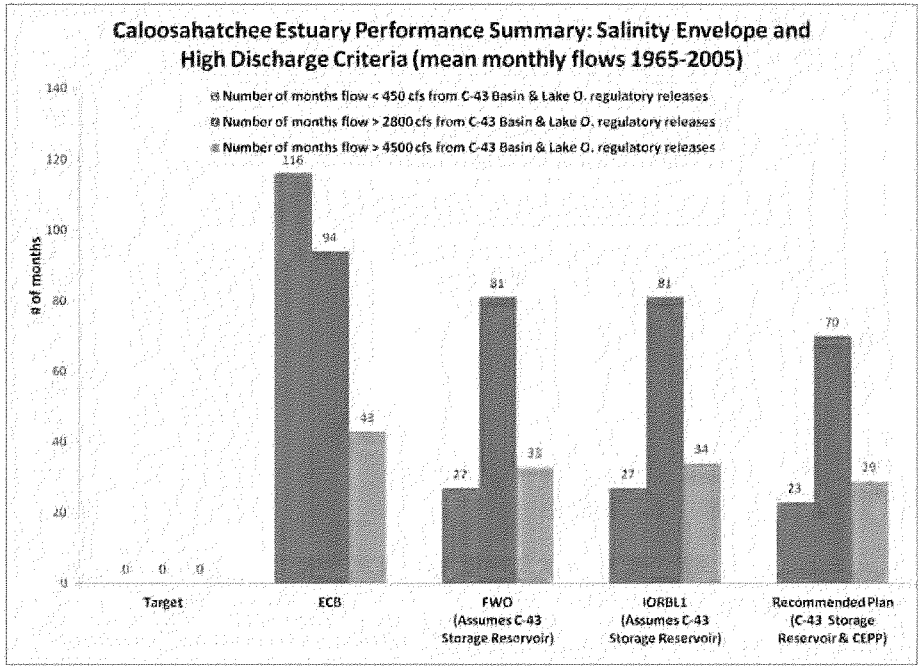


Figure 6-7. Number of Times Salinity Criteria not met for the Caloosahatchee Estuary for the ECB, FWO Project Condition, Initial Operating Regime Baseline (IORBL1) and the Recommended Plan. The salinity envelope target for the Caloosahatchee Estuary is a salinity range of 16 to 28 (PSU) practical salinity units. Meeting target discharges would result in achievement of the salinity envelope. The Caloosahatchee River (C-43) West Basin Storage Reservoir is assumed to be implemented in the FWO Project Condition, IORBL1 and the Recommended Plan.

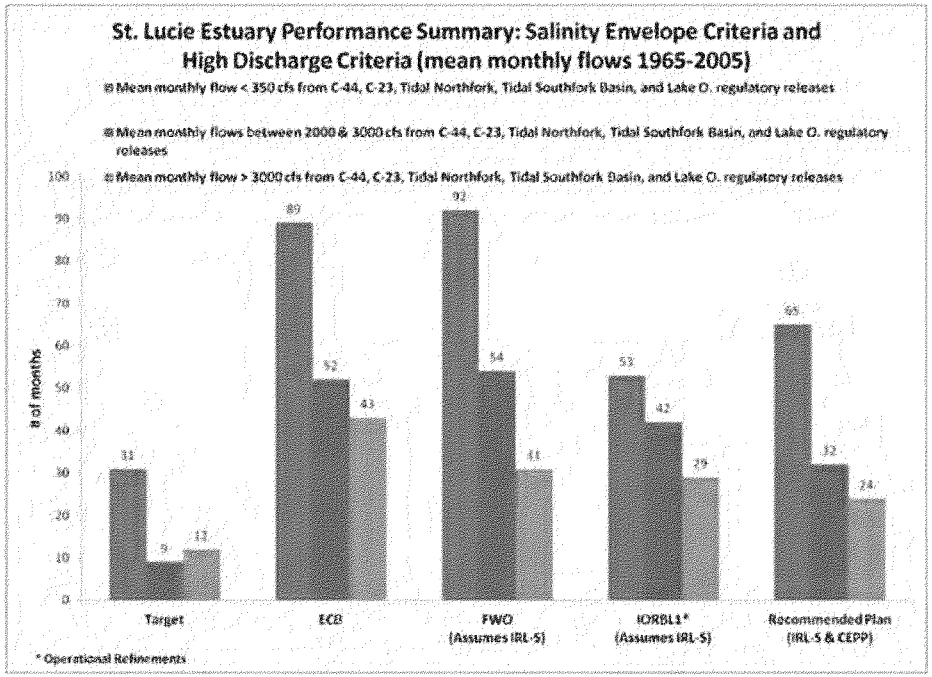


Figure 6-8. Number of Times Salinity Criteria not met for the St. Lucie Estuary for the ECB, FWO Project Condition, IORBL1, and the Recommended Plan. The salinity envelope target for the St. Lucie Estuary is a salinity range of 12 to 20 psu. Meeting target discharges would result in achievement of the salinity envelope. The Indian River Lagoon-South Project is assumed to be implemented in the FWO Project condition, IORBL1, and the Recommended Plan.

The recommended plan provides a significant increase in the quantity of freshwater (approximately 210,000 acre-feet per year, annual average) flowing into the Everglades. This additional freshwater flow to the central Everglades is essential to Everglades Restoration. In the pre-drainage system, the inundation pattern supported an expansive system of freshwater marshes including long hydroperiod sawgrass "ridges" interspersed with open-water "sloughs", higher elevation marl prairies on either side of Shark River Slough (SRS), and forested wetlands in the Big Cypress Marsh. The original C&SF Project compartmentalized and fragmented the Everglades landscape, reduced flows through the sloughs, and altered hydroperiod and depths. The result has been substantially altered plant community structures, reduced abundance and diversity of animals, and spread of nuisance and exotic vegetation. The recommended plan would provide for resumption of sheetflow and related patterns of hydroperiods and water depth that would significantly help to restore and sustain the microtopography, directionality, and spatial extent of ridges and sloughs, and improve the health of tree islands within the landscape. Additional water flowing into the Everglades would also result in beneficial shifts in habitat for desired wildlife species. Implementation of the recommended plan features and additional flow would provide greater project benefits to those areas located in northern WCA 3A and ENP. **Figure 6-9** through **Figure 6-14** depict the differences in hydroperiods and stage between the recommended plan and the FWO project condition in WCA 3 and ENP as modeled by the Regional Simulation Model for the Glades and Lower East Coast Service Areas (LECSA) (RSM-GL) (version 2.3.2) for the period of simulation (1965-2005). The years 1989 and 1995 are depicted which are representative of a dry and wet year, respectively, in the 41 year period of simulation. Average annual hydroperiod and stage differences across the period of simulation are also illustrated.

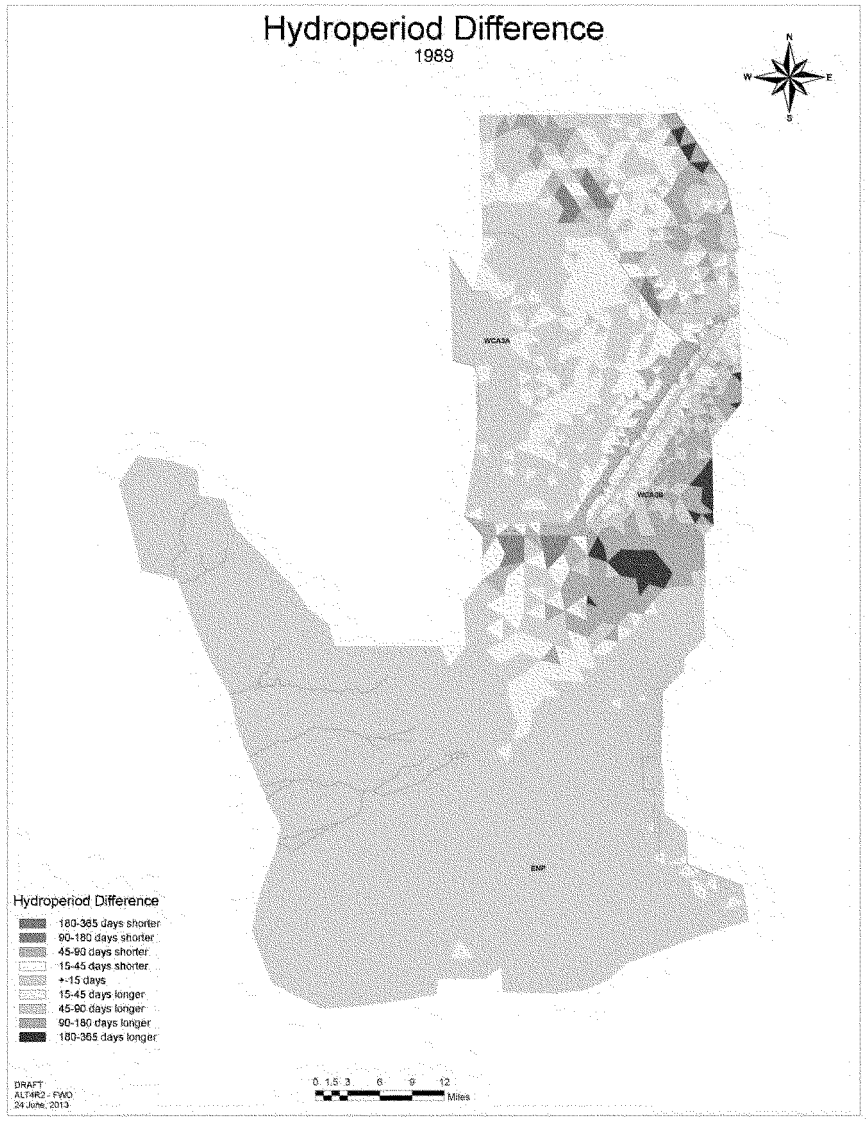


Figure 6-9. Differences in Hydroperiod Distribution within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for a Representative Dry Year (1989) in the Period of Record (1965-2005). Figure depicts hydroperiods resulting from implementation of the Recommended Plan that are shorter or longer than the FWO.

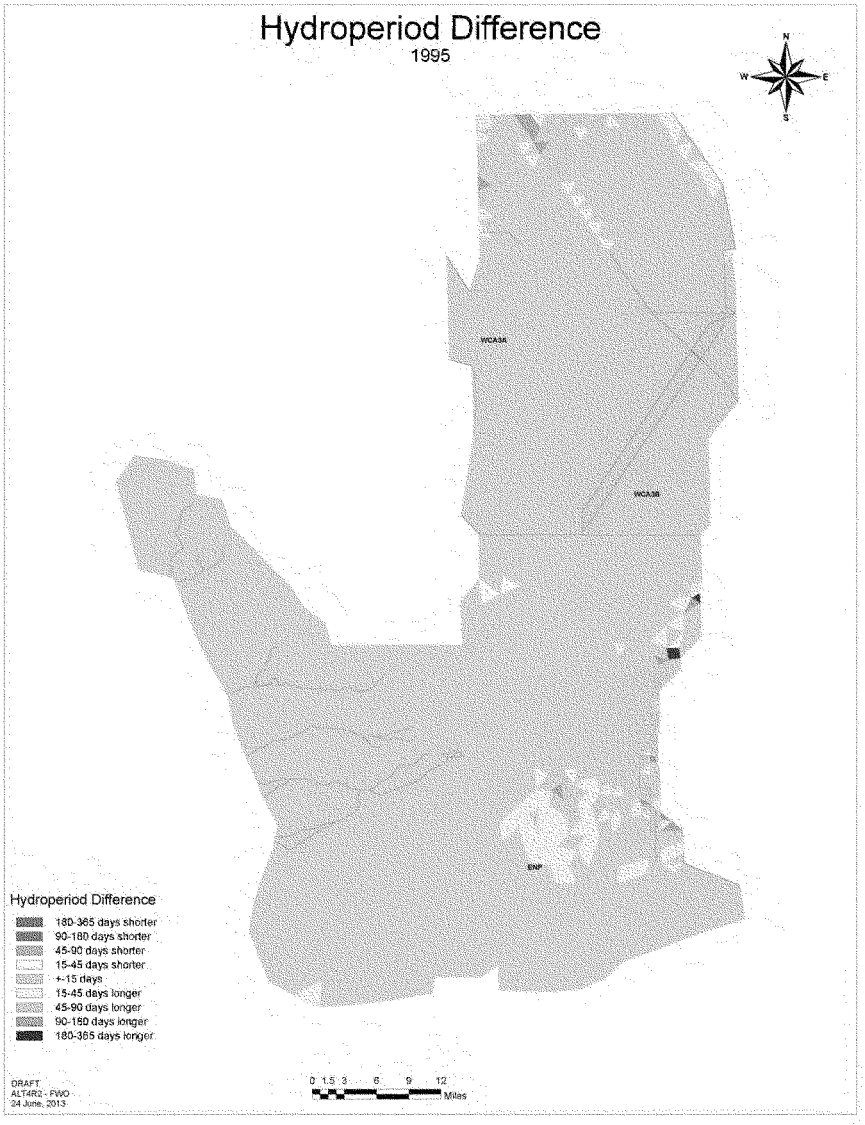


Figure 6-10. Differences in Hydroperiod within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for a Representative Wet Year (1995) in the Period of Record (1965-2005). Figure depicts hydroperiods resulting from implementation of the Recommended Plan that are shorter or longer than the FWO.

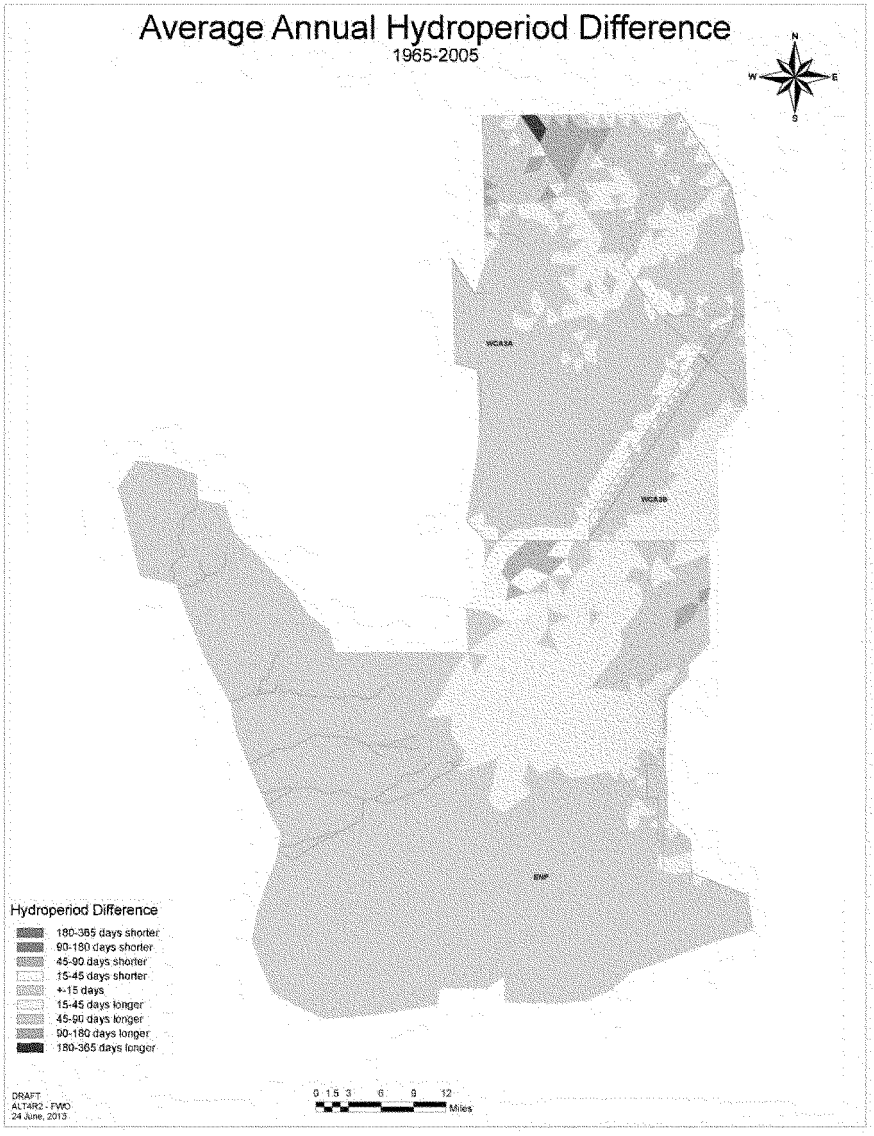


Figure 6-11. Differences in Average Annual Hydroperiod within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for the Period of Record (1965-2005). Figure depicts hydroperiods resulting from implementation of the Recommended Plan that are shorter or longer than the FWO

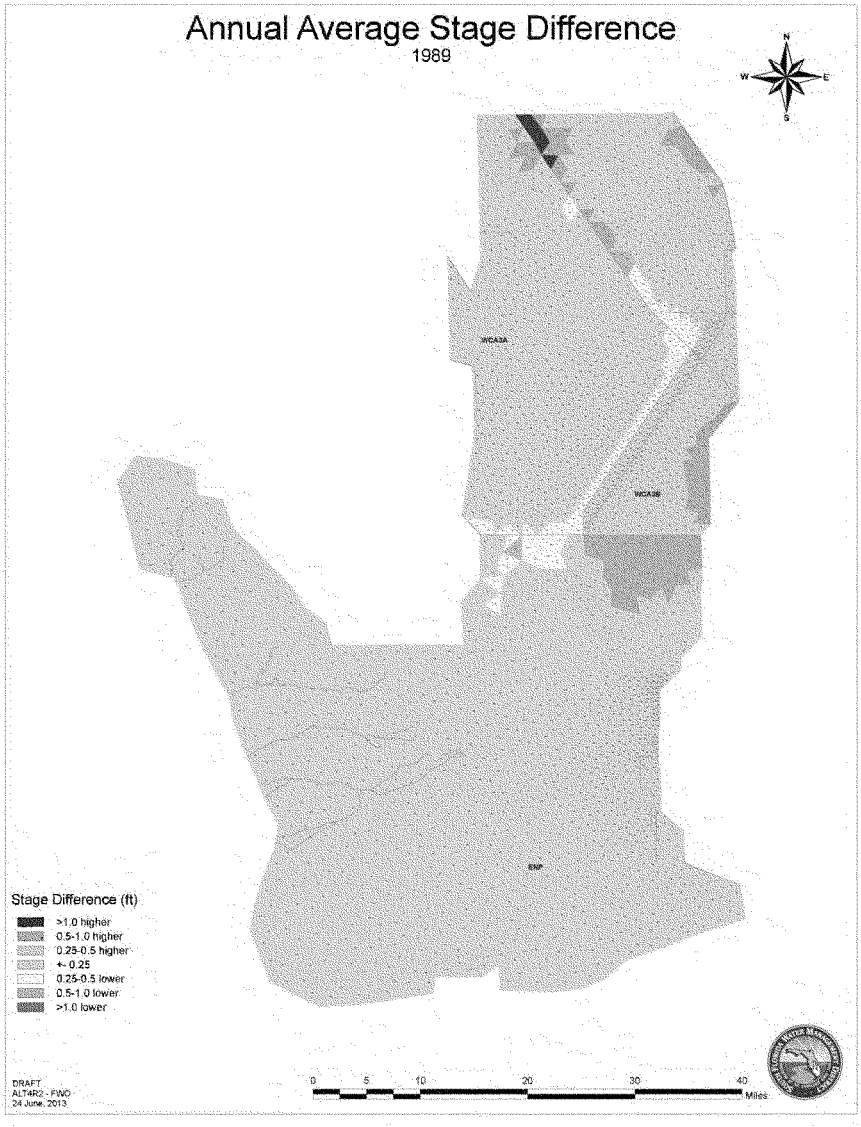


Figure 6-12. Differences in Stage within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for a Representative Dry Year (1989) in the Period of Record (1965-2005). Figure depicts stages resulting from implementation of the Recommended Plan that are higher or lower than the FWO.

Figure 6-13. Differences in Stage within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for a Representative Wet Year (1995) in the Period of Record (1965-2005). Figure depicts stages resulting from implementation of the Recommend Plan that are higher or lower than that of the FWO.

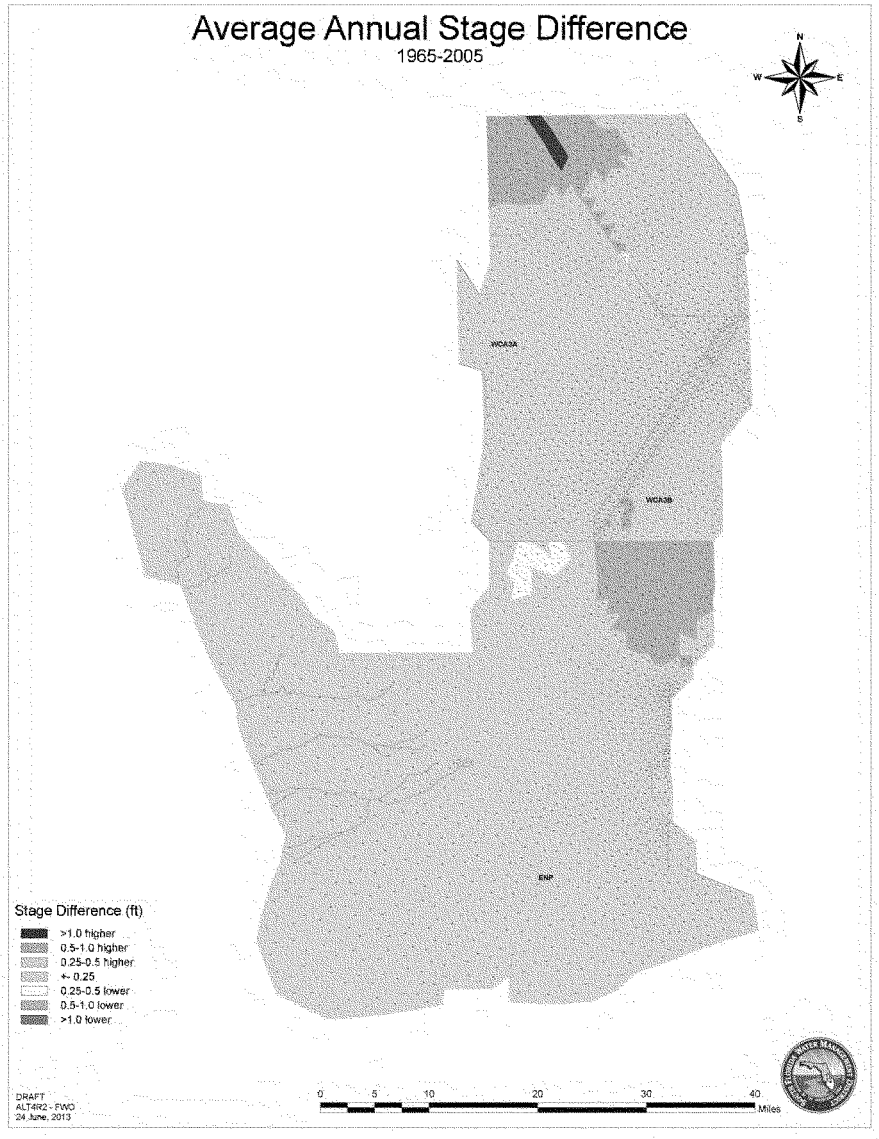


Figure 6-14. Differences in the Average Annual Stage Difference within WCA 3 and ENP between the FWO Project Condition and the Recommended Plan for the Period of Record (1965-2000). Figure depicts stages resulting from implementation of the Recommend Plan that are higher or lower than that of the FWO.

In northern WCA 3A, the Miami Canal functions as a major, unnatural drainage for WCA 3A. In combination with the northern levees of WCA 3A (L-4 and L-5), the Miami Canal has substantially impacted historical sheetflow and natural wetland hydroperiods. As a result, the natural capability of northern WCA 3A to store water is lost and the Miami Canal effectively over-drains the area. These hydrologic changes have increased the frequency of severe peat fires and have also resulted in the loss of ridge and slough topography that was once characteristic of the area. Most of WCA 3A north of Interstate 75 has experienced some form of fire and in more recent years those fires have moved farther south into the western portion of WCA 3A. Today, northern WCA 3A is largely dominated by sawgrass, cattail and scattered shrubs and lacks the structural diversity of plant communities seen in central and western WCA 3A. The recommended plan is expected to rehydrate much of northern WCA 3A by providing a means for redistributing treated STA discharges from the L-4 and L-5 in a manner that promotes sheetflow and by removing the drainage effects associated with the Miami Canal. This would promote the reversal of soil loss and would help in the restoration of organic soil accretion.

Central WCA 3A is considered to be fairly well conserved ridge and slough habitat. Vegetation and patterning in the central portion of WCA 3A resembles the pre-drainage conditions most closely and represents some of the best examples of Everglades habitat left in south Florida. This region of the Everglades appears to have changed little since the 1950s (which was already post-drainage) and contains a mosaic of tree islands, wet prairies, sawgrass stands, sawgrass ridges, and aquatic sloughs. Increases in depth within central WCA 3A were not as significant as increases in proposed depths in northern WCA 3A; however maintenance of existing conditions within this region of the project area is desirable as ridge and slough habitat is well conserved.

The southern portion of WCA 3A is primarily affected by long durations of high water and a lack of seasonal variability in water depths created by impoundment structures (*i.e.* L-67 and L-29 levees). The increased duration of high water events within southern WCA 3A has negatively impacted tree islands and caused fragmentation of the sawgrass ridges, again resulting in the loss of historic landscape patterning. Southern WCA 3A would remain largely unaffected by the recommended plan. The recommended plan would not result in significant benefits to southern WCA 3A through reduction in high water levels or durations.

Within WCA 3B, the ridge and slough landscape has been severely compromised by the virtual elimination of overland sheetflow since the construction of the L-67A/C Canal and Levee system. WCA 3B has become primarily a rain-fed compartment, experiencing very little overland flow and has largely turned into a sawgrass monoculture where relatively few sloughs or tree islands remain. Loss of sheetflow to WCA 3B has also accelerated soil loss reducing elevations of the remaining tree islands in WCA 3B, making them vulnerable to high water stages. The recommended plan would begin to re-establish hydrologic connectivity of WCA 3A, WCA 3B, and ENP. Increases in stages and hydroperiods would promote wetland vegetation transition, through contraction of sawgrass marshes and expansion of wet prairies and sloughs.

Flows through SRS under current water management practices, including the existing WCA 3A Regulation Schedule and the current limited capacity to redirect Lake Okeechobee water south to the Everglades, are much reduced when compared with pre-drainage conditions. The result has been lower wet season depths and more frequent and severe dry downs in the sloughs and reduction in the extent of the important shallow water "edges". Dry downs that are too frequent or severe inhibit the productivity and resilience of animal populations, including the prey base (i.e. marsh fishes and other aquatic animals) and wading birds that depend upon them. Over-drainage in the peripheral wetlands

along the eastern flank of Northeast Shark River slough (NESRS) has resulted in shifts in community composition, invasion by exotic woody species, and increased susceptibility to fire. The recommended plan is expected to rehydrate much of NESRS by providing a means for redistributing flows from WCA 3A through WCA 3B to ENP. Restoration of flow volumes will significantly improve hydroperiods and water depths while reducing the frequency and severity of dry downs.

Changes in hydrology of the freshwater systems have led to effects on the estuarine and marine environments of Florida Bay. Florida Bay is the main receiving water body of the Greater Everglades system and is heavily influenced by changes in the timing, distribution and quantity of freshwater flows. Alterations in seasonal inflow deliveries to Florida Bay have resulted in extreme salinity fluctuations. Water management actions that result from the recommended plan have the potential to reduce the intensity, frequency, duration and spatial extent of hypersaline events in Florida Bay and establish a persistent and resilient estuarine zone that extends further into the bay than currently exists. CEPP does not reconnect SRS to Taylor Slough or Florida Bay as it was historically, but it does allow additional surface water to flow southeastward around Mahogany Hammock towards West Lake, the Lungs, and Garfield Bight helping to negate the harmful buildup of hypersalinity. This is expected to help restore the bay to more natural conditions and increase biomass and diversity of bay flora and fauna including ecologically and economically important pink shrimp and spotted sea trout, and desired seagrass species. Further information pertaining to the evaluation of the recommended plan is described in **Appendix G**.

6.2.2 Contribution to Achievement of Interim Goals and Interim Targets

Section 601(h)(3)(C)(III) of WRDA 2000 (P.L. 106-541) required that CERP promulgate Programmatic Regulations which would include the "establishment of interim goals to provide a means by which the restoration success of the Plan may be evaluated throughout the implementation process." Section 385.38 of the Programmatic Regulations (33 CFR Part 385) describes the intent and the underlying principles for establishing interim goals and a process for their development. Recommendations for interim goals and interim targets were developed by Restoration, Coordination and Verification (RECOVER) in 2005. An intergovernmental agreement signed in 2007 among the USACE, DOI and SFWMD established interim goals for CERP. Section 385.39 also established the requirement to develop interim targets to measure progress toward meeting other water-related needs of the south Florida region, and described the intent, underlying principles, and the process for establishing interim targets. An agreement signed in 2007 between the USACE and SFWMD established interim targets.

The Programmatic Regulations also required that each PIR describe how the project contributes to the achievement of interim goals and interim targets (s. 385.26(a)(3)(xv)). Quantitative and qualitative predictions based on results from the RECOVER-approved performance measures, information gained from additional ecological planning tools and best professional judgment was used to evaluate the progress towards the interim goals.

6.2.2.1 Progress Toward Interim Goals

Each of the performance measures for the CEPP planning effort were derived from those approved for use in CERP by RECOVER. Detailed information about the performance measures and the methodology that was used to quantify ecosystem benefits and support plan evaluation and selection of the recommended plan can be found in **Appendix G**. The CEPP Planning Model underwent peer review per Engineering Circular (EC) 1105-2-412 (Assuring Quality of Planning Models) and was recommended for single-use by the National Ecosystem Restoration Planning Center of Expertise (ECO-PCX) and was approved by the USACE HQ Model Certification Panel. See **Section 6.10.1.2**. Further information on

ecological planning tools (i.e., Wood Stork Foraging Potential, Alligator Production Suitability, Everglades Landscape Vegetation Succession [ELVeS], Juvenile Sea Trout and Pink Shrimp) used to evaluate the environmental effects of CEPP alternatives can be found in **Appendix C.2**. Outputs from the regional hydrologic models used in plan formulation (RSM-BN and RSM-GL) were also used to evaluate and help quantify CEPP's progress towards meeting interim goals relevant to CEPP objectives. The RSM-BN and RSM-GL were approved for use through the current USACE Engineering software validation process. See **Section 6.10.1.1. Table 6-1** is a summary of the CEPP's effects on the interim goal indicators. Most analyses compare the recommended plan to the FWO project condition. When "acre-feet" are cited, this refers to an analysis of an average-annual water budget over the 41-year period of hydrologic model simulation (1965 – 2005).

Table 6-1. Progress Towards Meeting Interim Goals

Northern Estuaries Indicators
1.1 American Oysters : Increase areal coverage of American oysters in the Caloosahatchee and St. Lucie estuaries In the Caloosahatchee Estuary, more oysters were estimated under CEPP relative to the FWO and ECB at Cape Coral, values were similar for CEPP and the FWO at the more downstream and saline Shell Point. Compared to the ECB, CEPP could account for a 7.6% increase in oyster density at Cape Coral and a 4.4% increase at Shell Point. In the St. Lucie Estuary, the predicted seasonal pattern for oysters was similar at Roosevelt (US-1) Bridge, although densities were an order of magnitude lower than in the Caloosahatchee (there are fewer oysters to start with). There were more oysters predicted under CEPP relative to the FWO with a 13.1% improvement.
1.2 Submerged Aquatic Vegetation : Increase the areal coverage and improve the functionality of submerged aquatic vegetation in the northern estuaries The maximum number of seagrass shoots occurred in August and September in both estuaries with approximately 1.2 million shoots per acre of *Halodule wrightii* (shoal grass) at Shell Point in the Caloosahatchee and approximately 2.5 million shoots per acre of *Syringodium filiforme* (manatee grass) at Boy Scout Island near the Saint Lucie Inlet. Overall shoot densities predicted under the CEPP were greater than for either the FWO or the ECB. Compared to the FWO, increases of 8.5% and 6.6% more seagrass shoots were predicted with salinities representative of CEPP in the Caloosahatchee and St. Lucie, respectively. Functionality of existing seagrass beds in the Caloosahatchee and St. Lucie Estuaries are expected to improve with reductions in high flows and accompanying flow velocities.
1.3 Flows: Reduce high and low volume flows to the Caloosahatchee and St. Lucie estuaries High volume flows (>2,800 cfs) to the Caloosahatchee Estuary were reduced from 81 months in the FWO and IORBL1 to 70 months with CEPP (out of the 492 months in the period of record); incidences of low volume flows (<450 cfs) decreased slightly from 27 months in the FWO and IORBL1 to 23 months with CEPP. In the St. Lucie Estuary, the number of events where the 14-day moving average flow exceeded 2,000 cfs occurred 151 times in the FWO, 133 times in the IORBL1 and 86 times with CEPP; the number of months where average monthly flows <350 cfs occurred was 92 months in the FWO, 53 months with IORBL1, and 65 months with CEPP.
Greater Everglades Indicators
3.1 Water Volume: Distribute water across the ecosystem in a manner that reflects natural conditions while providing for other water-related needs of the region Although not always quantitative, the predictions for 3.2 *Sheetflow*, 3.3 *Hydropattern*, 3.13 *Flows to northern boundaries of the water conservation areas* and 3.14 *Flaws to Everglades Natianal Park*, below help to tell this hydrologic story.
3.2 Sheetflow in Natural Areas: Establish more historic magnitudes and directions of sheetflow in the natural areas of the Everglades Qualitatively, there is a greater magnitude of water flowing through WCA 3A, WCA 3B and ENP with CEPP. The distribution of flow relative to target indicates a 26% and 4% improvement for WCA 3A and ENP, respectively. Distribution decreases by 12% in WCA 3B.

3.3 Hydropattern: Restore the natural timing and pattern of inundation throughout the ecological communities of South Florida, including sawgrass plains, ridge and slough and marl marshes

With CEPP, the timing and inundation duration (length of time water was above ground) in WCA 3A improved 26% towards target. WCA 3B showed a 16% improvement. In ENP, these conditions moved 48% towards target.

3.4 System-Wide Spatial Extent of Habitat: Increase spatial extent of natural habitat

Fourteen thousand acres of public land currently leased for agricultural use will be shifted to higher quality wetland with construction of the A-2 FEB. CEPP will improve the functionality and habitat value of more than 1.5 million acres of Everglades fresh and saltwater marshes and estuaries.

3.6 Periphyton Mat Cover, Structure, and Composition: Restore periphyton mat cover, structure and composition that were characteristic of the spatially distinct hydroperiods (short and long hydroperiods) and low nutrient conditions in the greater Everglades wetland communities

Periphyton monitoring has shown that the continued input of above-ambient phosphorous concentrations will both increase severity of enrichment effects near canals and cause these effects to continue to cascade downstream. Increased input of water through restorative projects such as CEPP may increase periphyton development in areas formerly over-drained.

3.7 Ridge and Slough Pattern: Restore the historical ridge and slough landscape directionality and pattern

Restoration of the ridge slough pattern with CEPP may be highly geographically variable. Focusing flows to northwest WCA 3A could be advantageous from the perspective of local flow velocities. In WCA 3B, only in the area within the Blue Shanty flowway do restored flow lines track historical flow lines. One of the most restorable areas of the ridge-slough landscape is in southern WCA 3A, where the landscape retains high elevation variance, even though the bimodal nature of that distribution has been lost. As such, the inability to meaningfully change the hydrology in this impounded area remains problematic.

3.8 Everglades Tree Islands: Improve tree island health and maintain healthy tree islands

CEPP is protective of existing islands in northeast WCA 3A, and is highly protective of tree islands in Shark River Slough (SRS). Northwest WCA 3A and SRS are the most probable locations for the creation of new tree islands. CEPP provides improved hydrologic conditions for tree islands over the FWO in northern WCA 3A, WCA 3B, and SRS.

3.9 Aquatic Fauna Regional Populations in Greater Everglades Wetlands: Increase the abundance of fish to levels that approximate those predicted for pre-drainage conditions

Small fishes (up to ~8 cm) are expected to increase in abundance over the FWO in most of WCA 3 and ENP. Predictions in WCA 3A are slightly over 7% increase; WCA 3B ~4%; Shark Slough almost 14%; and Taylor Slough almost 7%. This predicted increase in fish biomass has the potential to greatly increase wading bird food availability. Larger fishes (≥ 8 cm) such as largemouth bass are also important components of the Everglades ecosystem. A catch-per-unit-effort abundance index indicates that largemouth bass will increase over the FWO by ~11% in WCA 3A and ~18% in Shark Slough.

3.10 American Alligator: Restore more natural numbers and distribution patterns for alligators across South Florida's major freshwater and estuarine landscapes

Alligator production potential increases over the FWO from ~5-7 years (out of a 41-year period of hydrologic record) in northern WCA 3A and around the backfilled Miami Canal. Gains in other areas (i.e., WCA 3B and ENP), while positive, are fairly negligible.

3.11 System-Wide Wading bird nesting patterns: Increase the total number of nesting pairs, the percentage of wading bird pairs nesting in estuarine locations and the frequency of super colony events and establish conditions that encourage wood storks to initiate nesting earlier in winter

Wood stork foraging suitability notably improves with CEPP in northern WCA 3A and within southern ENP relative to the FWO. Less substantial benefits occur within northwest WCA 3A and WCA 3B, and southeast ENP. Benefits generally result from the increased water deliveries to these regions which result in more suitable water depths for wood stork foraging as compared to existing conditions or future conditions without CEPP. While substantial declines in stork foraging suitability occur within northern ENP, it is predicted that southern ENP may become more suitable foraging habitat for wood storks, making it possible they would start nesting in this location once again. The general transitioning of wood stork foraging habitat from Shark River Slough, which historically was a deep water white-water lily-dominated habitat, back into southern ENP, is considered a progressive step toward ecosystem restoration.

3.12 Snail Kite: Increase the areal extent of suitable foraging for snail kites The apple snail is used as a proxy for snail kites, due to its being virtually the exclusive food source for the kite. CEPP provides better conditions for apple snail populations as well as an increase in suitable apple snail habitat in most of WCA 3A and in WCA 3B and Shark Slough in ENP.
3.13 Flows to Northern Boundaries of the WCAs: Provide more natural surface water flows to the northern boundaries of the water conservation areas CEPP reduces point source surface water discharge from S-8 by 219,000 acre-feet per year and spreads the water out to provide sheetflow through the western hydropattern restoration feature.
3.14 Flows to ENP: Provide more natural surface water flows to Everglades National Park Overland flows are introduced into NESRS from WCA 3B, estimated at 238,000 acre-feet per year, there was no overland flow here in the FWO.
Southern Estuaries Indicators
4.1 Salinity Patterns: Reduce the intensity, duration, frequency and spatial extent of high salinity events, reestablish low salinity conditions in mainland nearshore areas, and reduce the frequency of a rapidity of salinity fluctuations resulting from pulse releases of fresh water from canals Alt 4R2 will move Florida Bay, as a whole, 12% closer to the full restoration target (i.e. from 0.16 to 0.28 towards 1.0). Because of the generally poor current conditions, this 12% lift translates to about a 76% improvement relative to the FWO. Spatially, conditions are better in the east central, central, south, and west during the wet season and do improve in the east central, south, and west during the dry season.
4.2 Submerged Aquatic Vegetation: Reestablish a diverse seagrass community with moderate plant densities and more natural seasonality, and increase the percentage of Florida Bay having suitable habitat for seagrass growth Improved salinity regimes in the North Bay result in a stable mixed *Thalassia-Halodule-Ruppia* SAV community with a decrease in *Thalassia* and an increase in *Ruppia* densities over the FWO.
4.3 Juvenile Shrimp Densities: Increase densities of juvenile shrimp within the various basins of Florida Bay and Biscayne Bay Improved salinity regimes in the Central and Western Florida Bay result in less than 1% increase (0.68% and 0.35%, respectively) in potential pink shrimp annual harvest over the FWO.
4.4 American Crocodiles: Increase the frequency of salinities less than 20 parts per thousand in Florida Bay to foster optimal growth and survival of juvenile crocodiles Improved salinity regimes in north and central Florida Bay result in an increase in the crocodile growth and survival index overall of up to 7% and 14% respectively, and up to 4% and 28% respectively, during dry year conditions compared to the FWO.
4.6 Freshwater Flows to Florida Bay: Increase freshwater flows to Florida Bay Tidal outflows increase with CEPP by an average of 144,000 acre-feet per year.
System-Wide Water Volume
S.1 Quantity of Freshwater Lost to Tide: Reduce the quantity of freshwater lost to tide CEPP captures an estimated 79,000 acre-feet of water from being lost to the Gulf of Mexico in the Caloosahatchee (18% increase relative to the FWO) and 60,000 acre-feet from being lost to the Atlantic Ocean in the St. Lucie on average annually (32% increase relative to FWO).

6.2.2.2 Progress Toward Interim Targets

Each of the performance measures for the CEPP planning effort were derived from those approved for use in CERP by RECOVER and are applied for interim targets. Output from the regional hydrologic models used in plan formulation (RSM-BN and RSM-GL) was also used to evaluate and help quantify CEPP's progress towards meeting interim targets. **Table 6-2** is a summary of the CEPP's effects on the interim target indicators. Most analyses compare the recommended plan to the FWO. The interim targets analyzed in this section are based upon the objectives of CEPP.

Table 6-2. CEPP Progress Towards Meeting Interim Targets

Indicators	Interim Target	Summary of Project Effects
1. Water Volume	Distribute water across the ecosystem in a manner that reflects natural conditions while providing for other water-related needs of the region.	In general, increased water supplies and improved spatial distribution to the natural systems enables increased availability of water for other water related needs in some of the SFWMD water supply Service Areas.
2. Water Supply to Lower East Coast Service Area	Increase water supplies available for meeting existing and future water supply needs including the water supply rights of the Seminole Tribe of Florida, State of Florida, and the SFWMD.	The improved timing and inundation duration in WCA 3 enabled meeting existing permitted demands. An additional 12 million gallons per day (MGD) and 5 MGD of future water supply demands can also be met in LECSA 2 and 3, respectively.
3. Water Supply to Lake Okeechobee Service Area (LOSA)	Increase water supplies available for meeting existing and future needs including the water supply rights of the Seminole Tribe of Florida, State of Florida, and the SFWMD.	Timing and distribution of water from Lake Okeechobee provides the ability to maintain the existing level of water supply performance.

6.2.3 Ecosystem Services

Ecosystem services can be defined as the benefits human beings receive from resources and processes supplied by ecosystems (Murray et al. 2013). Some ecosystem services are material resources that can be used by people, such as food, timber, water, and medicine. Other ecosystem services come from ecological processes, such as carbon sequestration that results from the formation of peat soils. Describing ecosystem services helps capture a fundamental value of ecosystems - that they support human life on Earth.

CEPP would improve the ecological condition of the Everglades and associated estuaries and therefore should boost several ecosystem services. The services expected to improve include aesthetics; biodiversity and species composition; atmospheric carbon sequestration; commercial fishing; frogging; mangrove coastal stabilization and storm protection in Everglades National Park; recreation in the forms of biking, hiking, estuary fishing, some kinds of hunting (although deer hunting accessibility may decrease during some years), and non-motor boating; ecological connectivity of landscapes; educational opportunities; water quality in terms of reduction in phosphorous and sediment loads to estuaries; water quality in estuaries due to increased filtration by oysters; water supply to the LEC and for irrigation; wildfire management; and wildlife-associated activities such as wildlife photography, tours, and viewing.

6.3 ENVIRONMENTAL CONSIDERATIONS

6.3.1 Water Quality for Lake Okeechobee, the Northern Estuaries, and Water Conservation Area 3A

The recommended plan is not expected to significantly affect Lake Okeechobee water quality; however, increased backflow into the lake at the S-308 structure will result in a relatively small increase in lake phosphorus load. This additional load will be addressed through the Basin Management Action Plan process (Section 403.067, Florida Statutes). The Northern Estuaries should see slight improvements to water quality that result from reduced high flow events associated with Lake Okeechobee operations. The construction and operation of the A-2 FEB will slightly decrease EAA basin phosphorus loads to WCA 3.

Backfilling of northern portion of Miami Canal and re-direction of water into the northern marsh areas will result in greater uptake of nutrients and sulfate in northern WCA 3A. Increased flows and new flow patterns may result in an increase in water column phosphorus concentrations at one or more total phosphorous (TP) rule stations within WCA 3A and WCA 3B; however, this should have minimal impact on TP rule compliance. Reduced incidence of dry out of the northern marsh should limit peat oxidation and nutrient re-mobilization. Lower phosphorus and sulfate concentrations should occur in southern WCA 3A. The re-location of methylmercury "hotspots" within the northern Everglades will have limited practical impact on recreational fisheries since the area is already subject to a fish consumption advisory due to high levels of mercury in fish. The shifting of the methylmercury hotspots due to CEPP could impact wildlife; however, factors such as foraging patterns and atmospheric contributions of mercury are likely to play a greater role in regulating wildlife exposure to methylmercury than the hydrologic changes resulting from CEPP implementation.

6.3.2 Water Quality for Everglades National Park and the Southern Estuaries

Water entering ENP at the northern end of Shark River Slough (SRS) from WCA 3 is likely to have lower concentrations of TP as compared with the FWO condition due to the backfilling of the Miami Canal which will result in more water passing through the marsh areas and less water flowing directly from upstream canal sources. It is uncertain how changes in flow distributions proposed under CEPP will impact compliance with Appendix A of the 1991 Settlement Agreement. ALT 4R2 is expected to improve marsh hydroperiods over FWO conditions, which will reduce the risk of downstream TP spikes caused by dry-out and rewetting. Impact to the southern estuaries will be a decrease in average salinity conditions and the addition of nitrogen loading associated with the increase in flow. The effect of the added nitrogen is not expected to be ecologically significant.

Restoration of the Everglades requires projects that address hydrologic restoration as well as water quality improvement. The National Academy of Sciences in its most recent biennial report on restoration progress in the Everglades has recognized this where it noted that near-term progress to address both water quality and water quantity improvements in the central Everglades is needed to prevent further declines of the ecosystem. The significant amount of water resulting from CEPP will significantly improve restoration of the Everglades. Both the Federal and State parties recognize that water quantity and quality restoration should be pursued concurrently and have collaborated to develop and concur on a suite of restoration strategies being implemented by the State to improve water quality ("State Restoration Strategies"), as well as other State and Federal restoration projects, both underway and planned, to best achieve Everglades hydrologic objectives. Specific examples of Federally authorized projects include the Everglades Restoration Transition Plan (ERTP), Modified Water Deliveries to Everglades National Park Project, and the Tamiami Trail Next Steps Project. One of the goals of these projects and their associated operating plans, as well as certain components of the CERP awaiting authorization or that are being planned as part of the CEPP is to improve water quantity and quality in the Everglades through more natural water flow within the remnant Everglades which includes the water conservation areas and ENP. Variations in flows of the C&SF system may result from a variety of reasons. These reasons include natural phenomena (i.e. weather) and updates to the operating manuals to achieve the purposes of the C&SF Project such as flood control and water supply.

One goal of the Consent Decree[1] is to restore and maintain water quality within ENP. The Consent Decree established, among other things, long-term water quality limits for water entering ENP to achieve this goal. The existing limits for ENP are flow dependent and, generally, increased volume of water results in a lower allowable concentration of phosphorus to maintain the overall load of phosphorus entering the ENP. There will be redistribution of flows and increased water volume above existing flows associated with system restoration efforts beyond the current State Restoration Strategies projects. The Corps and its Federal and State partners recognize that to achieve long-term hydrologic improvement, water quality may be impacted, particularly as measured by the current Consent Decree Appendix A[2] compliance methodology. The Corps and the State partners agree that the monitoring locations/stations for inflows to ENP will require revision. The Technical Oversight Committee ("TOC") is currently conducting an evaluation of this and other aspects of the compliance methodology.

In an effort to address these potential impacts and determine updates to Appendix A to reflect increased inflows and new discharges into ENP since the Consent Decree was entered, the parties to the Consent Decree have established a process and scope for evaluating and identifying necessary revisions to the Appendix A compliance methodology utilizing the scientific expertise of the TOC. The TOC may consider all relevant data, including the 20 years of data collected since Appendix A was implemented. Ultimately, such evaluations and changes to the Appendix A compliance methodology would be recommended by the Consent Decree's TOC for potential agreement by all parties. Failure to develop a mutually agreed upon and scientifically supportable revised compliance methodology will impact the State's ability to implement or approve these projects.

The aforementioned State Restoration Strategies will be implemented under a CWA discharge permit that incorporates and requires implementation of corrective actions required under a State law Consent Order, as well as a Framework Agreement between the U.S. Environmental Protection Agency (USEPA) and the State discharge permitting agency, the FDEP, to ensure compliance with CWA and State water quality requirements for existing flows into the Everglades. The CWA permit for the State facilities, the associated Consent Order (including a detailed schedule for the planning, design, construction, and operation of the new project features), and technical support documents were reviewed by, and addressed all of, the USEPA's previous objections related to the draft National Pollutant Discharge Elimination System ("NPDES") permits, prior to issuance.

All parties are committed to implementing the State Restoration Strategies, joint restoration projects, and associated operational plans, in an adaptive manner that is consistent with the objectives of the underlying C&SF Project. The Corps and the State will use all available relevant data and supporting information to inform operational planning and decision making, document decisions made, and evaluate the resulting information from those decisions to avoid adverse impacts to water quality where practicable and consistent with the purposes of the C&SF Project. Based upon current and best available technical information, the Federal parties believe at this time that the State Restoration Strategies, implemented in accordance with the State issued Consent Order and other joint restoration projects, are sufficient and anticipated to achieve water quality requirements for existing flows to the Everglades. If there is an exceedance of the Appendix A compliance limits, which results from a change in operation of a Federal project, and it has been determined that an exceedance cannot be remedied

[1] *United States v. South Florida Water Management District, et al.*, Case No. 88-1886-CIV-Moreno (U.S.D.C., S.D. Fla.).

[2] Appendix A referenced in this section of chapter 6 refers to the Consent Decree compliance calculation appendix

without additional water quality measures, the Federal and State partners agree to meet to determine the most appropriate course of action, including what joint measures should be undertaken as a matter of shared responsibility. These discussions will include whether it is appropriate to exercise any applicable cost share authority. If additional measures are required and mutually agreed upon, then they shall be implemented in accordance with an approved process, such as a general re-evaluation report (GRR) or limited re-evaluation report (LRR), and if necessary, supported through individual project partnership agreements (PPA's). Failure to develop mutually agreed upon measures and cost share for these measures may impact the State's ability to operate the Federal project features.

6.3.3 Cumulative Impacts

Cumulative environmental effects for the proposed action were assessed in accordance with guidance provided by the President's Council on Environmental Quality (CEQ). The primary goal of cumulative effects analysis is to determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative effects of other past, present, and future actions. **Table 6-3** shows the net cumulative effects of the various resources which are directly or indirectly impacted. CEPP is expected to contribute to a net beneficial cumulative impact on the regional ecosystem. Further information on cumulative effects can be found in **Appendix C.2.2.2.**

Table 6-3. Summary of Cumulative Effects

Hydrology	
Past Actions	Flood and water control projects have greatly altered the natural hydrology.
Present Actions	Federal and State agencies are coordinating on and implementing projects to improve hydrology.
Proposed Action	Reductions in high discharge events from Lake Okeechobee to the Northern Estuaries. Significant beneficial hydrologic effects are anticipated within the Greater Everglades through restoration of sheetflow and rehydration of previously drained areas. Improved hydrologic conditions will result from increasing depths and extending hydroperiods in WCA 3A, WCA 3B, and ENP.
Future Actions	Additional CERP projects propose to restore hydrology to more natural conditions.
Cumulative Effect	Although it is unlikely that natural hydrologic conditions would be fully restored to pre-drainage conditions, improved hydrology would occur. CERP is expected to improve the quantity, quality, timing and distribution of freshwater flow.
Threatened and Endangered Species	
Past Actions	Water management practices and urbanization have resulted in the degradation of existing habitat function and direct habitat loss leading to negative population trends of threatened and endangered species.
Present Actions	Ongoing efforts have been made by Federal and State agencies to implement projects to improve hydrology within the project area. These ongoing efforts include Kissimmee River Restoration, Lake Okeechobee Regulation Schedule, Canal 111 South Dade and other CERP projects. In addition, several water control plans (e.g. Interim Operational Plan for Protection of the Cape Sable Seaside Sparrow, Everglades Restoration Transition Plan) have specifically been implemented to address operations to better protect endangered species including endangered Cape Sable seaside sparrow (CSSS), endangered Everglade snail kite and endangered wood stork. The FWS recovery plan is used as a management tool.
Proposed Action	May affect the Eastern indigo snake, Florida panther, wood stork, Everglade snail kite, Everglade snail kite critical habitat, Florida manatee, Florida manatee critical habitat, crocodile, crocodile critical habitat, CSSS, CSSS critical habitat, green sea turtle, leatherback sea turtle, Hawksbill sea turtle, loggerhead sea turtle, Kemp's ridley sea turtle, small tooth sawfish, and small tooth sawfish critical habitat (See **Annex A**).

Future Actions	CERP projects under construction, as well as ongoing projects previously mentioned, would assist in maintaining and improving conditions for threatened and endangered species within the project area. ERTP implementation represents a paradigm shift from single species to multi-species management. ERTP includes performance measures specifically directed at managing water levels and releases for the protection of multiple species and their habitats within the project area.
Cumulative Effect	Habitat improvement, monitoring and management of threatened and endangered species are anticipated to allow populations to be maintained. Improvement of degraded populations is expected to be facilitated by the restoration and enhancement of suitable habitat through efforts to restore more natural hydrologic conditions within the project area.
Fish and Wildlife Resources	
Past Actions	Water management practices have resulted in aquatic vegetation community changes and a resultant disruption of aquatic productivity and function that has had repercussions through the food web, including effects on wading birds, large predatory fishes, reptiles and mammals.
Present Actions	Ongoing efforts have been made by Federal and State agencies to implement projects to improve hydrology within the project area to restore habitat conditions for fish and wildlife resources.
Proposed Action	Negligible effects to fish and wildlife resources within Lake Okeechobee, and the EAA. Reductions in the number of high discharge events to the Northern Estuaries are anticipated to improve suitable habitat for key indicator species such as oysters. Significant beneficial effects are anticipated within the Greater Everglades. Rehydration within previously dry areas of WCA 3A, 3B, and ENP would increase the spatial extent of suitable habitat for several fish and wildlife resources. Increases in forage prey availability (crayfish, other invertebrates, and fish) would directly benefit amphibian, reptile, small mammal, and wading bird species. Nesting and foraging activities of resident bird species are anticipated to be significantly improved. Although mammals occurring within the action area are adapted to the naturally fluctuating water levels in the Everglades, there is an increased potential that mammals currently utilizing upland habitat may be negatively affected. Increased freshwater flows to Florida Bay would aid in improving suitable habitat for pink shrimp, juvenile spotted sea trout, sea turtles, manatee and crocodiles among other species.
Future Actions	Some level of improvement to fish and wildlife resources is expected to occur as a result of implementation of projects with the capability of improving the timing, quantity, quality and distribution of freshwater flow to the study area. Hydrologic restoration planned as part of CERP would further improve fish and wildlife habitat.
Cumulative Effect	Habitat improvement efforts are anticipated to benefit fish and wildlife resources.
Vegetation and Wetlands	
Past Actions	Drainage of Florida's interior wetlands, conversion of wetlands to agriculture, and urban development has reduced the spatial extent and quality of wetland resources.
Present Actions	Efforts are being taken by State and Federal regulatory agencies to reduce wetland losses.
Proposed Action	Negligible effects to vegetation within Lake Okeechobee and the EAA are anticipated. Reductions in the number of high discharge events to the Northern Estuaries are anticipated to improve conditions for seagrass beds. Significant beneficial effects are anticipated within the Greater Everglades. Improved hydroperiods and sheetflow within WCA 3A, 3B and ENP would result in reduced soil oxidation, promoting peat accretion necessary to rebuild the complex mosaic of habitats across the landscape. Increased freshwater flows to Florida Bay would aid to lower salinity levels, benefiting mangrove communities and seagrass beds.

Future Actions	Some level of improvement to vegetative communities is expected to occur as a result of implementation of projects with the capability of improving the timing, quantity, quality and distribution of freshwater flow to the study area. More natural hydrology as part of the CERP would assist in restoring natural plant communities.
Cumulative Effect	While the spatial extent of natural plant communities would not be restored to historic proportions, the quality of vegetative communities would be improved.
	Cultural Resources
Past Actions	Flood and water control projects, conversion of wetlands into agriculture and urban development have had adverse unmitigated effects to cultural resources either directly or indirectly.
Present Actions	Ongoing efforts have been made by Federal and State agencies to implement projects to improve hydrology within the project area, thereby stabilizing the tree islands which are known to have a high potential for cultural resources.
Proposed Action	While effects of the proposed action have been evaluated, a final determination of effects on cultural resources is not complete. Consultation with stakeholders, including the State Historic Preservation Office, Advisory Council on Historic Preservation, Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida is currently ongoing.
Future Actions	Continued improvement to hydroperiods and sheetflow within WCA 3A, 3B and ENP could reduce soil oxidation, which could stabilize the environment, and this in turn could stabilize tree islands containing cultural resources. Investigations mandated in the Programmatic Agreement for ERTP will be completed ca. 2016 and will determine the effects of fluctuating water on subsurface historic properties.
Cumulative Effect	Cumulative effects to historic properties and culturally significant sites will potentially be long-term adverse effects if not avoided. Mitigation measures for effects to historic properties could potentially reduce the cumulative effect to minor long-term adverse effects. Mitigation measures for culturally significant sites are unknown.
	Water Quality
Past Actions	Water quality has been degraded from urban, suburban, commercial, industrial, recreational and agricultural development.
Present Actions	Efforts to improve water quality from agricultural areas are ongoing. Federal and State projects would temporarily elevate localized levels of suspended solids and turbidity.
Proposed Action	Implementation of the project is not expected to significantly affect the water quality of Lake Okeechobee or the Northern Estuaries. Changes in the quantity, timing, and distribution of flows within WCA 3A and WCA 3B may result in temporary increases in phosphorus concentrations at some TP Rule monitoring stations; however, this should not significantly affect TP Rule compliance. Over the long-term, distributing the flow over the northern WCA 3A marsh, reducing short-circuiting down the canals, adding more flow from the lake that is treated to the water quality based effluent limits (WQBEL), should result in improved water quality within WCA 3 and a reduction in flow weighted mean total phosphorous concentration entering the Park. Southern Estuaries salinity conditions are expected to be improved by the project.
Future Actions	Actions by the State of Florida's Restoration Strategies would decrease nutrient concentration and loadings to the project area. The Broward County WPA Project, (Record of Decision signed in 2012, authorized in WRRDA 2014) would reduce storm runoff deliveries to WCA 3 and improve water quality coming across Tamiami Trail.
Cumulative Effect	While anthropogenic effects on water quality are unlikely to be eliminated, water quality is expected to slowly improve over existing and recent past conditions. During detailed planning and design, the USACE and SFWMD are committed to ensuring that project feature implementation will not result in violations of water quality standards.

Water Supply/Flood Control	
Past Actions	Water supply and flood control for agricultural and urban users has benefited from construction and operation of the C&SF Project.
Present Actions	Availability of water from Lake Okeechobee for agricultural users was recently diminished through implementation of 2008 LORS. Availability of water for urban and agricultural users were recently diminished through implementation of ERTP. The SFWMD has implemented Restricted Allocation Area Rules to cap users dependent on water supplies from Lake Okeechobee and the regional system (the Everglades).
Proposed Action	Implementation of the project would likely have no effect on water supplies to agricultural users dependent on Lake Okeechobee. Agricultural, municipal, and industrial water supply in LECSA 2 and 3 will increase slightly in the future.
Future Actions	Future supplies would not change in the future unless additional CERP storage or hydrologic improvements to the Everglades are implemented and increase water availability.
Cumulative Effect	While effects on water supplies are unlikely to improve, water supplies available for agricultural and urban users are expected to remain stable until additional storage mechanisms are implemented.

6.3.4 Incomplete or Unavailable Information

The analyses provided in this document are based upon current knowledge of the physical and biological conditions in the action area and on projections of the most probable future conditions, as indicated by hydrologic models. The PDT recognizes that there is uncertainty in the predictions derived from these models that stems from input variability and measurement errors, parameter uncertainty, model structure uncertainty and algorithmic (numerical) uncertainty as outlined in the CERP Model Uncertainty Workshop Report (RECOVER 2002). These uncertainties are also translated into uncertainty as to whether the specific performance indicators and measures used to characterize the overall system performance actually capture that overall performance. The likelihood of capturing all the processes occurring in a system as complex as the Everglades within simulation models is low. Even with a comprehensive model uncertainty analysis for CEPP, there will always be some uncertainty present in predicting environmental benefits associated with any CERP project because of the size and complexity of the Everglades ecosystem as well as the difficulty in fully understanding its physical and biological processes. However, the outputs of the sub-regional hydrologic models used to assess projected hydrologic changes and to quantify ecosystem benefits for CEPP were the best data available to predict the most likely hydrologic changes as a result of the project. Even though uncertainty is recognized, ecological benefits derived from performance measure metrics are useful in making planning level decisions. These values provide a quantitative means for comparing alternatives to identify the best performing alternative.

It is recognized that new technical information or models may be developed as the selected plan is implemented and that the observed results may differ from predicted results. Considering this, it may be necessary to adjust operations to address the new information or observed results to achieve better performance for environmental restoration and protection to ensure the health, safety, and well-being of the general public and affected individuals. Using an AM approach during implementation of CEPP, as documented in **Annex D**, would provide new information to address uncertainties and risks over time, decrease the potential for costly mistakes, and ultimately support fulfillment of the CEPP restoration goals and objectives.

6.3.5 Unavoidable Adverse Environmental Effects

As discussed under each resource in **Section 5.2**, adverse effects associated with implementing the recommended plan are expected to be minimal to moderate. Unavoidable potentially adverse impacts that would result from implementation of the recommended plan include effects to the CSSS and temporary, short term impacts to air quality, the noise environment, and aesthetic resources from operation of construction equipment through lands designated for staging, access and construction. Temporary disturbances to and displacement of fish and wildlife resources to other nearby habitat would occur during construction. Vegetation would be lost during construction that currently exists on levees and spoil mounds that would be degraded and/or in areas where project features would be constructed.

Significant beneficial effects to fish and wildlife resources are anticipated under the recommended plan. Adverse effects to alligators that utilize the Miami Canal would occur due to backfilling of the Miami Canal within northern WCA 3A. These effects are expected to be short-term as alligators would expand into other areas of suitable habitat created as a result of CEPP implementation. Due to increased water flow and changes in water distribution, it is anticipated that overdrained areas in northern WCA 3A will be rehydrated, triggering a vegetation transition from upland to wetland habitat. Although mammals occurring within the action area are adapted to the naturally fluctuating water levels in the Everglades, there is an increased potential that mammals currently utilizing upland habitat may be negatively affected. Refuge for terrestrial mammals and other upland species will continue to be provided by the retention of 22 of the highest priority FWC enhanced spoil mounds between S-339 to I-75 and the creation of additional upland landscape (constructed tree islands) approximately every mile along the entire reach of the Miami canal (S-8 to I-75). Changes in water quality also have the potential to affect prey forage base through altering of vegetation composition or structure. Water quality will continue to be monitored under CEPP.

Non-native and invasive plant infestations in the project area may be exacerbated by soil disturbance during construction and hydrological modification and may require active management. Many non-native and invasive species are flourishing in a variety of habitats and are negatively affecting the ecology throughout the Everglades. Introduction or expansion of non-native fish species due to changes in water distribution and increased connectivity between WCA 3A, WCA 3B and ENP is likely to occur; however, the extent of the impact is uncertain at this time.

Publically owned lands are being utilized for the recommended plan. Portions of the A-2 footprint are currently leased for purposes of agricultural production, including sugar cane. Potential adverse impacts on prime and unique farmland will be assessed during detailed design. Adverse impacts on wetland acreage would occur within WCA 3B with implementation of the recommended plan as a result of the construction of the Blue Shanty Levee (L-67D). This loss would be offset by improved conditions to wetland acreage elsewhere within the region. **Section 5.2.14.1** evaluates increases in wetland acreage directly associated with implementation of the recommended plan. The recommended plan provides a net gain of wetland acreage as a result of the construction of other project features including construction of the A-2 FEB, degradation of the L-4 Levee, backfill of the Miami Canal, construction of gaps in the L-67C Levee, degradation of the L-29 Levee and L-67 Extension Levee, and removal of Old Tamiami Trail.

The recommended plan will potentially have adverse effects to cultural resources, some of which are unavoidable and long term, and/or cannot be assessed until the detailed design phase of the project. Avoidance of adverse effects to cultural resources is the Corps preference, therefore, throughout the

planning process for CEPP, the project archaeologist, engineers, and plan formulators have worked closely to determine alternatives and features of alternatives that reduce or eliminate impacts to cultural resources. Pursuant to 36 CFR 800.1, where possible, the project design will be modified to avoid impacting significant historic properties and culturally significant sites. Where avoidance is not possible, other mitigation measures will be considered. As consulted on throughout CEPP, mitigation measures will be developed during the PED phase in consultation with the State Historic Preservation Office (SHPO), tribal groups and other interested parties as established in implementing regulations for Section 106 of the National Historic Preservation Act (NHPA) (see **Appendix C.5**).

With regards to sites containing human remains, the Corps is currently in consultation with the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida to draft a new policy guidance memorandum to update and expand the 2008 CERP Policy on Human Remains that currently applies to the CEPP study area, to apply to all Civil Works and Regulatory actions within the respective jurisdiction of these Jacksonville District programs in the State of Florida. This document is an internal guidance memorandum designed to consolidate and clarify existing Corps documents regarding the treatment of human remains pursuant to Section 106 of the NHPA and the Jacksonville District's Federal Trust Responsibilities for the State of Florida (see **Appendix C.5** (2008 CERP Policy)).

6.3.6 Irreversible and Irretrievable Commitment of Resources

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resource as they presently exist are lost for a period of time. Construction of the proposed project will include many features considered permanent as well as modifications to existing C&SF Project features, which may be deemed irreversible. This would include project features in the EAA for storage and features in the WCAs and ENP that would change the distribution and conveyance (location, direction, depth, volume, and/or timing) of the available water. The proposed project would also include features necessary to control resulting increased seepage along the eastern boundary of WCA 3B and ENP. Such construction and structural modifications are proposed on such a large scale that these features represent an irreversible and irretrievable commitment of resources. Resources to be committed if the project is approved include expenditure of State and Federal funding, labor, energy and project materials to build, operate and maintain the proposed project.

6.4 COST ESTIMATES OF RESTORATION ELEMENTS

The goal of the cost estimates for the CEPP are to present a Total Project Cost (Construction and Non-Construction costs) for the recommended plan at the current price level to be used for project justification/authorization. In addition, the costing efforts are intended to produce a final product (cost estimate) that is reliable and accurate and that supports the definition of the Government's and the non-Federal sponsor's obligations.

The cost estimate supporting the recommended plan is prepared in MCACES/MII tool. This estimate is supported by the preferred labor, equipment, materials and crew/production breakdown. A risk analysis addresses project uncertainties and sets contingencies for the recommended plan cost items. Guidance for estimating costs, the fully funded (escalated for inflation through project completion) cost estimate and the Total Project Cost Summary, including the risk analysis, is provided in **Appendix B**.

The recommended plan has undergone a higher level of engineering design than did the final array of alternatives. This lessened the risk-based approach of using a high contingency (82%) during plan

formulation to account for uncertainties. While the recommended plan construction cost estimate is slightly higher than Alternative 4R, the lower contingency (44%) has led to a lower overall project cost estimate for the recommended plan.

Table 6-4 includes a breakdown of the estimated costs of CEPP by construction and non-construction costs for ecosystem restoration activities. Lands and Damages generally include LERR (lands, easements, rights-of-way and relocations), Engineering During Construction (EDC), PED and S&A (Supervision and Administration) costs. Costs were estimated at Fiscal Year 2014 price levels and rounded to the nearest $1,000,000. The Federal discount rate of 3.5% and a 50-year economic period of analysis were used to amortize costs and determine the project investment costs. Based on preliminary engineering and design of the recommended plan, the average annual cost is $100,000,000 (**Table 6-5**).

Table 6-4. Ecosystem Restoration Cost Estimates (2014 Price Level) [1, 2]

Construction Phase Items	Cost
06 Fish and Wildlife (monitoring and adaptive management)	$106,000,000
09 Channels & Canals	$370,000,000
11 Levees	$399,000,000
13 Pumping Plant	$133,000,000
15 Floodway Control and Diversion	$342,000,000
18 Cultural Resources Preservation	$26,000,000
32 HTRW Investigations	$1,000,000
Construction Features Sub-Total	**$1,377,000,000**
Preconstruction Engineering and Design (PED), Engineering During Construction (EDC) and Planning	**$345,000,000**
Construction Management (S&A)	**$135,000,000**
Lands & Damages	**$37,000,000**
Total First Cost	**$1,894,000,000**

[1] Construction costs in this table include contingencies
[2] Recreation costs are not included in the ecosystem restoration cost estimates (see **Section 6.5**)

Table 6-5. Ecosystem Restoration Investment and Average Annual Costs

Investment Costs	
Total First Cost	**$1,894,000,000**
Interest During Construction: Construction	$96,000,000
Interest During Construction: Real Estate	$4,000,000
Total Investment Cost	**$1,994,000,000**
Average Annual Costs	
Interest and Amortization of Initial Investment	**$85,000,000**
OMRR&R Sub Total	**$11,250,000**
New Project Features	$4,150,000
State Facilities	$4,000,000
Invasive Species	$3,100,000
Monitoring Sub-Total	**$3,880,000**
Water Quality	$710,000
Hydrometerological	$195,000
Ecological Sub-Total	$2,145,000
Biological Opinion	*$1,885,000*
General Ecological Monitoring[1]	*$260,000*
Adaptive Management[1]	$690,000
Invasive Species[1]	$140,000
Total Average Annual Costs [2]	**$100,000,000**

[1] Costs reflect 10-year annual monitoring costs from Tables 6-8 and 6-9 amortized over the period of analysis
[2] Total rounded to the nearest $1,000,000

6.4.1 Real Estate

Fee title will be required for the project footprint of the A-2 FEB and the FEB Discharge Canal. The estimated real estate cost for the A-2 FEB utilizing the actual acquisition costs are $31,710,508. For the FEB Discharge Canal comprised of approximately 91.25 acres, SFWMD acquired 34.23 acres with Farm

Bill and State funds acquired at a cost of $89,047. Approximately $78,801 will be credited to the Federal Government and $10,246 will be credited to SFWMD. The approximately 57.02 acres owned by the State of Florida were valued at $712,750. SFWMD will recertify the lands in WCA 3A/3B to the Federal Government when required for construction or operations at no cost to the CEPP project. Administrative costs were estimated at approximately $2,494,811. A contingency of 44% was applied on only $2,986,500. Total estimated real estate costs were $37,000,000.

6.4.2 Operations, Maintenance, Repair, Replacement and Rehabilitation for Project Features

OMRR&R begins after physical project construction and Operational Testing and Monitoring is complete, and generally includes all operation activities and maintenance needed to keep the project features functioning as intended. OMRR&R for the CEPP project will occur for all new facilities constructed as a result of the project, and as an increase to the OMRR&R for State Facilities that CEPP will use to provide new water to the WCAs and ENP.

6.4.2.1 Average Annual Operations, Maintenance, Repair, Replacement and Rehabilitation for New Project Features

The Operations and Maintenance Costs Methodology Report Database developed by SFWMD was used to calculate OMRR&R costs. This tool is useful in calculating basic operations, maintenance, and repair costs and is based on historical accruals for similar operations, maintenance and repair activities. Rehabilitation and replacement costs include those costs required to keep the pump station operable for the period of analysis. Repair and rehabilitation costs on items such as pumps, drivers, and switchgear are assumed to be rehabilitated or replaced once during the 50-year life cycle. While rehabilitation costs are typically only 35-45 percent of replacement costs; in order to provide a conservative estimate for CEPP features, major equipment replacement is considered in the estimate. Replacement is estimated to occur 30 years after placing the station into operation. The replacement cost includes engineering and structural modification costs as well as the equipment costs. The following table (**Table 6-6**) lists the average annual OMRR&R costs for new CEPP facilities. See **Appendix A** for a list of OMRR&R activities.

Table 6-6. Average Annual OMRR&R costs for New CEPP Facilities

Structure	OMRR&R Costs
A-2 FEB	$2,090,000
S-620 (CS-1) 500 cfs gated culvert, S-621 (CS-2) 2,500 cfs gated spillway, S-622 (CS-3) 500 cfs gated spillway	$330,000
Modified S-8 (2 gated culverts)	$230,000
S-630 (360 cfs Pump Station)	$240,000
New S-333N - 1,150 cfs	$160,000
New (S-356) Pump Station at 1,000 cfs	$600,000
500 cfs gated culverts (S-631, S-632, and S-633)	$340,000
8.5 mile levee in WCA 3B	$50,000
S-355W-1,230 cfs gated spillway	$110,000
TOTAL Average Annual OMRR&R Costs New Facilities	**$4,150,000**

6.4.2.2 Average Annual Operations, Maintenance, Repair, Replacement and Rehabilitation for State Facilities used by CEPP

The future OMRR&R costs of operating the State facilities, without CEPP, are based on the Operations and Maintenance Costs Methodology Report Database developed by SFWMD, as described above. The

future OMRR&R costs of operating the system once CEPP is constructed and operational are based on the volume of new water flows through the State facilities as a portion of the overall water flows through the State facilities. In order to calculate the average annual OMRR&R costs attributed to CEPPs usage of State Facilities, a series of steps were taken to determine the new average annual OMRR&R costs of operating the State owned facilities and associated infrastructure, including the structures named in **Table 6-7** and in Appendix A Table A-35 and A-36.

Step 1: Calculation of CEPPs proportion of total flow through State Facilities

The recommended plan is designed to deliver approximately 210,000 acre-feet per year of additional flows from Lake Okeechobee to the central Everglades on an average annual basis. Since the CEPP hydrologic modeling encompasses a 41-year period of record consisting of a wide range of hydrologic conditions, it is recommended that cost sharing for OMRR&R be based upon the average annual treatment capacity water budgets for the "Future Without Project" and "Future With Project" conditions. The total average annual treatment capacity water budget of the State-owned/State-operated features as identified from the SFWMD Restoration Strategies is ~877,000 acre-feet per year. The total average annual treatment capacity water budget of these same features in the CEPP "Future With Project" condition includes ~210,000 acre-feet per year of new water for a total of ~1,087,000 acre-feet per year. The percent of total usage attributed to the new flows under CEPP is estimated as follows:

$$= \left[\frac{\text{New Water Provided by CEPP Ave Annual Water Budget}}{\text{SFWMD Restoration Strategies Water Budget}}\right] x\ 100\%$$

$$= \left[\frac{210{,}000\ \text{ac} - \text{ft/yr}}{1{,}087{,}000\ \text{ac} - \text{ft/yr}}\right] x\ 100\% = \sim 19\%$$

New water provided by CEPP will comprise ~19% of the total water volume through the State-owned/State-operated facilities.

Step 2: Calculation of total average annual OMRR&R costs for the State facilities used by CEPP:

Average annual OMRR&R costs with CEPP operational are commensurate with the increase in flows associated with the CEPP features. Therefore, since average annual flows are expected to increase approximately 23.5% (i.e., from 877,000 ac-ft to 1,087,000 ac-ft), then the total average annual OMRR&R cost, including CEPP, will be increased by ~23.5% over the without-project condition costs.

Step 3: Apply CEPP flow proportion to total OMRR&R costs of the State facilities used by CEPP:

Applying the 19% flow proportion to the new total average annual OMRR&R costs ($21,000,000) with CEPP in place will yield the marginal cost of CEPP. The estimated average annual OMRR&R for State facilities that CEPP depends on for operational functionality is projected to increase approximately from $17,000,000 to $21,000,000 per year. Nineteen percent of the new average annual OMRR&R costs for the State facilities used by CEPP are $4,000,000 per year.

Table 6-7. Average Annual OMRR&R Costs of State Facilities used by CEPP

Structure	Without CEPP Per Year Costs	Costs with CEPP in Place
Current G-404 PS costs	$ 340,000	$410,000
STA 2 and Associated Infrastructure[1]	$ 3,010,000	$3,720,000
STA 3/4 and Associated Infrastructure[1]	$3,680,000	$4,550,000
FEB A-1 and Associated Infrastructure	$1,850,000	$2,290,000
G-357 Gated Culvert	$ 110,000	$140,000
G-370 PS	$1,480,000	$1,820,000
G-371 Gated Spillway	$110,000	$140,000
G-372 PS	$1,850,000	$2,280,000
G-434 PS	$610,000	$760,000
G-435 PS	$300,000	$ 370,000
S-6 PS	$1,480,000	$1,820,000
S-7 PS	$1,270,000	$1,570,000
S-8 PS	$810,000	$1,000,000
S-150 Gated Culverts	$100,000	$130,000
TOTAL Average Annual OMRR&R Costs State Facilities	**$17,000,000**	**$21,000,000**

[1] See Appendix A Table A-35 and Table A-36 for a list of the STA structures. STA associated infrastructure will be identified prior to executing the Project Partnership Agreement for New Water.

6.4.3 Invasive Species Management

Invasive species management costs accrue during all phases of the project, as shown in **Table 6-8** below. Pre construction management activities, construction phase activities, and Operational Testing and Monitoring Period (OTMP) activities are all construction based activities and are included in the Fish and Wildlife account of the Total Project Cost Summary. As can be seen in **Table 6-8**, some post construction monitoring and management will occur during 10-year cycles and some management activities for invasive species including surveillance, control, etc. will occur throughout the OMRR&R phase.

Table 6-8. Summary of Cost Estimates for Invasive Species Management

Construction Costs[1]	
Pre Construction Management and Monitoring	**$1,220,000**
Construction Phase Management	**$5,720,000**
Operational Testing and Monitoring Period (OTMP)	
Management	$4,430,000
Monitoring	$570,000
Sub Total OTMP	**$5,000,000**
Total Invasive Species Management During Construction	**$11,940,000**
Post Construction Costs	
Post Construction Monitoring Costs – cost per year for a 10-year cycle	**$400,000**
Post Construction Management Costs – average annual cost	**$3,100,000**

[1] Construction costs in this table include the project contingency of 44%

6.4.4 Monitoring and Adaptive Management

The methods, locations, timing, and funding requirements for conducting adaptive management and monitoring are included in **Annex D**. The CEPP monitoring plan was designed to provide the monitoring required addressing CEPP-specific needs while being integrated with other Everglades monitoring to take advantage of existing monitoring efforts, knowledge, and information. The CEPP AM and Monitoring Plan leverages several existing programs to avoid redundancies and insure cost-effectiveness. Since CEPP relies on existing physical instrumentation, stations, locations, servicing, and analysis efforts funded by RECOVER, CERP sponsors, and partner agencies, the monitoring requirements described in the CEPP plan are limited to the additional increase in monitoring resources and analysis efforts needed to address CEPP-specific questions. The CEPP monitoring plan assumes these other monitoring efforts will continue into the future at least for the period required by CEPP. Adaptive management and monitoring costs accrue during different phases of the project, as shown in **Table 6-9** below. Construction for adaptive management options, pre construction data investigation, construction phase monitoring, and OTMP are all construction based activities and are included in the Fish and Wildlife line of **Table 6-4**. Post construction monitoring of CEPP's success at meeting ecological objectives and to inform adaptive management will occur during 10-year windows that are staggered to coincide with CEPP's construction schedule (**Annex D**, Part 1, Figure D.1.10). Monitoring such as hydrometeorological monitoring that informs project operations may continue longer than 10 years. Table 6-9 provides a conservative estimate of annual costs for monitoring that may continue as necessary and required during OMRR&R. A conservative estimate for potential water quality monitoring has been included. It is anticipated that the monitoring requirements will be assessed periodically and revised as needed.

The USFWS Programmatic Biological Opinion (BO) states that further consultation will be needed when more specific project details are finalized during PED. While this document does not provide provisions for incidental take of three endangered avian species (CSSS, snail kite, and wood stork), it does describe the anticipated effects based on current information. Upon completing ESA Section 7 consultation for each PPA, USACE will undertake the agreed-to avoidance and minimization measures and implementing terms and conditions (TCs). When USACE is closer to constructing phases of CEPP that will affect listed species, FWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable reasonable and prudent measures (RPMs) and TCs. Although the Programmatic BO does not specify RPMs and TCs for the three avian species, endangered species monitoring costs include a conservative estimate of potential required monitoring based on information provided by USFWS to ensure the costs were captured. Estimated endangered species monitoring costs are $3,111,200 pre construction, $35,122,200 during the construction period and the O&M cost will be approximately $1,885,200 annually. It is anticipated that the monitoring requirements will be assessed periodically and revised as needed.

Table 6-9. Summary of Cost Estimates for Monitoring and Adaptive Management

Construction Costs – Construction General Funding(FY 14)[1]	
Adaptive Management Options	**$23,500,000**
Pre Construction Data Investigation (PED) - Adaptive Management	**$40,000**
Pre Construction USFWS BO Ecological Monitoring	**$3,111,000**
Construction Phase Monitoring	
Adaptive Management	$7,010,000
Water Quality	$20,000
Ecological	$1,200,000
USFWS BO Ecological Monitoring	$35,122,000
Sub-Total Construction Phase Monitoring	**$43,352,000**
Operational Testing and Monitoring Period(OTMP)	
Water Quality Monitoring	$710,000
Hydrometeorological Monitoring	$2,490,000
USFWS BO Ecological Monitoring	$1,885,000
Sub-Total OTMP Monitoring	**$5,085,000**
Total Monitoring And Adaptive Management First Cost (rounded)	**$75,088,000**
Post Construction Costs – Operations and Maintenance Funding	
Post Construction Monitoring Costs – cost per year for a 10 year cycle	
General Ecological Monitoring	$740,000
Adaptive Management	$1,950,000
Sub-total Post Construction Monitoring ($ annually over 10 years)	**$2,690,000**
Post Construction Monitoring Costs – average annual cost	
Hydrometeorological	$195,000
Water Quality	$710,000
USFWS BO Ecological Monitoring	$1,885,000
Sub-total Post Construction OMRR&R ($ average annual)	**$2,790,000**

[1] Costs in this table are rounded and include the project contingency of 44%

6.4.5 Operational Testing and Monitoring Period Costs

As defined in the CERP Master Agreement, the term "Operational Testing and Monitoring Period" (OTMP) shall mean a reasonable, limited period of time within the period of construction, after physical construction has been completed, during which the authorized CERP Project or a functional portion of the authorized CERP Project is operated, tested and monitored to verify that the constructed features operate as designed, and to allow for any adjustments to such features as may be necessary so that such features perform as designed.

The OTMP costs for new CEPP project features are included in the PED/EDC construction costs in **Table 6-4** and accrue for interim operation of project features during OTMP. The total amount for operations and testing is equivalent to one year of OMRR&R for new CEPP project features at $4,150,000.

The invasive species management and monitoring costs during OTMP of approximately $5,000,000 (**Table 6-8**) and project monitoring during OTMP of approximately $,5000,000 (**Table 6-9**) are included in the Fish and Wildlife line in **Table 6-4**.

6.4.6 Cultural Resources Preservation Costs

The identification, evaluation and mitigation of cultural resources are included in **Table 6-10**. Data Recovery is 100% Federal responsibility until the cost of Data Recovery reaches 1% of the total project cost. Afterwards, anything above the 1% cap will be cost shared 50/50 between the Government and the non-Federal sponsor. Data Recovery caps are identified in Engineering Regulation (ER) 1105-2-100 Appendix C-4.d(6)(d) and the Archaeological and Historic Preservation Act Section 7. Costs in **Table 6-10** for mitigation are included in the Cultural Resources Preservation line item in **Table 6-4**, the PED costs are included within the PED line item in **Table 6-4**.

Table 6-10. Cultural Resources Cost Breakdown

Item	Total
Mitigation	**$25,740,000**
Data Recovery[1]	$1,750,000
PED	**$3,050,000**
Cultural Resources Cost Total[2]	**$29,000,000**[3]

[1] Data Recovery is 0.1 percent of the total CEPP cost.

[2] Cultural resources cost total includes contingency

[3] Cultural resources costs include PED, **Table 6-4** cultural resources line only includes mitigation; total is rounded

6.5 COST ESTIMATE FOR RECREATION ELEMENTS

Recreation elements of the Recommended Plan include sufficient gravel parking with boat ramps and trailheads, dry vault toilets, shelters, primitive camping sites and American with Disabilities Act compliant fishing platforms as described in Section 6.1.6 and Appendix F. The expenditures attributed to recreation features are justified using a benefit to cost ratio. The tangible economic justification of the proposed project can be determined by comparing the equivalent average annual costs with the estimate of the equivalent average annual benefits realized over the period of analysis. The average annual recreation benefits and costs are summarized in **Table 6-11**. The Federally mandated project evaluation interest rate of 3.5 percent, an economic period of analysis of 50 years and 2014 price levels were used to evaluate economic feasibility. The benefit to cost ratio for the recreation features is 1.6 to 1, with net annual benefits of $215,000.

Table 6-11. Summary of Recreation Costs and Benefits (FY 14)

Total Recreation Costs	$6,400,000
Interest During Construction	$330,000
Total Investment	$6,730,000
Amortized	$287,000
OMRR&R	$68,000
Average Annual Cost	**$355,000**
Unit Day Value[1]	$7.79
Daily Use	200 users
Annual Use (200 users x 365 days)	73,000
Average Annual Benefit	**$570,000**
Benefit to Cost	1.6 to 1
Net Annual Benefits	$215,000

[1] Unit Day Values are derived from EGM 14-03, Unit Day Values for Recreation

6.6 COST SHARING

The total first cost of the restoration features of CEPP, including the value of LERR and PED costs, will be shared between the Federal Government and the non-Federal sponsor under the CERP program as a whole (**Table 6-12**). The non-Federal sponsor will provide cash, perform work-in-kind during planning, engineering and design or manage a portion of construction as necessary to meet its 50 percent share of the total first cost of the project to be balanced according to Section 601 of WRDA 2000.

Table 6-12. Cost Share for the CEPP Recommended Plan

Item	Federal Cost	Non-Federal Cost	Total[1]
Ecosystem Restoration (ER)			
Restoration Construction	$676,875,000	$700,125,000	$1,377,000,000
PED[1]	$172,500,000	$172,500,000	$345,000,000
Construction Management	$67,500,000	$67,500,000	$135,000,000
LER&R	$31,000,000	$6,000,000	$37,000,000
ER Subtotal	$947,875,000	$946,125,000	$1,894,000,000
Recreation (NED)			
Recreation Subtotal	$3,000,000	$3,000,000	$6,000,000
Total Project First Cost[2]	$950,875,000	$949,125,000	$1,900,000,000
Average Annual Costs			
OMRR&R - CEPP Features	$2,075,000	$2,075,000	$4,150,000
OMRR&R - State Facilities	$2,000,000	$2,000,000	$4,000,000
OMRR&R - Invasive Species	$1,550,000	$1,550,000	$3,100,000
OMRR&R - Monitoring (cost per year over 10- year cycle)[3]	$1,345,000	$1,345,000	$2,690,000
OMRR&R - Monitoring (annual cost)	$1,395,000	$1,395,000	$2,790,000
OMRR&R - Recreation		$65,000	$65,000

[1]Construction costs totals are FY '14 First Costs Rounded to the nearest $1,000,000 and include a 44% contingency
[2]Federal costs include cultural resources data recovery of $1,750,000 represented at 100% federal responsibility
[3]10-year monitoring costs are included in Table 6-9, and are amortized over the period of analysis in Table 6-5

6.6.1 Cost Sharing of Real Estate

Total estimated real estate costs were $37,000,000 (rounded), of which approximately $31,000,000 (rounded) are creditable to the Federal Government and approximately $6,000,000 (rounded) are creditable to the SFWMD. Federal funds contributed by DOI pursuant to the Farm Bill Section 390 of the Federal Agriculture Improvement and Reform Act of 1996 (Public Law 104-127, 110 Stat. 1022) are credited to the Federal share of the project cost pursuant to Section 601 (e)(3) of the WRDA of 2000. DOI contributed approximately $30,299,207 toward the purchase of the A-2 FEB and FEB Discharge Canal. SFWMD contributed approximately $1,376,598 toward the purchase of the A-2 FEB and FEB Discharge Canal. SFWMD's contribution of approximately $1,500,348 will be credited to SFWMD. For those lands owned by the State of Florida valued at $712,750, SFWMD will receive credit for the fair market value as of date these lands are provided. More details are provided in **Appendix D**.

6.6.2 Cost Sharing of Operations, Maintenance, Repair, Replacement and Rehabilitation

Section 601(e)(4) of the WRDA 2000 specifies that the (OMRR&R) of authorized projects of the CERP would be cost shared equally by the Federal Government and the non-Federal sponsor. Consistent with the provisions of Section 601(e)(4) of the WRDA of 2000 and given the multi-objective nature of the features in this plan, it is appropriate for the OMRR&R associated with the features of this plan to be shared equally between the Federal Government and the non-Federal sponsor. The Federal and non-Federal sponsor's obligations to provide OMRR&R will continue indefinitely unless the project is de-authorized by Congress. OMRR&R costs associated with recreation features of the plan will be funded 100 percent by the non-Federal sponsor.

The plan recommended by this PIR requires the use of several State facilities constructed and operated pursuant to State permits. The facilities are necessary for the State to meet CWA requirements as approved by the USEPA, and as litigated by the U.S. Department of Justice. Some of these requirements are currently subjected to a Settlement Agreement filed with and overseen by the Federal District Court (United States v. South Florida Water Management District, Case No. 88-1886-CIV-Moreno (S.D. Fla. 1988)).

The Non-Federal Sponsor is responsible for the operation, maintenance, repair, replacement, and rehabilitation of all State features, including the State Restoration Strategies and Everglades Construction Project facilities. Certain of those facilities, as named below and herein after referred to as "State facilities", are to be used by CEPP until such time as CEPP is deauthorized or it is determined use of the State facilities are no longer necessary for the purpose of achieving CEPP project purposes. However, the State's A-1 FEB operations will be integrated with the A-2 FEB project feature and operated pursuant to a mutually agreed upon water control manual. The joint water control plan for the FEBs will integrate the operation of CEPP and the operation of the State facilities used by CEPP. The State facilities will use excess capacity to process "new water" provided by CEPP in addition to the water processed for purposes of achieving the State's water quality requirements.

The State has requested cost sharing OMRR&R of the State facilities to be used by the CEPP as set forth in Section 8.1. Given the State features in question are Everglades Construction Project features, already constructed, or under construction pursuant to State compliance requirements and under permit for that purpose, and/or United States v. So. Fla. Water Management District. Settlement Agreement requirements, they may not be included as Federal project features and no cost sharing for construction would be allowed. There is currently no applicable authority which would allow for cost sharing any expenses associated with such features, including the OMRR&R costs. Thus, because of the current statutory and policy prohibitions against such cost sharing, as the 30 November 2007, *CERP, Water Quality Improvements, Policy Determination* Memorandum indicates new statutory language affording such authority must be adopted as part of the CEPP project authorization in order for the State's request to be effected.

The PIR recommends Congressional authorization of the project with specific statutory language allowing cost share of the OMRR&R for the following State facilities not previously cost shared for construction under the C&SF Project or other Federal authority and the listed C&SF features that are currently cost shared pursuant to executed resolutions: (1) STA 2, (2) STA 3/4, (3) A-1 FEB, (4) G-370 Pump Station, (5) G-371 Gated Spillway, (6) G-372 Pump Station, (7) G-357 Gated Culvert, (8) G-404 Pump Station, (9) G-434 Pump Station, (10) G-435 Pump Station, (11) S-6 Pump Station, (12) S-7 Pump Station, (13) S-8 Pump Station, and (14) S-150 Gated Culverts and their corresponding remote-control facilities. All features required for the State's Restoration Strategies and the Everglades Construction

Project are independent State facilities and are not CEPP components or features. The State facilities will not be incorporated as Federal CEPP project features; however, the operation of State facilities is required to ensure that new water made available by CEPP meets water quality standards and achieves CEPP project benefits

The aforementioned State facilities will use excess capacity to process "new water" provided by CEPP, which has been estimated to comprise approximately 19% of the total water volume that could flow through these facilities. For the purposes of this report, OMRR&R costs are assumed to be linear with flow volumes and will therefore increase the OMRR&R costs for the State facilities that are to be used by CEPP by 19%. Therefore, consistent with the general CERP authorization for cost sharing OMRR&R (WRDA 2000 Section 601(e)(4)), the Corps recommends Congressional authorization of CEPP to contribute 19% of the OMRR&R costs of the aforementioned facilities to the extent that OMRR&R activities are directly related to their use for treating "new water." The Corps' pro-rated share for OMRR&R for the aforementioned State facilities used by CEPP is therefore 50% of the 19%, or 9.5% of the total OMRR&R costs. The 19% CEPP cost share will apply to the State facilities and the C&SF features listed above to the extent that OMRR&R activities are directly related to their use for treating "new water."

After CEPP has operated for an appropriate period of time, an analysis based on monitoring data shall be undertaken to evaluate project performance and verify that CEPP successfully delivers and annual average of approximately 210,000 acre-feet of new water for the natural system, as described in this PIR. If the monitoring data and analyses show CEPP actually produces less than the anticipated 210,000 acre-feet of "new water" on average, then the Federal project is not fully realizing the projected benefits and the State facilities are not being burdened as projected. In such a case, the analysis will be used to inform changes in operations in order to achieve the quantity, timing, or distribution of water as described in this PIR, or recommend changes to the amount of water reserved or allocated to the natural system. Additionally, if the monitoring data and analyses show CEPP actually processes significantly more or less than the anticipated 210,000 acre-feet of "new water" on average, then the analysis may be used to adjust the calculation of OMRR&R cost share upward or downward to reflect the actual average annual use of excess capacity by the Federal project. Any recommended adjustments to the OMRR&R cost share calculation may require additional Congressional approval and legislation. This will be accomplished through consultation with the State and USACE Headquarters and is necessary after operations have begun to capture the true Federal interest and cost share responsibility. Additionally, it must be recognized and the adjustment made given these State facilities are subject to legal requirements outside of the Federal project and will not be operated in such a manner that the Federal project will cause exceedances of the State's water quality requirements under State NPDES and EFA permits and associated Consent Orders. Such State requirements may limit the anticipated Federal project benefits.

No cost share of the aforementioned State facilities shall commence before the date the CEPP project produces "new water" and the associated Federal project feature is declared construction complete and the state assumes its OMRR&R responsibilities as established in the appropriate PPAs. Similarly, no cost share for State facilities is allowed until the State facilities are shown to be construction complete and the State begins regular operation of such facility.

The proposed Federal cost-share for OMRR&R is intended to include only the State facilities listed above. Modifications to this list of State facilities used by CEPP, including new flow control structures that may be constructed within STA 2, STA 3/4, and the A-1 FEB, must be coordinated with, and

approved for cost-sharing purposes by, the USACE Headquarters and the Office of the Assistant Secretary of the Army for Civil Works (ASA (CW)). For proposed modifications to this list, the State will coordinate any additional State water quality facilities upon which CEPP is dependent and which the State has determined are needed to meet water quality standards and achieve CEPP project purposes, with the Corps' Jacksonville District. Upon receipt of the State's request to modify the list of cost shared facilities, the Corps' Jacksonville District will prepare a recommendation for USACE Headquarters approval. USACE Headquarters will coordinate the Corps' recommendation with the Office of the ASA (CW). Preparation and approval of a Modifications to Completed Projects report, in accordance with ER 1165-2-119 may be required as a prerequisite to Federal cost share.

Similarly, as a condition of the Corps' cost share for replacement and rehabilitation actions for the State facilities listed above, prior to commencing such actions early coordination with, and approval by, the USACE Headquarters and the Office of the ASA (CW) will be required, using the procedures outlined above. Preparation and approval of a Modifications to Completed Projects report, in accordance with ER 1165-2-119, may be required as a prerequisite to Federal cost share. Costs associated with major rehabilitation of the wetland treatment areas (STA 2, STA 3/4, and the A-1 FEB) due to peat soil accretion are excluded from cost sharing. A pro-rata determination of appropriate repair, replacement, and rehabilitation cost share at the time of turnover of the CEPP A-2 FEB project feature, will be conducted based on the remaining life expectancy of the State facilities. USACE Headquarters will approve the established Corps obligation. The State may request, through coordination with Corps' Jacksonville District, that USACE Headquarters approve exemptions for certain replacement and rehabilitation activities that they deem to be minor actions. Additionally, during PED the State and the Corps will coordinate on more specific definitions of activities that are considered as either repair, replacement or rehabilitation. The Corps' Jacksonville District will subsequently coordinate these determinations with USACE Headquarters for approval.

6.6.3 Cost Sharing of Monitoring

CERP post construction project monitoring is cost-shared for a maximum period of 10-years for performance based ecological monitoring, and monitoring required for operations may continue longer. Given that the construction of all project features may require more than 10-years, the duration of cost-shared performance based ecological monitoring will extend past 10-years for the entire project; however, each monitoring activity associated with individual project features will not be cost-shared for more than 10-years post transfer of project component to local sponsor. **Annex D Part 1, AM Plan** provides the explanation of the staggered implementation of 10-year monitoring windows. These efforts will be cost shared during the construction phase of the project in accordance with Section 601(b)(2) of WRDA 2000. After construction, the costs will become part of the project's OMRR&R plan and cost-shared as described in the recommendations section of this report.

System-wide monitoring will be performed as part of the CERP Monitoring Assessment Program implemented by RECOVER. Data collected as part of this monitoring program is critical to the overall success of CERP Projects. Funding for system-wide monitoring is provided by and for RECOVER, and is independent from project-level funding. A draft POM (**Annex C**) has been developed for use in water management. Operational monitoring will be cost shared during the operation and maintenance phase of the Project.

6.6.4 Cost Sharing of Cultural Resources Preservation

Data recovery is 100% Federal responsibility until the cost of Data Recovery reaches 1% of the total project cost. Data recovery caps are identified in ER 1105-2-100 Appendix C-4.d(6)(d) and the Archaeological and Historic Preservation Act Section 7.

6.6.5 Non-Federal Sponsor Work-In-Kind for Construction

Should the non-Federal sponsor construct phases of the CEPP prior to execution of a PPA, then this work must be covered by a Pre-Partnership Credit Agreement (PPCA). The non-Federal sponsor would receive credit for such construction costs at the time the PPA for CEPP is executed. Such credit would be applied toward the non-Federal sponsor's share of the costs associated with the implementation of the CERP as authorized by Section 601(e)(5)(C) of WRDA 2000, shall not include cash reimbursements, and shall be subject to: a) the authorization of the CEPP project by law; b) a determination by the Secretary of the Army that the construction work completed under the PPCA is integral to the authorized CERP restoration project; c) a certification by the District Engineer that the costs are reasonable, allowable, necessary, auditable, and allocable; and d) a certification by the District Engineer that the activities have been implemented in accordance with USACE design and construction standards and applicable Federal and State laws. Also, per Section 601(e)(5)(E) of the Water Resources Development Act of 2000, in-kind credit is subject to audit by the Secretary.

6.7 PLAN IMPLEMENTATION

Implementation of CEPP will occur over many years and include many actions by USACE and SFWMD. This subsection discusses the major implementation phases that are expected to occur after Congressional authorization and appropriation of funding for project construction. Multiple PPAs will be executed prior to construction. Each PPA will cover a separable element that groups inter-related project features to provide hydrologic and ecological benefits. These PPAs include the construction of logical groupings of plan elements, agreed upon by the USACE and SFWMD, that maximize benefits to the extent practicable consistent with project dependencies (**Table 6-13**) and the CEPP AM and Monitoring Plans (see **Annex D**).

A multiple PPA approach incorporates the adaptive management process, per the guidance of the Programmatic Regulations for the CERP (2003) and the WRDA of 2007. Sequencing of the PPAs will allow earlier restoration benefits by initially building project components that take advantage of existing water in the system that meets State water quality standards, while providing assurances of sound financial investments.

6.7.1 Implementation and Construction Sequencing

6.7.1.1 Dependencies and Requirements

Upon identification of a recommended plan for CEPP, the next step is to consider how CEPP features will be implemented (sequencing scenarios) when considering internal and external project dependencies. Development of sequencing for CEPP features considers that a number of CERP and non-CERP projects (**Table 6-13**) must be constructed and operating before implementing most CEPP features to avoid unintended consequences. Additionally, several basic principles considered in development of an implementation plan for CEPP features include the following:

1. All features of the State's Restoration Strategies must be completed and meet State water quality standards prior to initiating construction of most CEPP project features.

2. Construction of CEPP Project features cannot proceed until it is determined that construction and operation of the feature:
    a. Will not cause or contribute to a violation of State water quality standards; and
    b. Will not cause or contribute to a violation of any applicable water quality permit discharge limits or specific permit conditions ; and
    c. Reasonable assurances exist that demonstrate adverse impacts on flora and fauna in the area influenced by the Project features will not occur.

3. Appendix A water quality compliance must be addressed consistent with Section 8.3 for new project water entering ENP.

4. The operation of State facilities is required to ensure that new water made available by CEPP meets water quality standards and to ensure achievement of CEPP project benefits. If after construction and operation of CEPP project features State water quality standards are not being met, the Federal and State partners agree **per paragraph 8.3** of **Section 8** of this PIR/EIS to meet to determine the most appropriate course of action in accordance with existing law and policy. In such an event, an evaluation of CEPP benefits, including the possibility of reduced benefits, will be included in the assessment of any suggested resolution. It is recognized that the operation of the State facilities has a primary permitted purpose of achieving water quality compliance for existing flows.

5. Sequencing takes into account the earliest opportunity to realize benefits, including the features that can provide benefits that utilize existing water meeting State water quality standards.

6. Additional outlet capacity from the south end of WCA 3A must be provided before new project water from Lake Okeechobee is released into WCA 2A and WCA 3A.

7. The sources of material needed for Miami Canal backfilling and the Blue Shanty Levee were considered to minimize costs associated with double handling and stockpiling of materials.

8. Where possible sequencing should include steps and timing to test concepts, as described in the CEPP AM Plan (**Annex D**).

9. Recreation features will be constructed in conjunction with corresponding CEPP project plan features.

In the future these CERP and non-CERP features will be built as described in **Table 2-2** of **Section 2**, however, the timing of their completion affects CEPP implementation. Specific project features cannot be constructed until other CERP and non-CERP projects are constructed and operational. **Table 6-13** provides a complete list of which CEPP features are dependent on other projects and their operation in order to operate CEPP and obtain the full benefits envisioned, further detailed information is contained in **Section G.6** of **Appendix G**.

Table 6-13. Project Dependencies

Project	CEPP Feature Dependencies
A-1 FEB State Restoration Strategies	Required prior to implementation of northern WCA 3A distribution features (L-4 degrade, new pump station, S-8 Modifications, L-5 and L-6 improvements, Miami Canal Backfilling) to ensure adequate water quality treatment of inflows. Construction of the A-1 FEB initiated in 2014 and the FEB is projected to begin start-up operations in 2018. Construction of the remainder of the Restoration Strategy projects is projected to be complete in 2025 and demonstrate compliance with water quality standards in 2029.
8.5 Square Mile Area and	Construction of the C-358 seepage collector canal and structure S-357N within the 8.5

Project	CEPP Feature Dependencies
Existing S-356	SMA must be completed to allow full utilization of the 8.5 SMA features to provide seepage mitigation for increasing flows into Northeast Shark River Slough. Construction of these features is underway and anticipated to be complete in 2015. Operation of the existing S-356 pump station (500 cfs) is required prior to significantly increasing flows to NESRS, to provide seepage management. Construction of the project feature is complete. Operational testing projected to begin in 2015 in support of development of the required final integrated operational plan for the Modified Water Deliveries and C-111 South Dade project expected to be complete in 2018.
C-111 South Dade	Extension of the detention area levees to connect with 8.5 Square Mile Area (SMA) required prior to significantly increasing flows to NESRS to enable operation of S-357 pump station up to full design capacity to provide seepage management to 8.5 SMA. Contracts 8 and 9 construction projected to be complete in 2017. Final integrated operational plan for the Modified Water Deliveries and C-111 South Dade project is expected to be complete in 2018.
MWD 1-Mile Bridge & Road Raising	The MWD bridge and road raising will be complete and operational prior to implementation of WCA 3B inflow structures along the L-67A&C levees or increasing flows through existing S-333 to NESRS to ensure adequate road protection to allow for increased stages in L-29 canal. Construction of the 1-mile bridge and road raising completed in 2014.
BCWPA C-11 Impoundment	Required prior to increasing flow through S-333 or implementation of WCA 3B inflow structures along the L-67A&C levees to ensure adequate water quality of inflows to WCA 3B and NESRS. The Broward Water Preserve Area was authorized in WRRDA 2014. Construction of the C-11 Impoundment projected to be complete in 2021.
Tamiami Trail Next Steps Bridging and Road Raising	Required prior to increasing capacities of S-333 and S-356 and implementation of the two WCA 3B inflow structures along the L-67A levee to the flowway, gaps in L-67C levee and Blue Shanty flowway (L-67C removal, L-29 levee removal). Construction of the 2.7 mile western bridge projected to be complete in 2020.
C-44 Reservoir (IRL-S) and connection to C-23 Canal	Required prior to re-directing the maximum amount of water from Lake Okeechobee south to the FEB to meet environmental performance, to avoid reduction in low flows to the St. Lucie Estuary and to avoid low Lake Okeechobee water levels that effect the LOSA. Construction is underway and projected to be complete in 2021.
Modification of the Lake Okeechobee Regulation Schedule	Anticipated prior to full utilization of the A-2 FEB in order to achieve the complete ecological benefits envisioned through re-directing the full 210,000 acre-feet per year south and to avoid low Lake levels that would affect the LOSA. The modification to the 2008 LORS which may be developed in response to system-wide operating plan updates to accommodate CERP Band 1 projects (Section 2.5, Section 6.1.3.2) and/or sufficient HHD remediation for reaches 1, 2 and 3 and associated culvert improvements is anticipated in 2022, subject to outcome of the Dam Safety Modification Report.

In addition to the project feature dependency considerations listed in **Table 6-13**, other factors influencing implementation include funding availability and maintenance of the cost-share balance between the Federal and non-Federal sponsor. The USACE and the SFWMD will undertake integration of the recommended plan and the other CERP projects awaiting authorization into the CERP programs' Integrated Delivery Schedule (IDS), which contains the Master Implementation Sequencing Plan (MISP), through a robust public process.

6.7.1.2 Multiple Project Partnership Agreements

Project features were grouped into three separate PPAs based upon the spatial distribution of the recommended plan features and the locations within the CEPP study area where separable hydrologic

and environmental benefits would accrue as described below. These groupings include a PPA of project features in northern WCA 3A (PPA North), a PPA of project features in southern WCA 3A, 3B and ENP (PPA South), and a final PPA which provides the new water and required seepage management that benefits the entirety of the study area (PPA New Water).

Table 6-14. Project Features by PPA

PPA North	
Project Features	**Construction Contract**
• L-6 Diversion	• Contract 1
• S-8 Pump Modifications	• Contract 1
• L-4 Levee Degrade and Pump Station	• Contract 1
• L-5 Canal Improvements	• Contract 2
• Miami Canal Backfill	• Contract 2
PPA South	
Project Features	**Construction Contract**
• L-67 A Structure North	• Contract 3
• One L-67 C Gap (6,000 ft)	• Contract 3
• Increase S-356 to 1,000 cfs	• Contract 4
• Increase S-333	• Contract 4a
• L-29 Gated Spillway	• Contract 4b
• L-67 A Structures 2 and 3 South	• Contract 5
• L-67 A Spoil Mound Removal	• Contracts 3 & 5
• Remove L-67 C Levee Segment	• Contract 6
• Remove L-67 Extension Levee (No Backfill)	• Contract 6
• 8.5 Mile Blue Shanty Levee	• Contract 6
• Remove L-29 Levee Segment	• Contract 7
• Backfill L-67 Canal Extension	• Contract 7
• Remove Old Tamiami Trail*	• Contract X*
PPA New Water	
Project Features	**Construction Contract**
• Seepage Barrier L-31 N	• Contract 8
• A-2 FEB	• Contract 9

* Contract X - Old Tamiami Trail can be completed at any time during implementation, but must precede backfilling of L-67 Extension Canal. NOTE: Reference **Figure 6-1** through **6-4** for more detailed description of project features. PPA North contains the features of **Figure 6-2**. PPA South contains the features of **Figure 6-3**. PPA New Water contains the features in **Figure 6-1** and **Figure 6-4**.

The report text, tables, and figures that follow demonstrate that PPA North and PPA South can be executed, regardless of the status of the other two PPAs. While not providing full benefits to the region, each would provide a reasonable level of benefits commensurate with its cost, as demonstrated during the screening of options that made up the complete alternatives. PPA New Water is not cost effective as an independent separable element, and additional outlet capacity from WCA 3A (a PPA South

component) must be provided before new project water from Lake Okeechobee is released into the system. As a construction element following construction of PPA North and PPA South, PPA New Water is a cost effective element.

Two potential implementation sequencing scenarios are possible with the three PPAs identified:

Scenario 1 – PPA North --> PPA South --> PPA New Water
Scenario 2 – PPA South --> PPA North --> PPA New Water

Additional information in **Table G-39** of **Appendix G** shows four sets of cost and benefit information, one for each of the proposed three PPAs as stand-alone elements, and one with the costs and benefits gained from implementation of PPA New Water subsequent to the completion of features included in PPA North and PPA South. The information should not be used to justify the exclusion of individual PPAs from the recommended plan, since only regional benefits will be realized if the connectivity and timing of water deliveries through the system is not restored. A cost effective comparison between PPAs is inappropriate due to aforementioned project dependencies and the difference in ecosystem regions. Instead, each PPA is justified on the significance of the resource being restored, and the cost effectiveness of the features within an individual PPA has been conducted to ensure that features within PPAs are cost effective regardless of the status of the other PPAs.

Additional information in **Table G-39** of **Appendix G** presents multiple estimates of performance associated with implementation of each PPA. Performance expectations for each PPA are described consistent with each of the Conceptual Ecological Models (Northern Estuaries, Greater Everglades Ridge and Slough, and Florida Bay) for the CEPP study area by stressors, ecological effects, and attributes (Barnes 2005, Ogden 2005a, Rudnick et al. 2005, Sime 2005). Project zones (See **Appendix G**) and associated acreages estimated to benefit from implementation of each PPA were identified. Acreages shown do not reflect the magnitude or degree to which each acre is improved. The entire acreage associated with each project zone was assumed to benefit since detailed modeling for each PPA was not conducted. Features of the recommended plan identified in each PPA were not separately modeled using the RSM-GL and RSM-BN regional models; as such, a quantification of habitat units with the CEPP Planning Model was also not performed for individual PPAs. Modeling of each PPA would require development of an optimized operations plan to meet project constraints while providing benefits.

6.7.1.3 Approach Taken to Estimating Phased Benefits

The percentage gained in project performance for each PPA was estimated using two separate approaches. Each approach has inherent uncertainties and relies upon simplifying assumptions and professionals judgments. Using two varying approaches are a means to increase the confidence in the overall conclusions. The first approach, the volume based approach, estimated the percentage gained in average annual overland flow (1000 ac-ft) for each PPA relative to that achieved by the recommended plan based upon modeling efforts for the CEPP final array. This approach was solely based on the potential volume of water produced from implementation of each PPA. The volume based approach is limited because it estimates either minimum or maximums flows but not both, for each spatial region. The volume based approach does not integrate timing and spatial variability of benefits. The second approach is a consensus based interpretation of the results from modeling performed during screening and from analysis of the final array of alternatives. The estimates of the percentage gained in average annual overland flow (first approach) were considered during this second approach. The second approach also accounted for the additional portion of overall benefits that are attributable to improved intra-annual timing of flows and spatial variability across benefit zones. The approach produced a range

of percentages to represent the minimum and maximum potential of benefits gained. Percentages were based on the collective scientific knowledge among project team members about the relative contribution of each PPA to the overall benefits resulting from the implementation of CEPP. Further detailed information for each approach can be found in **Appendix G**.

In order to provide a simple representation of the percent of CEPP benefits achieved for each PPA, the results from the two separate approaches were combined. The midpoint of the ranges from the consensus based approach was averaged with the value from the volume based approach by region, and the regions were summed to obtain a percentage of CEPP benefits achieved for each PPA. While a single estimate is useful to provide a broad perspective, it is important to remember that uncertainty exists within each approach and with the combined estimate.

6.7.1.4 Project Partnership Agreement North Only

PPA North includes the hydropattern restoration features in northern WCA 3A and the backfilling of the Miami Canal. The area within WCA 3A affected by the implementation of PPA North would encompass 272,070 acres (i.e. summation of acreages within Zones 3A-NE, 3A-NW, and 3A-MC). WCA 3A provides approximately 41% of the overall benefits being captured from the recommended plan. Construction of these features that re-distribute inflows into WCA 3A provide the benefits identified in the recommended plan associated with restoration of hydroperiods in northern WCA 3A, associated reduction in the risk of muck fires, and restoration of more natural sheetflow. A limited portion of these benefits could be realized through improvements in the re-distribution and delivery of water currently entering northwest WCA 3A prior to bringing in any additional water from Lake Okeechobee.

Backfilling approximately 13.5 miles of the Miami Canal between I-75 and 1.5 miles south of the S-8 pump station, and converting the L-4 Canal into a spreader canal by removing 2.9 miles of the southern L-4 levee will provide benefits to the areas directly adjacent to the canal. Northeastern WCA 3A is expected to benefit from backfilling the Miami Canal; however this region of the study area would receive even more benefits with the additional water that becomes available from implementation of PPA New Water.

Figure 6-15 illustrates the estimated percent of project performance resulting from implementation of PPA North. Implementation of PPA North achieves approximately 17% of the overall CEPP benefits. See **Section G.6.1** of **Appendix G** for further explanation of this calculation.

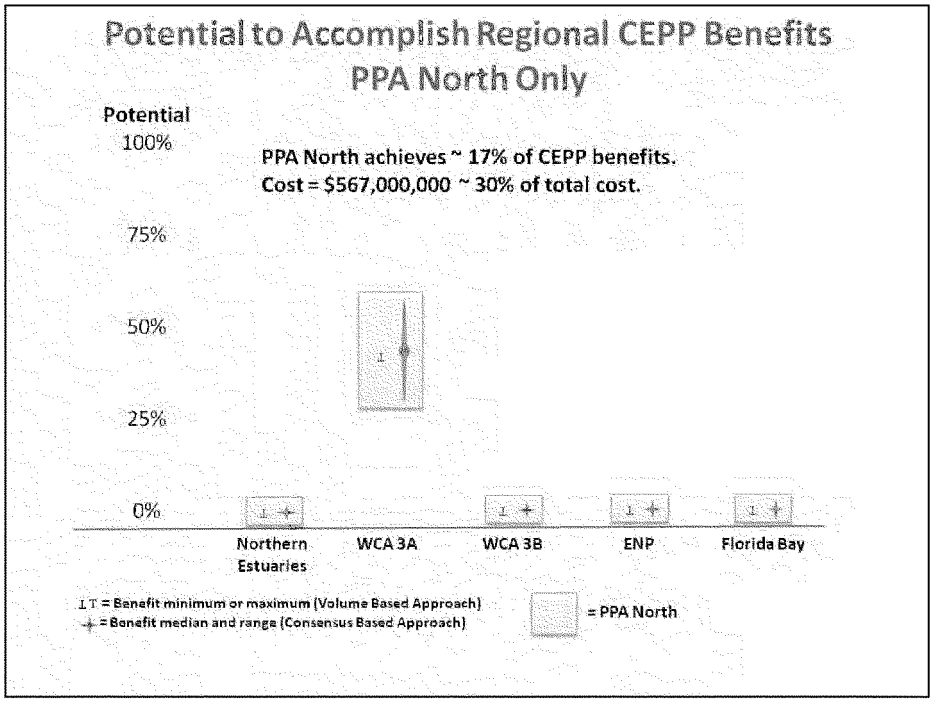


Figure 6-15. Potential Benefits Achieved from Implementation of PPA North by CEPP Planning Region

The PPA North features function together to improve the distribution of available water across northern WCA 3A. The North of the Redline screening consisted of modeled 15 combinations of management measures utilizing existing inflows into WCA 3A of which seven combinations of backfilling and hydropattern restoration features were evaluated in detail (See **Section 3.2.2**). A MCDA analysis combined with parametric cost calculations resulted in four cost effective options out of the seven. The features in these cost effective options were combined with the L-6/WCA 2A diversion component. This provided a dual purpose of delivering water from STA 2 to WCA 3A and a source of backfill material for the Miami Canal, thereby ensuring the features in PPA North are a cost effective means of achieving the standalone ecological and hydrological benefits that are realized from implementation of PPA North.

6.7.1.4.1 Project Partnership Agreement North Construction Sequencing and Adaptive Management

Implementation of this PPA would only occur after the State has completed construction of the State's Restoration Strategy to ensure adequate water quality treatment of existing water. Other non-CEPP project dependences identified in **Table G-39** would also need to be completed. The specific features of the recommended plan to be implemented in PPA North would include the L-4 Levee degrade and pump station, the S-8 pump station modifications, the L-6 Canal improvements, the L-5 Canal improvements, and the backfilling of the Miami Canal. It is important to note that the L-4 Levee degrade and the L-5 Canal improvements generate the primary source of fill for backfilling the Miami

Canal. Grouping these features together for implementation avoids additional costs associated with stockpiling fill and double handling fill material.

6.7.1.5 Project Partnership Agreement South Only

The specific features of the recommended plan to be implemented in PPA South would include conveyance features that function to re-distribute water from WCA 3A to WCA 3B and ENP (**Table 6-14**). WCA 3B and ENP provide approximately 4% and 31% of the overall benefits captured from the recommended plan, respectively. Increasing water flow to NESRS and introducing water flow into WCA 3B could occur once the Broward Water Preserve Area C-11 impoundment is in place to reduce S-9 discharges to the L67-A Canal, which contributes to phosphorus loads into ENP through S-333.

An increase in flows to NESRS could be realized utilizing the existing S-333 and the existing S-356 pump station once the MWD Tamiami Trail Modifications project and the 8.5 SMA is completed, which will allow for the maximum operating stage in the L-29 Canal to be raised from 7.5 ft to 8.5 ft NGVD under conditions where the existing S-356 pump station can effectively manage the increased seepage. Increasing the capacities of the S-356 pump station and the S-333 structure as part of the CEPP PPA South implementation would enable further increases in water flow to NESRS following completion of the DOI Tamiami Trail Next Steps bridging and roadway modifications. Tamiami Trail roadway improvements and the PPA South features will allow for L-29 Canal stages above 7.5 ft NGVD up to the limit imposed by flood control requirements. This limit will be event specific, but it is expected to accommodate increased durations for operational stages approaching, and potentially exceeding, 8.5 ft NGVD in the L-29 Canal. Central and southern WCA 3A are also expected to slightly benefit with the implementation of PPA South.

The southern portion of WCA 3A is primarily affected by long durations of high water and lack of seasonal variability in water depths created by impoundment structures (i.e., L-67 and L-29 Levees) and recommended plan modeling results note a decrease in stages during the wettest 5% of conditions. Removal of the Old Tamiami Trail would slightly alleviate the high water conditions currently experienced in WCA 3A by potentially providing a small increase in the conveyance capacity of the S-12 structures. Benefit from these PPA South facilities could be realized within WCA 3A, WCA 3B, and NESRS from the added outlet capacity. Improved hydrologic conditions in ENP are expected to result in improved salinity conditions in Florida Bay. Florida Bay provides approximately 20% of the overall benefits captured from the recommended plan. The area within WCA 3A, WCA 3B, ENP and Florida Bay to be affected by the implementation of PPA South would encompass 1,316,273 acres.

Implementation of PPA South achieves approximately 21% of the overall CEPP benefits. **Figure 6-16** illustrates the estimated percent of regional gain in project performance because of implementation of PPA South. See **Section G.6.2** of **Appendix G** for further explanation of this calculation.

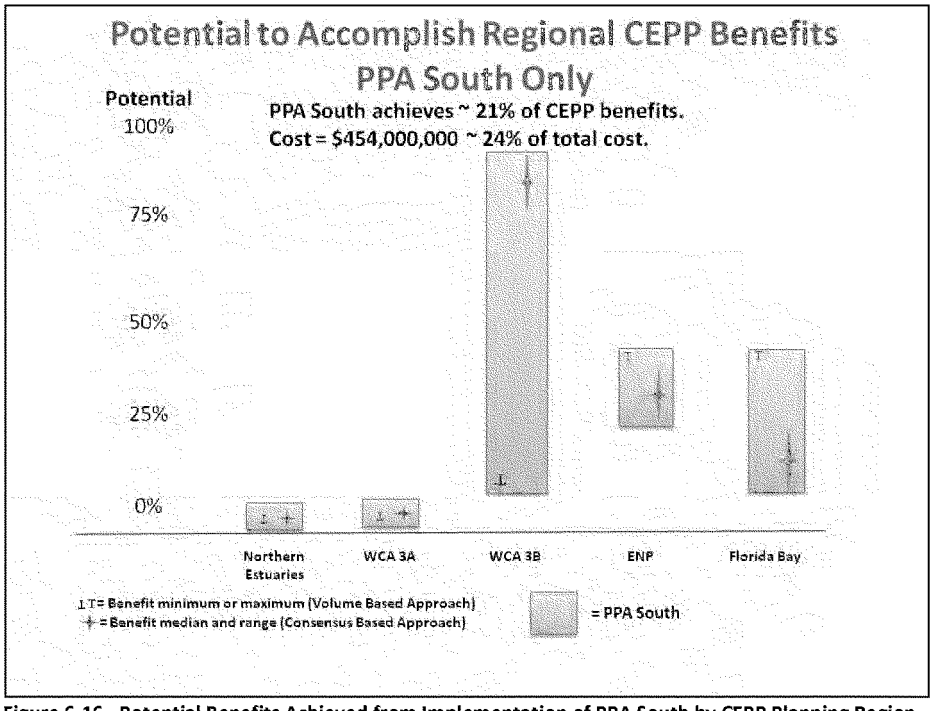


Figure 6-16. Potential Benefits Achieved from Implementation of PPA South by CEPP Planning Region

The screening analysis for the conveyance and distribution measures in southern WCA 3A, WCA 3B and ENP included new water provided by the storage and treatment features in the North. However, the components were sized to handle peak wet seasons flows and stages when the new water is not delivered. In the absence of adding new water to the system, the features would still have to be sized as designed in order to handle the existing water in the system and provide the stand-alone benefits of PPA South.

6.7.1.5.1 Project Partnership Agreement South Construction Sequencing and Adaptive Management

Construction of CEPP features in PPA South will also ready the system for the additional inflows from Lake Okeechobee by providing the necessary additional outlet capacity from WCA 3A. Once the increase in S-356 capacity is on-line to provide requisite seepage management, construction of the Blue Shanty flowway would be undertaken to complete the WCA 3A outlet capacity needed prior to introduction of additional water from Lake Okeechobee.

As described in the Adaptive Management Plan, (**Annex D**, Uncertainty ID#77) construction of the northern most gated-culvert structure on the L-67A Levee and the associated 6,000-ft degrade of the L-67C Levee as the next Phase of implementation would allow for introducing additional inflow to WCA 3B to begin restoration of hydroperiod and reduce continued degradation and soil oxidation in WCA 3B. Implementation of this first structure to provide inflows to WCA 3B will provide the opportunity to: 1)

evaluate water movement within WCA 3B; 2) determine to what extent inflows will move south to the S-355 outlet structures on the L-29 Levee or east where it would move out of WCA 3B via seepage through L-30, and; 3) provide information on seepage out of WCA 3B. Evaluation of results from introducing flows into WCA 3B through this first structure will determine whether an additional inflow structure could be implemented prior to construction of the Blue Shanty Levee (L-67D). Implementation of an additional inflow structure would be dependent on demonstration that the full capacity of the initial structure could be utilized and that any further increase of inflow would not cause adverse or unacceptable effects to resources within WCA 3B or overwhelm the available seepage management facilities capability to prevent flooding of the developed areas to the east. Implementation of these features in L-67A and L-67C will require use of the existing S-356 pump station (500 cfs capacity) to manage additional seepage from WCA 3B and completion of the MWD Tamiami Trail Modifications. This implementation approach is consistent with the adaptive management approach envisioned for CERP in the Programmatic Regulations for the Comprehensive Everglades Restoration (2003) Section 385.31 and described in the Water Resources Development Act of 2007 and its implementation guidance, as well as the incremental adaptive restoration approach identified by the National Academy of Sciences (National Research Council 2007). It incorporates opportunities to learn, reduce uncertainties, provide incremental restoration benefits as early as possible, and minimize the continued degradation of the ecosystems.

6.7.1.6 Project Partnership Agreement New Water Only

Features in PPA New Water include the construction of the A-2 FEB and the seepage barrier along L-31N to ensure adequate seepage management would be in-place prior to moving the additional inflows from Lake Okeechobee provided by the A-2 FEB.

Implementation of PPA New Water would decrease high volume freshwater discharges from Lake Okeechobee that are currently sent to the Northern Estuaries. While water could be moved away from the Northern Estuaries, only a limited amount could be passed south into WCA 3 without the additional outlet capacity provided by PPA South. As a result, the FEB storage capacity would remain largely unavailable following the initial FEB filling each year and the opportunities to divert water away from the Northern Estuaries that the full CEPP plan provides would be extremely limited.

The additional water sent south from the Northern Estuaries to the A-2 FEB would provide some benefit to northern WCA 3A. Additional storage capacity resulting from the construction of the A-2 FEB would help to improve the timing of deliveries to northern WCA 3A; however benefits would be limited. The Miami Canal would continue to function as a source of drainage for WCA 3A. Water would continue to be distributed to northern WCA 3A through a single point source at the S-8 pump station. PPA New Water would provide no benefits to WCA 3B as it does not include conveyance and distribution features located on the L-67 A/C Canals. Limited benefits would be expected in ENP due to construction of the seepage barrier wall, since additional inflows from WCA 3A to NESRS would be limited by water supply and the need to maintain preferred hydrology in WCA 3A with existing inflows (prevent increased dry outs). Florida Bay may benefit, as it is largely influenced by changes in freshwater flows upstream.

Figure 6-17 illustrates the estimated percent gain in project performance as a result of implementation of PPA New Water only. As can be seen in the figure, only negligible benefits are realized with PPA New Water only. The negligible benefits do not support the $800 million cost, and do not represent a cost effective solution as a standalone increment.

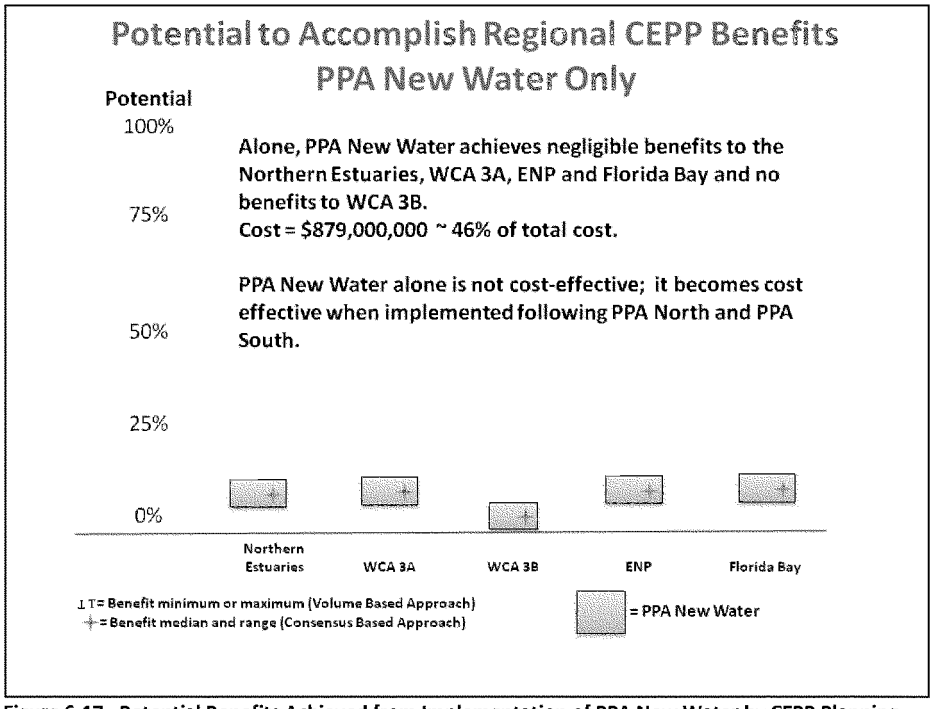


Figure 6-17. Potential Benefits Achieved from Implementation of PPA New Water by CEPP Planning Region

6.7.1.7 Project Partnership Agreement New Water (Assumes North and South Built)

If PPA New Water is implemented subsequent to the construction of PPA North and South (**Figure 6-18**), the area within WCA 3A, WCA 3B, ENP and Florida Bay affected by the implementation of PPA New Water encompasses more than 1.5 million acres and provide 62% of the overall benefits of CEPP. Since PPA New Water is dependent upon PPA North and PPA South features being complete, benefits attributed to PPA New Water were calculated by subtracting the percentage of benefits of PPA North and PPA South from the overall CEPP benefits (100%). The following figure represents the cumulative benefits of constructing PPA North and PPA South by region based on the average of both benefit calculation methods. This figure clearly demonstrates the additional benefits added by PPA New Water as the final construction element to arrive at 100% of CEPP benefits by region. As can be seen in the following figure, PPA New Water is expected to provide approximately 100% of the benefits for the Northern Estuaries, 56% of WCA 3A, 54% of WCA 3B, 60% of ENP and 70% of Florida Bay as a separable increment implemented post construction of PPAs North and South. Implementation of PPA New Water achieves approximately 62% of the overall CEPP benefits post construction of PPAs North and South.

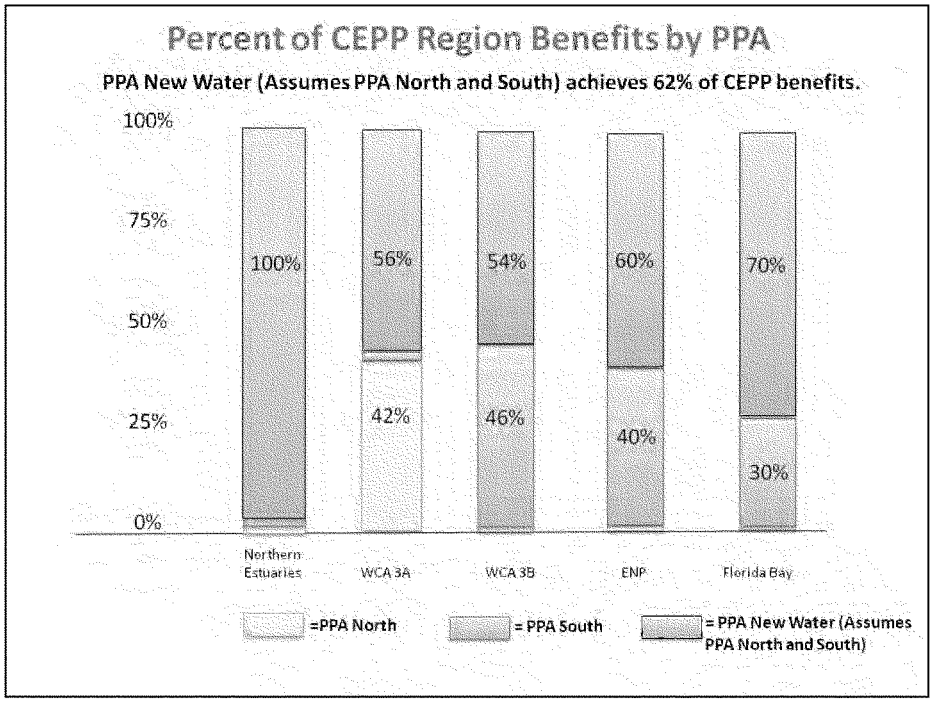


Figure 6-18. Potential Benefits Achieved from Implementation of PPA New Water by CEPP Planning Region. Assumes implementation of PPA North and PPA South.

The configuration of storage and treatment and the required seepage contained within PPA New Water has been determined to be cost effective through the screening process, which utilized both the RESOPS and LOOPS models to identify efficient means of delivering water. Hundreds of options considered during screening (see **Section 3.2.1**) led to the identification of two cost effective solutions for delivering additional water to the Everglades. The FEB configuration was determined to be a cost effective approach to delivering approximately 210,000 ac-ft of additional water on an average annual basis, and a value planning approach (**Section 3.2.4**) was conducted to determine the most efficient manner to implement the seepage management infrastructure required for the new water.

When implemented post construction of PPA North and PPA South, PPA New Water benefits in ENP result from the additional new water and seepage management features that allow for higher L-29 Canal stages and higher inflows during high water periods, and fewer dry downs during dry periods. Tamiami Trail roadway improvements and the PPA South features will allow for L-29 Canal stages above 7.5 ft NGVD up to the limit imposed by flood control requirements. This limit for PPA South will be event specific, but it is expected to accommodate increased durations for operational stages approaching, and potentially exceeding, 8.5 ft NGVD in the L-29 Canal. Full build out of the seepage management components with PPA New Water would allow for L-29 Canal stages up to 9.7 ft NGVD.
Peak simulated L-29 Canal stages for the recommended plan were 9.59 ft NGVD within the flowway west of the S-355 W gated spillway and 9.50 ft NGVD east of the flowway and S-355 W gated spillway,

with a percent exceedance of 8.5 ft NGVD approximately 10% and 5% of the time respectively over the period of record (1965-2005); therefore, the incremental increase to high-water stages and high inflow events which PPA New Water provide are relatively infrequent. However, the seepage management components from PPA New Water (i.e., 4.2 miles seepage barrier wall), in addition to the increased capability to use the increased capacity of S-356 from PPA South (through the higher L-29 Canal maximum operating stage) help to maintain stages east of the East Coast Protection Levee and provide additional benefits to WCA 3B, ENP, and consequently Florida Bay. Without PPA New Water, at times there will not be sufficient water to maintain desired water levels in both WCA 3A and ENP, resulting in the need to optimize operations which balance the upstream and downstream needs.

6.7.1.7.1 Project Partnership Agreement New Water Construction Sequencing and Adaptive Management

Construction of PPA New Water last would allow time for consideration of information collected from the recently constructed 2-mile seepage barrier along the L-31N, as well as any additional investigations that may be undertaken to develop detailed design for the seepage barrier feature. There is a possibility that the permittee may construct an additional 5 miles of seepage wall south of the 2-mile seepage wall, if permitted. Since the capability and effectiveness of the existing seepage wall to mitigate seepage losses from ENP remains under investigation, the recommended plan conservatively includes an approximately 4.2 mile long, 35 foot deep tapering seepage barrier wall in the event construction is necessary. This implementation sequence will also allow time for completion of the Indian River Lagoon, South (IRL-S) C-44 reservoir, to ensure there will not be any adverse effects to low flows to the St. Lucie Estuary or the LOSA from re-directing water south to the FEB.

CEPP benefits gained from sending new water south from Lake Okeechobee are derived in part from operational refinements that can take place within the existing, inherent flexibility of the 2008 LORS, and in part with refinements that are beyond the schedule's current flexibility. As summarized in **Section 6.1.1**, modifications to the 2008 LORS will be required to optimally utilize the added storage capacity of the A-2 FEB to send the full 210,000 acre-feet per year of new water available in CEPP south to the Everglades, while maintaining compliance with Savings Clause requirements for water supply and flood control performance levels. Independent of CEPP implementation, there is an expectation that revisions to the 2008 LORS will be needed following the implementation of other CERP projects and HHD infrastructure remediation. It is anticipated that the need for modifications to the 2008 LORS will be initially triggered by non-CEPP actions and that these actions will occur earlier than implementation of CEPP. Therefore, the CEPP PIR will not be the mechanism to propose or conduct the required NEPA evaluation of modifications to the LORS. However, depending on the ultimate outcome of these future LORS revisions, including the level of inherent operational flexibility provided with these revisions, CEPP implementation may still require further LORS revisions to optimize system-wide performance and ensure compliance with Savings Clause requirements.

6.7.1.8 Implementation Scenarios

The Everglades lie at the center of the complex south Florida regional water management system in which water distributed to any part of the system affects many others. The current system provides most of the inflows to the project area at the peak of the wet season; however, flow is not spatially distributed as desired due to structural limitations and other project constraints. Providing supplemental flows during the periods outside of the peak wet season is ecologically important to reverse the current adverse effects of marsh dry out during the dry months. Providing storage and treatment will serve to both increase water volume and improve the timing of deliveries to the

Everglades. Additional storage will also reduce the frequency of undesirable high water volume discharges to the Northern Estuaries.

Separable PPAs are useful in informing financial decisions and budgets, and identifying the locations and significance of benefits, but the intent of multiple PPAs is not to compare PPAs against each other for cost-effectiveness. All project features of the recommended plan are needed to beneficially affect the more than 1.5 million acres in the St. Lucie and Caloosahatchee Estuaries, WCA 3, ENP, and Florida Bay. The cost-effectiveness of the features within each PPA has been thoroughly examined during the screening of options that made up the complete alternatives and substantial standalone project benefits have been identified. PPA North and PPA South are expected to achieve only regional benefits by utilizing existing inflows to improve deliveries to WCA 3, ENP, and Florida Bay. The ability to increase flows to the south as envisioned with the recommended plan depends on the construction of the A-2 FEB and seepage wall in PPA New Water, as well as the distribution and conveyance features in PPA North and PPA South. Implementation of all three PPAs are needed to see all of CEPP's improvements associated with the reduction of undesirable high volume discharges to the Northern Estuaries and the restoration of hydroperiods and sheetflow from WCA 3 and ENP to the coastal mangroves of Florida Bay. The total benefits predicted (See **Section 6.2.1**) with implementation of the recommended plan cannot be achieved without the combination of storage and treatment, distribution and conveyance, and seepage management.

The benefits and construction of PPA North is not dependent on implementation and construction of PPA South and vice versa. The benefits of PPA New Water are dependent on features in PPA North and PPA South. Commencing construction on PPA New Water may occur after an executed agreement between the SFWMD and USACE occurs for both PPA North and PPA South. Construction of PPA New Water may be in parallel with construction of PPA North and PPA South components. **Figure 6-19** includes an implementation scenario with unconstrained resources and funding to demonstrate the duration of construction per PPA, while considering construction dependencies and limitations such as staging and access. This figure illustrates a best-case implementation timeframe for simultaneous execution and construction of all three PPAs, which would achieve realization of the full CEPP benefits within 6 years of project initiation.

UNCONSTRAINED CEPP IMPLEMENTATION AND CONSTRUCTION DURATION

Duration (Days)	CEPP	Cnt. No.	PPA	YR 1	YR 3	YR 4	YR6	YR 7
365	L-6 Diversion	1	N					
730	S-8 Pump Modifications	1						
730	L-4 Levee Degrade and Pump Station	1						
540	L-5 Canal Improvements	2						
913	Backfill Miami Canal	2						
365	L-67A 500 CFS Structure North	3	S					
180	Spoil Mound Removal West L-67A (N)	3						
180	L-67C 6000' Levee Gap	3						
1186	Increase S-356	4						
365	Increase S-333	4a						
365	L-29 Gated Spillway	4b						
270	L-67A 500 CFS Structures 2 & 3 South	5						
180	Spoil Mound Removal West L-67A (S)	5						
730	Remove L-67C Levee in BS (~8 miles)	6						
730	8.5 Mile Blue Shanty Levee	6						
365	Remove L-67 Extension Levee	6						
365	Remove L-29 Levee in Blue Shanty	7						
730	Remove Old Tamiami Trail *	X						
365	Seepage Barrier L-31N	8	NW					
1825	A-2 FEB (5 sub contracts)	9						

* Contract X - Old Tamiami Trail can be completed at any time during implementation, but must precede backfilling of L-67 Extension Canal. NOTE: Reference **Figures 6-1** through **6-4** for more detailed description of project features. PPA North contains the features of **Figure 6-2**. PPA South contains the features of **Figure 6-3**. PPA New Water contains the features in **Figure 6-1** and **Figure 6-4.**

Figure 6-19. Unconstrained CEPP Implementation and Construction Duration.

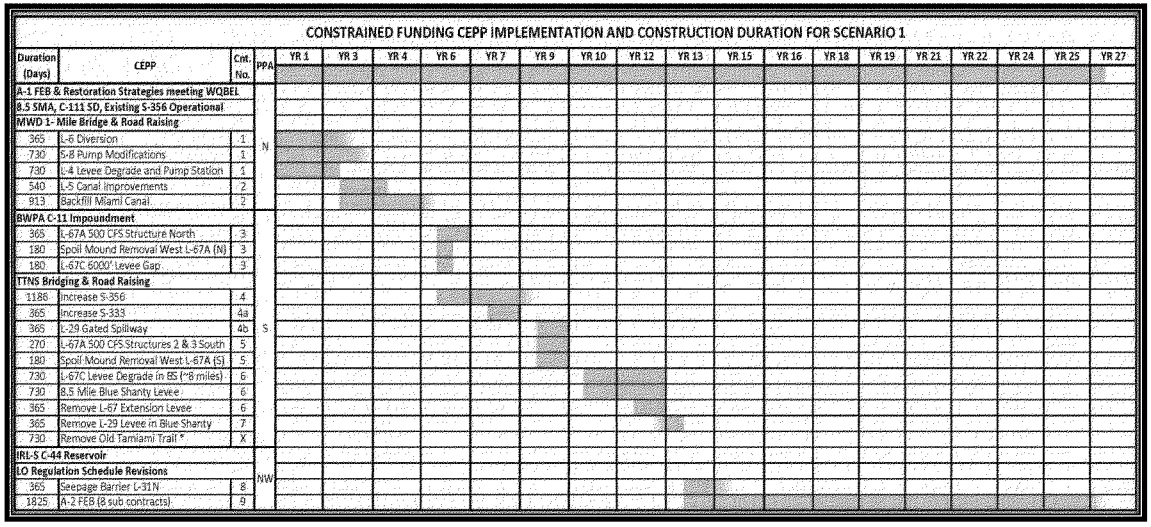
Uncertainty surrounding the timing of CEPP project dependencies, funding, resources, stakeholder input and potential conflicting priorities will likely lead to a longer implementation period. The implementing agencies are committed to engaging in a public process to integrate CEPP into the IDS (which incorporates the CERP MISP) that defines the order in which CERP projects would be planned, designed, and constructed. **Figure 6-20** illustrates the construction duration associated with implementation Scenario 1 (sequentially constructing PPA North, then PPA South and finally PPA New Water) and assumes constrained project funding of $100 million per year ($50 million Federal, and $50 Million non-Federal sponsor) that escalates through time. **Figure 6-21** also shows construction durations for Scenario 1, but is based on $100 million per year that does not escalate. These figures illustrate more realistic timelines to realize full project benefits. .

CONSTRAINED CEPP IMPLEMENTATION AND CONSTRUCTION DURATION FOR SCENARIO 1

Duration (Days)	CEPP	Cnt. No.	PPA	YR 1	YR 3	YR 4	YR 6	YR 7	YR 9	YR 10	YR 12	YR 13	YR 15	YR 16	YR 18	YR 19
A-1 FEB & Restoration Strategies meeting WQBEL																
8.5 SMA, C-111 SD, Existing S-356 Operational																
MWD 1- Mile Bridge & Road Raising																
365	L-6 Diversion	1	N													
730	S-8 Pump Modifications	1	N													
730	L-4 Levee Degrade and Pump Station	1	N													
540	L-5 Canal Improvements	2	N													
913	Backfill Miami Canal	2	N													
BWPA C-11 Impoundment																
365	L-67A 500 CFS Structure North	3	S													
180	Spoil Mound Removal West L-67A (N)	3	S													
180	L-67C 6000' Levee Gap	3	S													
TTNS Bridging & Road Raising																
1186	Increase S-356	4	S													
365	Increase S-333	4a	S													
365	L-29 Gated Spillway	4b	S													
270	L-67A 500 CFS Structures 2 & 3 South	5	S													
180	Spoil Mound Removal West L-67A (S)	5	S													
730	L-67C Levee Degrade in BS (~8 miles)	6	S													
730	8.5 Mile Blue Shanty Levee	6	S													
365	Remove L-67 Extension Levee	6	S													
365	Remove L-29 Levee in Blue Shanty	7	S													
730	Remove Old Tamiami Trail *	X	S													
IRL-S C-44 Reservoir																
LO Regulation Schedule Revisions			NW													
365	Seepage Barrier L-31N	8	NW													
1825	A-2 FEB (5 sub contracts)	9	NW													

* Contract X - Old Tamiami Trail can be completed at any time during implementation, but must precede backfilling of L-67 Extension Canal. NOTE: Reference **Figures 6-1** through **6-4** for more detailed description of project features. PPA North contains the features of **Figure 6-1** and **6-2**. PPA South contains the features of **Figure 6-3**. PPA New Water contains the features in **Figure 6-1** and **6-4**.

Figure 6-20. Constrained CEPP Implementation and Construction Duration for Scenario 1



* Contract X - Old Tamiami Trail can be completed at any time during implementation, but must precede backfilling of L-67 Extension Canal. NOTE: Reference **Figures 6-1** through **6-4** for more detailed description of project features. PPA North contains the features of **Figure 6-1** and **6-2**. PPA South contains the features of **Figure 6-3**. PPA New Water contains the features in **Figure 6-1** and **6-4**.

Figure 6-21. Constrained CEPP Implementation and Construction Duration for Scenario 1, with non-escalating funding

Other viable options for the implementation of construction phases and subsequent groupings into PPAs may be considered in the future. This flexibility is essential to successful CEPP implementation given the uncertainties associated with the lengthy implementation period and the inevitable improvement in scientific knowledge about the functioning of the greater Everglades that will occur as planned CERP and non-CERP projects are completed. Deviation from the PPAs outlined above (i.e. PPA North, PPA South, and PPA New Water) would require coordination with SFWMD, USACE Headquarters and the Office of the ASA (CW). For example, coordination is required if recommended plan features are reassigned to a different PPA then as originally established and presented in the Final PIR/EIS. Features not included in the recommended plan shall not be added to any of the implementation phases without proper coordination or NEPA analysis if necessary.

Federal laws and regulations applicable to implementing the CERP require PIRs to address certain assurances as part of the project recommendation for approval and subsequent implementation. For the CEPP PIR, the analyses for CEPP associated with Section 601(h)(4) and 601 (h)(5) of WRDA 2000 and the Programmatic Regulations for the CERP (33 CFR Part 385) for Project-Specific Assurances and Savings Clause were conducted for the recommended plan. The recommended plan will be implemented in multiple PPAs. The USACE and the SFWMD will undertake updated project assurances and Savings Clause analyses, if necessary, for the implementation phases that are selected to be included in a Project Partnership Agreement or amendment thereto prior to entering into the PPA or PPA amendment. The USACE District Engineer will ensure that Project-Specific Assurances and Savings Clause requirements are met per PPA, per applicable policies and laws. NEPA documentation will be updated, if applicable, as revisions are made to Water Control Plans and/or Project Operating Manuals associated with each PPA. Compliance with the requirements of the Savings Clause will be maintained throughout the entirety of the CEPP implementation period.

6.7.2 Preconstruction Engineering and Design

Appendix A represents a limited level of design, but includes documentation of all engineering assumptions and conceptual designs. PED for recommended plan features could begin after Congressional authorization and upon SFWMD's concurrence consistent with the implementation phases. USACE will prepare an Engineering Design Report updating the conceptual design and prepare initial, intermediate and final plans and specifications for each phase of construction. All work will be coordinated and reviewed between the USACE and the SFWMD, and approved by the USACE and SFWMD prior to construction, to ensure that the work meets USACE standards and regulations and incorporates SFWMD design guidance, as applicable. PED will include site-specific surveys and geotechnical investigations. During the design phase, detailed analyses, subsurface and site investigations will be conducted to prepare construction documents. During PED, project assurances, Savings Clause analysis and operating manuals will be updated consistent with the implementation phases, if necessary. After completion of 60 percent final plans and specifications for a given project feature, the lead construction agency (USACE or SFWMD) will prepare and submit a CERPRA permit application (Florida Statutes 373.1502) to the FDEP. The FDEP will review the application material to determine if reasonable assurance that the feature will be consistent with State water quality standards in compliance with rules in effect at the time of application. See **Section 6.1** for a list of plan features to be constructed. See **Appendix A** and **Annex C-2** of **Appendix A** for limited design details and conceptual design plates.

USACE continues the usage of the NGVD of 1929 (NGVD 29) system for elevation comparisons used with monitoring data, hydrologic modeling and design for Florida. This allows the continuity of years of valuable data to be transitioned during PED to the more accurate North American Vertical datum

(NAVD) of 1988 (NAVD 88). This PIR continues of the usage of NGVD and NAVD where appropriate in hydrologic modeling and preliminary design of CEPP recommended features. In PED, the NGVD 29 elevations will be converted to NAVD 88 for design analyses and completion of construction documents (plans and specifications). In some prior instances, the local sponsor has requested both vertical datums to be referenced during PED. There are appropriate conversions based on spatial relevance to maintain design intent changing from the NGVD 29 datum to the NAVD 88 datum.

6.7.3 Construction

The project will be constructed using conventional means and methods. Multiple contracts will be awarded in a sequenced and phased approach. Construction contracts for project features will not be awarded by the USACE prior to obtaining CERPRA permit authorization or other water quality certification, as applicable. The project features will be sequenced in contracts that maximize opportunities to realize benefits with water that meets State water quality standards, capitalize on use of onsite material, reduce multiple handling scenarios, and maintain flood control operations of existing features. Adaptive Management will help with future development of the implementation and sequencing.

6.7.4 Operational Testing and Monitoring Period

Prior to initiating OTMP, each major operational component will undergo a short period of testing and commissioning. This short period includes functional performance tests on all features to verify all modes of operation and to verify other relevant contract requirements. Following the testing and commissioning, operational testing and monitoring will be conducted for one full wet season (i.e. June 1 to November 30). If the OTMP begins after the start of a wet season, the OTMP should be extended as needed to encompass a full wet season. Contractor services to be provided during the OTMP will include, but will not be limited to, the following: vegetation management including control of exotics, answering questions on equipment operation; contacting the appropriate vendor/manufacture for response or site visits; arranging and officiating supplemental owner training sessions; and assisting in resolution of functionality issues. The operational testing and monitoring period activities of the construction contractor will be separate from and supplemental to the warranty requirements of the contract. The USACE and SFWMD will share in the responsibilities for conducting water management operations during OTMP.

During OTMP the Federal Government and the non-Federal sponsor will work together closely to identify any features that are not operating as designed. Any features that are not operating as designed will be identified in writing to the District Engineer and the non-Federal sponsor. At the conclusion of OTMP, the District Engineer and the non-Federal sponsor will make a determination as to whether the Project is "operational" as defined in the CERP Master Agreement. Once the Project, or a functional portion of the project, is determined to be operational, the feature(s) will be transferred to SFWMD for OMRR&R.

6.7.5 Flood Plain Management and Flood Insurance Programs Compliance

As CEPP is part of the multi-purpose C&SF program, the non-Federal sponsor agrees to participate in and comply with applicable Federal floodplain management and flood insurance programs consistent with its statutory authority. Not less than once each year, the non-Federal sponsor shall inform affected interests of the extent of protection afforded by the authorized CERP project.

The non-Federal sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future

development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the CERP Project.

The non-Federal sponsor shall comply with Section 402 of WRDA 1986, as amended (33 U.S. C. 701b-12), which requires a non-Federal interest to have prepared, within one year after the date of signing a PPA for the authorized CERP Project, a floodplain management plan. The plan shall be designed to reduce the impacts of future flood events in the project area, including but not limited to, addressing those measures to be undertaken by non-Federal interests to preserve the level of flood protection provided by the authorized CERP Project. As required by Section 402, as amended, the non-Federal interest shall implement such plan not later than one year after completion of construction of the authorized CERP project. The non-Federal sponsor shall provide an information copy of the plan to the Government upon it preparation.

The non-Federal sponsor shall prescribe and enforce regulations to prevent obstruction of or encroachment on the authorized CERP project or on the lands, easements, and rights-of-way determined by the Government to be required for the construction, operation, maintenance, repair, replacement, and rehabilitation of the authorized CERP project, that could reduce the level of protection the authorized CERP project affords, hinder operation or maintenance of the authorized CERP project, or interfere with the authorized CERP project's proper function.

6.7.6 Environmental Commitments

The USACE commits to avoiding, minimizing or mitigating for adverse effects during construction activities by including the following commitments in the contract specifications:

1. The contractor would be required to keep construction activities under surveillance, management, and control to avoid pollution of surface, ground waters, and wetlands. The contract specifications would require the contractor to employ best management practices (BMPs) with regard to erosion and turbidity control.
2. The contractor would be required to prevent oil, fuel, or other hazardous substances from entering the air, ground, drainage, local bodies of water, or wetlands. The contract specifications would require that the contractor adopt safe and sanitary measures for the disposal of solid wastes and would require a spill prevention plan. The contractor would also be required to transport and dispose of any construction and demolition debris in accordance with applicable requirements.
3. The contractor would be required to keep construction activities under surveillance and control to minimize damage to the environment by noise and pollution of air resources.
4. The contractor would be required to keep construction activities under surveillance, management, and control to minimize interference with, disturbance to, and damage of fish and wildlife. The contractor would be required to inform the construction team of the potential presence of threatened and endangered species in the work area, the need for construction conservation measures, and any requirements resulting from Endangered Species Act (ESA) Section 7 consultation.
5. The contractor would be required to take appropriate measures to protect historic, archeological and cultural resources within the work area.
6. The contractor would be required to keep construction activities under surveillance, management, and control to prevent the transfer and spread of invasive species due to construction activities. The contract specifications would require the contractor to employ BMPs and measures to prevent the transfer and spread of invasive species.

In addition, as required under WRDA 2000, the CERP Programmatic Regulations, and current USACE policy, the PDT has taken the following actions:

1. The PDT has identified water to be reserved or allocated for the natural system. **Annex B** addresses this requirement.
2. The recommended plan has been evaluated in light of its potential effects on existing legal sources of water and the level of service for flood protection. **Annex B** addresses this requirement.
3. WRDA 2000, the authorizing legislation for CERP, has now made a formal monitoring plan a requirement for all CERP restoration projects. The Selected Plan includes adaptive management, water quality, hydrometeorologic, and ecological monitoring activities to ensure that the intended purposes of the project would be achieved through long term operations. **Annex D** addresses this requirement.
4. In addition to the project level monitoring plan, the PDT has developed a nuisance and exotic vegetation control plan which strives to either prevent or reduce the establishment of invasive and non-native species within the project area. **Annex D** addresses this requirement.
5. USACE guidance interpreting the WRDA of 2007 (Section 2039), requires preparation of an adaptive management plan for all ecosystem restoration projects. Adaptive management is a formal process for continually improving management policies and practices by learning from their outcomes. In the context of CEPP, the adaptive management plan provides an approach for addressing project uncertainties by testing hypotheses, linking science to decision making, and adjusting implementation of the project as necessary, to improve the probability of restoration success. **Annex D** addresses this requirement.
6. The recommended plan has been evaluated in light of its potential effects on fish and wildlife resources, including effects to Federally listed species. Consultation was initiated with USFWS on August 5, 2013 with completion of a Biological Assessment (BA). A Programmatic Biological Opinion (BO) was received on April 9, 2014, which clearly states that further consultation will be needed when more specific project details are finalized during project design and implementation activities. While this document does not authorize incidental take of three endangered avian species (CSSS, snail kite, and wood stork), it does describe the anticipated effects based on current information. Upon completing ESA Section 7 consultation for each PPA, USACE will undertake the agreed-to avoidance and minimization measures and implementing terms and conditions (TCs). When USACE is closer to constructing phases of CEPP that will affect listed species, USFWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable reasonable and prudent measures (RPMs) and TCs. Additional information can be found in **Annex A**.

6.8 PROJECT ASSURANCES AND SAVINGS CLAUSE SUMMARY

WRDA 2000 requires the inclusion of "Project-Specific Assurances" and "Savings Clause" analyses within each CERP PIR. "Project-Specific Assurances" ensure that the water needed for the natural system to achieve CERP restoration goals is identified and subsequently protected from other potentially competing uses. The "Savings Clause" protects existing legal sources of water supply, such as water for municipal and agricultural uses, and ensures that CERP implementation does not reduce the level of service for flood protection. Refer to **Annex B** for complete documentation of the Project Assurances and Savings Clause analysis for the recommended plan, responsive to the requirements of WRDA 2000.

The analyses for Project Assurances and the Savings Clause followed identification of the recommended plan during plan formulation. In June 2013, the CEPP base condition assumptions established for plan formulation were subsequently revisited and updated to represent the most current information for the analysis of Savings Clause requirements and Project-Specific Assurances. Specifically, the ECB was updated to the 2012EC and the FWO baseline was updated utilizing new information for the Initial Operating Regime Baseline (IORBL1). In the **Annex B** analysis, the potential effects of CEPP are analyzed through comparison of the with-project condition (Alt 4R2) to the without project condition (IORBL1). This comparison segregates the effects of the intervening non-CERP and intervening CERP projects. In addition, **Annex B** also additionally compares Alt 4R2 to the two existing baseline conditions (2012EC and ECB) to inform evaluators of the cumulative potential effects of both CEPP and other intervening CERP and non-CERP projects relative to conditions experienced previously.

6.8.1 Project Assurances: Identification of Water Made Available for the Natural System and Water for Other Water-Related Needs

Section 601(h)(4) of WRDA 2000, entitled "Project-Specific Assurances", requires CERP PIR reports to:

- identify the appropriate quantity, timing, and distribution of water dedicated and managed for the natural system
- identify the amount of water to be reserved or allocated for the natural system necessary to implement, under State law

The 2003 Programmatic Regulations for the CERP, which were developed in response to statutory requirements in WRDA 2000, further established the processes and procedures to guide the Corps in the implementation of the CERP. Section 385.35(b) of the Programmatic Regulations requires that each PIR identify the quantity, timing and distribution of water to be dedicated and managed for the natural system necessary to meet the restoration goals of the CERP. This evaluation considers the availability of the pre-CERP baseline water and previously reserved water, and whether improvements in water quality are necessary. Section 385.35(b) of the Programmatic Regulations also requires that procedures be developed for identifying water generated by the CERP for use in the human environment and specifies that the quantity, timing and distribution of water for other water-related needs be identified in CERP PIRs.

6.8.1.1 Project Assurances: Identifying Water for the Natural System

The identification of water for the natural system captures the quantity, timing, and distribution of water. Hydrologic model data extracted from the RSM-GL simulations was used to develop the volume probability curves at three specified locations in the regional system: inflows to WCA 3 (along the formulation redline), inflows to ENP, and overland flows to Florida Bay. These specified locations represent the inflows to the three basins where ecosystem benefits (habitat units) are expected as a result of implementation of the recommended plan. Specifically, the volumes of water at the 10th, 50th, and 90th percentiles are identified and compared for the pre-project (future without) condition and the recommended plan (future with project) conditions. The pre-project available water (IORBL1), the with-project total water available (Alt4R2), and the water made available by the project (differences between Alt 4R2 and IORBL1, which were computed for each water year within the RSM period of simulation) for the natural system can be found in **Table 6-15** through **Table 6-17**.

The water made available by the project to WCA 3, ENP and Florida Bay is displayed as a volume probability curve in **Figure 6-22**. Compared to the future without project condition, inflows to WCA 3

with the recommended plan are higher during each of the 40 water years analyzed with the CEPP hydrologic modeling. Similarly, inflows to ENP and Florida Bay are higher than or equivalent to the future without project inflows in 37 and 36 years, respectively, of the 40 water years analyzed. The recommended plan provides a significant net increase in inflow volumes to WCA 3, ENP, and Florida Bay when compared to the future without project condition

Table 6-15. Pre-Project Volume of Water (kAF/yr) Available for the Natural System

Pre-project Water Available for the Natural System (IORBL1)			
Location	*Water Available equaled or exceeded 10% of Water Years (kAF)*	*Water Available equaled or exceeded 50% of Water Years (kAF)*	*Water Available equaled or exceeded 90% of Water Years (kAF)*
WCA 3	839	513	286
ENP	1,771	732	212
Florida Bay	1,969	704	218

Table 6-16. Total Volume of Water (kAF/yr) Available for the Natural System

Total Water Available for the Natural System (Alt 4R2)			
Location	*Water Available equaled or exceeded 10% of Water Years (kAF)*	*Water Available equaled or exceeded 50% of Water Years (kAF)*	*Water Available equaled or exceeded 90% of Water Years (kAF)*
WCA 3	1,404	846	420
ENP	2,187	850	419
Florida Bay	2,113	729	287

Table 6-17. Water Made Available by the Project (kAF/yr) for the Natural System

Water Made Available by the Project (difference between Alt 4R2 and IORBL1)			
Location	Water Made Available equaled or exceeded 10% of *Water Years (kAF)*	Water Made Available equaled or exceeded 50% of *Water Years (kAF)*	Water Made Available equaled or exceeded 90% of *Water Years (kAF)*
WCA 3	647	357	97
ENP	534	256	37
Florida Bay	418	137	-13

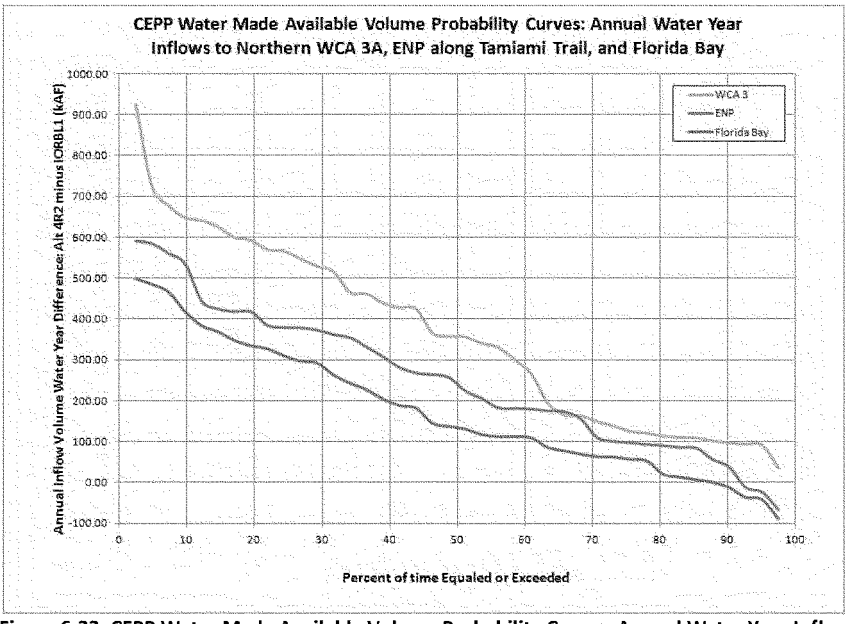


Figure 6-22. CEPP Water Made Available Volume Probability Curves: Annual Water Year Inflows to Northern WCA 3A, ENP along Tamiami Trail, and Florida Bay.

6.8.1.2 Water to be Reserved or Allocated for the Natural System

As required by Section 601(h)(4)(A) of the of the WRDA 2000 and Section 385.35 of the Programmatic Regulations for the Implementation of CERP, the water made available by the project will be protected using the State of Florida's reservation or allocation authority under State law as in represented by **Table 6-17**. The SFWMD has protected the pre-project water for the natural system in the Holey Land and Rotenberger Wildlife Management Areas; WCA 1, WCA 2A, WCA 2B, WCA 3A, and WCA 3B; and ENP through the Restricted Allocation Area Rule for the Everglades and North Palm Beach/Loxahatchee River Watershed water bodies. The combination of protecting the pre-project existing water and the water made available by the CEPP project features is required for the CEPP to achieve its intended benefits.

The SFWMD will protect the water made available by the CEPP project features using its reservation or allocation authority as required by 373.470, Florida Statutes (F.S.). Protection of water made available by CEPP project features is required in order for the SFWMD and the Department of the Army to enter into one or more PPAs to construct the CEPP project features.

6.8.1.3 Project Assurances: Identifying Water Made Available for Other Water Related Needs

The ability of the CEPP project features to provide water to meet other water related needs in the LOSA, LECSA 2, and LECSA 3 was analyzed for the recommended plan. Based on the analysis, the level of service for the LOSA water supply has not improved, nor has it been degraded by CEPP. Therefore, no water was quantified for other water related needs in the LOSA. However, by virtue of additional water being stored in Lake Okeechobee, additional water may reach water users located in the LOSA.

Additional water available for allocation to consumptive use permit applicants is expected to be generated by CEPP in LECSA 2 and LECSA 3. The specific locations, volumes, and/or timing of where this water will be available for withdrawal in LECSA 2 and LECSA 3 will be developed when the following, project-related conditions are met: 1) completion of all CEPP project features and 2) upon a formal determination by the SFWMD's Governing Board that these project features are operational consistent with requirements of the appropriate CEPP PPA. Water will be allocated in accordance with the requirements of the SFWMD's consumptive use permitting rules in effect at that time.

6.8.2 Savings Clause Summary

The Savings Clause analyses, described in Section 601(h)(5) of WRDA 2000, is a means to protect users of legal sources of water supply and flood protection that were in place at the time of enactment of WRDA 2000. Section 385.36 of the Programmatic Regulations requires that CERP PIRs determine if existing legal sources of water will be eliminated or transferred as a result of project implementation. If a project is expected to result in an elimination or transfer of an existing legal source of water, the PIR shall include an implementation plan that ensures a new source of water of comparable quantity and quality is available to replace the source that is being transferred or eliminated. Section 385.36 of the Programmatic Regulations requires that CERP PIRs include analyses to ensure the level of service for flood protection will not be reduced by implementation of the CERP project features.

6.8.2.1 Savings Clause- Water Supply from Existing Legal Sources

Sources of water to meet agricultural and urban demand in the LOSA and LECSAs will continue to be met by their current sources, primarily Lake Okeechobee, the Everglades (including the WCAs), surface water in the regional canal network, and the surficial aquifer system. Sources of water for the Seminole Tribe of Florida and Miccosukee Tribe of Indians of Florida are also influenced by the regional water management system (C&SF Project, including Lake Okeechobee); however these sources will not be affected by the CEPP project. In addition, water supplies to ENP with implementation of the recommended plan exceed FWO project and ECB volumes. Water sources for fish and wildlife located in the Northern Estuaries, WCA 2, WCA 3, Biscayne Bay, and Florida Bay will not be diminished. Therefore, there will be no elimination or transfer as a result of the recommended plan on existing legal sources of water supply for the following:

- Agricultural or urban water supply in the LECSA
- Allocation or entitlement to the Seminole Tribe of Florida under Section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e)
- The Miccosukee Tribe of Indians of Florida
- Water supply for ENP
- Water supply for fish and wildlife

Some of the water utilized by agricultural users in the LOSA from Lake Okeechobee will be transferred to WCA 3 and further south as a result of the implementation of the recommended plan. This transfer is anticipated to occur after the modification of the LORS that will allow full utilization of the A-2 FEB. The recommended plan has identified an additional source of water of comparable quantity and quality that will be available to replace the water sent south. Instead of discharging all water stored in the reservoir to tide via the S-80 or to meet C-44 Basin agricultural water supply demands, as assumed in the future without project IORBL1 baseline condition operations, the recommended plan retains a portion of the water stored in the CERP Indian River Lagoon-South C-44 Reservoir/STA in the regional system for backflow to Lake Okeechobee via the C-44 Canal and raises the Lake Okeechobee stage criteria to allow increased C-44 Canal backflow (**Figure 6-23**). This added operation does not affect existing permitted

allocations within the C-44 Basin. The additional C-44 Canal backflow operations to Lake Okeechobee included in the recommended plan improves the ability to meet existing permitted demands in the LOSA by retaining more water in the regional system and making it available to agricultural users. The operations do not benefit agricultural users in the C-23 Basin. The recommended plan backflow operations capture a portion of releases from the C-44 Reservoir/STA that would otherwise be directed to the Saint Lucie Estuary as excess water.

Specifically, the future without project condition (IORBL1) allows backflow to Lake Okeechobee from the C-44 Canal when S-308 (the Lake Okeechobee discharge structure to the C-44 Canal) is not open for regulatory discharges and when the stage in Lake Okeechobee is 0.25 ft below the base of the 2008 LORS low sub-band (within the baseflow sub-band), which varies between 13.0 and 14.5 ft NGVD seasonally. This operational assumption is consistent with the existing operational protocols of Lake Okeechobee (2008 LORS) and the SFWMD Lake Okeechobee Water Shortage Management (LOWSM) operations. Discharges from the Indian River Lagoon-South project C-44 Reservoir to the C-44 Canal are otherwise limited to environmental deliveries for the St. Lucie Estuary and C-44 Basin agricultural water supply demands during these backflow operations.

The recommended plan operations expand on the IORBL1 backflow to Lake Okeechobee through the following operational changes: (1) backflow to Lake Okeechobee from the C-44 Canal is allowed when S-308 is not open for regulatory discharge and the stage in Lake Okeechobee is below 14.5 ft NGVD (no seasonal variability); and (2) discharges from the Indian River Lagoon-South project C-44 Reservoir to the C-44 Canal are made when the stage in Lake Okeechobee is below the baseflow zone of the 2008 LORS schedule (the bottom of this zone varies seasonally between 12.6 and 13.0 ft NGVD) to provide an additional source of backflow water to Lake Okeechobee. Water captured in the C-44 Reservoir/STA includes excess water conveyed from the C-23 Canal and Basin (approximately 6 kAF on an average annual basis) that is not needed to meet the Indian River Lagoon-South North Fork water reservation target. The recommended plan operational changes result in an average annual increase in C-44 Canal backflow volume to Lake Okeechobee of 57.3 kAF (97.3 kAF in the recommended plan, compared to 40.0 kAF in the IORBL1) and an average annual increase in C-44 Reservoir discharges to the C-44 Canal of 21.3 kAF (37.6 kAF in the recommended plan, compared to 16.3 kAF in the IORBL1).

The transfer of water from Lake Okeechobee to WCA 3 would not be implemented until the CERP C-44 Reservoir/STA, the canal connecting the C-44 Reservoir to both the C-23 Basin and the C-23 Canal, and the CEPP FEB on the EAA A-2 site are operational. If the canal to the C-23 Basin and the C-23 Canal is not operational when the CEPP FEB on the EAA A-2 site is ready to store water, the operations, and ultimately the delivery of water from Lake Okeechobee to the CEPP FEB, may need to be modified to avoid elimination of this portion of the source of water for the LOSA. The water retained in Lake Okeechobee also maintains the level of service for water supply for existing legal users dependent on Lake Okeechobee and its connected conveyance system. Specifically, this includes the agricultural users in the LOSA and the Seminole Tribe of Florida.

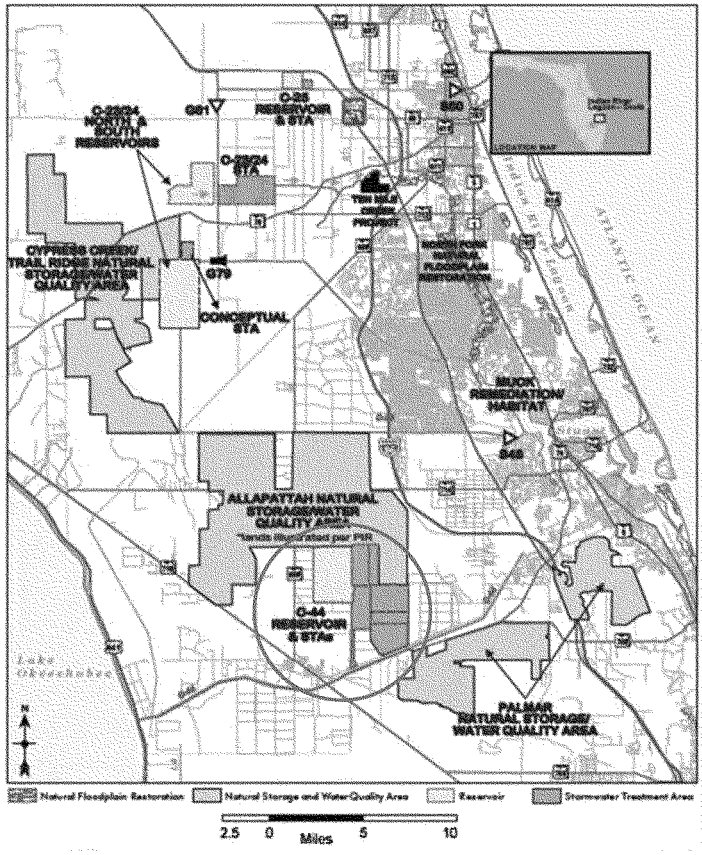


Figure 6-23. Location and Project Features of Indian River Lagoon-South Project. Location of C-44 Reservoir Identified in Red.

6.8.2.2 Savings Clause: Flood Protection

Comparison of canal stages and groundwater levels at key locations (refer to **Annex B** for complete details) indicate that implementation of the project will not reduce the levels of service for flood protection within the areas affected by the project, including the EAA, LECSA 2, and LECSA 3. This includes the areas affected by the project including the Seminole Tribe of Florida's Big Cypress Reservation and the Miccosukee Tribe of Indians of Florida's reservation areas and resort. However, modeling simulation results for one area in the South Dade Conveyance System (RSM-GL cell 4328), specifically located immediately east of the C-111 Canal between the C-103 and C-113 Canals, has shown increased stages relative to the existing base conditions simulated in the RSM-GL. As further described within **Annex B**, the predicted modeled performance for both the future without condition (IORBL1) and Alt 4R2 is likely the result of the calibrated C-111 Canal roughness coefficient likely being set too high and causing higher upstream C-111 Canal stages (and adjacent groundwater levels). The

hydrologic modeling results in this specific case are not representative of the Alt 4R2 performance that is expected following CEPP implementation, and it is recognized that the Alt 4R2 simulated stages along this reach of the C-111 Canal and adjacent agricultural areas would not be deemed acceptable to local stakeholders.

The recommended plan maintains the pre-project flood protection level of service for the EAA by providing the same total pumping capacity at the S-8 (4170 cfs) and S-7 (2490 cfs) pump stations, which provide drainage for the upstream EAA basin. CEPP will maintain this existing design capacity for the S-8 complex through a combination of pump station design modifications, a new hydraulic connection from S-8 to the degraded L-4 Levee, utilization of the existing G-404 pump station (570 cfs design capacity), and leaving the 1-2 mile segment of the Miami Canal as available getaway conveyance capacity during peak flow events. Modifications of the S-8 pump station complex for CEPP operations will be further analyzed during the PED phase of CEPP, including further confirmation that CEPP construction and implementation sequences will not adversely impact the pre-project level of service for flood protection within the EAA.

6.8.3 Project Assurances and Savings Clause Incremental Analysis during CEPP Implementation

CEPP is composed of features which can be grouped into implementation phases. The USACE and the SFWMD will undertake updated project assurances and Savings Clause analyses, if necessary, for the implementation phases that are selected to be included in a PPA or amendment thereto prior to entering into the PPA or PPA amendment. The USACE District Engineer will ensure that Project-Specific Assurances and Savings Clause requirements are met per PPA, per applicable policies and laws. NEPA Documentation will be updated, if applicable, as revisions are made to Water Control Plans and/or Project Operating Manuals associated with each PPA. Compliance with the requirements of the Savings Clause will be maintained throughout the entirety of the CEPP implementation period.

6.9 PROJECT CONCERNS AND CONTROVERSIES

The planning of CEPP and choice of the recommended plan relied on extensive existing scientific and local knowledge of the Everglades, and associated water bodies and estuaries, from the initial defining of the problems and opportunities to the evaluation of alternatives and estimation of potential restoration performance. While the recommended plan is based on this wealth of knowledge, concerns and controversies were documented during the planning process. The CEPP AM Plan (**Annex D, Part 1**) provides a forum to address the concerns and controversies exacerbated by information gaps. The AM Plan provides site and question-specific methods to inform ongoing project adjustments intended to address controversies and continually improve project performance. It should be noted that uncertainties exists in every natural resource management and restoration effort, and it is not unexpected to have controversies associated with a project of CEPP's scale with its proximity and importance to several varied users and supporters. The AM Plan documents a culmination of scientific and local knowledge that has developed over decades of experience, and structured methods for obtaining information to resolve CEPP specific questions, to promote the role of science in restoration and in the management of concerns and controversies.

6.9.1 Incremental Restoration and Future Opportunities

The National Academy of Sciences (National Resource Council 2007) has recommended the implementation of CERP through an incremental adaptive restoration (IAR) process. CEPP has adopted that recommendation and has formulated a solution for an increment of overall restoration of the south Florida ecosystem. Incidentally, there are problems and opportunities remaining. CEPP is not meeting all targets of CERP that are based on the understanding of the pre-drainage Everglades, however CEPP

does provide for significant and substantial restoration of the Everglades ecosystems and achieves approximately 2/3 of the additional water flow into the WCAs that CERP envisioned. Although the recommended plan provides a significant increase in freshwater needed for the restoration of the central Everglades, additional actions are needed to achieve the restoration envisioned in CERP. The actions may include further reduce harmful discharges of freshwater from Lake Okeechobee to the St. Lucie and Caloosahatchee Estuaries and improve estuary habitat for oysters and SAV; further reduce the intensity, frequency, duration, and spatial extent of hypersaline events in Florida Bay. Additional freshwater flows of 500,000 to 700,000 acre-feet per year, annual average, into Shark River Slough and Taylor Slough may be necessary to bring Florida Bay to full restoration. Additionally, the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida have voiced concerns about conditions on Tribal lands in the western basins and the lack of progress on CERP components or other initiatives that would benefit those areas. The AM Plan contains methods for informing optimization of the flows in order to maximize the portion of CERP's vision that CEPP will achieve, i.e., A-2 FEB operations will be optimized based on knowledge gained from the A-1 FEB, which will precede the construction of A-2 FEB, and based on monitoring of the A-2 FEB performance (**Annex D, Uncertainty ID#4**).

6.9.2 Water for Other Water-Related Needs

During the CEPP study, agricultural and municipal/industrial water supply stakeholders expressed concerns about lack of progress on CERP projects intended to increase agricultural and municipal/industrial water supply.

6.9.2.1 Water for Other Water-Related Needs –Lower East Coast

To address this concern, the modeled operations of the recommended plan were optimized to improve water supply performance, increasing the amount of water made available by the project in LECSA 2 (Broward County) and LECSA 3 (Miami-Dade County) without reducing the beneficial effects on the natural system that justify the project. Additional improvements in water supply for the LEC will need to be considered in future increments of CERP that provide additional storage for capturing water currently being sent to tide or other sources. Future CERP increments that provide this additional storage will increase water made available in the regional system for other water related needs.

6.9.2.2 Water for Other Water-Related Needs –Lake Okeechobee Service Area

As initially authorized in WRDA 2000, the CERP EAA Storage Reservoir – Phase I included two conceptual 20,000-acre compartments capable of storing up to 120,000 acre-feet each. Compartment I was to be used to meet EAA agricultural irrigation demands by storing excess EAA runoff. Compartment II was envisioned to capture both Lake Okeechobee regulatory releases and Compartment I overflow and served to supply environmental water deliveries to the WCAs. The CEPP PIR is recommending authorization of a portion of the Compartment 2 functions identified in the initially authorized CERP project. CEPP proposes to implement this component by constructing an approximately 14,000-acre FEB on the A-2 footprint with a maximum storage depth of 4 ft that would provide approximately 60,000 acre-feet of storage by capturing Lake Okeechobee regulatory releases. Operated in conjunction with the State Restoration Strategies' FEB on the A-1 footprint, an additional 210,000 acre-feet of water will be delivered to WCA 3A on an average annual basis.

During CEPP plan formulation and screening, multiple configurations of storage and treatment options were examined, ranging from STAs to 12-foot deep reservoirs. The amount of effective storage in a reservoir is dependent upon its release capabilities, and the release capabilities of reservoirs in the EAA are directly related to the requirement to meet State water quality standards for water delivered to the WCAs. The screening evaluations led to the conclusion that deeper reservoirs are initially able to

capture more water but do not offer the limited water quality treatment capabilities of an FEB, thereby requiring additional STAs. FEBs supplement the treatment efficiency of STAs by reducing the phosphorus concentrations of inflows; consequently, given consideration of water quality treatment requirements, FEBs were able to provide downstream water deliveries at substantially less cost than deeper reservoirs. Therefore, FEB storage components on the A-1 (State Restoration Strategies) and A-2 footprints (CEPP) were recommended as a component of all CEPP final array alternatives.

The recommended plan A-2 FEB does not preclude future increments of CERP planning for additional storage in the EAA to provide additional water supply deliveries for either agricultural irrigation or environmental water deliveries. For example, the A-2 FEB could be converted to an STA or deeper reservoir that works in conjunction with the State's existing STA system to accommodate any future upstream storage and treatment to further increase water deliveries to the Water Conservation Areas, and/or the CERP EAA – Phase I Component I storage functions could be implemented. CEPP is not seeking the deauthorization of the CERP EAA Reservoir Phase – I, recognizing that improvements in water supply for the LOSA will need to be considered in future increments of CERP that provide additional storage for capturing water currently being sent to tide from Lake Okeechobee or capturing water from other sources. Future CERP increments that provide this additional storage will increase water made available in the regional system for other water related needs.

6.9.3 Water Quality and Effects on State Facilities

The recommended plan depends on SFWMD-owned-and-operated water quality treatment facilities (STAs 2 and 3/4) and is integrated with a yet-to-be constructed flow equalization basin (A-1 FEB) included in SFWMD's "Restoration Strategies" project. To achieve restoration objectives for WCA 3A, the recommended plan involves discharges from these STAs to previously un-impacted areas. Concerns were expressed about the effects of the new discharges on water quality and native flora and fauna in those un-impacted areas. To ensure that the recommended plan meets State water quality standards, NPDES discharge permits and Everglades Forever Act watershed permits with associated effluent limits will govern STA discharges from the State facilities.

The recommended plan also increases flows into SRS in ENP subject to the limits for total phosphorus contained in Appendix A of the 1991 Settlement Agreement for U.S. vs. FDER (Case no. 1:88-01886cvHoeveler) Since the compliance determination calculation is inversely proportional to flow, increases in flow will lower the compliance limit. State and Federal water managers expressed concerns that the recommended plan may increase the probability of exceeding the compliance limit and agreed to develop a process and scope for updating, if appropriate, the SRS compliance calculation. Based on current and best available technical information, the federal parties believe at this time that the State Restoration Strategies, implemented in accordance with the state issued Consent Order and other joint restoration projects, are sufficient and anticipated to achieve water quality requirements for existing flows to the Everglades.

6.9.4 Effects on Endangered Species

To achieve restoration objectives, the recommended plan increases the amount of water delivered into areas inhabited by endangered species, including the critically-endangered CSSS. FWS supports the recommended plan and is developing measures to improve the number and distribution of sparrows, but has expressed concerns about operations during nesting periods and effects on sparrow habitat. Upon completing ESA Section 7 consultation for each PPA, USACE will undertake the agreed-to avoidance and minimization measures and implementing TCs. When USACE is closer to constructing

phases of CEPP that will affect listed species, FWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable RPMs and TCs.

6.9.5 Effects of Invasive Species on the South Florida Ecosystem

South Florida contains numerous harmful invasive plant and animal species that have the potential to significantly alter ecological communities throughout the region. Concerns have been expressed that hydrologic restoration efforts to improve the greater Everglades, including the CEPP, may be ineffectual if invasive plant and animal species continue to spread and overtake natural communities of plants and animals. Scientists generally agree that restoring natural system processes and managing those areas provide greater resilience to threats posed by invasive species, refer to **Annex G**.

6.9.6 Water Levels in Water Conservation Area 3A

Sending water through historic sloughs and flow paths in northern WCA 3A, with flows, hydroperiods, and water levels that will restore topographical differences between sloughs, ridges, and tree islands, is paramount to reestablishing a 500,000-acre flowing system through the northern most extent of the remnant Everglades. Restoring topographic diversity will support plant and wildlife species that require higher or lower areas, resulting in a mosaic of habitats that are adapted to variations of topography. There is potential for adverse impacts to species that have become accustomed to the drier conditions associated with Everglades drainage, such as mammals dependent upon upland habitat. Although the historic Everglades contained higher ground, and therefore hosted these species, current drained conditions have expanded the area of high ground. As CEPP transitions the Everglades back to an environment of slowly flowing, shallow water frequently interspersed by higher ridges and tree islands, the species may have to adjust to new landscape patterns. The AM Plan contains monitoring of tree islands, topographic ridges, higher ground wildlife including mammals, sloughs, flows, and slough-inhabiting fish in order to watch for unintended effects of CEPP on these important components of the diverse Everglades, and to provide quick reporting if unintended effects are seen (**Annex D, Uncertainty ID#76**).

6.9.7 Blue Shanty Levee

The Blue Shanty flowway achieves a central goal of CERP and of CEPP: restoration of continuous sheet-flow in the historical direction and re-connection of a portion of WCA 3B to ENP. Concerns have been expressed that advancing Everglades restoration through construction of an additional levee appears counterintuitive to Decompartmentalization goals. Although the levee is controversial, it is necessary to ensure the functioning of a whole levee system in the WCA 3B area and to create the flowway. Construction of CEPP structures in WCA 3B to create the flowway will be conducted in a step-wise fashion in order to test assumptions that all of the structures are needed. The number of structures may be reduced if the on-the-ground data shows that not all are needed; this includes a small possibility that the Blue Shanty flowway could be created without constructing the Blue Shanty levee (**Annex D, Uncertainty ID#77**).

6.9.8 L-67A Water Control Structures Passive versus Control

Passive control features were screened out during the CEPP plan formulation process and will not be further considered during future CEPP implementation. Active control structures, such as the gated culverts along L-67A included in the recommended plan, are required to most effectively address: adaptive management flexibility and system uncertainties (the WCA3A regulation schedule varies seasonally, whereas passive weir elevations are most likely predetermined and static); water quality considerations and constraints; threatened and endangered species considerations within WCA 3A and ENP, including flexibility for management of recession/ascension rate targets; and surface water velocity

considerations within the flowway. Further, the CEPP modeling and preliminary draft POM recognize that the only anticipated operational constraint for the proposed controllable L-67A structures within the Blue Shanty flowway (S-632 and S-633) would be the 9.7 ft NGVD maximum stage elevation for the L-29 Canal based on the planned DOI Tamiami Trail Next Steps Tamiami Trail roadway modifications, and this same constraint would equally apply under a passive weir scenario.

The recommended plan does not preclude future increments of CERP planning for increased hydrological connectivity between WCA 3A and WCA 3B, including potential consideration of passive weir components and other associated additional infrastructure, consistent with features included in the original CERP Recommended Plan.

6.9.9 CERP and CEPP Comparison

Since CERP, twelve years of updated science, new information, improved hydrologic modeling tools and varying water treatment assumptions have led to the differences in CERP components and the recommended plan. There are six CERP (Yellowbook) components which have features or increments included within the components in the recommended plan: (1) EAA Reservoirs; (2) Flow to Northwest and Central WCA 3A; (3) WCA 3 Decompartmentalization and Sheetflow Enhancement; (4) S-356 Pump Station Modifications; (5) L-31 Levee Seepage Management; and (6) System-wide Operational Changes-Everglades Rain Driven Operations. These six CERP components were built upon (additional components of CERP added) as CEPP progressed through the scoping period. Some of the components considered during scoping and detailed analysis were not retained in the recommended plan. Reference **Section 1** and **Section 3** or **Appendix E** for details. A comparison of the CERP/CEPP feature functions, elements and costs was completed for inclusion in the CEPP PIR. The differences between the CERP and CEPP features are illustrated in **Appendix B** (CERP and CEPP Comparison). A descriptive comparison is provided below.

EAA Reservoir (CERP Component G): The CERP EAA storage reservoir improves timing of environmental deliveries to the WCAs including reducing damaging flood releases from the EAA to the WCAs; reduces Lake Okeechobee regulatory releases to estuaries; meets supplemental irrigation demands; and increases flood protection within the EAA.

The CERP proposed EAA Storage Reservoir –Phase I included two conceptual 20,000-acre (6-ft deep) compartments capable of storing up to 120,000 ac-ft each. Compartment I was to be used to meet EAA agricultural irrigation demands by storing excess EAA runoff. Compartment II was envisioned to capture both Lake Okeechobee regulatory releases and Compartment I overflow and served to supply environmental water deliveries to the WCAs. CEPP proposes to implement a portion of the Compartment 2 functions identified in the initially authorized CERP project. CEPP proposes to implement this component by constructing an approximately 14,000-acre FEB on the A-2 footprint with a maximum storage depth of 4 ft, which would provide approximately 60,000 ac-ft of storage by capturing Lake Okeechobee regulatory releases. Operated in conjunction with the State Restoration Strategies' FEB on the A-1 footprint, an additional 210,000 acre-feet of water will be delivered to WCA 3A on an average annual basis.

The recommended plan A-2 FEB does not preclude future increments of CERP planning for additional storage in the EAA to provide additional water supply deliveries for either agricultural irrigation or environmental water deliveries. For example, the A-2 FEB could be converted to an STA or deeper reservoir and STA that works in conjunction with the State's existing STA system to accommodate any

future upstream storage to further increase water deliveries to the WCAs, and/or the CERP EAA – Phase I Component I storage functions could be implemented. CEPP is not seeking the deauthorization of the CERP EAA Reservoir Phase – I, recognizing that improvements in water supply for the LOSA will need to be considered in future increments of CERP that provide additional storage for capturing water currently being sent to tide from Lake Okeechobee or capturing water from other sources. Future CERP increments that provide this additional storage will increase water made available in the regional system for other water related needs.

Flow to Northwest and Central WCA 3A (CERP Component II): CERP proposed to increase the capacity of the pump station G-404 (from 1000 cfs to 2000 cfs) to improve the hydropattern restoration in the northwest corner of WCA 3A and increase the amount of water available in the west-central region of WCA 3A to reduce dry out periods. Modifications to the L-4 and L-5 borrow canals and the S-8 pump station were included conceptually as considerations for CERP but not explicitly included in the CERP estimated costs.

CEPP recommends modification to the S-8 pump station complex (potentially including the G-404 pump station, pending further analysis during PED) and degrading of 2.9 miles of the L-4 Levee needed to restore sheetflow and hydropattern restoration of the northwest corner of WCA 3A. CEPP also includes the modifications to the L-4 and L-5 borrow canals to increase conveyance capacity that CERP anticipated may be needed.

CEPP recommended features do not preclude future increments of CERP plan for improved hydropatterns in northwest WCA 3A or increased flows to reduce dryout in west-central WCA 3A.

Decompartmentalization of WCA 3 (CERP Components AA, QQ): CERP component AA provided additional conveyance (3000 cfs) between WCA 3A and WCA 3B (expanding on the assumed 1500 cfs conveyance capacity proposed with the original MWD project) to help in re-establishing pre-drainage hydroperiods and hydropatterns in WCA 3B and the ENP NESRS. Component QQ expanded on these concepts to remove most flow obstructions to achieve unconstrained or passive flow between WCA-3A and WCA 3B (8 passive weirs) and between WCA 3B and NESRS (remove L-29 Canal and Levee) and reestablish the ecologic and hydrologic connection between these areas.

CEPP recommends implementing a portion of these CERP components as outlined below:

- implement 3 of the 6 gated culverts in L-67A which were proposed in CERP (1500 cfs)
- backfill 13.5 miles of the approximately 35 miles of backfilling Miami canal proposed in CERP
- degrade 8 miles of the approximately 24 miles of L-67C levee removal proposed in CERP
- degrade 4.3 miles of the approximately 20 miles of L-29 Levee removal proposed in CERP

CEPP does not preclude implementation of future increments of CERP such as additional backfilling of Miami Canal, additional conveyance features in L-67A or L-67C, and L-68A or additional L-29 Levee removal.

Construction of S-356 A & B Structures (CERP Component FF): CERP proposed the removal of S-356 pump station, relocation of S-357 pump station, addition of two 900 cfs pump stations, a reroute of L-31N borrow canal, relocation of L-31N levee and backfill L-31N canal to improve deliveries to NESRS in ENP and reduce seepage to LECSA 3.

CEPP recommends removal of the existing S-356 pump station and construction of one 1000 cfs S-356 pump station to capture seepage from WCA 3 and deliver to NESRS. CEPP does not require the rerouting of L-31N borrow canal or relocation of L-31N levee, relocation of the S-357 pump station or backfilling of L-31N canal, and does not preclude implementation of these features in future increments.

L-31N Levee Seepage Management (CERP Component V): CERP proposed seepage management along the eastern edge (L-31N) of ENP to eliminate losses due to levee seepage to the East Coast and restore hydropatterns in ENP. It was contemplated that these features would be complimented by the Bird Drive Basin Recharge Area Reservoir (BDRA; CERP Component U) and Dade Broward Levee Improvements (DBL; CERP Component BB) to form the larger Everglades National Park Seepage Management Project (ENPSM).

CERP realized that more detailed planning, design and pilot studies would be conducted to determine the appropriate technology to control seepage from ENP. CERP proposed a Seepage Barrier (Cutoff Wall), a distributed system of groundwater wells and an L-31N (Pilot) project. The seepage management pilot consisted of an approximately 1.7 mile long barrier wall located between S-334 and S-335 with groundwater wells. Since CERP authorization, this pilot project was designed and costs were prepared, but the Pilot Project has not been implemented. Planning efforts on the BDRA component raised concern about the high porosity and transmissiveness of the aquifer, ability of the retention area to hold water onsite for deliveries to the SDCS, and the resulting potential for flooding impacts to urban areas east of the project site. The BDRA design and operation may not be feasible as contemplated in CERP.

CEPP recommends to implement an approximately 4 mile partial depth seepage barrier along the L-31N levee similar to the CERP proposed a cutoff wall. CEPP's wall will meet the intent of reducing seepage losses and restoring hydropatterns in ENP. There are remaining uncertainties about the effectiveness of the recommended plan seepage cutoff wall in maintaining desired stages in marshes of ENP while maintaining flood protection and canal stages to the east without limiting water availability to water users and Biscayne Bay. Therefore, additional analysis of the CEPP seepage cutoff wall will be conducted as an early phase in PED.

The CEPP recommended seepage barrier wall does not preclude future increments of the CERP plan for seepage management along eastern edge of ENP or Pennsuco Wetlands, additional restoration of hydroperiods in ENP, enhancement of hydroperiods in Pennsuco Wetlands, or any other CERP seepage management components.

Everglades Rain Driven Operations (CERP Component H): The CERP rain-driven operational concept is a basic shift from the current operational practice, which uses calendar-based regulation schedule for the WCAS. The rain-driven operational concept includes rules for importing and exporting water in order to mimic a desired target at key locations throughout the Everglades system. The target stages are based upon an estimate of the more natural water level response to rainfall.

CERP proposed operations that covered WCA 2, WCA 3 and ENP. Modifications to the regulation schedules for WCAs 2A, 2B, 3A, 3B and the current Rainfall Delivery Formula for ENP were proposed with CERP to implement rain-driven operations for all of these areas. These new operational rules were intended to improve timing and location of water depths in the WCAs and ENP and to restore more natural hydropatterns. Regulation schedules, also referred to as flood-control schedules, typically specify the release rules for a WCA based on the water level at one or more key gages. Regulation

schedules do not typically contain rules for importing water from an upstream source. The schedules also repeat every year and make no allowance for inter-annual variability. The rain driven operational concept includes rules for importing and exporting water from the Water Conservation Areas in order to mimic a desired target stage hydrograph at key locations within the Everglades system. The target stage hydrographs mimic an estimate of the more natural (pre-drainage Everglades) water level response to rainfall.

CEPP recommends to implement an Everglades Rain Driven Operations schedule for WCA 3. WCA 3A outflows are currently operated in accordance with the 2012 WCAs, ENP, ENP-South Dade Conveyance System Water Control Plan. More specifically, WCA 3A outflows adhere to the Rainfall Plan for ENP (Rainfall Plan). Under CEPP, the Rainfall Plan would be revised but still be comprised of two distinct components: (1) a regulatory component operated in accordance with the 2012 WCA 3A Interim Regulation Schedule, and (2) an environmental rainfall component that consists of Rainfall Driven Operations (RDO). The RDO is currently conceptual in nature and variables such as the target stages have not yet been developed.

The CEPP WCA 3A RDO would employ a mechanism that resists the stage going into Zone A of the WCA 3A Interim Regulation Schedule. As part of a system-wide optimization, the WCA 3A RDO would be constrained with the amount and timing of inflows upstream, and the restoration targets and constraints in WCA 3B and the ENP (these have not yet been developed for WCA 3B or ENP). It is recognized that transitioning to RDO would likely be a lengthy and complex process for the USACE, but a necessary step to achieve the proposed restoration objectives within WCA 3A and ENP.

CEPP RDO does not preclude future increments of CERP RDO.

The CERP and CEPP comparison has been completed in compliance with the CERP Programmatic Regulations. The recommended plan does preclude any future components of CERP from authorization or implementation.

6.10 RISK AND UNCERTAINTY

Issues of risk and uncertainty are inherent in the planning, design and implementation of the recommended plan. An overview of feasibility, forecasting, and implementation issues is presented in this section. The role of CEPP's adaptive management strategies in addressing risk and uncertainty is discussed in the following sections and can be reviewed in more detail in the CEPP AM Plan (**Annex D, Part 1**). Monitoring and adaptive management strategies will continue to evaluate and address issues pertaining to construction sequencing, ecosystem connectivity, and potential for early restoration benefits. Such evaluations will continue to reduce uncertainties and increase the likelihood for overall project success.

6.10.1 Planning

Two primary areas of focus for this risk and uncertainty evaluation are simulation model confidence and project performance. This analysis addresses the reliability and accuracy of the assumptions and tools used to forecast with- and without-project conditions.

6.10.1.1 Hydrologic Simulation Tools

The RSM-GL and RSM-BN regional models and the Dynamic Model for Stormwater Treatment Areas (DMSTA) were approved for use through the current USACE Engineering software validation process. The validation reviews were conducted by qualified senior USACE engineers with support from technical

experts, and USACE approval indicates that that software is technically/theoretically sound and approved for use by knowledgeable and trained staff for purposes consistent with the software's purposes and limitations. These modeling tools were used to evaluate the effects of the final array of alternatives.
Model building/generic software tools (STELLA, Excel, etc.) are generally allowed for use under the validation process, but these tools are not pre-validated and additional USACE Agency Technical Review (ATR) of the inner workings of the model is required. ATR is conducted by a qualified senior team from a separate USACE District than involved in the project. All other CEPP modeling tools, which were applied during preliminary screening efforts, were approved for use in CEPP through the ATR process.

The CEPP modeling strategy identified these tools as the best models available for assessment of the hydrologic and water quality effects of CEPP within the Everglades system. Additional information on the USACE model review process and the CEPP modeling strategy is provided in **Appendix A**.

6.10.1.2 Uncertainty of Project Benefits

6.10.1.2.1 Predicting Ecosystem Response to Hydrologic Change

There is no standardized methodology for predicting ecosystem benefits that result from habitat restoration projects. For the USACE planning process, the most apparent adverse risks of employing a given benefit estimation methodology are: 1) the most effective project alternative is not selected for implementation, 2) the selected project provides significantly fewer benefits than estimated, or 3) the selected project significantly harms the resource. An uncertainty analysis is typically used to reduce the likelihood of the adverse outcomes listed above. The CEPP team has reviewed the CEPP planning model to document qualitatively and, where possible, quantitatively assessments of how well the CEPP planning model represents the anticipated ecosystem benefits of the alternatives. This was conducted to ensure that decision-makers are informed about uncertainties that affect interpretation of planning model outputs.

For CEPP, the two most apparent sources of uncertainty in the overall benefits quantification arise from the use of regional hydrologic models for the prediction of changes in hydrology and the use of performance measures to represent the ecological significance of the predicted change in hydrologic conditions. The CEPP Planning Model underwent peer review per EC 1105-2-412, 31 May 2011, (Assuring Quality of Planning Models) and was recommended for single-use by the National Ecosystem Restoration Planning Center of Expertise (ECO-PCX) on July 24, 2013. The HQUSACE Model Certification Panel approved the CEPP Planning Model on August 13, 2013. During review of the application of the model a recommendation was received to develop a possible range of potential outcomes (i.e. Habitat Units) and associated frequencies of producing those outcomes to establish confidence limits. Development of confidence limits was not included in the CEPP planning model. Additional analyses were conducted to specifically evaluate how error in the hydrologic model could reflect alternative results' reliability. Inclusion of these additional analyses in **Appendix G** did not influence the overall rank of alternative performance, indicating that the developed methodology is robust. Additional analyses documenting the capabilities and limitations of the CEPP planning model can be found in **Appendix G**.

6.10.1.2.2 Lake Okeechobee Regulation Schedule

CEPP benefits gained from sending new water south from Lake Okeechobee are derived in part from operational refinements that can take place within the existing, inherent flexibility of the 2008 LORS,

and in part with refinements that are beyond the schedule's current flexibility. The CEPP modeling effort provided reasonable and likely implementable future operating conditions under CEPP that can be translated to an implementable regulation schedule. Since USACE has authority to do a study to revise LORS when needed and implement it after compliance with NEPA and other rules and regulations, there is a high likelihood that the LORS will be modified so that benefits of CEPP PPA New Water will be achieved. Approximately 60% of the overall CEPP benefits are attributed to sending new water south from Lake Okeechobee, based on the implementation analysis in **Section 6.7.1**. In the absence of operational refinements to Lake Okeechobee, such a drastic reduction in benefits would not be likely since it is expected that most of these benefits can be achieved under the inherent flexibility of the 2008 LORS schedule.

At the start of the CEPP plan formulation process, the FWO project condition adopted the 2008 LORS as a reasonable assumption since it would be speculation to change the operations plan based on future actions occurring independent of CEPP (e.g. HHD rehabilitation or CERP Band 1 project construction. See **Section 6.1.1**. The USACE had also determined during CEPP scoping that the expedited CEPP planning process and PIR would not be the mechanism to propose or conduct the required NEPA evaluation of modifications to the LORS. Due to these actions occurring independent of CEPP, even if a NEPA evaluation and modifications to the LORS occurred with this CEPP PIR, the actual LORS at the time of PPA New Water implementation might differ from the regulation schedule used in the NEPA analysis. Depending on the ultimate outcome of these future LORS revisions, including the level of inherent operational flexibility provided with these revisions, CEPP implementation may still require further LORS revisions prior to CEPP PPA New Water implementation. However, NEPA analysis will not be required if future LORS revisions prior to CEPP incorporate the additional flexibility needed for CEPP.

The implementation plan approach of using multiple PPAs led to the identification of separable elements for implementation. These PPAs include the construction of logical groupings of plan elements that maximize benefits to the extent practicable consistent with project dependencies. These groupings include a PPA of project features in northern WCA 3A (PPA North), a PPA of project features in southern WCA 3A, 3B and ENP (PPA South), and a final PPA which provides the new water and required seepage management that benefits the entirety of the study area (PPA New Water). PPA North and South are both justified as stand-alone elements, but PPA New Water requires the implementation of both PPA North and PPA South prior to operation of the PPA New Water components. PPA New Water is the only PPA that will require revisions to the LORS. Since NEPA analysis and Savings Clause analysis will be revisited and updated, if necessary, prior to construction of PPA New Water components (refer to **Section 6.7.1.8**), there is little risk for expending PPA New Water funds without realizing benefits. Consequently, in the unlikely event that LORS revisions as described in CEPP are untenable, either a modified regulation schedule will be proposed that provides the projected outcome of CEPP prior to the execution of PPA New Water, or PPA New Water would not be executed and neither the costs nor benefits from this PPA would be realized. However, depending on the ultimate outcome of these future LORS revisions, including the level of inherent operational flexibility provided with these revisions, CEPP implementation may still require further LORS revisions to optimize system-wide performance and ensure compliance with Savings Clause requirements.

6.10.1.3 Sea Level Change

The effects of sea level change were analyzed per (EC 1165-2-212). This analysis looked at the effect of sea level change on the benefits predicted for the recommended plan. See **Annex I** for detailed analysis. The results indicate that within a 50-year period the average annual net project benefits are likely to be reduced by less than 8 percent in comparison to the projected net annual average project benefits

estimated assuming no sea level rise. This relatively moderate decrease in average annual project benefits occurs largely because of closely matching habitat losses under the FWO condition. However, when considering total freshwater wetland habitat, sea level rise will significantly reduce this habitat area. For instance, under the high rate sea level change scenario, total project area habitat function will be reduced by 8, 21, and 37 percent at the 20, 50, and 100-year timelines, respectively. The total habitat function is significantly higher with CEPP in place under any SLR scenario and timeframe when compared to the FWO condition. The ability of the CEPP project to provide significantly higher habitat functionality when compared to the FWO is partly a function of the increase in freshwater that reduce the loss of freshwater habitat within ENP. The most significant uncertainties associated with the sea level change impact projections provided here are: 1) the lag time between when freshwater wetlands become significantly impaired due to salinity impacts and when replacement estuarine habitat becomes fully productive, and 2) the degree to which project related water reservations will protect natural system water supplies given SLR related demand from the developed areas.

6.10.2 Design and Implementation

The feasibility assessment includes evaluations of design and construction issues, such as project scheduling, technology, construction cost estimate contingencies, land availability, and hazardous or toxic waste. AM is included in the CEPP implementation schedule to reduce uncertainties during implementation using on-the-ground data.

6.10.2.1 L-31N Seepage Barrier Demonstration Project

A seepage barrier from Tamiami Trail southward approximately 4.2 miles along the L-31N Levee is critical for balancing ecological performance, including in ENP and Biscayne Bay, and water supply and flood control performance of the recommended plan. There is an existing 2-mile wall in the same vicinity that was constructed by the Miami-Dade Limestone Products Association (Association) in July 2012 as mitigation to offset authorized impacts under a CWA Section 404 permit (**Figure 6-24**). If the 2-mile wall is effective, the Association may extend the seepage wall to the south up to an additional 5 miles, if approved by the Lake Belt Mitigation Committee. Since the capability and effectiveness of the existing seepage wall to mitigate seepage losses from ENP remains under analysis, the recommended plan conservatively includes a seepage wall of the length and depth necessary for CEPP project seepage management requirements, in the event CEPP construction is necessary.

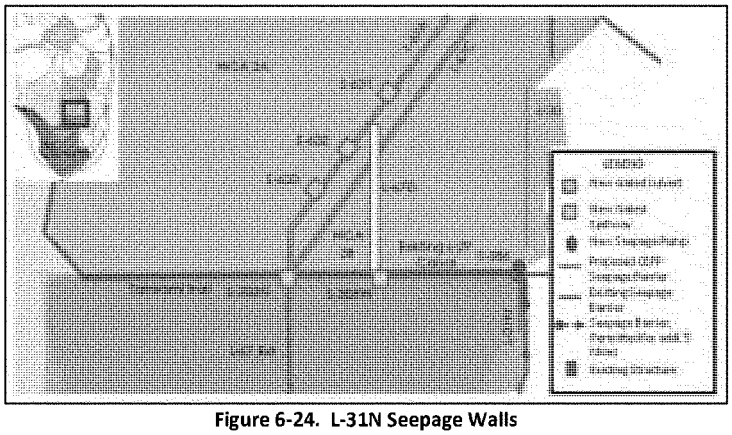


Figure 6-24. L-31N Seepage Walls

There are remaining uncertainties about the effectiveness of the recommended plan seepage wall in maintaining desired stages in marshes of ENP while maintaining flood protection and canal stages to the east without limiting water availability to water users and Biscayne Bay. Therefore, additional analysis of the CEPP seepage wall will be conducted as an early phase in PED. See **Section 6.10.1.2**, the Engineering Appendix (**Appendix A**), the analyses required by WRDA 2000 (**Annex B**), and the CEPP Adaptive Management Plan (**Annex D Part 1**) for more detail about the remaining uncertainties and suggested analysis to be completed to determine the need for and extent of a CEPP seepage barrier wall. The CEPP AM Plan contains provisions for a pre-PED assessment of existing data, which should include the Association's seepage wall monitoring results, U.S. Geological Survey (USGS) hydrologic data, and other relevant information, to determine if a CEPP seepage wall is still needed in this area given the presence of the Associations' wall and changes that may occur in the future before CEPP is implemented (**Annex D, Uncertainty ID#35**). In addition, there will be an assessment of whether the existing seepage barriers have unintentionally directed seepage flow north to the 'triangle area' where CEPP is not currently planning to construct a seepage barrier. If this pre-PED assessment concludes that CEPP's seepage barrier would be needed, then further assessment will take place as part of PED to determine the length and extent of the barrier. Additionally, the CEPP AM Plan strategy on this topic includes monitoring to check performance and inform future decision-making regarding seepage management in the area as needed.

Additionally, during PED, a technical evaluation of the existing seepage barrier wall will be conducted to determine its capability and acceptability to meet the CEPP project requirements. Although CEPP proposes a similar feature, CEPP would not construct a new feature if the existing wall achieves CEPP project requirements. The existing wall is currently the Association's responsibility. If the existing wall, located on SFWMD property, and constructed in a C&SF Project feature, is necessary for CEPP implementation, it would have to become a project feature. The Association would thereafter be relieved of responsibility for the wall and operation, maintenance, repair, rehabilitation, and replacement will become a sponsor responsibility associated with the Federal project. The Association will continue to receive mitigation credit for the constructed portions of the wall pursuant to the Lake Belt Mitigation Plan.

If it is determined that the existing wall does not meet CEPP project requirements, then CEPP will have two options in order to proceed. The project can either retrofit the wall to bring it up to USACE standards and make the wall a project feature or construct a new wall as proposed in the recommended plan at a separate location within the same vicinity. The CEPP seepage wall will not adversely impact compensatory mitigation but will enhance and provide additional environmental benefits to ENP. CEPP would proceed to cost share with the local sponsor on both the construction and OMRR&R of the CEPP wall. CEPP will benefit from continued analysis of the monitoring data collected for the existing seepage wall through gained knowledge of how the barrier affects hydroperiod in the ENP and effects on seepage along the project footprint. Additionally, to the extent it functions properly and addresses CEPP requirements, CEPP may save costs by not constructing a duplicate feature or possibly retrofit the existing wall to bring it up to the standard of the USACE, if feasible. The extent to which additional seepage management features will be constructed along L-31N as part of CEPP will be determined during the PED phase.

6.10.2.2 Blue Shanty Levee

The initial location for the Blue Shanty Levee (L-67D) was aligned along the existing Blue Shanty canal since that area is an existing alteration in the landscape. The northern end of the proposed levee was

angled slightly westward to avoid impacting several large tree islands that exist north of the terminus of the Blue Shanty Canal. Although the initial location of the new levee generally along the Blue Shanty Canal minimized impacts to unexcavated wetlands, it created other concerns: 1) it was directly in the center of the western 2.6 mile Tamiami Trail Next Steps bridge and would fail to fully take advantage of the new bridge span opening, and 2) excluding the tree islands would result in a levee alignment that intercepts the desired southerly flow path dictated by landscape patterning in the area. Shifting the levee to include the tree islands within the flowway would provide an opportunity to utilize an adaptive management approach to address the uncertainties regarding restoration of water flows and levels throughout WCA 3B and maximize the benefits of the downstream bridge span opening.

The proposed alignment (**Figure 6-25**) was identified that shifts the southern terminus of the levee to the east to align with the eastern end of the bridge span opening, includes the tree islands within the 3B flowway and follows the landscape directionality to its northern most intersect the L-67A Levee. Inclusion of the tree islands within the 3B-W flow-way will provide restorative water depths, flow velocities, and flow directions, onto an area of degraded Ridge and Slough landscape.

The current proposed levee alignment spanning to the terminus of the 2.6 mile Tamiami Trail Next Steps bridge opening has concerns regarding impacts to undisturbed wetlands areas due to the length of the levee. The wetlands in the current location are in better condition than wetlands along the Blue Shanty canal. A levee in proximity of the Blue Shanty Canal would be approximately 6.25 miles long and would impact 85 acres while the proposed location would be approximately 8.5 miles long and impact 113 acres. The changes for the flow-way are: L-67D Current - 113 acres (8 miles long) versus the Blue Shanty - 85 acres (6.25 miles). Both were calculated using approximately 110 ft width for the construction corridor.

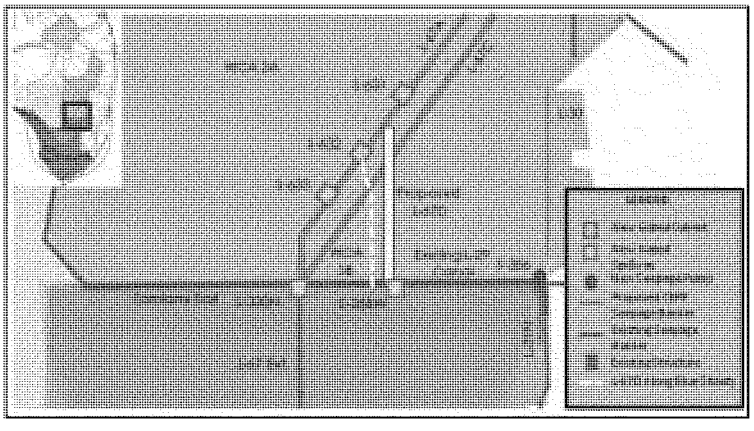


Figure 6-25. Location of Blue Shanty levee

The alignment and dimensions of the levee will be further investigated as the project progresses into the PED phase. Construction of CEPP structures in WCA 3B to create the flowway will be conducted in a step-wise fashion in order to test assumptions that all of the structures are needed. The number of structures may be reduced if the on-the-ground data shows that not all are needed; this includes a small

possibility that the Blue Shanty flowway could be created without constructing the Blue Shanty Levee (**Annex D, Uncertainty #77**).

6.10.2.3 Project Schedules

Implementation of CEPP will occur over many years and include many actions by USACE and SFWMD. There is extensive uncertainty regarding when construction will commence and complete; influenced by funding, legal requirements, permitting, and authorization among other factors. In order to manage expectations and uncertainties regarding the project schedule, the recommended plan is composed of implementation phases that include the construction of logical groupings of recommended plan features, agreed upon by the USACE and SFWMD.

6.10.2.4 Construction Cost Estimate Contingencies

A statistical analysis of cost risk was performed in **Appendix B**.

6.10.2.5 Land Availability and Acquisition Issues

Most land required for the project was previously acquired under the C&SF Project. Most of the new lands required for the project, but not already included in the C&SF project are already owned by the SFWMD – the 14,521 acre A-2 site in the EAA. An additional 146 acres owned by the State of Florida and SFWMD is needed for a canal to connect the Miami Canal to the A-2 site.

Uncertainties surrounding land acquisition include keeping on schedule to complete acquisition of estates in order to meet construction schedules; the potential for any unknown utility relocations not identified during the study; the potential presence of minerals and mineral rights on lands to be acquired; the potential for hazardous, radioactive, or toxic materials on the lands to be acquired.

6.10.2.6 Residual Agricultural Chemicals and Hazardous or Toxic Waste

The 14,521 acre A-2 site that is proposed for a FEB was surveyed for hazardous, toxic, and radioactive waste (HTRW) as well as residual agricultural chemicals in the cultivated soils. The FDEP and FWS reviewed the results of the environmental audits and risk assessments and concluded that the required remediation actions have been completed and that the detected residual agricultural chemicals in cultivated soils are present at concentrations that do not present a risk to humans or environmental receptors. Since the A-2 site is currently under cultivation, close out environmental audits and sampling will be performed again prior to certification of the lands. Consistent with the September 14, 2011 Memorandum from Jo-Ellen Darcy, ASA (CW), unless addressed as part of normal engineering and construction activities, SFWMD, the non-Federal sponsor, will be 100% responsible for the costs of all actions taken due to the presence of residual agricultural chemicals, at no expense to the Federal Government and any future costs associated with the presence of residual agricultural chemicals at the Federal project site are 100% a SFWMD cost and responsibility. As stated in the September 14, 2011 Memorandum, normal project engineering and construction activities will remain part of total project cost, provided that these are the same activities required to implement the project features absent the presence of residual agricultural chemicals. More specifically:

- SFWMD will ensure the development, planning and execution of Federal, State, and/or locally required response actions to address residual agricultural chemicals, including any soil management activities, at 100% SFWMD cost.
- SFWMD is 100% responsible for costs of characterization of the project lands necessary to determine an appropriate response action for the residual agricultural chemicals.
- Removal of soils that are RCRA hazardous waste are a 100% SFWMD responsibility.

- SFWMD is 100% responsible for the costs of characterizing the project lands in preparation for conducting a response action for removal of soils that are identified as hazardous waste.
- SFWMD will regularly update the District Commander regarding its progress in developing and ensuring execution of the required response actions.
- SFWMD agrees that any future costs associated with the presence of residual agricultural chemicals remaining on Federal project lands are 100% SFWMD responsibility, including any potential liability related to their presence. This includes future responsibility for any disposal units.
- SFWMD acknowledges that the Jacksonville District will not conduct actions to address residual agricultural chemicals during the operation, maintenance, repair, replacement and rehabilitation phase of the project.
- If the Corps determines in the future, based upon coordination with resource agencies, project soils containing residual agricultural chemicals would need to be removed or isolated, and SFWMD requests incorporation of impacted soils into project features or requests that the materials remain on site in a disposal unit, SFWMD will demonstrate compliance with the September 14, 2011 Memorandum from Jo-Ellen Darcy, ASA (CW), and the Corps will demonstrate compliance to HQUSACE prior to execution of the work.

A discussion of the CERP Residual Agricultural Chemical policy requirements as it applies to this project is in **Appendix C.2.2**. HTRW reports, sampling protocol, and correspondence are included in **Annex H**.

CENTRAL EVERGLADES PLANNING PROJECT (CEPP) RECOMMENDED PLAN – ALTERNATIVE 4R2

STORAGE AND TREATMENT

- Construct A-2 FEB and integrate with A-1 FEB operations
- Lake Okeechobee operation refinements

DISTRIBUTION/CONVEYANCE

- Diversion of L-6 flows, Infrastructure and L-5 canal improvements
- Remove western ~2.9 miles of L-4 levee west of S-8 (3,000 cfs capacity)
- Construct 360 cfs pump station at western terminus of L-4 levee removal
- Backfill Miami Canal and Spoil Mound Removal ~1.5 miles south of S-8 to I-75

DISTRIBUTION/CONVEYANCE

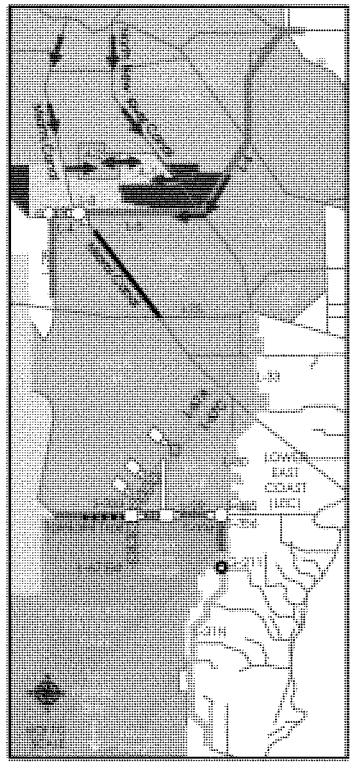
- Increase S-333 capacity to 2,500 cfs
- Two 500 cfs gated structures in L-67A, 0.5 mile spoil removal west of L-67A canal north and south of structures
- Construct ~8.5 mile Blue Shanty levee in WCA 3B, connecting L-67A to L-29
- Remove ~8 miles of L-67C levee in Blue Shanty flowway (no canal back fill)
- One 500 cfs gated structure north of Blue Shanty levee and 6,000-ft gap in L-67C levee
- Remove ~4.3 miles of L-29 levee in Blue Shanty flowway; construct gated spillway east of Blue Shanty levee at terminus of western bridge
- Tamiami Trail western 2.6 mile bridge and L-29 canal max stage at 9.7 ft NGVD 29 (FUTURE WORK BY OTHERS)
- Remove entire 5.5 miles L-67 Extension levee, backfill L-67 Extension canal
- Remove ~6 mile Old Tamiami Trail road (from L-67 Ext to Tram Rd)

SEEPAGE MANAGEMENT

- Increase S-356 pump station to ~1,000 cfs
- Partial depth seepage barrier south of Tamiami Trail (along L-31N)
- G-211 operational refinements; use coastal canals to convey seepage

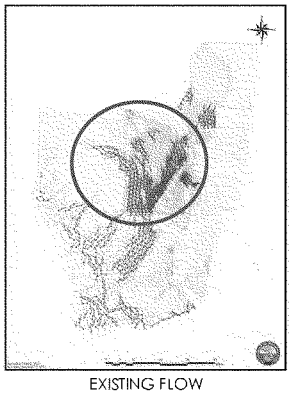
Note: System-wide operational changes and adaptive management considerations will be included in project.

FEB STA Pump Backfill Levee Removal Seepage Barrier

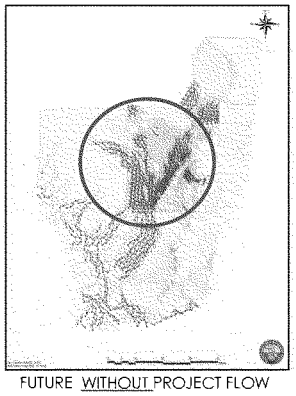


CENTRAL EVERGLADES PLANNING PROJECT EXISTING AND FUTURE FLOWS

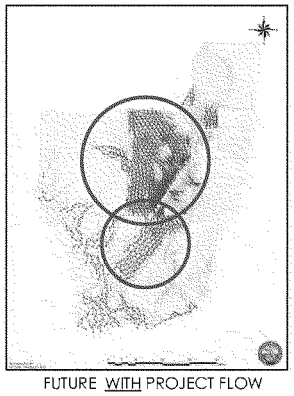
The graphics depict Average Annual Overland Flow across the period of record (1965-2005) as modeled by the CEPP regional hydrologic model. The coloration of the arrows represent the relative volume of flow, while the direction of the arrows represent the movement of flow across the landscape.



EXISTING FLOW



FUTURE WITHOUT PROJECT FLOW



FUTURE WITH PROJECT FLOW

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7.0 ENVIRONMENTAL COMPLIANCE

7.1 PUBLIC INVOLVEMENT

7.1.1 Scoping

A National Environmental Policy Act (NEPA) scoping letter dated November 23, 2011 was used to invite comments from Federal, State, and local agencies, affected Indian Tribes, and other interested private organizations and individuals. Scoping comments were accepted through January 20, 2012. A Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) for the Central Everglades Planning Project (CEPP) was published in the Federal Register (FR Volume 76, Number 232) December 2, 2011. Public scoping meetings were held December 14, 2011 in Plantation, Florida and December 15, 2011 in Clewiston, Florida. A copy of the scoping letter, NOI, scoping letters received and a comment response matrix are located in **Appendix C.3**. Five NEPA public workshops were also held: December 10, 2012 in Estero, Florida, December 11, 2012 in Homestead, Florida, December 12, 2012 in Clewiston, Florida, December 13, 2012 in Stuart, Florida and December 18, 2012 in Coconut Creek, Florida to present the preliminary final array of alternatives.

7.1.2 Agency Coordination and Public Involvement

Project Delivery Team (PDT) membership consists of those individuals designated by the U.S. Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD), the implementing agencies, and representatives designated by other governmental agencies or Tribes. Interagency participation is encouraged to take advantage of technical skills and knowledge of other agencies. Several Federal, Tribal and state agencies are active members of the PDT. Participants include United States Environmental Protection Agency (USEPA), Unites States Fish and Wildlife Service (USFWS), United States Geological Survey (USGS), National Park Service (NPS), Miccosukee Tribe of Indians of Florida, Seminole Tribe of Florida, Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Agriculture and Consumer Services and Florida Department of Environmental Protection (FDEP). Representatives from Okeechobee, Glades, Martin, Palm Beach, Broward, Miami-Dade, and Monroe Counties are also active participates. Designated public comment periods provide opportunities for public participation during PDT meetings.

Agencies including the Department of the Interior, National Park Service, U.S. Fish and Wildlife Service and South Florida Water Management District, the local sponsor, were asked at the beginning of the planning process to become cooperating agencies under NEPA for the Central Everglades Planning Project (CEPP). Due to the robust interagency process planned for this project, no agencies wished to enter into a cooperating agency agreement, however, these agencies were fully involved in all phases of the CEPP planning process.

Public outreach efforts for CEPP began early in the planning process. Due to intense public, political, and media interest in restoration of the south Florida ecosystem, public participation is a critical component of the development of this Project Implementation Report (PIR). Workshops were held at key phases of CEPP planning process during the formulation of project objectives, management measures, and evaluation of alternatives. **Table C.3.2-1** in **Appendix C.3** summarizes all the agency and public meetings.

The U.S. Department of the Interior (DOI) Office of Everglades Restoration Initiatives South Florida Ecosystem Restoration Task Force (Task Force) Working Group (WG) hosted a series of public workshops and provided input to USACE. Workshops have also been held by the Task Force's Science Coordination Group (SCG) and the Water Resources Advisory Commission (WRAC). Presentations have also been

provided to SFWMD Governing Board, the South Florida Ecosystem Restoration Task Force, and the South Florida Ecosystem Restoration Task Force Joint Working Group and Science Coordination Group, Water Resources Advisory Commission, Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP), Ten County Coalition, and Biscayne Bay Regional Restoration Coordination Team Meetings.

Table C.3.2-1 in **Appendix C.3** provides a list of interagency coordination and public presentations conducted throughout the planning process for CEPP. A summary of public participation as required by NEPA is described in **Section 7.1.1** above. In addition to NEPA, coordination with agencies as required by other Federal laws, statues, and Executive Orders has been conducted. See **Appendix C.3** for agency coordination with the FDEP, National Marine Fisheries Service (NMFS), State Historic Preservation Officer (SHPO), United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), and USFWS. Meetings were also held individually with representatives of the Miccosukee Tribe of Indians of Florida and the Seminole Tribe of Florida.

7.1.3 Draft Project Implementation Report and Environmental Impact Statement

The Notice of Availability (NOA) of the CEPP Draft PIR/EIS was published in the Federal Register (FR Volume 78, Number 169) August 30, 2013 and mailed to interested stakeholders to begin the 64 day review period. The Draft PIR/EIS was filed in accordance with ER-FRL-8994-7, Amended Environmental Impact Statement Filing System Guidance for Implementing 40 CFR 1506.9 and 1506.10 of the Council on Environmental Quality's Regulations Implementing the NEPA and made available for public and agency review. Five NEPA Draft PIR/EIS public meetings were held September 16, 2013 in Plantation, Florida, September 17, 2013 in Fort Myers, Florida, September 18, 2013 in West Palm Beach, Florida, September 19, 2013 in Stuart, Florida and September 25, 2013 in Homestead, Florida. A copy of the NOA is located in **Appendix C.3**.

7.1.4 Comments and Responses

A comment response matrix detailing comments received during the NEPA scoping process (**Table C.3-1.1**) and other public comments received during the planning process along with USACE responses are included within **Appendix C.3**. **Table C.3-2.2** provides a summary of specific concerns raised by stakeholders throughout the planning process through emails to the Task Force. Videos of each of the Task Force WG sponsored workshops are posted on and the dialogue with the public can be viewed: http://www.sfrestore.org/cepp/cepp.html.

The Draft PIR/EIS presented the tentatively selected plan. The Draft PIR/EIS was circulated for a 64 day review period to agencies, organizations, and other interested stakeholders. Comments received during the review period were taken into consideration in determination of the recommended plan presented in the Final PIR/EIS. Comment response matrices detailing comments received on the Draft PIR/EIS by formal letter and email are included in **Tables C.3.3-2** and **C.3.3-3**, respectively. Comment response matrices detailing comments made during the public meetings held in September of 2013 (see **Section 7.1.3**) are included in **Table C.3.3-4**.

7.1.5 Statement Recipients

Copies of the November 23, 2011 scoping letter and NOA of the Draft PIR/EIS and this document were mailed to the parties listed in **Table C.3.3-1** in **Appendix C.3**. Recipients included Federal, State, and local agencies, affected Indian Tribes, and other interested private organizations and individuals. A complete mailing list is available upon request. A copy of the Draft PIR/EIS and this document was

posted on evergladesplan.org and also on the USACE Jacksonville District website at the following address:

http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

http://www.saj.usace.army.mil/About/DivisionsOffices/Planning/EnvironmentalBranch.aspx

7.2 COMPLIANCE WITH ENVIRONMENTAL LAWS, STATUTES AND EXECUTIVE ORDERS

The following table summarizes required compliance with specific Federal acts, Executive Orders (E.O.) and other applicable environmental laws. **Table 7-1** provides a summary of environmental compliance with each act, E.O. or applicable law. Detailed descriptions indicating the coordination completed to date and the status of any ongoing or compliance issues are located in **Appendix C.4**.

Table 7-1: Compliance with Environmental Laws, Regulations, and Executive Orders: Recommended Plan.

Law, Policy and Regulations	Status	Comments
Anadromous Fish Conservation Act	In compliance with this Act.	Proposed action would not adversely affect anadromous fish species.
Archaeological Resources Protection Act of 1979	CEPP is in compliance with this act and will continue to comply throughout construction and operation.	Further investigations may be needed within Federally owned lands (Everglades National Park [ENP]) once the project is authorized and the Preconstruction, Engineering and Design (PED) has started.
American Indian Religious Freedom Act	In compliance with this Act.	The policy of the U.S. is to protect and preserve for American Indians, Alaska Native Groups and Native Hawaiians, their inherent rights of Freedom to believe, express, and exercise traditional religions. These rights include, but are not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremony and traditional rites.
Bald and Golden Eagle Protection Act	In compliance with this Act.	Proposed action would not adversely affect the Bald eagle. No permits for takes are required.
Clean Air Act of 1972	In compliance with this Act, will obtain any required permits.	Potential for permanent sources of air emissions. Air emissions permit may be required for large diesel pumps.
Clean Water Act of 1972	In compliance with this Act and will obtain Water Quality Certification (WQC) from the State of Florida and any required National Pollutant Discharge Elimination System (NPDES) permits and will update 404(b) analysis prior to construction.	In accordance with the Clean Water Act, a Section 404(B)(1) Evaluation has been completed and is contained within **Appendix C.4, Section C.4.32.** Comprehensive Everglades Restoration Plan Regulation Act (CERPRA) permit would be sought from State of Florida for Water Quality Certification.
Coastal Barrier Resources Act and Coastal Barrier Improvement Act of 1990	The official Coastal Barrier Resources System (CBRS) maps were reviewed and the CEPP project does not fall into any designated CBRS areas. These Acts are not applicable to this project.	There are no designated coastal barrier resources in the project area that would be affected by this project.
Coastal Zone Management Act of 1972	In compliance with this Act and obtaining concurrence by the State of Florida. The Corps will be in compliance with the Coastal Zone Management Act at the time of construction.	Florida Coastal Zone Consistency Determination has been prepared in accordance with the provisions of 15 CFR 930 and is located in **Appendix C.4, Section C.4.32.** The USACE has determined that the proposed action is consistent to the maximum extent practicable with the enforceable policies of Florida's approved Coastal Zone management program. In a letter dated October, 11 2013, the State determined that the USACE's Draft PIR/EIS for CEPP is consistent with the Florida Coastal Management Program (FCMP). To ensure the project's continued consistency with the FCMP, the concerns identified by the reviewing agencies must be addressed prior o project

Law, Policy and Regulations	Status	Comments
		implementation. The State's continued concurrence will be based on the activities' compliance with FCMP authorities, including Federal and State monitoring of the activities to ensure their continued conformance, and the adequate resolution of issues identified during this and subsequent regulatory review.
Endangered Species Act of 1973	In compliance with this Act and ongoing consultation throughout the PED and construction phase as appropriate.	Formal consultation initiated with USFWS on August 5, 2013 with completion of Biological Assessment. The Corps received a Request for Additional Information (RAI) from USFWS on September 4, 2013. The Corps provided a Supplemental Technical Analysis in Response to USFWS' RAI for CEPP on October 24, 2013. On December 13, 2013 the Corps changed its request from formal to early consultation. The Corps entered formal consultation with USFWS on the Everglade snail kite (*Rostrhamus sociablis plumbeus*), and its designated critical habitat, Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*), (CSSS) and its designated critical habitat, wood stork (*Mycteria americana*) and eastern indigo snake (*Drymarchon corais couperi*). A Programmatic Biological Opinion (BO) was received on April 9, 2014, which clearly states that further consultation will be needed when more specific project details are finalized during PED. While this document does not provide provisions for incidental take of three endangered avian species (CSSS, snail kite, and wood stork), it does describe the anticipated effects based on current information. Upon completing ESA Section 7 consultation for each PPA, USACE will undertake the agreed-to avoidance and minimization measures and implement any required terms and conditions (TCs). When USACE is closer to constructing portions of CEPP that will affect listed species, FWS will provide separate consultation document(s) which may authorize incidental take, and provide applicable reasonable and prudent measures (RPMs) and TCs. The preliminary conclusion is that the proposed project is not likely to jeopardize the continued existence of the species listed above and is not likely to adversely modify critical habitat, where designated. The Programmatic Biological Opinion concurred with the Corps' determination of may affect, but is not likely to adversely affect the Florida panther (*Puma concolor coryi*), West Indian manatee (*Trichechus manatus*), and its critical habitat, American crocodile (*Crocodylus acutus*) and its critical habitat, deltoid spurge (*Chamaesyce deltoidea* ssp. *deltoidea*), Garber's spurge (*Chamaesyce garberii*), Small's milkpea (*Galactia smallii*), and tiny polygala (*Polygala*

Law, Policy and Regulations	Status	Comments
		smallii). Furthermore, the Service concurred with all the "No Effect" determinations made by the Corps in regard to the applicable threatened or endangered species that are found in the action area. Incidental take was not provided for the Everglade snail kite, the CSSS and the wood stork, however take is anticipated on these three species. Take will be enumerated when a final biological opinion is required for each phase of CEPP implementation. Incidental take of eastern indigo snake is likely during construction and operation, particularly construction of the A-2 FEB and the Miami Canal backfill. The amount of take includes 14,000 acres of the FEB currently in sugar cane and row crops that will become inundated and mostly unusable to indigo snakes. Up to 268 snakes could be harassed through being displaced as a result of the CEPP and up to two indigo snakes may be injured or killed (harmed). Although the Programmatic Biological Opinion does not specify RPMs and TCs for the three avian species, endangered species monitoring costs include a conservative estimate of potential required monitoring based on information provided by USFWS to ensure the costs were captured. Estimated endangered species monitoring costs are $3,111,200 pre construction, $35,122,200 during the construction period and the O&M cost will be approximately $1,885,200 annually. A programmatic Endangered Species Act Section 7 consultation for the Comprehensive Everglades Restoration Plan (CERP) was prepared on March 15, 2013 to evaluate potential effects of CERP on listed species and designated critical habitat under the NMFS' purview. The Corps provided a Programmatic Biological Assessment for the Comprehensive Everglades Restoration Plan to NMFS on 2 July 2013. NMFS provided a Programmatic Biological Opinion for the Comprehensive Everglades Restoration Plan to the Corps on 17 December 2013 that includes CEPP.
Estuary Protection Act of 1968	In compliance with this Act.	The objectives of the proposed action are focused on environmental protection. The proposed action provides increased opportunities to redirect water that is currently discharged to the Caloosahatchee and St. Lucie Estuaries at undesirable times or in undesirable quantities for flood control purposes, allowing for the re-establishment of oyster and sea grass populations that are important for providing water quality and habitat functions within the northern estuaries. The proposed project would

Law, Policy and Regulations	Status	Comments
		increase flows from southern ENP to Florida Bay and result in favorable changes to salinity levels to improve conditions for key species such as seagrasses, sea trout, pink shrimp, and crocodiles
Federal Water Project Recreation Act/Land and Water Conservation Fund Act	In compliance with this Act.	Effects of proposed action on outdoor recreation have been considered in **Section 5.2.15.3** and **Appendix C.2.15**. Proposed action would not adversely affect existing recreational opportunities. Recreational opportunities have been considered.
Fish and Wildlife Coordination Act of 1958, as amended.	In compliance with this Act.	Proposed action has been coordinated with USFWS. Planning Aid Letters were received. USFWS active participation on the CEPP team has provided information on fish and wildlife elements on project. The Final Fish and Wildlife Coordination Act (FWCA) Report was received on December 17, 2013 and is included in Annex A. The Corps' responses to the FWCA Report recommendations are in Annex A.3.
Farmland Protection Policy Act of 1981	The Corps is in compliance and will be in full compliance with the Act at the time of construction.	Coordination with USDA/NRCS to meet the requirements of the Farmland Protection Act is ongoing. Coordination with NRCS was done during the planning phase and NRCS concluded that they would defer to PED due to the large footprint of the project action area and the relatively smaller construction footprint in order to more accurately determine level of acres affected. When detailed design information that locates each of the plan components is completed, it can then be determined how many acres of unique farmland would be affected by the Project. Refer to **Appendix C.4** for more information.
Magnuson-Stevens Fishery Conservation and Management Act	In compliance with this Act.	An Essential Fish Habitat (EFH) assessment has been prepared and coordinated with the NMFS on February 20, 2013. After review of the Draft PIR/EIS in September of 2013, NMFS determined the EFH provisions of the document were sufficient and that additional comments or EFH conservation recommendations were not needed.
Marine Mammal Protection Act of 1972	The Corps is in compliance and will be in full compliance with the Act at the time of construction.	Project sites are accessible to West Indian Manatees. Incorporation of safeguards to protect threatened and endangered species during construction would protect marine mammals in the area. No take is anticipated.
Marine Protection, Research and Sanctuaries Act	This Act is not applicable.	Term "dumping" as defined in the Act does not apply to this project. Proposed action does not consider ocean disposal of dredged material.
National Environmental Policy Act of 1969	The Corps is complying with the NEPA process and will be in full compliance with	Initial public coordination for this project began with the distribution of a scoping letter dated November 23, 2011 announcing the preparation of the

Law, Policy and Regulations	Status	Comments
	the Act at the time of construction. The Corps will update NEPA documentation as appropriate.	Draft EIS and inviting public and agency comment (**Appendix C.3**). On December 2, 2011 a NOI to prepare an EIS was published in the Federal Register (FR Volume 76, Number 232). Public scoping meetings were held on December 14 and 15, 2011. Public Meetings on the final array of alternatives were held on December 10, 11, 12, 13 and 18 2012. The NOA of the CEPP Draft PIR/EIS was published in the Federal Register (FR Volume 78, Number 169) August 30, 2013 and mailed to interested stakeholders to begin the 64 day review period. Five NEPA Draft PIR/EIS public meetings were held on September 16, 17, 18, 19 and 25 2013. .
National Historic Preservation Act of 1966	The Corps is currently in compliance and will continue to meet the requirements of this act throughout construction and operation.	Significant cultural resources are known to exist within the vicinity of the project area. Once the project is authorized and PED is implemented, further investigations and consultation will be needed.
Native American Graves Protection and Repatriation Act	In compliance with this Act. Neither human remains nor funerary objects were recovered during excavations on Federally owned or managed lands during the course of this feasibility study.	This Act applies to Federal owned lands, including Reservation lands. "Human remains and/or funerary objects were not recovered during excavations on Federally owned or managed lands during the course of this feasibility study. Should inadvertent discoveries occur within ENP during PED or construction phases of the CEPP, procedures established by ENP will be followed. Ground disturbing activities will not occur on Reservation Lands."
Resource Conservation and Recovery Act, as Amended by the Hazardous and Soils Waste Amendments of 1984, CERCLA as Amended by the 5.26.21 Superfund Amendments and Reauthorization Act of 1996, Toxic Substances Control Act of 1976.	The Corps is currently in compliance and will continue to meet the requirements of this act throughout construction and operation.	No items regulated under these laws or other laws related to hazardous, toxic, or radioactive waste substances have been discovered through previous Phase 1 Hazardous, Toxic, and Radioactive Wastes (HTRW) assessments of the project area. If any items regulated under these laws are discovered, the Corps and the non-Federal sponsor will comply with applicable requirements.
Rivers and Harbors Act of 1899	In compliance with this Act.	Proposed action would not obstruct navigable waters of the United States.
Submerged Lands of 1953	In compliance with the goals of this Act.	The proposed project would reduce freshwater flows to the Caloosahatchee Estuary and the St. Lucie Estuary and provide freshwater overland flow to Florida Bay that will ultimately benefit the ecological habitats that occur on submerged lands of the State of Florida. The proposed project does not occur on submerged lands and no construction is expected on submerged

Law, Policy and Regulations	Status	Comments
		lands.
Wild and Scenic River Act of 1968	This Act is not applicable.	No designated wild and scenic rivers are located within project area.
E.O. 11514, Protection of the Environment.	In compliance with this E.O	The objectives of the proposed action are focused on environmental protection.
E.O. 11593 Protection and Enhancement of the Cultural Environment	In compliance with this E.O.	The area of potential effect for cultural resources for this proposed action includes state and DOI owned lands only. Consultation is ongoing to ensure compliance for this EO.
E.O. 11988 Flood Plain Management	In compliance with this E.O.	Purpose of E.O. is to discourage Federally induced development of floodplains. Commitment of lands to restoration precludes such development.
E.O. 11990 Protection of Wetlands	In compliance with this E.O.	Areas proposed for restoration are considered freshwater wetlands. The objectives of the proposed action are focused on environmental protection.
E.O. 12962, Recreational Fisheries	In compliance with this E.O.	Proposed action would have an adverse affect on recreational fisheries in Water Conservation Area 3 (WCA 3) with the backfilling of the Miami Canal, but is expected to have a beneficial affect with improved recreational fisheries in Florida Bay and slight improvements in the Caloosahatchee and St. Lucie Estuaries, the Blue Shanty flow way and the rehydration of northern WCA 3A.
E.O. 12898 Environmental Justice	In compliance with this E.O.	CEPP does not present any environmental impacts that are high, adverse and disproportionate to low income, or minority populations. Sufficient scoping and public participation ensured potential impacts were understood by the public. No comments were presented as possible environmental impacts that may be disproportionate to low income or minority populations.
E.O 13007 Indian Sacred Sites	This E.O. is not applicable	This E.O. is directed towards executive branch agencies with statutory or administrative responsibility for the management of Federal lands. The proposed action would not affect Department of Defense owned or Corps managed lands.
E.O. 13045 Protection of Children	In compliance with this E.O.	Proposed action is not expected to have environmental or safety risks that may disproportionately affect children.
E.O. 13089 Coral Reef Protection	This E.O. is not applicable	Coral reefs are not affected.
E.O. 13122 Invasive Species	In compliance with this E.O.	A nuisance and exotic vegetation control plan has been prepared to prevent or reduce establishment of invasive and non-native species within the

Law, Policy and Regulations	Status	Comments
		project area. Control plan is located in **Annex G**.
E.O. 13175 Consultation and Coordination with Indian Tribal Governments	In compliance with this E.O.	Consultation with members and representatives of the Seminole Tribe of Florida and the Miccosukee Tribe of Indians of Florida have been ongoing. See **Appendix C.3** and **Appendix C.5** for specifics. Pursuant to E.O. 13175, the Corps developed the November 01, 2012 Tribal Policy Memorandum, which dictates Federal responsibilities, including Trust Responsibilities, to Federally recognized Tribes.
E.O. 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	In compliance with this E.O.	Proposed action would not adversely affect migratory bird species. Proposed action is expected to benefit species by improving habitat and increasing availability of foraging opportunities.
Memorandum on Government to Government Regulations with Native American Tribal Governments	In compliance with this Memorandum.	The USACE has consulted with the Miccosukee Tribe of Indians of Florida and Seminole Tribe of Florida throughout CEPP planning process (see **Appendix C.3** and **Appendix C.5**).
Seminole Indian Claims Settlement Act of 1987	In compliance with the Act	This Act also involves an agreement known as the Water Rights Compact, which specifically defines tribal water rights.

7.3 COMPLIANCE WITH USACE CERP AGRICULTURAL CHEMICAL POLICY

The USACE HTRW policy (ER 1165-2-132) directs that Construction of Civil Works projects in HTRW-contaminated areas should be avoided where practicable. In September 2011, the Assistant Secretary of the Army for Civil Works (ASA(CW)) provided clarification to this HTRW policy for CERP Projects (Memorandum for Deputy Commanding General for Civil and Emergency Operations, Subject: Comprehensive Everglades Restoration Plan (CERP) – Residual Agricultural Chemicals, Dated September 14, 2011). A copy of this policy is included in **Appendix C.4**. If specific criteria are met, this policy memorandum allows residual agrichemicals to remain on project lands and allows the USACE to integrate response actions directly into the construction plan. The SFWMD has requested application of the policy to the A-2 Flow Equalization Basin (FEB) lands. A copy of the letter from the SFWMD is included in **Annex H**.

The Agricultural Chemical section of **Appendix C.2.2** of the PIR partially fulfills the requirements established in the aforementioned policy for the A-2 FEB portion of the CEPP. Pursuant to paragraph 4 of the policy and prior to beginning construction, the Jacksonville District will obtain written documentation of regulatory approval(s) for all response actions from the SFWMD, and enter into an agreement with the SFWMD wherein the USACE accepts and expends funds, contributed by the SFWMD, for performance of the approved response action(s).

7.3.1 Recommendation

The A-2 FEB project feature requires the land conversion from agricultural production to aquatic restoration which inundates the land with water. The project site was selected to avoid significant adverse impacts to wetland communities. The avoidance of lands containing residual agricultural chemicals is not practicable. Based on limited soil sampling conducted in January and February of 2013, approximately 4,000 acres within the A-2 FEB 14,408 acre site likely contain low concentrations of residual copper and other agricultural chemicals. The testing indicated that soils do not exhibit any hazardous waste characteristic under the RCRA. Based on the sampling, it is reasonable to surmise that the chemical concentrations are indicative of the lawful application of commercially available products intended to enhance agricultural production. The chemicals detected on-site are active ingredients found in commercially available products registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). The USFWS and FDEP have preliminarily determined that the residual agricultural chemicals found on the A-2 FEB lands do not present a risk to protected resources. Based on the results of the 2013 soil testing, the USFWS and FDEP are recommending that during the initial operations of the A-2 FEB, the SFWMD perform testing of water for several contaminants (2,4, D, atrazine, barium, metribuzin, phorate, dieldrin, chromium, mercury, selenium, copper) as well as testing of periphyton and apple snails for copper. The water quality monitoring plan in **Appendix D** includes a start-up operation sampling event that should be performed at the 30 or 60-day period from inundation, as well as an additional surface water sampling event that should be performed after one year of operations. The FDEP and USFWS at this time are not recommending remedial action to address residual agricultural chemicals.

The A-2 lands will remain in agricultural production for several years until the A-2 project feature is set for construction at which time the agricultural leases will be terminated. Once farming has ceased on the project lands, an Exit Assessment will be performed to determine the presence of any new potential sources of HTRW since the completion of the previous Phase II ESA, and to verify the concentration of contaminants in the cultivated areas at selected locations. The results of these audits will be provided to the FDEP and USFWS for their review, comment, and concurrence regarding the need for remedial actions. The USACE Jacksonville District (CESAJ) will provide this information to the EMCX

(Environmental Munitions Center of Expertise) for review and to USACE Headquarters (HQUSACE) for concurrence prior to initiating construction of the A-2 FEB.

The non-Federal sponsor will be 100% responsible for the cost of actions taken due to the presence of residual agricultural chemicals, at no expense to the Federal Government. Any future costs associated with the presence of residual agricultural chemicals at the Federal project site will be 100% non-Federal sponsor cost and responsibility. The costs for characterization of the project lands in preparation for conducting a response action for the residual agricultural chemicals and removal of soils that are hazardous waste will be included as 100% non-Federal sponsor responsibility. The CESAJ shall not conduct actions to address residual agricultural chemicals for the SFWMD during the operation and maintenance, repair, replacement and rehabilitation (OMRR&R) phase of the project.

7.4 COMPLIANCE WITH FLORIDA STATUTES

The State of Florida has enacted several laws pertaining to implementation of CERP projects. These include amendments to Section 373.026 (8), Florida Statutes (F.S.), which establishes a requirement for the SFWMD to submit a report for review and approval by FDEP prior to formal submission of a request for authorization from Congress and prior to receiving an appropriation of State funds for construction and other implementation activities (except the purchase of lands from willing sellers); the enactment of Section 373.1501 F.S., which establishes the intent of the Florida Legislature with respect to CERP and the criteria for FDEP approval and the procedures to be followed by the SFWMD and FDEP for submitting and reviewing requests for approval; the enactment of Section 373.1502 F.S., which establishes permitting requirements and a process for the submittal, review, and issuance of certain regulatory permits for CERP projects; and the enactment of Section 373.470 and Section 373.472 F.S., establishing the "Save Our Everglades Trust Fund," funding and reporting requirements, and procedures for distributions from the trust fund.

The SFWMD's State Compliance Report addressing the criteria for approval listed in Section 373.1501 F.S. is included in **Annex B**. In addition to the above-described statutory requirements, other sections of Chapters 373 (Water Resources) and 403 (Environmental Control) of the F.S. include requirements that may apply to various aspects of CERP project planning and implementation. In particular, Chapter 403 F.S. and the administrative laws adopted in accordance with Chapters 373 and 403 F.S., contain the requirements for facilities that involve the discharge or potential discharge of pollutants to surface and groundwaters, and the discharge of air pollutants, including facilities regulated under the Federal Clean Water and Safe Drinking Water Acts and the Federal Clean Air Act. Based on the information contained in this PIR, the recommended plan complies with the applicable provisions of the F.S. A detailed explanation of how the project complies with the applicable requirements for CERP projects contained in the F.S. can be found in **Annex B**.

7.4.1 Permits, Entitlements and Certifications

The USACE will obtain WQC prior to advertising any construction contract. Section 402 of the NPDES permits required under the Clean Water Act may be necessary for the construction (non-point source runoff) of project features depending on means and methods of construction. This program has been delegated by the USEPA for implementation to the State of Florida (FDEP). At this time, a NPDES permit would not be required for the operation of CEPP features, as the project does not involve the discharge of pollutant. All required permits and/or modifications to existing permits would be acquired prior to construction activities.

7.4.2 Compliance with Applicable Water Quality Standards and Permitting Requirements

The CEPP is not expected to significantly affect Northern Estuaries and Southern Estuaries compliance with applicable water quality criteria. Water quality conditions in Lake Okeechobee are expected to be similar to the future without (FWO) project conditions with the exception of a slight increase in nutrient loads from increased S-308 backflow to the lake. This will slightly affect the allocation of waste loads included in the 2008, USEPA Total Maximum Daily Load (TMDL) Waste Load Allocation for Lake Okeechobee inflow sub-basins. This can be addressed through a TMDL revision or additional load reduction in other contributing sub-basins. The construction and operation of the A-2 FEB will slightly decrease Everglades Agricultural Area (EAA) basin phosphorus loads and the additional storage capacity is expected to reduce the risk that the 2012 water quality based effluent limit (WQBEL) for discharges from the EAA will not be met. Increased flows and new flow patterns may result in increase water column phosphorus concentrations at one or more total phosphorous (TP) rule stations within WCA 3A and WCA 3B; however, this should have minimal impact on TP rule compliance. It is uncertain how changes in flow distributions proposed under CEPP will impact Shark River Slough compliance with Appendix A of the 1991 Settlement Agreement. Over the long-term, distributing the flow over the northern WCA 3A marsh, reducing short-circuiting down the canals to ENP, adding more flow from the lake that is treated to the WQBEL, and distributing these flows over the marsh should result in improvements by lowering the flow weighted mean total phosphorous concentration entering the Park. In the short-term, to address the uncertainty in compliance with Appendix A, the Technical Oversight Committee is reviewing applicability of the current Appendix A compliance methodology for a restored ecosystem. Relative to FWO, no change to Settlement Agreement compliance for Loxahatchee and Taylor Slough is expected.

In general, any short-term impacts to water quality associated with construction of the recommended plan would be ameliorated by construction sequencing, best management practices for erosion and sedimentation control and monitoring during construction. If potentially adverse effects are observed or predicted, longer-term impacts to water quality associated with the operation of project features would be addressed through operational monitoring and adaptive management actions.

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8.0 DISTRICT ENGINEER'S RECOMMENDATIONS

The Central Everglades Planning Project (CEPP) will redirect some of the high volume discharges of freshwater currently flowing from Lake Okeechobee into the Northern Estuaries (Caloosahatchee and St. Lucie Estuaries) and deliver a portion of this water southward to the central Everglades. The increased flows will be directed through the storage and treatment facilities within the Everglades Agricultural Area (EAA), prior to ultimate delivery of this water to Water Conservation Area 3 (WCA 3), Everglades National Park (ENP), and Florida Bay. Reducing high discharges to the Northern Estuaries will improve salinity and turbidity conditions and benefit seagrass beds and the animals that inhabit them. The environmentally beneficial releases from Lake Okeechobee to WCA 3, ENP, and Florida Bay will restore a more natural mosaic of habitat conditions in these areas by improving the quantity, quality, timing, and distribution of flows to the central Everglades system.

The specific components of CEPP are increments of several components of the Comprehensive Everglades Restoration Plan (CERP), and the CEPP plan represents a first increment of restoration in the central Everglades system. Implementation of this plan is expected to be adaptively managed and sequenced in implementation phases that include the construction of logical groupings of recommended plan features that are compatible with other CERP and non-CERP components. This implementation strategy does not preclude future increments of restoration.

The project is integral to achieving restoration in the central Everglades and plays an important role in meeting CERP system-wide ecosystem goals and objectives. The project will enhance more than 1.5 million acres of freshwater and estuarine habitats in Palm Beach, Broward, Miami-Dade, Monroe, Martin and Lee counties. The project will deliver an average of 210,000 acre-feet per year of additional water from Lake Okeechobee to the central Everglades, which is essential to Everglades' restoration.

I find that CEPP project features located in Palm Beach, Broward, and Miami-Dade counties are an integral part of CERP. The CEPP plan includes:

Everglades Agricultural Area (EAA): 14,000 acre A-2 flow equalization basin (FEB) and associated distribution, inlet, and outlet structures. Operation of the A-2 FEB would be integrated with the future operation of the Everglades Construction Project and the State's Restoration Strategies features, including the A-1 FEB, and the State's existing stormwater treatment area (STA) 2 and STA 3/4 facilities.

WCA 2A and Northern WCA 3A: 500 cubic feet per second (cfs) gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal; 500 cfs gated spillway to deliver water from the remnant L-5 Canal to the western L-5 Canal (during L-6 diversion operations); 2,500 cfs gated spillway to deliver water from STA 3/4 to the S-7 Pump Station during peak discharge events (including L-6 diversion operations); approximately 13.6 miles of conveyance improvements to the L-5 Canal; degradation of approximately 2.9 miles of the southern L-4 Levee along the northwest boundary of WCA 3A; 360 cfs pump station to move water within the L-4 Canal to maintain water supply deliveries to retain the existing functionality of STA-5 and STA-6 and maintain water supply to existing legal users, including the Seminole Tribe of Florida; gated culverts and an associated new canal to deliver water from the Miami Canal (downstream of S-8, which pulls water from the L-5 Canal) to the L-4 Canal, along with potential design modifications to the existing S-8 and G-404 pump stations; and backfill approximately 13.5 miles of the Miami Canal and include constructed tree islands, between a point 1.5 miles south of the S-8 pump station and Interstate Highway I-75.

Southern WCA 3A, WCA 3B, and the Northern edge of ENP: 1,150 cfs gated spillway adjacent to S-333; 500 cfs gated culvert in L-67A Levee and an associated 6,000 foot gap in L-67C Levee; flowway through the western end of WCA 3B (two 500 cfs gated culverts in L-67A Levee; removal of approximately 8 miles of L-67C Levee; removal of approximately 4.3 miles of L-29 Levee; construction of new approximately 8.5 mile levee in WCA 3B); 1,230 cfs gated spillway in L-29 Canal; removal of approximately 5.5 miles of the L-67 Extension Levee; removal of approximately 6 miles of Old Tamiami Trail, and removal of spoil mounds along the northwestern side of the L-67A Canal.

Eastern edge of ENP: 1,000 cfs pump station; approximately 4.2 miles long, 35 feet deep tapering seepage barrier cutoff wall along the L-31N Levee just south of Tamiami Trail.

The Corps shall seek water quality certification on the above features as appropriate.

Therefore, I recommend that the CEPP as described in the section of the report entitled "The Recommended Plan", with such modifications that may be deemed advisable at the discretion of the Chief of Engineers, be authorized for construction. The total estimated first cost for the CEPP is $1,900,000,000 (Fiscal Year (FY) 2014 price level), with an estimated Federal cost of $950,875,000 and an estimated non-Federal cost of $949,125,000. The project first cost includes recreation features totaling $6,400,000. The average annual cost of the recreation features is $355,000 and the average annual benefits are $570,000, resulting in net benefits of $215,000 and a 1.6 to 1 benefit to cost ratio. The estimated total annual cost of operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) for the ecosystem restoration elements is $11,250,000 with an estimated Federal annual OMRR&R cost of $5,625,000 and an estimated non-Federal OMRR&R cost of $5,625,000. Average annual monitoring costs, which includes both 10-year cycle costs amortized over the period of analysis and the annual cost of longer-term monitoring requirements, totals $5,480,000. The estimated Federal cost is $2,740,000 and the non-Federal cost is $2,740,000. The estimated cost for OMRR&R of the recreation elements is $65,000 that is 100 percent non-Federal responsibility.

8.1 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION OF STATE FACILITIES USED BY CEPP

The non-Federal sponsor is responsible for operation, maintenance, repair, replacement, and rehabilitation of their State Restoration Strategies and Everglades Construction Project facilities. Certain of those facilities, as named below and herein after referred to as the "State facilities", are to be used by CEPP until such time as CEPP is deauthorized or it is determined use of the State facilities are no longer necessary for the purpose of achieving CEPP project purposes. This PIR recommends congressional authorization of the project with specific statutory language allowing cost share of the OMRR&R for the following State facilities not previously cost shared for construction under the C&SF project or other Federal authority, and the listed C&SF features that are currently cost shared pursuant to executed Resolutions: (1) Stormwater Treatment Area 2, (2) Stormwater Treatment Area 3/4, (3) Flow Equalization Basin A-1, (4) G-357 Gated Culvert, (5) G-370 Pump Station, (6) G-371 Gated Spillway, (7) G-372 Pump Station, (8) G-404 Pump Station, (9) G-434 Pump Station, (10) G-435 Pump Station, (11) S-6 Pump Station, (12) S-7 Pump Station, (13) S-8 Pump Station, and (14) S-150 Gated Culverts, and their corresponding remote-control facilities. All features required for the State's Restoration Strategies and the Everglades Construction Project are independent State facilities and are not CEPP components or features. The State facilities will not be incorporated as Federal CEPP project features; however, the operation of State facilities is required to ensure that new water made available by CEPP meets water quality standards and achieves CEPP project benefits.

The State retains sole responsibility for performing operations activities at State facilities pursuant to State Operations Plan, with the exception of the FEB A-1 which will be integrated with FEB A-2 and operated pursuant to a mutually agreed upon water control manual. The joint water control plan for the FEBs will integrate the operation of CEPP and the operation of the State facilities used by CEPP. Pursuant to the Item of Local Cooperation paragraph (f), the State has agreed that the USACE shall have the opportunity to collaborate, review, and comment on the OMRR&R of the State facilities used by CEPP, including updates to optimize operations to achieve Federal project purposes. This is intended to ensure continuous achievement of CEPP project purposes and support the Federal interest in cost sharing OMRR&R. To the extend applicable, any operational modifications to the State facilities that would impair the usefulness of any Corps project, including all CEPP and other CERP and C&SF project features, may require a 33 U.S.C. Section 408 permit from the USACE.

The aforementioned State facilities will use excess capacity to process "new water" provided by CEPP, which has been estimated to comprise approximately 19% of the total water volume that could flow through these facilities. For the purposes of this report, OMRR&R costs are assumed to be linear with flow volumes and will therefore increase the OMRR&R costs for the State facilities that are to be used by CEPP by 19%. Therefore, consistent with the general CERP authorization for cost sharing OMRR&R (WRDA2000 Section 601(e)(4)), the Corps recommends Congressional authorization of CEPP to contribute 19% of the OMRR&R costs of the aforementioned State facilities to the extent that OMRR&R activities are directly related to their use for treating "new water". The Corps' pro-rated share for OMRR&R for the aforementioned facilities used by CEPP is therefore 50% of the 19%, or 9.5% of the total OMRR&R costs. The 19% CEPP cost share will apply to the State facilities and C&SF features listed above to the extent that OMRR&R activities are directly related to their use for treating "new water".

The request for authorization shall include specific statutory language allowing the Corps to cost share 19% of the yearly OMRR&R costs of State facilities and listed C&SF features from appropriations made available for CERP OMRR&R activities. The term "OMRR&R costs" is defined the same as the term "project OMRR&R costs" in Article I.E. of the Master Agreement between the Department of the Army and the non-Federal sponsor dated August 13, 2009. As a condition of the Corps' cost share, prior to commencing replacement and rehabilitation actions for the State facilities listed above that CEPP is dependent on, approval by USACE Headquarters and the Assistant Secretary of the Army Civil Works is required. **Section 6.6.2** describes the coordination and approval process.

Pursuant to Section 601(h)(4) of WRDA 2000, the Non- Federal Sponsor is required to execute a water reservation or allocation of water identified in each CERP Project Implementation Report for the natural system[1]. The Operating Manual associated with each CERP Project Implementation Report shall "...reflect the operational criteria used in the identification of the appropriate quantity, timing, and distribution of water dedicated and managed for the natural system."[2] Pursuant to the Programmatic Regulations, the Corps and the SFWMD shall periodically update, as appropriate, the estimated total quantity of water expected to be generated for the natural system and for use in the human environment "based on new information resulting from changed or unforeseen circumstances, new or

[1] According to 33 CFR 385.27(b) "The Project Cooperation Agreement shall include a finding that the South Florida Water Management District or the Florida Department of Environmental Protection has executed under State law the reservation or allocation of water for the natural system as identified in the Project Implementation Report". This finding shall be verified by the District Engineer prior to executing the PCA.
[2] 33 CFR §385.28(a)(6)(vi).

scientific or technical information, new or updated models, or information developed through the adaptive assessment principles contained in the Plan, or future authorized changes to the Plan integrated into the implementation of the Plan."[3] Furthermore, the Programmatic Regulations require that the PIR "...include a plan for operations of the project in the event that the project fails to provide the quantity, timing, or distribution of water described in the PIR."[4]

After CEPP has operated for an appropriate period of time, an analysis based on monitoring data shall be undertaken to evaluate project performance and verify that CEPP successfully delivers an annual average of approximately 210,000 acre-feet of new water for the natural system as described in this PIR. If the monitoring data and analysis show that CEPP actually produces less than the anticipated 210,000 acre feet of new water on average, then the Federal project is not fully realizing the projected benefits and the State facilities are not being burdened as projected. In such a case, the analysis will be used to inform changes in operations in order to achieve the quantity, timing or distribution of water as described in this PIR, or recommend changes to the amount of water to be reserved or allocated to the natural system. Additionally, if the monitoring data and analysis show CEPP actually processes significantly more or less than the anticipated 210,000 acre-feet of "new water" on average then the analysis may be used to adjust the calculation of OMRR&R cost share upward or downward to reflect the actual average annual use of excess capacity by the Federal project. Any recommended adjustments to the OMRR&R cost share calculation may require additional Congressional approval and legislation. This will be accomplished through consultation with the State and USACE Headquarters and is necessary after operations have begun to capture the true Federal interest and cost share responsibility. Additionally, it must be recognized and the adjustment made given these State facilities are subject to legal requirements outside of the Federal project and will not be operated in such a manner that the Federal project will cause exceedances of the State's water quality requirements under State NPDES and EFA permits and associated Consent Orders. Such State requirements may limit the anticipated Federal project benefits.

No cost share of the aforementioned State facilities shall commence before the date of the CEPP project produces "new water" and the associated Federal project feature is declared construction complete and the state assumes its OMRR&R responsibilities as established in the appropriate project partnership agreements. Similarly, no cost share for State facilities is allowed until the State facilities are shown to be construction complete and the state begins regular operation of such facility.

A number of non- CEPP projects must be in place before implementing any CEPP features and certain non- CEPP projects must be integrated into the sequencing of CEPP implementation as shown in Table 6-13 in Section 6 in order to avoid unintended adverse consequences. For example, all features of the State's Restoration Strategies must be completed and meet State water quality standards prior to initiating construction of most CEPP project features.

Implementation of CEPP will occur over many years. The plan is composed of implementation phases that include a recommended plan feature or logical groupings of recommended plan features, agreed upon by the USACE and SFWMD, that maximize benefits to the extent practicable consistent with project dependencies and the Adaptive Management and Monitoring Plan (see **Annex D**). These implementation phases will achieve incremental hydrologic and environmental benefits. The phased implementation approach incorporates the adaptive management process, maximizing the opportunity

[3] 33 CFR §385.35(b).
[4] 33 CFR §385.35(c).

to realize incremental restoration benefits by initially building features that utilize existing water in the system that meets State water quality standards. Individual project partnership agreements, or amendments to existing project partnership agreements, will be executed prior to construction for each implementation phase.

8.2 ITEMS OF LOCAL COOPERATION

The above recommendations are made with the provision that the non-Federal sponsor and the Secretary of the Army shall enter into binding project partnership agreements defining the terms and conditions of cooperation for implementing the project, and that the non-Federal sponsor agrees to perform the following items of local cooperation:

a. Provide 50 percent of total project costs consistent with the provisions of Section 601(e) of the Water Resources Development Act (WRDA) of 2000, as amended, including authority to perform design and construction of project features consistent with Federal law and regulation;

b. Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations that the Government and the non-Federal sponsor jointly determine to be necessary for the construction, operation, maintenance, repair, replacement and rehabilitation of the project and valuation will be in accordance with the Master Agreement;

c. Shall not use the ecosystem restoration features or lands, easements, and rights-of way required for such features as a wetlands bank or mitigation credit for any other non-CERP projects;

d. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon land that the non-Federal sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of constructing, completing, operating, maintaining, repairing, replacing, or rehabilitating the project;

e. Assume responsibility for OMRR&R of the project or completed functional portions of the project, including mitigation features, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and specific directions prescribed in the OMRR&R manuals and any subsequent amendments thereto. Cost sharing for OMRR&R will be in accordance with Section 601(e) of WRDA 2000, as amended. Notwithstanding Section 528(e)(3) of WRDA 1996 (110 stat. 3770), the non-Federal sponsor shall be responsible for 50 percent of the cost of OMRR&R activities authorized under this section;

f. The State shall provide the Corps an opportunity to collaborate, review and comment on the State Operations Plans for the State facilities used by CEPP, including updates to optimize operations for Federal project purposes.

g. The non-Federal sponsor shall operate, maintain, repair, replace and rehabilitate the recreational features of the project and is responsible for 100 percent of the cost;

h. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms;

i. Unless otherwise provided for in the statutory authorization for this project, comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the WRDA of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

j. Hold and save the Government free from all damages arising from construction, operation, maintenance, repair, replacement and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors;

k. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs in accordance with the Master Agreement between the Department of the Army and the non-Federal sponsor dated August 13, 2009, including Article XI Maintenance of Records and Audit;

l. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government;

m. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-ways that the Government determines necessary for construction, operation, maintenance, repair, replacement and rehabilitation;

n. As between the Government and the non-Federal sponsor, the non-Federal sponsor shall be considered the operator of the project for purposes of CERCLA liability. To the maximum extent practicable, the non-Federal sponsor shall operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

o. Prevent obstruction of or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the ecosystem restoration features, hinder operation and maintenance of the project, or interfere with the project's proper function;

p. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;

q. Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army;" and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 [revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)];

r. Comply with Section 106 of the National Historic Preservation Act in completion of all consultation with the Florida State Historic Preservation Officer, and other interested parties including Federally recognized Tribes and as necessary, the Advisory Council on Historic Preservation, prior to construction as part of the preconstruction engineering and design phase of the project;

s. Provide 50 percent of that portion of total data recovery activities associated with historic preservation that exceed one percent of the amount authorized to be appropriated for CEPP; data recovery costs under one percent of the authorized CEPP cost will be funded in its entirety by the Government. Any costs of data recovery that exceed one percent of the amount authorized to be appropriated for CEPP shall not be included in project construction costs or project OMRR&R costs (as defined by the Master Agreement); therefore, credit shall not be afforded to the non-Federal sponsor for costs or work in kind associated with data recovery activities that exceed one percent of the amount authorized to be appropriated for CEPP;

t. Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized and in accordance with Section 601 (e)(3) of the WRDA of 2000, as amended, and in accordance with the Master Agreement;

u. The non-Federal sponsor agrees to participate in and comply with applicable Federal floodplain management and flood insurance programs consistent with its statutory authority:

1. Not less than once each year the non-Federal sponsor shall inform affected interests of the extent of protection afforded by the project;

2. The non-Federal sponsor shall publicize flood plain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the flood plain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

3. The non-Federal sponsor shall comply with Section 402 of WRDA 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to have prepared, within one year after the date of signing a project partnership agreement for the project, a floodplain management plan. The plan shall be designed to reduce the impacts of future flood events in the project area, including but not limited to, addressing those measures to be undertaken by non-Federal interests to preserve the level of flood protection provided by the project. As required by Section 402, as amended, the non-

Federal interest shall implement such plan not later than one year after completion of construction of the project. The non-Federal sponsor shall provide an information copy of the plan to the Government upon its preparation;

4. The non-Federal sponsor shall prescribe and enforce regulations to prevent obstruction of or encroachment on the project or on the lands, easements, and rights-of-way determined by the Government to be required for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project, that could reduce the level of protection the project affords, hinder operation or maintenance of the project, or interfere with the project's proper function.

v. The non-Federal sponsor shall execute, or certify that FDEP executed, under State law the reservation or allocation of water for the natural system as identified in the Project Implementation Report (PIR) for this authorized CERP project as required by Section 601(h)(4)(B)(ii) of WRDA 2000 and the non-Federal sponsor shall provide information to the Government regarding such execution. In compliance with 33 CFR 385, the District Engineer will verify such reservation or allocation in writing. Any change to such reservation or allocation of water shall require an amendment to the project partnership agreement after the District Engineer verifies in writing in compliance with 33 CFR 385 that the revised reservation or allocation continues to provide for an appropriate quantity, timing, and distribution of water dedicated and managed for the natural system after considering any changed circumstances or new information since completion of the PIR for the authorized CERP project.

w. Consistent with the September 14, 2011 Memorandum from Jo-Ellen Darcy, ASA (CW) the non-Federal sponsor shall be 100% responsible for the cost of all actions taken due to the presence of residual agricultural chemicals, at no expense to the Federal Government and any future costs associated with the presence of residual agricultural chemicals at the Federal project site are 100% a non-Federal sponsor cost and responsibility. As stated in the September 14, 2011 memorandum, normal project engineering and construction activities will remain part of the total project cost provided that these are the same activities required to implement the project features absent the presence of residual agricultural chemicals.

8.3 WATER QUALITY

In addition to the aforementioned items of local cooperation, the United States Army and the State of Florida agreed to the following concepts regarding water quality that is intended to govern the implementation and operation of CEPP project features:

> Restoration of the Everglades requires projects that address hydrologic restoration as well as water quality improvement. This has been recognized by the National Academy of Sciences in its most recent biennial report where it noted that near-term progress to address both water quality and water quantity improvements in the central Everglades is needed to prevent further declines of the ecosystem. The significant amount of water resulting from CEPP is contemplated to significantly improve restoration of the Everglades. Both the Federal and State parties recognize that water quantity and quality restoration should be pursued concurrently and have collaborated to develop and concur on a suite of restoration strategies being implemented by the State to improve water quality ("State Restoration Strategies"), as well as other State and Federal restoration projects, both underway and planned, to best achieve Everglades hydrologic objectives. Specific examples of Federally authorized projects include the Everglades Restoration Transition Plan, Modified Water Deliveries to Everglades National Park Project, and

the Tamiami Trail Next Steps Project.[5] One of the goals of these projects and their associated operating plans, as well as certain components of the CERP awaiting authorization or that are being planned as part of the CEPP is to improve water quantity and quality in the Everglades through more natural water flow within the remnant Everglades which includes the water conservation areas and ENP. Variations in flows of the C&SF system may result from a variety of reasons. These reasons include natural phenomena (e.g. weather) and updates to the operating manuals to achieve the purposes of the C&SF Project such as flood control and water supply.

One goal of the Consent Decree[6] is to restore and maintain water quality within ENP. The Consent Decree established, among other things, long-term water quality limits for water entering ENP to achieve this goal. The existing limits for ENP are flow dependent and, generally, increased volume of water results in a lower allowable concentration of phosphorus to maintain the overall load of phosphorus entering the ENP. There will be redistribution of flows and increased water volume above existing flows associated with system restoration efforts beyond the current State Restoration Strategies projects. The USACE and its Federal and State partners recognize that to achieve long-term hydrologic improvement, water quality may be impacted, particularly as measured by the current Consent Decree Appendix A compliance methodology. The USACE and the State partners agree that the monitoring locations/stations for inflows to ENP will require revision. An evaluation of this and other aspects of the compliance methodology are currently being conducted by the Technical Oversight Committee (TOC).

In an effort to address these potential impacts and determine updates to Appendix A to reflect increased inflows and new discharges into ENP since the Consent Decree was entered, the parties to the Consent Decree have established a process and scope for evaluating and identifying necessary revisions to the Appendix A compliance methodology utilizing the scientific expertise of the TOC. The TOC may consider all relevant data, including the 20 years of data collected since Appendix A was implemented. Ultimately, such evaluations and changes to the Appendix A compliance methodology would be recommended by the Consent Decree's TOC for potential agreement by all parties. Failure to develop a mutually agreed upon and scientifically supportable revised compliance methodology will impact the State's ability to implement or approve these projects.

The aforementioned State Restoration Strategies will be implemented under a Clean Water Act discharge permit that incorporates and requires implementation of corrective actions required under a State law Consent Order, as well as a Framework Agreement between the U.S. Environmental Protection Agency and the State discharge permitting agency, the Florida Department of Environmental Protection, to ensure compliance with Clean Water Act and State water quality requirements for existing flows into the Everglades. The Clean Water Act permit for the State facilities, the associated Consent Order (including a detailed schedule for the planning, design, construction, and operation of the new project features), and technical support documents were reviewed by, and addressed all of, the U.S. Environmental Protection Agency's previous objections related to the draft National Pollutant Discharge Elimination System ("NPDES") permits, prior to issuance.

[5] The next phase of bridging for Tamiami Trail roadway as authorized by Congress.

[6] *United States v. South Florida Water Management District, et al.*, Case No. 88-1886-CIV-Moreno (U.S.D.C., S.D. Fla.).

All parties are committed to implementing the State Restoration Strategies, joint restoration projects, and associated operational plans, in an adaptive manner that is consistent with the objectives of the underlying C&SF Project. The USACE and the State will use all available relevant data and supporting information to inform operational planning and decision making, document decisions made, and evaluate the resulting information from those decisions to avoid adverse impacts to water quality where practicable and consistent with the purposes of the C&SF Project. Based upon current and best available technical information, the Federal parties believe at this time that the State Restoration Strategies, implemented in accordance with the State issued Consent Order and other joint restoration projects, are sufficient and anticipated to achieve water quality requirements for existing flows to the Everglades. If there is an exceedance of the Appendix A compliance limits, which results from a change in operation of a Federal project, and it has been determined that an exceedance cannot be remedied without additional water quality measures, the Federal and State partners agree to meet to determine the most appropriate course of action, including what joint measures should be undertaken as a matter of shared responsibility. These discussions will include whether it is appropriate to exercise any applicable cost share authority. If additional measures are required and mutually agreed upon, then they shall be implemented in accordance with an approved process, such as a general reevaluation report or limited reevaluation report, and if necessary, supported through individual project partnership agreements. Failure to develop mutually agreed upon measures and cost share for these measures may impact the State's ability to operate the Federal project features.

8.4 REQUEST FOR CONGRESSIONAL AUTHORIZATION

The plan recommended by this PIR requires the use of several State facilities constructed and operated pursuant to State permits. The facilities are necessary for the State to meet water quality requirements as approved by the U.S. Environmental Protection Agency, and as litigated by the U.S. Department of Justice. Some of these requirements are currently subject to a Settlement Agreement filed with and overseen by the Federal District Court (United States v. South Florida Water Management District, Case No. 88-1886-CIV-Moreno (S.D. Fl. 1988)). These features are a part of the Everglades Construction Project. These State features are statutorily excluded from Federal cost sharing.

Section 528 of WRDA 1996, provides in part:

"(e) COST SHARING.—

(1) IN GENERAL.—Except as provided in sections 315 and 316 and paragraph (2), the non-Federal share of the cost of activities described in subsection (b) shall be 50 percent.

(2) WATER QUALITY FEATURES.—

(A) IN GENERAL.—Except as provided in subparagraph (B), the non-Federal share of the cost of project features to improve water quality described in subsection (b) shall be 100 percent.

(B) EXCEPTION.—

(i) IN GENERAL.—Subject to clause (ii), if the Secretary determines that a project feature to improve water quality is essential to Everglades restoration, the non-Federal share of the cost of the feature shall be 50 percent.

(ii) APPLICABILITY.—Clause (i) shall not apply to any feature of the Everglades Construction Project of the State of Florida.

(3) OPERATION AND MAINTENANCE.—The operation and maintenance of projects carried out under this section shall be a non-Federal responsibility."

Given this explicit statutory prohibition and as explained below, this PIR recommends that the Chief of Engineers request new statutory language specifically authorizing the cost sharing of OMRR&R responsibilities at the listed State facilities and change cost sharing at the listed C&SF facilities as described above in **Section 8.1** in order to proceed with the recommended plan.

As noted above, Section 528(e) of WRDA 1996 provides that the non-Federal share of the cost of CERP project features to improve water quality shall be 100 percent, unless the Secretary determines that a project feature to improve water quality is essential to Everglades Restoration. If the Secretary determines that a project feature to improve water quality is essential to Everglades Restoration, then the non-Federal share of the cost of the feature shall be 50 percent. However, the statute expressly prohibits the application of the exception to any feature of the State of Florida's Everglades Construction Project. Furthermore, the legislative history for Section 528 clarifies that this authority is not intended to interfere with future judicial proceedings or agreements related to those features, such as the recent State Restoration features planned or under construction and in answer to litigation (See Miccosukee Tribe of Indians of Florida, et al., v. United States, et al., Case No. 04-21448-CIV-Gold/Goodman (S.D. Fl. 2004) and United States v. South Florida Water Management District, Case No. 88-1886-CIV-Moreno (S.D. Fl. 1988)).

A November 30, 2007 Assistant Secretary of the Army (Civil Works) Memorandum for the Army Corps of Engineers Director of Civil Works, Subject: *CERP, Water Quality Improvements, Policy Determination*, reiterates the assumption under the CERP Plan that water received by a Federal project will meet all water quality standards and such compliance will be 100% a non-Federal responsibility. It also allows that for CERP projects where inflows do not currently meet water quality standards, but the benefits of water quality features are determined to be essential to Everglades restoration, the Corps may recommend to Congress in a PIR that it be given specific statutory authority to build and cost share the subject water quality features to both help achieve existing water quality requirements and provide additional restoration benefits critical to the successful implementation of CERP. Per the Memorandum, the O&M costs for such features were to be limited to only the increment attributed to raising water quality standards from compliant levels for the existing use to the restoration standards necessary under CERP and the percentage prorated for cost sharing. With regard to operational activities, the Memorandum limited its discussion of cost sharing to only O&M costs.

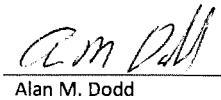
The State has requested cost sharing OMRR&R of the State facilities as set forth in Section 8.1. Given the State features in question are Everglades Construction Project features, already constructed, or under construction pursuant to State compliance requirements and under permit for that purpose, and/or United States v. South Florida Water Management District Settlement Agreement requirements, they may not be included as Federal project features and no cost sharing for construction would be allowed. There is currently no applicable authority which would allow for cost sharing any expenses associated with such features, including the OMRR&R costs. Thus because of the current statutory and policy prohibitions against such cost sharing, as the 30 November 2007 Memorandum indicates new statutory language affording such authority must be adopted as part of the CEPP project authorization in order for the State's request to be effected.

The Jacksonville District has concluded that the additional water flows that will be delivered by CEPP are essential to Everglades restoration. Furthermore, water quality treatment of these additional flows of "new water" provided by CEPP to restoration standards utilizing State-owned and State-operated Everglades Construction Project facilities will increase the OMRR&R costs of those facilities above and

beyond the requirements of the State for treatment of existing flows to compliance levels. Given the cost of constructing separate water quality facilities that would only be used by the CEPP project, and assurances by the State that their facilities will have an excess capacity which can accommodate the average annual flow increase of approximately 210,000 acre feet per year of new water projected to made available by the recommended CEPP, the Jacksonville District has determined that cost sharing of the increased OMRR&R costs at State facilities to be used by CEPP is the most economical alternative for achieving CERP purposes.

Additionally, this PIR recommends that the Chief of Engineers request new statutory language specifically changing current law and authorizing the cost sharing of OMRR&R responsibilities at the listed C&SF features as described above in Section 8.1 in order to proceed with the recommended plan. According to Section 203 of the Flood Control Act of 1948 and the Flood Control Act of 1954, SFWMD is 100% responsible for operation and maintenance of all project facilities not operated and maintained by the Corps of Engineers, including S-6, S-7, S-8, and S-150. SFWMD memorialized its commitment to performing and funding operation and maintenance for the S-6, S-7, S-8, and S-150 in Resolution Nos. 12, 224, and 398, all titled "Assumption of Responsibility for Compliance with Conditions of Local Cooperation with Federal Government." The project partnership agreements executed for each CEPP implementation phase shall incorporate by reference the aforementioned Resolutions and include an OMRR&R cost share provision, as described above in Section 8.1, implementing the new statutory language if adopted.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the Sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.



Alan M. Dodd
Colonel, Corps of Engineers
District Engineer

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9.0 LIST OF REPORT PREPARERS

This section provides a list of persons involved in the preparation and review of this document (**Table 9-1**).

Table 9-1. List of CEPP Report Preparers and Reviewers

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10.0 GLOSSARY OF ACRONYMS AND TERMS

10.1 LIST OF ACRONYMS

A	
ac	Acres
ac-ft	Acre-Feet
ACHP	Advisory Council on Historic Preservation
AM	Adaptive Management
APE	Area of Potential Effect
B	
BCNP	Big Cypress National Preserve
BMP	Best Management Practices
C	
CEPP	Central Everglades Planning Project
CERP	Comprehensive Everglades Restoration Plan
C&SF	Central and Southern Florida
cm/s	Centimeters Per Second
COP	Combined Operational Plan
D	
DSAC	Dam Safety Action Classification
DOI	Department of Interior
DPOM	Draft Project Operation Manual
E	
EAA	Everglades Agricultural Area
ECB	Existing Conditions Baseline
EDR	Engineering Documentation Report
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENP	Everglades National Park
EO	Executive Order
EPA	Everglades Protection Area
ERTP	Everglades Restoration Transition Plan
ESA	Endangered Species Act
F	
F.A.C.	Florida Administrative Code
FEB	Flow Equalization Basin
FEIS	Final Environmental Impact Statement
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FIFRA	Federal Insecticide, Fungicide, Rodenticide Act
F.S.	Federal Statute
ft	feet
FWC	Florida Fish and Wildlife Conservation Commission
FWO	Future Without Project Condition (or the No Action Alternative under NEPA)
G	
GDM	General Design Memorandum
GRR	General Reevaluation Report
H	
HHD	Herbert Hoover Dike
HRF	Hydropattern Restoration Feature
HTRW	Hazardous, Toxic and Radioactive Waste
I	
IOP	Interim Operations Plan
J	
K	
L	
LEC	Lower East Coast
LERRD	Lands, Easements, Rights of Way, Relocations, and Disposals
LOOPS	Lake Okeechobee Operations Screening Model
LORS	Lake Okeechobee Regulation Schedule
LOSA	Lake Okeechobee Service Area
LNWR	Loxahatchee National Wildlife Refuge

LTGM	Long Term Geometric Mean
M	
MCDA	Multi Criteria Decision Analysis
MeHg	Methyl Mercury
MGD	Million Gallons per Day
MG/L	Milligrams Per Liter
MRR	Major Rehabilitation Report
MWD	Modified Water Deliveries
N	
NEPA	National Environmental Policy Act
NESRS	Northeast Shark River Slough
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NRC	National Research Council
O	
OMRR&R	Operations, Maintenance, Repair, Rehabilitation, and Replacement
P	
PDT	Project Delivery Team
PED	Preconstruction, Engineering, and Design
PIR	Project Implementation Report
PPA	Project Partnership Agreement
POM	Project Operating Manual
ppb	Parts Per Billion
ppt	Parts Per Thousand
PWS	Public Water Supply
Q	
R	
RECOVER	Restoration Coordination and Verification
RESOPS	Reservoir Sizing Operations Screening Model
RSM-BN	Regional Simulation Model for Basins
RSM-GL	Regional Simulation Model for the Glades and Lower East Coast Service Area
S	
SAFM	South Atlantic Fisheries Management Council
SAV	Submerged Aquatic Vegetation
SDCS	South Dade Conveyance System
SFWMD	South Florida Water Management District
SHPO	State Historic Preservation Office(er)
SRS	Shark River Slough
STA	Stormwater Treatment Area
T	
THPO	Tribal Historic Preservation Officer
TMDL	Total Maximum Daily Limits
TP	Total Phosphorous
U	
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
V	
W	
WQBELs	Water Quality Based Effluent Limits
WCA	Water Conservation Area
WG	Working Group
WPA	Water Preserve Areas
WRDA	Water Resources Development Act
WRRDA	Water Resources Reform and Development Act
X	
Y	
Z	

10.2 GLOSSARY OF TERMS

A

Acre — Area of land equal to 43,560 square feet. In the S.I. metric system, one acre is equal to 4,046.9 square meters or 2.471 hectares.

Acre-foot — The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 43,560 cubic feet (1,233.5 cubic meters).

Action Plan — A plan that describes what needs to be done and when it needs to be completed.

Activity — A specific project task that requires resources and time to complete.

Adaptive Management — A process for learning and incorporating new information into the planning and evaluation phases of the restoration program. This process ensures that the scientific information produced for this effort is converted into products that are continuously used in management decision-making.

Adverse Effect – In relation to historic properties, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the NRHP in a manner that will diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Adverse Impact — The detrimental effect of an environmental change relative to desired or baseline conditions.

Affected Environment — Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Air Quality — Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Anthropogenic — Of, relating to, or resulting from the influence of human beings on nature.

Aquatic — Consisting of, relating to or being in water; living or growing in, on or near the water; or taking place in or on the water.

Aquifer — An underground geologic formation, a bed or layer of earth, gravel or porous stone, that yields water or in which water can be stored.

Authorization — An act by the Congress of the United States, which authorizes use of public funds to carry out a prescribed action.

B

Baseline — The initial approved plan for schedule, cost or performance management, plus or minus approved changes, to which deviations will be compared as the project proceeds.

Benthic — **Bottom** of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.

Best Management Practices — The best available land, industrial and waste management techniques or processes that reduce pollutant loading from land use or industry, or which optimize water use.

Biological Opinion — Document issued under the authority of the Endangered Species Act stating the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Services finding as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

Borrow Canal — Canal or ditches where material excavated is used for earthen construction

nearby. Also, typically denotes a canal with no conveyance or water routing purpose.

C

Canal — A human-made waterway that is used for draining or irrigating land or for navigation by boat.

Candidate Species — Plant or animal species not yet officially listed as threatened or endangered, but which is undergoing status review by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Central and Southern Florida Project (C&SF) — A multi-purpose project, first authorized by Congress in 1948, which provides flood control, water supply protection, water quality protection and natural resource protection.

Channel — Natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Coastal Ridge — Area of land bordering the coast whose topography is elevated higher than land further inland.

Comprehensive Everglades Restoration Plan (CERP) — The plan for the restoration of the greater Everglades and to meet water supply and flood protection needs in the urban and agricultural regions of south Florida.

Control Structure — A human-created structure that regulates the flow of waters or the level of waters.

Conveyance Capacity — The rate at which water can be transported by a canal, aqueduct, or ditch. In this document, conveyance capacity is generally measured in cubic feet per second (cfs).

Cost-Benefit Analysis — An analysis, often stated as a ratio, used to evaluate a proposed course of action.

Critical Habitat — A description, which may be contained in a Biological Opinion, of the specific areas with physical or biological features essential to the conservation of a listed species and which may require special management considerations or protection; these areas have been legally designated via Federal Register notices.

Cubic feet per second (cfs) — A measure of the volume rate of water movement. As a rate of stream flow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 meter /second (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

Culture – The National Park Service defines culture as "a system of behaviors, values, ideologies, and social arrangements. These features, in addition to tools and expressive elements such as graphic arts, help humans interpret their universe as well as deal with features of their environments, natural and social. Culture is learned, transmitted in a social context, and modifiable. Synonyms for culture include life ways, customs, traditions, social practices, and folkways. The terms folk culture and folk life might be used to describe aspects of the system that are unwritten, learned without formal instruction, and deal with expressive elements such as dance, song, music and graphic arts as well as storytelling."

Cultural Resources – Encompasses both culturally significant sites and historic properties.

Culturally Significant Site – Geographically defined areas supporting current or past human use such as a community meeting area, spiritual sites, places of worship, medicinal plant gathering areas or cemeteries and burial sites.

Culvert — A concrete, metal or plastic pipe that transports water.

D

Data – (cultural resources) Per Engineering Regulation 1105-2-100(b)(10), the DOI defines "data" as "evidence about historic and prehistoric periods, which are buried in the ground" and recovered as evidence...when construction projects pose threats that would result in their irreparable loss or destruction."

Data Recovery – (cultural resources) also known as Mitigative Excavations is a way to remedy or offset an adverse effect or a change in qualifying characteristics within an archaeological site. Through mitigative excavations, important information that makes the site eligible for NRHP listing is retrieved from the site before the site's integrity is compromised or destroyed.

Discharge — The rate of water movement as volume per unit time, usually expressed as cubic feet per second.

Dissolved Oxygen (D.O.) — The concentration of oxygen dissolved in water, sometimes expressed as percent saturation, where saturation is the maximum amount of oxygen that theoretically can be dissolved in water at a given altitude and temperature.

Dry Downs — Refers to marsh water levels going below ground in the Everglades. Dry downs occur naturally in the pre-drainage Everglades, but were not as frequent, nor as long in duration as does occur in the current system.

Dry Season — Hydrologically, for south Florida, the months associated with a lower incident of rainfall, typically November through May.

Duration — The period of time over which a task occurs, in contrast to effort, which is the amount of labor hours a task requires; duration establishes the schedule for a project, and effort establishes the labor costs.

E

Ecology — The science of the relationships between organisms and their environments, also called bionomics; or the relationship between organisms and their environment.

Ecosystem — A functional group of animal and plant species that operate in a unique setting that is mostly self-contained.

Ecotone — A transitional zone between two communities containing the characteristic species of each.

Effectiveness — A measure of the quality of attainment in meeting objectives; this is distinguished from efficiency, which is measured by the volume of output achieved for the input used.

Endangered Species — Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion of its range. Federally endangered species are officially designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register.

Enhancement — Measures which develop or improve the quality or quantity of existing conditions or resources beyond a condition or level that would have occurred without an action; i.e., beyond compensation.

Environmental and Economic Equity (EEE) — A program-level activity, referred to in early phases of the program as Socioeconomic and Environmental Justice.

Environmental Consequences — The impacts to the Affected Environment that are expected from implementation of a given alternative.

Environmental Impact Statement (EIS) — An analysis required by the National Environmental Policy Act for all major Federal actions, which evaluates the environmental risks of alternative actions.

Estuary — A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Eutrophic — Referring to a body of water which is naturally or artificially enriched in dissolved nutrients, and often shallow with a seasonal deficiency in dissolved oxygen due to high primary production.

Evaluate — To appraise or determine the value of information, options or resources being provided to a project.

Evaporation — The change of a substance from the solid or liquid phase to the gaseous (vapor) phase.

Evapotranspiration — Evapotranspiration is part of the hydrologic cycle that is a combination of evaporation and transpiration. Solar energy induces evaporation, causing water vapor to condense and fall as precipitation. A portion of the precipitation seeps into the ground and is consumed by plants. It is then recycled back into the atmosphere in the form of transpiration.

Exotic species — Introduced species not native to the place where they are found.

F

Fallowed Land — Cultivated land that lies idle during a growing season.

Feasibility Study — The second phase of a project. The purpose is to describe and evaluate alternative plans and fully describe recommended project.

Federally Endangered Species — An endangered species which is officially designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register.

Flood Control Storage Capacity — Reservoir capacity reserved for the purpose of regulating flood inflows to reduce flood damage downstream [compare with reservoir storage capacity].

Flow — The volume of water passing a given point per unit of time.

Instream Flow Requirements — Amount of water flowing through a stream course needed to sustain instream values.

Minimum Flow — Lowest flow in a specified period of time.

Peak Flow — Maximum instantaneous flow in a specified period of time.

G

Geospatial Data — Information, which includes, but is not limited to surveys, maps, aerial photography, aerial imagery, and biological, ecological and hydrological modeling coverage's.

Goal — Something to be achieved. Goals can be established for outcomes (results) or outputs (efforts).

Groundwater — Water stored underground in pore spaces between rocks and in other alluvial materials and in fractures of hard rock occurring in the saturated zone.

Groundwater Level — Refers to the water level in a well, and is defined as a measure of the hydraulic head in the aquifer system.

Groundwater Pumping — Quantity of water extracted from groundwater storage.

Groundwater Seepage — Groundwater flow in response to a hydraulic gradient.

Groundwater Table — The upper surface of the zone of saturation, except where the surface is formed by an impermeable body.

H

Habitat — Area where a plant or animal lives.

Hammock — Localized, thick stands of trees that can grow on natural rises of only a few inches in the land.

Hectare — A unit of measure in the metric system equal to 10,000 square meters or 2.47 acres.

Historic Properties – Encompasses archaeological, traditional, and built environment resources, including but not limited to buildings, structures, objects, districts and sites over 50 years of age.

Hydraulic Gradient — Denotes slope of watercourse, above or below ground water level. Typically, defines energy loss or consumption in the conveyance process.

Hydraulic Head (Lift) — Denotes relative comparison of water stages for gravity flow. Pump stations generally provide lift or increase water level elevations.

Hydrologic Condition — The state of an area pertaining to the amount and form of water present. For example, saturated ground (water table at surface), lake stage and river flow rate.

Hydric — Characterized by, relating to, or requiring an abundance of moisture.

Hydrologic Response — An observed decrease or increase of water in a particular area.

Hydrology — The scientific study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.

Hydropattern — Refers to depth as well as hydroperiod. Hydropatterns are best understood by a graphic depiction of water level (above as well as below the ground) through annual cycles.

Hydroperiod — For non-tidal wetlands, the average annual duration of flooding is called the hydroperiod, which is based only on the presence of surface water and not its depth.

I

Impoundment — An above ground reservoir used to store water.

Independent Technical Review Team — A group autonomous of the Project Team established to conduct reviews to ensure that design products are consistent with established criteria, guidance, procedures and policies.

Indicator Species — Organism, species, or community which indicates presence of certain environmental conditions.

Invertebrate — A small animal that does not have a backbone, examples include crayfish, insects and mollusks, which can be indicators of ecosystem status.

J

K

L

Lag — The amount of time after one task is started or completed before the next task can be started or completed.

Land Classification — An economic classification of variations in land reflecting its ability to sustain long-term agricultural production.

Levee — A human-created embankment that controls or confines water.

Littoral Zone — The shore of land surrounding a water body that is characterized by periodic inundation or partial saturation by water level. Typically defined by species of vegetation found.

Local Sponsor — The South Florida Water Management District.

M

Macrophytes — Visible plants found in aquatic environments, including sawgrass, sedges and lilies.

Marl — Soils comprised of clays, carbonates, and shell remains.

Marsh — An area of low-lying wetland.

Master Program Management Plan (MPMP) — A document which describes the framework and processes to be used by the USACE and the SFWMD for managing and monitoring implementation of the Comprehensive Everglades Restoration Plan.

Mercury — Heavy metal that is toxic to most organisms when concerted into a byproduct of inorganic-organic reaction. Distributed into the environment mostly as residual particles from industrial processes.

Mitigation — To make less severe; to alleviate, diminish or lessen; one or all of the following may comprise mitigation: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments.

Model — A tool used to mathematically represent a process which could be based upon empirical or mathematical functions. Models can be computer programs, spreadsheets, or statistical analyses.

Monitoring — The capture, analysis and reporting of project performance, usually as compared to plan.

Muck — Soil type consisting of 25% to 65% plant material mixed with sand silt, and clay.

N

National Economic Development (NED) — Corps of Engineers benefit evaluation process used to justify Recreation expenditures.

No Action Alternative — The planning process by which the action agency decides to not carry forth any planned action to alter existing conditions. In this report the No Action Alternative is the same as the Future Without Project Condition (FWO) and is referred to throughout the document as FWO.

O

Objective — A goal expressed in specific, directly measurable terms.

Off-peak — Less than peak design flow rate during storm runoff producing events.

Operation, Maintenance, Repair, Rehabilitation, Replacement (OMRR&R) — 100% local sponsor responsibility to OMRR&R recreation facilities and amenities.

Outreach — Proactive communication and productive involvement with the public to best meet the water resource needs of south Florida.

Oxygen Demand — The biological or chemical demand of dissolved oxygen in water. Required by biological processes for respiration.

P

Peat — Soil type consisting of 65% or more plant material with relatively little mineral matter. Everglades peat is formed mostly from partially decayed sawgrass. The upper 12 inches is a nearly black, finely fibrous peat which contains approximately 10% mineral soil. The subsoil is brown, fibrous peat which rests on the underlying rock, sand or marl.

Performance Measure — A desired result stated in quantifiable terms to allow for an assessment of how well the desired result has been achieved.

Periphyton — The biological community of microscopic plants and animals attached to surfaces in aquatic environments, for example algae.

Phosphorus (P) — Element or nutrient required for energy production in living organisms. Distributed into the environment mostly as phosphates by agricultural runoff (fertilizer) and life cycles. Frequently the limiting factor for growth of microbes and plants in south Florida.

Programmatic Regulations — Section 601(h) of WRDA 2000 states that the overarching purpose of the Comprehensive Plan is the restoration, preservation and protection of the south Florida ecosystem while providing for the other water related needs of the region, including water supply and flood protection. The purpose of the regulations is to ensure that the goals and objectives of CERP are achieved. The regulations will contain: (1) processes for the development of Project Implementation Reports, Project Cooperation Agreements and operating manuals that ensure the goals and objectives of the plan are achieved; (2) processes that ensure new scientific, technical, or other information such as that developed through adaptive management is integrated into the implementation of the plan; and (3) processes to establish interim goals to provide a means by which the restoration success of the plan may be evaluated throughout the implementation process.

Project — A sequence of tasks with a beginning and an end that uses time and resources to produce specific results. Each project has a specific, desired outcome, a deadline or target completion date and a budget that limits the amount of resources that can be used to complete the project.

Project Partnership Agreement (PPA) — A document that describes the roles and responsibilities of the USACE and SFWMD for real estate acquisition, construction, construction management and operations and maintenance.

Project Delivery Team — An interdisciplinary group formed from the resources of the implementing agencies, which develops the products necessary to deliver the project.

Project Duration — The time it takes to complete an entire project from starting the first task to finishing the last task.

Project Implementation Report (PIR) — A decision document that will bridge the gap between the conceptual design contained in the Comprehensive Plan and the detailed design necessary to proceed to construction.

Proposed Action — Plan that a Federal agency intends to implement or undertake and which is the subject of an environmental analysis. Usually, but not always, the proposed action is the agency's preferred alternative for a project. The proposed action and all reasonable alternatives are evaluated against the no action alternative.

Public Involvement — Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any EIS.

Public Outreach — A program-level activity with the objectives of keeping the public informed of the status of the overall program and key issues associated with restoration implementation and providing effective mechanisms for public participation in the restoration plan development.

Pump Station — A human constructed structure that uses pumps to transfer water from one location to another.

Q

Quality Assurance (QA) — The process of evaluating overall project performance on a regular basis to provide confidence that the project will satisfy the relevant quality standards.

Quality Control (QC) — The process of monitoring specific project results to determine if they comply with relevant quality standards, and identifying means of eliminating causes of unsatisfactory performance.

R

Recharge — The processes of water filling the voids in an aquifer, which causes the piezometric head or water table to rise in elevation.

Record of Decision — Concise, public, legal document which identifies and publicly and officially discloses the responsible official's decision on the alternative selected for implementation. It is prepared following completion of an Environmental Impact Statement.

Regional Water Supply Plan — Detailed water supply plan developed by the District under Ch. 373.0361, F.S.

Reservoir — Artificially impounded body of water.

Reservoir Storage Capacity — Reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirements.

Flood Control Storage Capacity — Reservoir capacity reserved for the purpose of regulating flood inflows to reduce flood damage downstream.

Restoration — The recovery of a natural system's vitality and biological and hydrological integrity to the extent that the health and ecological functions are self-sustaining over time.

Restoration Coordination and Verification (RECOVER) — A program-level activity whose role is to organize and apply scientific and technical information in ways that are most effective in supporting the objectives of the Comprehensive Everglades Restoration Plan.

Restudy — The Central and South Florida Project Comprehensive Review Study, authorized by the Water Resources Development Act of 1992, which examined the Central and Southern Project to determine the feasibility of modifying the project to restore the south Florida ecosystem and provide for other water-related needs of the region, and which resulted in The Final Integrated Feasibility Report and Programmatic Environmental Impact Statement, which was transmitted to Congress on July 1, 1999.

Risk Analysis — An evaluation of the feasibility or probability that the outcome of a project or policy will be the desired one; usually conducted to compare alternative scenarios, action plans or policies.

S

Scoping — The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under the National Environmental Policy Act.

Scrub — A community dominated by pinewoods with a thick understory of oaks and saw palmetto, and which occupies well-drained, nutrient-poor sandy soils.

Seepage — Water that escapes control through levees, canals or other holding or conveyance systems.

Sheet Flow — Water movement as a broad front with shallow, uniform depth.

Slough — A depression associated with swamps and marshlands as part of a bayou, inlet or backwater; contains areas of slightly deeper water and a slow current; can be thought of as the broad, shallow rivers of the Everglades.

South Florida Ecosystem — An area consisting of the lands and waters within the boundary of the South Florida Water Management District, including the Everglades, the Florida Keys and the contiguous near-shore coastal waters of South Florida.

Spatial Extent — Area that is continuous without non-integrating internal barriers or land usage.

Spillway — Overflow structure of a dam.

Spreader berm — A lateral weir used to spread water in creation of a sheetflow system over a very shallow depth.

Spreader canal — Canal used to equalize flow (to some degree) across a bank into an area with a shallow water depth. The spreader canal depth allows a water source to be delivered across the full reach enabling a deeper depth of sheetflow to occur.

Stakeholders — People or organizations having a personal or enterprise interest in the results of a project, who may or may not be involved in completing the actual work on that project.

Stormwater — Surface water resulting from rainfall that does not percolate into the ground or evaporate.

Subsidence — A local mass movement that principally involves the gradual downward settling or sinking of the earth's surface with little or no horizontal motion. It may be due to natural geologic processes or mass activity such as removal of subsurface solids, liquids, or gases, ground water extraction, and wetting of some types of moisture-deficient loose or porous deposits.

Surficial Aquifer — An aquifer that is closest to the surface and is unconfined; the water level of a surficial aquifer is typically associated with the groundwater table of an area.

Sustainability — The state of having met the needs of the present without endangering the ability of future generations to be able to meet their own needs.

Swamp — A generally wet, wooded area where standing water occurs for at least part of the year.

T

Threatened species — Legal status afforded to plant or animal species that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range, as determined by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Tiering — Procedure which allows an agency to avoid duplication of paperwork through incorporation by reference of the general discussions and relevant specific discussions from an environmental impact statement (EIS) of broader scope into a subsequent EIS of narrower scope.

Trade-Off — Allowing one aspect of a project to change, usually for the worse, in return for another aspect of the project getting better.

Traditional Cultural Property – The NPS defines "traditional" in this context as referring "to those beliefs, customs, and practices of a living community of people that have been passed down through the generations, usually orally or through practice. The traditional cultural significance of a historic property, then, is significance derived from the role the property plays in a community's historically rooted beliefs, customs, and practices."

Tributary — A stream feeding into a larger stream, canal or waterbody.

U

V

W

Water Budget — An account of all water inflows, outflows and change in storage for a prespecified period of time.

Water Conservation Areas (WCAs) — Marshland areas that were designed for use as storage to prevent flooding, to irrigate agriculture and recharge well fields and as input for agricultural and urban runoff; the Water Conservation Areas WCA-1, WCA-2A, WCA-2B, WCA-3A and WCA-3B comprise five surface water management basins in the Everglades; bounded by the Everglades Agricultural Area on the north and the Everglades National Park basin on the south, the WCAs are confined by levees and water control structures that regulate the inflows and outflows to each one of them.

Watershed — A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Wetlands — Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

Wet Season — Hydrologically, for south Florida, the months associated with a higher than average incident of rainfall, June through October.

Wildlife Corridor — A relatively wide pathway used by animals to transverse from one habitat arena to another.

Wildlife Habitat — An area that provides a water supply and vegetative habitat for wildlife.

X

Y

Z

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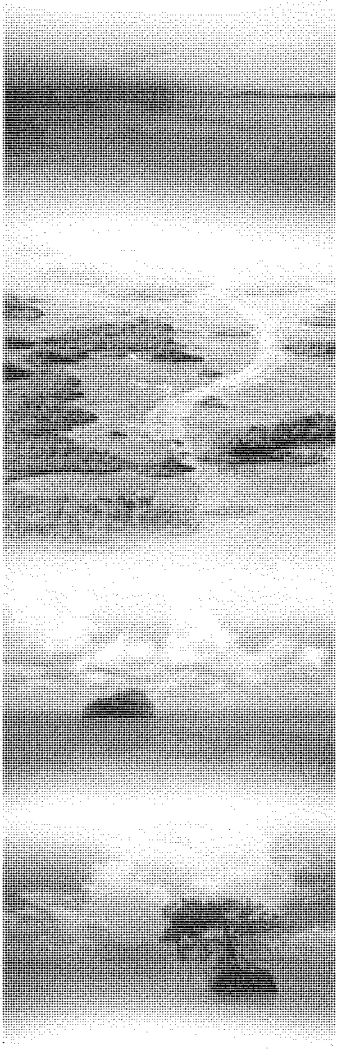
RESTORING THE HEART OF THE EVERGLADES

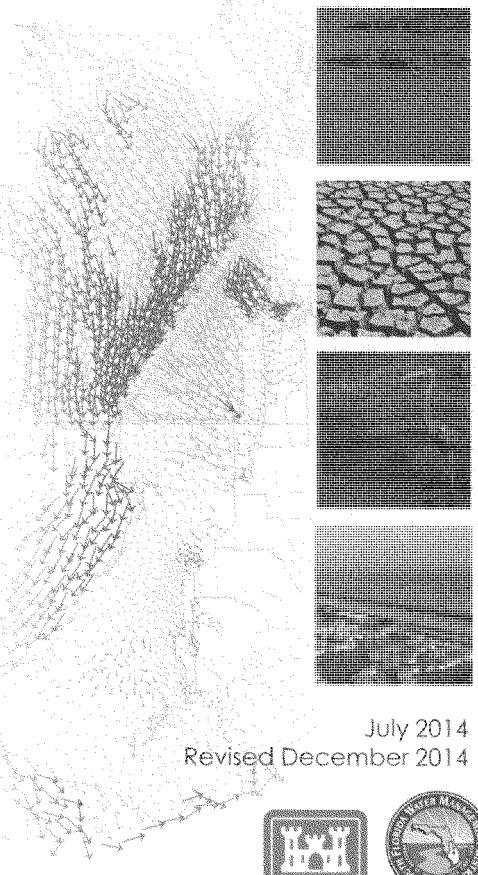
CENTRAL EVERGLADES PLANNING PROJECT



COMPREHENSIVE EVERGLADES RESTORATION PLAN

CENTRAL EVERGLADES PLANNING PROJECT

FINAL INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT



July 2014
Revised December 2014

Appendix A - Annex A

Cover insets (left to right):

Landscapes: Lake Okeechobee, Water Conservation Area 3, Everglades National Park, Florida Bay; **Map:** Depicts Average Annual Overland Flow across the period of record (1965-2005) for existing conditions, as modeled by the CEPP regional hydrologic model (the coloration of the arrows represents the relative volume of flow, while the direction of the arrows represents the movement of flow across the landscape); **Small Landscapes:** Ponding, soil oxidation (peat reduction), dry area of Everglades National Park, juxtaposition of urban development.

APPENDIX A

ENGINEERING APPENDIX

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A.0 ENGINEERING DESIGN APPENDIX

The Engineering Appendix of the Project Implementation Report (PIR) provides a comprehensive record of the technical support provided by the USACE Jacksonville District Engineering Division to the Central Everglades Planning Project, with technical information and analyses provided by the following engineering disciplines: Civil, Cost, Electrical, Geotechnical, Mechanical, Structural and Water Resources. The main Engineering Appendix, which is organized by technical discipline within each geographic sub-region, includes the following general information: an overview of the features of the CEPP Recommended Plan, overview status of Engineering design activities and analyses, discussion of general construction procedures, overview of preliminary civil site design information; overview of geotechnical considerations and analyses; overview of hydrologic and hydraulic design and analyses; documentation of the hydrologic modeling, and a summary of value engineering analyses. For the summary of costs, cost considerations and assumptions, refer to Appendix B – Cost Engineering. Consistent with the formulation approach, the geographic sub-regions are defined as: 1) North of the Redline (Storage and Treatment); 2) South of the Redline (Diversion and Conveyance) and 3) Blue Green Yellow line (Distribution, Conveyance and Seepage Management).

A.1 CENTRAL EVERGLADES PLANNING PROJECT

The study area for the Central Everglades Planning Project (CEPP) encompasses the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), Lake Okeechobee, a portion of the Everglades Agricultural Area (EAA), the Water Conservation Areas (WCAs), Everglades National Park (ENP), the Southern Estuaries (Florida Bay and Biscayne Bay), and the Lower East Coast (LEC). The purpose of CEPP is to improve the quantity, quality, timing and distribution of water flows to the Central Everglades. Existing Conditions are summarized in **Section 2.0** (Existing and Future Conditions) of the main PIR Report and Environmental Impact Statement (EIS). Greater detail is further described and provided in Appendix C.1.

A.2 RECOMMENDED PLAN

The recommended plan will provide approximately 210,000 ac-ft per year of additional water flow to the Everglades (measured at the Redline) by redirecting water which is currently being discharged to tide via the St. Lucie and Caloosahatchee Estuaries south to the existing EAA canals. The EAA Miami Canal and North New River Canal will convey the redirected flows to the recommended plan FEB storage feature, which will attenuate flow rates prior to water quality treatment using available, off-peak capacity of the state-operated STA-2 and STA-3/4. Following water quality treatment, this additional flow quantity will be re-distributed as inflows to WCA 2A and WCA 3A, and the recommended plan features will modify the quantity, quality, timing, and spatial distribution of flows into and through WCA 3A, WCA 3B, and ENP to Florida Bay in order to meet the project objectives. This plan would be accomplished by a combination of modifications to the existing Central and South Florida project components, construction of additional components, and modifications to current approved water control manuals. Several proposed or existing levees, canals, and culverts, and pump stations would be constructed, modified, or removed to improve the flow of water through the system as the first increment of CEPP.

The recommended plan was refined from Alternative 4 to Alternative 4R2 through the formulation process (refer to **Section 4.6** of the PIR main report). The recommended plan elements were further refined based on engineering analysis, preliminary design recommendations, costs described below and

in detail in this **Appendix A – Engineering**. The limited engineering and design analysis does not affect the plan formulation, as the cost changes and project refinements would similarly apply to all alternatives. Similarly, the total benefits derived by the plan are not anticipated to significantly change based on these engineering refinements. The recommended plan includes features in three major studied areas: North of the Redline, South of the Redline, and along Blue Green Yellowline. For general graphical depictions of the recommended plan features, please refer to **Section 6** of the PIR main report. This appendix includes additional figures to describe the engineering refinements to the recommended plan, where appropriate.

Features in the EAA (North of the Redline) include construction of the 14,000 acre A-2 Flow Equalization Basin (FEB) (L-624 perimeter levee and L-625 interior levee; C-624, C-624E, C-626 internal distribution channels; S-623, S-624, S-628 inlet structures; S-625 outlet structures, and C-625E, C-625W canals and channels connecting the FEB to the Miami Canal). Operation of the A-2 FEB would be integrated with the operation of the A-1 FEB, a state-funded and state-constructed FEB.

Conveyance features in WCA 2A and northern WCA 3A (South of the Redline) include: S-620, a gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal; S-622, a new gated spillway to deliver water from the remnant L-5 canal to the western L-5 canal (during L-6 diversion operations); S-621, a new gated spillway to deliver water from STA 3/4 to the S-7 pump station during peak discharge events (eastern flow route is not typically used during normal operations), including L-6 diversion operations; conveyance improvements to approximately 13.6 miles of the L-5 Canal; degrade approximately 2.9 miles of the southern L-4 Levee along the northwest boundary of WCA-3A; S-630, a new 360 cfs pump station to move water within the L-4 Canal to maintain water supply deliveries to maintain existing functionality of STA-5 and STA-6 and maintain water supply to existing legal users, including the Seminole Tribe of Florida; S-8A new gated culverts to deliver water from the Miami Canal (downstream of S-8, which pulls water from the L-5 Canal) to the L-4 Canal; and backfill approximately 13.5 miles of the Miami Canal and include constructed tree island mounds, between a point approximately 1.5 miles south of the S-8 pump station and Interstate Highway I-75.

Additional conveyance features that would be located in southern WCA 3A, WCA 3B, and the northern edge of ENP (Blue Green line) include: S-333N, a 1,150 cfs gated spillway adjacent to S-333; S-631, a 500 cfs gated culvert in L-67A Levee and an associated 6,000 foot gap in the L-67C Levee; a flowway through the western end of WCA 3B (S-632 and S-633 2 gated culverts in L-67A Levee; removal of approximately 8 miles of L-67C Levee; removal of approximately 4.3 miles of L-29 Levee; construct L-67D a new approximately 8.5 mile levee); S-355W, a gated spillway in the L-29 Canal to maintain water deliveries in the L-29 Canal to the eastern Modified Water Deliveries (MWD) 1-mile bridge and maintain western access to the L-29 Levee; remove approximately 5.5 miles of the L-67 Extension Levee; and remove approximately 6 miles of Old Tamiami Trail between the Everglades National Park (ENP) Tram Road and the L-67 Extension Levee. Work in this area also includes removal of spoil along the western L-67A canal in the vicinity of the new control structures and removal of vegetation along WCA-3B agricultural ditches.

Features primarily for seepage management (Yellowline), which are required to mitigate for increased seepage resultant from the Blue Green line features include: S-356, a new 1,000 cfs pump station to replace the existing temporary S-356 pump station; and an approximately 4.2 mile long, 35 feet deep tapering (potential variable seepage wall depths) seepage barrier cutoff wall along the L-31N Levee, just south of Tamiami Trail and east of the ENP Northeast Shark River Slough (NESRS).

To address quality, quantity, timing and distribution of the water through the CEPP project various types of infrastructure were considered during the formulation process such as: Stormwater Treatment Areas (STAs), a Flow Equalization Basin (FEB), deep storage reservoir, spreader canals, pumps, canal backfilling and canal plugs, levee removal and levee gaps, culverts/gated structures, seepage barrier walls, seepage control pumps, hydraulic ridge detention areas, and step down levees.

To meet the overall objectives of CEPP to deliver additional water to the Everglades system, the project features detailed in **Table A-1** were selected as components of the recommended plan, or Recommended Plan to best achieve the goals for this project based on cost effective benefits.

A.2.1 PROJECT FEATURES

TABLE A-1. SUMMARY OF RECOMMENDED PLAN FEATURES

Structure/Feature Number	Structure/Feature Type	Design Capacity (cfs)	Location	Tech Specs & Notes
NORTH OF THE REDLINE – STORAGE AND TREATMENT FLOW EQUALIZATION BASIN (FEB) – A 2				
S-623 (DS-8)	Gated Spillway	3700	On STA 3/4 Supply Canal	Delivers water from Miami Canal to existing G-372. When closed, FEB outflows are isolated from the Miami Canal for delivery to STA-3/4.
S-624 (DS-5)	Gated Sag Culvert (FEB inflow structure)	1550	On STA 3 / 4 Supply Canal	Receives water from G-372 via STA 3 / 4 Supply Canal and delivers to C-624 canal.
S-625 (DS-7)	Gated Culverts (FEB discharge structure)	1550	Discharge structure in FEB perimeter levee L-624	Delivers water to FEB outflow canal
S-626 (PS-1)	Seepage Pump Station	500	West side of seepage canal, C-626	Delivers seepage back into the FEB outflow canal C-625W
S-627 (CS-4)	Emergency Overflow weir	445	Between A-2 and A-1 FEB, just north of S-628	445 cfs for 100-yr 24 hr (per DCM-2)
S-628 (DS-9)	Gated Culvert FEB intake/ discharge structure	930	Between A-2 and A-1 FEB	Delivers water in both directions between A-2 and A-1 FEB
L-624	Levee		FEB Perimeter Levee	~ 20 miles, 11.3 height, 14ft width, 3:1 side slopes
L-625	Levee		FEB interior inflow canal levee	~ 4 miles, 11.3 height, 12ft width, 3:1 side slopes
C-624	Inflow Canal	1550	West side interior of FEB	~ 4 miles
C-624E	Spreader Canal		Northern boundary of FEB	~ 4 miles
C-625E	Collection Canal	400	FEB interior collection canal along southern perimeter	Existing seepage canal for STA 3 /4 Supply Canal will be repurposed and used to supplement FEB sheetflow to S-625 during normal operating conditions; C-625E provides primary conveyance to S-625 when no sustained pool depth (i.e., only sheet flow)
C-625W	Outflow Canal	1550	FEB exterior outflow; between S-625 and G-372 headwater	FEB outflow canal is the extended seepage canal for the STA 3 / 4 Supply Canal
C-626	Seepage Canal	400	West and northern exterior perimeter of FEB	~ 11 miles
SOUTH OF THE REDLINE – DIVERSION & CONVEYANCE				
S-620 (CS-1)	Gated Culvert	500	In L-6 Canal	Delivers water from L-6 canal to L-5 canal

TABLE A-1. SUMMARY OF RECOMMENDED PLAN FEATURES CONT'D				
Structure/Feature Number	**Structure/Feature Type**	**Design Capacity (cfs)**	**Location**	**Tech Specs & Notes**
SOUTH OF THE REDLINE CONT'D – DIVERSION & CONVEYANCE				
S-621 (CS-2)	Gated Spillway	2500	On STA 3 / 4 Outflow Canal	Closed to direct STA 3 /4 discharges to western L-5 Canal during normal operations; controls water from STA 3 /4 to the S-7 pump station during peak events.
S-622 (CS-3)	Gated Spillway	500	In L-5 Canal	Delivers water from east to west in L-5 canal
New (S-8A)	Gated Culverts w/canal	3080 & 1020	In Miami and L-4 Canal	Delivers water from the Miami Canal west to L-4 (3120 cfs) and to the remaining Miami Canal segment 1040 cfs). S-8 delivers water from the L-5 Canal to the Miami Canal, upstream of S-8A. Potential design modifications to the existing S-8/G-404 complex will be assessed during PED.
S-630	Pump Station	360	In L-4 Canal	Delivers water from L-4 Canal west to maintain existing water supply deliveries
	Levee Removal		L-4 Interior Levee	Remove ~2.9 miles, 6ft ht, 10ft width, 2.5:1 side slopes
	Canal Backfill		Miami Canal	Remove ~ 13.5 miles
	Tree Islands Mounds		Miami Canal	Create habitat and promote sheetflow in WCA-3A
	Canal	500	Remnant L-5 Canal east	Enlarging canal between S-621 and S-622
	Canal	3000	L-5 Canal west	Enlarging canal between S-622 and S-8
BLUE GREEN YELLOW LINE – DISTRIBUTION, CONVEYANCE & SEEPAGE MANAGEMENT				
S-333 (N)	Gated Spillway w/new canal	1150	Just north of existing S-333	Delivers water from L-67A Canal to L-29 Canal
New S-356	Pump Station	1000	In vicinity of existing temporary S-356	Provides seepage management for WCA 3B and NESRS stages
S-631	Gated Culvert	500	In L-67A Levee	Delivers water from WCA 3A to 3B, east of L-67D Levee
S-632	Gated Culvert	500	In L-67A Levee	Delivers water from WCA 3A to 3B, west of L-67D Levee
S-633	Gated Culvert	500	In L-67A Levee	Delivers water from WCA 3A to 3B, west of L-67D Levee
	Levee Removal Gap		L-67C Levee	~ 6000 ft gap corresponding to S-631, 5ft ht, 10ft width, 3:1

TABLE A-1. SUMMARY OF RECOMMENDED PLAN FEATURES CONT'D				
Structure/Feature Number	Structure/Feature Type	Design Capacity (cfs)	Location	Tech Specs & Notes
BLUE GREEN YELLOW LINE CONT'D – DISTRIBUTION, CONVEYANCE & SEEPAGE MANAGEMENT				
L-67D	New Levee		In WCA 3B	~ 8.5 miles connects from L-67A to L-29, 6 ft height, 14 ft crest width, 3:1 side slopes
	Levee Removal		L-67C Levee	~ 8 miles complete removal from New Levee (L-67D)south to intersection of L-67A/L-67C; L-67C canal is not backfilled
S-355W	Gated Spillway	1230	In L29 Canal, east of L-67D Levee terminus and 2.6 mile bridge	Maintains water deliveries in L-29 Canal to 1-mile bridge & maintains access for Tigertail Camp to Tamiami Trail.
	Levee Removal		L-29 levee	~ 4.3 miles removal east of ValuJet monument to L-67D Levee intersection with L-29 Levee. 10ft ht, 10ft width, 3:1
	Road Removal		Old Tamiami Trail (from L-67 Ext west to ENP Tram Rd)	~ 6 miles of Old roadway removal , 5 ft height, 30 ft width, 2:1 side slopes
	Levee Removal and Canal Backfill		L-67 Ext levee and Canal	~ 5.5 miles complete removal of L-67 Ext; 8ft height, 10ft width, 3:1 side slopes
	Seepage Barrier Cutoff Wall		In L-31N levee just south of Tamiami Trail	~4.2 miles of 3ft wide, 35 ft deep, Soil Cement Bentonite (SCB) Wall
S-346	2-72" metal culvert w/Flash Board Removal	165	In Old Tamiami Trail	Anticipate removal if ~5.5 miles of L-67 Ext removed

Key: cfs = cubic feet per second

A.2.2 Pre-Recommended Plan Design

Due to an expedited schedule, absence of site specific data and limited data, design for alternative development employed best professional judgment and prior knowledge of existing CERP components. The assumptions and limited design are captured in latter sections of this Appendix. As documented in this appendix many traditional design analyses are delayed to future design phase. The assumptions and limited design to date contributed to the development of the Final Array of Alternatives. For a description of the Final Array of Alternatives, see main PIR document **Section 3** Formulation of Alternative Plans and **Section 4** Evaluation and Comparison of Alternative Plans.

A.2.3 Cost Estimates

Refer to PIR main report, Appendix B – Cost Engineering for cost development and methods to include the CEPP Recommended Plan cost.

A.3 STATUS OF ENGINEERING DESIGN ACTIVITIES AND ANALYSES

A.3.1 Level of Design Efforts

Design Engineering Regulation, ER 1110-2-1150, Engineering and Design for Civil Works Projects provides guidance for Feasibility level design to accompany decision documents. Early during CEPP project scoping, risks were identified that accompanied the expedited pilot planning process. The risks were presented in a project risk register. Those pertaining to Engineering were: ENG-01 Limited Data for Engineering Design; ENG-02 Design Details accomplished and ENG-13 Levee Safety Analysis. With the Risks identified and Decision Point (DP) 1 meeting, it was marked that due to the expedited schedule to execute and the limited ability to acquire site specific data, traditional analyses typical for feasibility level design would not be accomplished for inclusion in this project PIR report. The team identified work that would be deferred to preconstruction engineering and design phase (PED). The up-front project risks recognized the potential for these design activities to significantly affect project costs. Due to the limited design, it is expected that higher risk based contingencies would be generated yet Cost certification would still be achieved. This is in accordance with additional guidance from Engineering Construction Bulletin (ECB) 2012-18.

A.3.2 Recommendation for Design Completion

Features of the Recommended Plan have been identified according to available data, historic information, and best engineering judgment. All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and information as it becomes available. Prior to finalzing design, an economic analysis will be conducted on pump station components to be in compliance with EM 1110-2-3102. Design completion recommendations are provided by geographic region and discipline specific areas.

A.4 GENERAL CONSTRUCTION PROCEDURES DISCUSSION

A.4.1 General Construction Recommendations

It is envisioned that the project will be constructed using conventional means and methods. The project features were scoped by project areas and conceptually placed in contracts that maximize opportunities to realize benefits with clean water already in the existing system. The features/contracts capitalize on use of onsite material, reduce multiple handling scenarios, and to maintain flood control operations and level of service provided by existing features. Other schedule and construction assumptions included that all engineering design work would be completed by USACE with in-house resources. Beginning with investigative information gathering, multiple contracts would be awarded every year based on construction durations estimated from existing similar USACE construction projects. Adaptive Management will help with future development of the implementation and sequencing. During PED, detailed analyses, subsurface investigations and site investigations will be conducted to prepare construction documents.

A.4.1.1 North of Redline

It is assumed that the A-1 FEB will be completed in FY 2018 and operated at least 5 years prior to any construction of the CEPP A-2 FEB. The A-2 FEB would not initiate construction until the Blue Green Yellowline Seepage Barrier is in place. There are multiple structures, canals and levees with subsequent access and electrical works. It is generally assumed that construction for the A-2 FEB would start north

east ward and proceed west and south. During PED construction sequencing will be further investigated and defined for USACE contracts.

A.4.1.2 South of Redline

It is assumed that the work in the area would need to be sequenced together based on earthwork dependencies. The L-6 diversion structures with incidental canal improvement may be performed independent of L-5 canal conveyance improvements. The L-4 degrade and S-630 construction should be performed in the same contract concurrently. S-8 modifications should be completed to permit the diversion of L-6 flows and must maintain flood control operation capability during S-8 modifications. Miami Canal backfilling is primarily dependent upon material from the L-5 canal conveyance improvements with other material coming from the L-4 levee degrade, new S-8A canal (that connects the L-4 and Miami Canal) and the adjacent spoil mounds located along the Miami Canal north of Interstate 75 (I-75). These two features should be performed concurrently in a contract. There are multiple structures, canals and levees with subsequent access and electrical works. It is generally assumed that construction for the Miami Canal backfilling would start north and proceed south to S-339 and eventually to I-75. Conceptual construction impacts acres are provided in the main PIR document. During PED construction requirements and sequencing will be further investigated and defined for USACE contracts. See Appendix A, Annex C-2 for conceptual degrade and backfill plates.

A.4.1.2.1 Miami Canal Tree Island Construction/Planting

Approximately 13.5 miles of Miami Canal will be backfilled to bedrock from about a mile south of S-8 to S-339 and to about one foot above bedrock from S-339 to I-75 so that the entire length of the backfilled canal template will be ~1.5 below the peat surface. All spoil mounds on the east and west side of the Miami Canal will be removed from S-8 to S-339. From S-339 to I-75 all spoil mounds will be removed except for 22 FWC enhanced spoil mounds identified by FWC as the highest priority. In addition to the backfilling, CEPP will construct and create (14) tree islands approximately every mile along the entire reach of the Miami canal (S-8 to I-75) where historic tree islands once existed. The remaining FWC spoil mounds will be incorporated into the constructed tree island that will be constructed along the ridges of the historic ridge and slough landscape to use as potential tree island generators.

Purpose of Tree Islands
The constructed tree islands are intended to block flow down the backfilled canal by having a profile across the landscape that varies, or undulates in elevation. The longitudinal cross section of this series of tree islands varies from marsh grade to ~1.5' above marsh grade. This undulated elevation will provide somewhat natural slopes for vegetation and wildlife, provide higher habitat for diverse plant and animal species that require such habitat, and provide low elevation slough areas between each island to promote natural water flow paths through the Everglades.

Recommendations for the composition, design and construction of the tree islands in full detail and reference project photos with graphics are provided in Appendix A, Annex C-2. A summary of the ecological recommendation is provided below. Constructed tree island design details will be determined during CEPP PED phase. CEPP PED discussions regarding Miami Canal backfilling and tree island construction/planting will involve coordination with appropriate science team members with expertise in these topics to accomplish the restoration vision and intent of CEPP's backfilling and tree island construction. Scientists included in the PED effort will bring information from Florida Fish and Wildlife

Commission and Loxahatchee Impoundment Landscape Assessment (LILA) tree island design and planting projects, and other relevant efforts.

Islands from S-8 to S-339

The constructed tree islands from S-8 to S-339 will range from 280' to 210' in total width and overall length from 210' to 310'. The flat area should be 1.5' above marsh grade, with a maximum 18:1 transition to marsh grade.

Islands from S-339 to I-75

The constructed tree islands from S-339 to I-75 are adjusted slightly from that described above to blend constructed islands with the remaining portions of the FWC planted tree islands. These constructed islands range from approximately 500' to 1500' long and up to 210' in width. All areas with a FWC Island will have at its northern end a flat portion, raised 1.5' above marsh grade, that abuts and transitions into the adjacent, existing FWC Island at a maximum 18:1 down or up to marsh grade. For specific details on the possible configurations see Appendix A, Annex C-2.

Construction of Tree Islands

A summary of the ecological recommendation is provided below. Miami Canal will be filled to bedrock level using local compacted fill material that excludes branches, trunks, or organic material. The layer of fill from the top of the bedrock to the elevation of the tree island will include a wide range of grain and rock sizes as well as non-uniform, randomly placed, non-mulched branches and trunks from Miami Canal spoil material after consultation with FDEP during the PED phase. This would provide the needed porosity throughout the tree island to the bedrock level. The goal is to have enough porosity for plant roots to be able to reach water through the island material which is an essential need for tree island creation. The end result should be rough terrain that is "difficult to walk on." See Appendix A, Annex C-2, LILA construction photos for examples. Size of rock and volume will need to be specified. Organic muck should be spread 12" to 18" thick over the planting areas (holes) to help plants have room to establish. The top layer of organic material is critical in the planting holes, where the plantings will be expected to root and grow.

Once islands are created, planting holes will be created and filled them with organic material which provides a rooting medium for the native plants and promote survival in harsh conditions without irrigation. The holes should be at least 1-ft diameter per tree. It is suggested that the hole depths can be a randomly distributed mixture of 1/3 each at 1', 2', 3' depths. Details can be determined during PED based on contracting capabilities. Contracting options will be fully explored during PED to accomplish Miami Canal backfilling, tree island creation and plantings.

Tree Island Planting

Local plant sources are recommended for planting to maintain Everglades' genetic consistency among planted seedlings. All proposed plantings are assuming 3-gallon size plants. Immediately after planting, individual plants will be protected by ~3-ft metal enclosure, secured by metal stakes, to deter herbivores while the plants are becoming established. A diverse array of species will be planted, including trees, shrubs, and herbaceous species that are appropriate for these tree islands. The array will include a mix of faster-growing, desirable native species that will help to quickly create an environment on the constructed tree islands that is conducive for restoration, i.e., that will shade out weedy species and protect the organic layer on the island, will quickly develop root systems, and that will attract wildlife to the islands. Other desirable species that may grow more slowly will also be planted to result in the appropriate species composition for restored tree islands in this area. In addition, species will be chosen

that are fire tolerant for the outer edges of the constructed tree islands to buffer the inner island area from wildfires. It is expected that the islands will accrue additional native species over time by natural recruitment.

It is recommended that construction of the tree islands not take place in the wet season, but recommended that planting be done at beginning of the wet season to attempt to avoid irrigation. However, design and construction sequencing to include planting will be detailed in PED phase. Refer to Appendix A, Annex C-2, Civil Plates for full recommendation details.

A.4.1.3 Blue/Green/Yellowline

It is assumed the Tamiami Trail western 2.6 mile bridge and appropriate road raising are completed by FY 2022 under the Department of Interior (DOI) Tamiami Trail Modifications: Next Steps project. Passive control features were screened out during the CEPP plan formulation process and will not be further considered during future CEPP implementation. Active control structures, such as the gated culverts along L-67A included in the CEPP Recommended Plan, are required to most effectively address: adaptive management flexibility and system uncertainties (the WCA-3A regulation schedule varies seasonally, whereas passive weir elevations are most likely predetermined and static); water quality considerations and constraints; T&E species considerations within WCA-3A and ENP, including flexibility for management of recession/ascension rate targets; and surface water velocity considerations within the flowway. Further, the CEPP modeling and preliminary DPOM recognize that the only anticipated operational constraint for the proposed controllable L-67A structures within the Blue Shanty Flowway (S-632 and S-633) would be the 9.7 feet NGVD maximum stage elevation for the L-29 Canal based on the planned DOI TTNS Tamiami Trail roadway modifications, and this same constraint would equally apply under a passive weir scenario.

It is assumed that CEPP work in the area would need to be sequenced together based on earthwork dependencies. The L-67A structure S-631 and designated L-67C gapping would be performed first as an adaptive management strategy. The new S-333N, S-355W and S-356 structures may be completed as separate contracts independent of each other and other work in the area. They are not dependent upon any other new feature but must consider the existing facilities currently or planned to be in use in the construction vicinity. The existing S-356 is a temporary pump station which could be replaced as the first contract in this area, to maintain seepage mitigation associated with operation of the existing temporary S-356 pump station. The remaining L-67A structures (S-632 and S-633), designated L-67C levee removal with associated spoil removal westward of L-67A canal and L-67 extension levee removal may be performed concurrently with construction of new WCA 3B levee (L-67D). Including L-67 extension levee removal with this work assists with utilization of onsite material for the new L-67D construction. The new levee (L-67D) will require a variance from USACE mandatory vegetation management standards found in Engineering Technical Letter (ETL) 1110-2-571, Vegetation Standards for Levees and Floodwalls Safety Guidance for vegetation management zones. This variance will maintain 15 foot clearance on each side of L-67D of woody vegetation but allow marshy vegetation within the zone. The next sequenced contract in this area would be removal of the L-29 levee since it is contingent upon total L-67D levee and the S-355W being in place. The L-29 levee removal would proceed starting east of the ValuJet monument and progress east to coincide with L-67D terminus. The material from the L-29 levee removal would be used in the L-67 extension canal backfill. It is assumed that the last works in this area, which include the new L-31N Seepage barrier cutoff wall, Old Tamiami Trail removal and L-67 extension canal backfill, are each independent contracts. L-67 extension canal backfill will not be sequenced prior to the removal of the Old Tamiami Trail, in order to maintain the

conveyance capability of the S-12s to discharge excess water from WCA-3A. There are remaining uncertainties about the effectiveness of the CEPP Recommended Plan seepage cutoff wall in maintaining desired stages in marshes of ENP while maintaining flood protection and canal stages to the east without limiting water availability to water users and Biscayne Bay. Therefore, additional analysis of the CEPP seepage cutoff wall will be conducted as an early phase in PED. See Section 6.10.2.1, the Engineering Appendix (Appendix A), the analyses required by WRDA 2000 (Annex B), and the CEPP Adaptive Management Plan (Annex D Part 1) for detail. The A-2 FEB construction could initiate immediately following or with the L-31N Seepage barrier wall. There are multiple canals, ditches and levees with subsequent access and electrical works that will require coordination to minimize cultural resource and wetland impacts. Conceptual construction impacts acres are provided in the main document. During detail design phase construction sequencing will be further investigated and defined for USACE contracts. See Appendix A, Annex C-2 for conceptual plates.

A.5 NORTH OF THE REDLINE – FLOW EQUALIZATION BASIN

A.5.1 CIVIL - SITE DESIGN

Features identified in the Recommended Plan have been designed to the level of detail necessary to provide cost estimates. Best professional judgment and previous project design knowledge for EAA and the SFWMD A-1 FEB were used during plan formulation alternative development and design efforts. Components north of the redline have been identified according to available data, historic information, and best engineering judgment. All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and information as it becomes available.

All levees in the Recommended Plan have a crown of 14 feet with one on three side slopes. The levees will be seeded to prevent erosion. All perimeter levees will have a 15 foot clear zone at the toe as required by EM 1110-2-1913, Design and Construction of Levees. For the internal levee, a variance will be investigated during PED. Upon completion of construction the levees will be entered into the National Levee Data Base for regular inspections as required by P.L. 84-99 to be part of the Federal Emergency Management System.

A.5.1.1 General Status of Completed and Non-Executed Efforts

The following civil site project efforts remain either incomplete or were not initiated:
evaluation of alignments,
site grading,
aesthetics,
relocation of facilities,
required improvements on lands to enable proper construction of components and disposal of material,
requirements of lands for construction,
operation and maintenance of the project,
identification of methods for accomplishing relocations to include appropriate lands,
site selection and project development, and
design with respect to recent Levee Safety criteria.

These analyses will be completed in PED.

A.5.1.2 Surveying Mapping Geospatial data

During PED phase site specific surveys of the features, utilities to be relocated and internal canals to be filled shall be done for the design. There is no survey information available for this area to utilize for civil site design. All survey will be in 1988 NAVD with a 1929 NGVD correction as required for the Water Control Plan. See Appendix A, Annex C-1 for data points.

A.5.1.3 Access

Access to this area is from US 27 utilizing the A-1 FEB access road that connects the northeast corner of the A-1 to the recreation area by culverts. There is an existing east-west road, "Central Agricultural Road", that could provide direct access to the A-2 footprint, but this is projected to be degraded for the A-1 project. If new haul roads are needed, they will have to divert from the nearest public road and will be forward placed limestone displacing the underlying peat materials. Access within the A-2 FEB footprint will be accomplished using and improving existing local levees and roads.

A.5.1.4 Material Balance and Disposal

Cut and fill quantities will be completed during PED phase to balance the design as much as possible. Peat material will be used to dress levee slopes and could be utilized in Miami Canal tree island construction. Unsuitable material will be hauled to a certified land fill. If enough material is not available on site from the canal construction of C-624, C-624E, C-625E, C-625W, and C-626 to provide suitable levee construction material for L-624 and L-625, material may be brought from an offsite borrow area to construct the remainder of the levees. If excess material is generated from the construction, dispose of excess material first for recreation related features that require fill. Then dispose of remaining excess material by balance access roads, canal embankment improvements, or adding additional width for levee adjacent to excavation. Another disposal option would be to store the remaining excess material for future improvements onsite or either export to Miami Canal area for backfill.

A.5.1.5 Utility Relocations

Florida Power and Light lines will have to be relocated or abandoned from the center of the FEB. Additional utility lines will need to be provided for structures S-623, S-624, S-625, S-626, and S-628. The length and type will be determined during design.

A.5.2 GEOTECHNICAL DESIGN

The features presented herein represent elements of the Recommended Plan. Due to an absence of geotechnical investigation data, most of the current geotechnical design is based on assumptions about the subsurface conditions that will be encountered during construction. Preliminary or tentative design parameters and conditions presented below will need to be validated with site specific subsurface exploration which will be one of the first orders of work during the design phase. Enough construction has occurred over the years in South Florida and although the individual site conditions and the geotechnical design parameters associated with them may vary substantially, construction methods and practices used represent the general configurations that have performed satisfactorily in this region. Due to a general lack of subsurface information except at extremities of the features, detailed analyses are only of limited value for design at this stage of the project. It should also be noted that the final locations and the shape of many of the features is still in the developmental stage.

FEB structures S-625 and S-624 (culverts and siphon)

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project were assumed based on typical values for similar materials on COE projects in South Florida, empirical relationships from literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater investigations have been performed in the vicinity of this feature to date, nor are any anticipated during future design.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that the culvert structure foundations will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the culvert and siphon structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 6 inches in effective diameter can be loaded onto dump trucks and hauled to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 6 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be used at the Miami Canal filling area. The organic materials will then be disposed in an area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab

permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

FEB S-626 seepage pump station

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater investigations have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that the pump structure foundations will be founded on underlying limestone. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after receipt of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the culvert and siphon structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 6 inches in effective diameter can be loaded onto dump trucks and hauled to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 6 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be delivered to and used at the Miami Canal filling area. The organic materials will be disposed in an area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

New FEB Dikes and Canals

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date. Geophysical testing may be utilized in the design phase to locate solution cavity locations in the perimeter dike, interior levees and the FEB bottom for treatment.

c. Groundwater Studies. Black and Veatch 2006 performed hydraulic interval testing on five boreholes in 2005. However, additional field and laboratory hydraulic conductivity tests will be performed along with 2D/3D seepage analyses of the embankment and foundation system. A pump test in the FEB may be required.

d. Recommended Instrumentation. Vibrating wire piezometers through the crest and at the toe of the exterior dike at various stations along the dike perimeter may be required as part of the design of this feature.

e. Earthquake Studies. Due to the extremely low seismicity of South Florida, adverse effects to the FEB embankments are not anticipated. Nevertheless, a liquefaction screening analysis will be performed during the design phase to verify this assumption for this feature.

f. Preliminary foundation design and slope stability analyses. The dikes will be founded on underlying limestone after stripping and removal of surficial organic peats and organic silts. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. Slope stability analyses during the design phase will be required for the steady state and end-of-construction cases. A preliminary slope stability analysis has been performed for the FEB dike embankment with results provided in Appendix A, Annex G.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the dike foundation and canals areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Excavated inorganic cobbles and grains less than 3 inches in effective diameter can be processed and used as embankment fill. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock. Excavation of the top organic layers in the foundation is anticipated to be in a wet condition. As the fill materials are primarily cohesionless, a single vibratory steel drum with pneumatic tires at least 5 tons is expected to be used on this site.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as fill for the inner and exterior dikes. Pervious fill (<5% fine grained material) will be used as the bridging lift between the underlying foundation limestone and the groundwater surface. The bridging lift will be placed loosely into the excavated pit and pushed forward with dozers until satisfactory bearing is achieved for dry placement. The pervious material can either be imported or derived from processing canal borrow material. Above the groundwater level, satisfactory fill from the canal borrow material shall be placed in compacted lifts in the dry. Oversize particles greater than 3 inches in nominal diameter shall be crushed into satisfactory fill or used for erosion protection features. Excess inorganic material will be destined to be delivered to the Miami Canal filling area. The organics will be disposed in an area to be determined during the design phase. These may be used later for mixing and seeding of embankment erosion protection. Riprap and bedding materials required for erosion protection will be obtained from offsite sources unless suitable rock is found on-site. Riprap and bedding will be sized during the design phase based on design water velocities. Access roads and the FEB crest road will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. From previous studies in the EAA Reservoir to the east of the FEB, and from previous core boring logs from L-24 to the west, solution cavities are expected to be encountered in foundation grade for the perimeter dike, interior levees and FEB interior. Hydraulic tests are planned to minimize seepage losses in the FEB and protect against piping losses of embankment material from beneath the dike foundation. A preliminary 2D seepage analysis and site characterization is contained in Appendix A, Annex G. A seepage analysis evaluation will be performed during the design phase which will be integrated into the slope stability analysis. Seepage control systems will be utilized depending on the results of the seepage analysis. These could include toe drains, chimney drains or cutoff walls. A piping evaluation analysis will be conducted following the seepage analysis. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Geophysical mapping may also be used to identify the location of large voids in the dike foundation limestone and within the FEB. In the presence of such highly permeable cavities, some sort of filtering or impervious filling may be required to meet storage requirements for the FEB. Full scale pump tests in the FEB are recommended to capture the global permeability of the FEB subsurface materials. A granular filter or geotextile may be required to fill large voids lying within the dike foundation footprint to circumvent piping of embankment material through the foundation rock conduits.

A.5.2.1 General Status of Completed and Non-Executed Efforts

From experience with the adjacent EAA Reservoir A-1 facility design, there are unanswered questions as to the ability of the new FEB to retain the design storage levels. The geotechnical exploration program for the FEB will be extensive, costly and these costs should be anticipated in the budget estimates and design and construction schedules. Since no reservoir/FEB holding capacity evaluation was performed on this feature during the planning stage, it may be discovered during design that a seepage control system may be required and this eventuality should also be accounted for in the budget projections.

Summary of additional geotechnical exploration for all CEPP culverts, siphons, spillways and divide structures. Extremely limited or minimal geotechnical data is available for the site specific location of the structures in this project. Most if not all of these structures will be constructed, in part, below the groundwater table. Therefore, geotechnical explorations need to encompass dewatering features in addition to data required for facilities constructed at ground level. Each structure shall receive a minimum of two core borings consisting of standard split spoon sampling and auger drilling in soil and rock core barrel drilling in rock. At least one boring shall be deep enough to identify suitable bearing layers for deep foundations and establish the hydrogeologic properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength and density parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests.

Summary of additional geotechnical exploration for all CEPP pump station structures. Extremely limited or minimal geotechnical data is available for the site specific location of the structures in this project. Even though the existing pump station may have geotechnical data available, much of the available subsurface data was obtained using non-standard techniques and it is unlikely that the expansion of pump capacity will involve connection to the existing structure. All of these structures will be constructed, in part, below the groundwater table. Therefore, geotechnical explorations need to encompass dewatering features in addition to data required for facilities constructed at ground level. Each structure shall receive a minimum of two core borings consisting of standard split spoon sampling and auger drilling in soil and rock core barrel drilling in rock. At least one boring shall be deep enough to identify suitable bearing layers for deep foundations and establish the hydrogeologic properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests.

Summary of additional geotechnical exploration for the FEB embankments and all CEPP canals. Extremely limited or minimal geotechnical data is available for the site specific location of the FEB dike and interior levees and canals in this project. Much of the available subsurface data was obtained using non-standard techniques and is located outside the footprint of the FEB and dike/canal system. It is foreseen that the surficial organic materials under the dike footprint will be removed and replaced with

a pervious fill bridging lift below the groundwater table. Therefore, geotechnical explorations need to encompass dewatering features in addition to data required for facilities constructed at ground level. The FEB embankments will receive a minimum core boring at the crest and toe at a tentative spacing of 1000 feet. These borings shall consist of standard split spoon sampling and auger drilling in soil and rock core barrel drilling in rock. Borings shall be deep enough to identify soft layers in the foundation and establish the hydrogeologic properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests. A full scale pumping test with monitoring wells is recommended to be performed to establish the overall transmissivity of the FEB subsurface. Areas of canal excavation widening and deepening shall be explored with test pits. Samples shall be taken of excavated material for index testing as excavated material will become fill for other features of this project. Rip ability tests will be conducted in conjunction with the test pit exploration. Sporadic shallow core borings shall be drilled in the canal area to the depth of the canal to obtain rock samples for unconfined compression testing. Geophysical testing may be used to identify and map solution cavities in the FEB footprint and within the dike alignment. A test fill for embankment construction feasibility in the wet and a breakdown analysis of excavated limestone and soil after compaction will also be evaluated during the exploration program. Rock core samples may be mapped by digital photography to stochastically estimate porosity, permeability and filtration characteristics of limestone layers.

A.5.2.2 Soils

The soils in the EAA are primarily composed of peats and mucks (Bottcher 1994). Deep, clean sands characterize the area east of the Everglades and to the South of Lake Okeechobee with wet, gray or grayish-brown, sandy soils underlain by sandy clay cover the area west of the Everglades. The peat and muck soils, which are dark brown to nearly black, cover approximately 90 percent of the area being considered in the study area. They were formed in marshes or swamps by the partial decay of plant materials, with some admixture of mineral soil in the case of muck. Peat generally, consists of 65 percent or more organic material with relatively little mineral matter. Muck on the other hand, consists of 25 to 65 percent plant material mixed with sand, silt, and clay. The peat and muck soils may differ from each other in the kind of plant material that they contain, in the corresponding depths, and/or in the nature of the underlying material. The peat and muck may rest directly on limestone or on an intermediate layer of sand or marl.

The highly organic soils have been divided into four types: Okeechobee muck, Okeelanta peaty muck, Everglades peaty muck, and Everglades peat.

1) Okeechobee muck is a nearly black mixture of organic material and fine mineral soil. The organic portion of the soil is formed from the remains of water plants, while the mineral content probably results from the deposition of fine sediment during overflows from Lake Okeechobee.
2) Okeelanta peaty muck consists of finely fibrous, well-decomposed organic matter over a layer of black plastic muck; it usually overlies hard limestone.

3) Everglades peaty muck contains somewhat less mineral matter than Okeelanta peaty muck. The surface layer rests on brown, fibrous peat, and it usually lacks the subsurface layer of black plastic muck.
4) Everglades peat, the most extensive of the organic soils, is formed mostly from partially decayed sawgrass. The upper 12 inches is a nearly black, finely fibrous peat which contains approximately 10 percent mineral soil. The subsoil is brown, fibrous peat which rests on the underlying rock, sand, or marl.

Most of the characteristics, properties, and composition of the muck and peat soils depend on the fact that those types of soils are essentially mixtures of water and partly decomposed plant materials. When saturated, the soil is a little heavier than water. One of the outstanding characteristics of the peat soil is its light weight when dry. The oven-dry weight of peat is about 7 pounds per cubic foot, and the mineral content is about 10 to 15 percent by weight of the dry material. Another important property is the high shrinkage value. Peat soils will shrink as much as 75 percent of their original volume when dried, and will not expand to their original volume when water is added.

Another important property is their high propensity for water retention. Peats vary considerably in that respect, depending on their origin, degree of decomposition, and chemical composition. While a dry mineral soil will absorb and hold from 20% to 40% its weight of water, a peat soil will retain many times its dry weight of moisture, depending on conditions. On an oven-dry weight basis, some of the peats have as much as 1,200 percent water when saturated, with the average having about 750 percent.

Laboratory permeability tests and field pumping tests indicate that seepage through peat soil is much greater vertically than horizontally. That can reasonably be attributed to the fibrous nature of the soil and its characteristic vertical root channels. Peat and muck material presented in less recent geotechnical exploration reports provide a general idea of the thickness of organic surface materials in the region. However, there are selected areas where the organic soil has been reduced due to recent construction, development, fire, erosion, compression, or removal. In other areas, there may be accretion of organic materials. Where peat is encountered in the borrow area, it would be removed and not used as construction material. The available geotechnical information indicate suitable materials for embankment construction and other fills, mainly interbedded sands and/or marls with limestone, are available throughout the project area. In some areas, in-situ materials may have to be processed to achieve feature performance requirements.

Seepage movement in the Everglades is largely through the porous rock and sands beneath the peat. . In some areas, marl, consisting of fine sandy silt derived from neighboring limestone occurs. Marl soils tend to be quite impermeable, and act as a seal that retards movement of water.

The sands, in general, are fine-grained and poorly graded having intermediate coefficients of permeability. The marl soils are widely distributed under the organic soils, and in places are consolidated into a hard limestone just under the peat. Usually, however, the marl is a soft, grayish-white, calcareous silt of fresh-water origin. Other marls, with inclusions of sand, silt, clay, and shell, appear within the area.

A.5.2.3 Geology

The character of the marginal marine sediments changes from north to south of the Redline. North of the Red Line within Palm Beach County, the sediment thickness consists of poorly consolidated marine

limestone, quartz sandstone, and sandy limestone with abundant mollusk fossils (Reese and Wacker, 2009) and is known as the Fort Thompson Formation.

A surficial aquifer system in the southeastern portion of the Redline is wedge shaped, thickening eastward toward the Atlantic Ocean. The surficial aquifer system (Fish, 1988; Fish and Stewart, 1991) comprises a sequence of highly permeable limestone, quartz sand, shell, and terrigeneous mudstone of Pliocene to Holocene age **Figure A-1**). The sand content of the surficial aquifer system is high in the far southeastern corner of the EAA.

FIGURE A-1. SURFICIAL AQUIFER SYSTEM

Base and extent of the surficial aquifer system in south eastern Florida. Modified from Fish (1988), Shine and others (1989), and Fish and Stewart (1991).

The surficial aquifer system has been divided into separate aquifers and semiconfining (leaky) units of quartz sand, terrigeneous mudstone, and limestone (Fish, 1988; Fish and Stewart, 1991). The Fort Thompson Formation, Anastasia Formation, and Key Largo Limestone yield the most water and constitute the prolific Biscayne aquifer. The Biscayne aquifer does not extend into central and northern Palm Beach County but does encompass the very southeastern portion of the EAA north of the Red Line.

Although karst features have not been documented in Palm Beach County, a "cavity-riddled" zone (Fischer, 1980) is likely associated with karst dissolution.

Prior to the development of the EAA, peat deposits (resting on top of the surficial aquifer) ranged from 6 to 17 ft thick (Stephens and Johnson, 1951). Peat deposits thinned where they extend southward south of the Redline. Near the boundary of the Red Line (the northernmost part of the Everglades), a calcareous marl sequence separates the peat deposit from underlying limestone bedrock; freshwater marl is considered indicative of a shorter hydroperiod that cannot support peat accumulation (Gleason and others, 1984). Drainage works in agricultural areas designed to control flooding south of Lake Okeechobee (north of the Redline) have contributed greatly to oxidation- and compaction-driven subsidence of peat deposits (Renken and others, 2013). Subsidence ranged from 3 to 9 ft in the EAA.

Black and Veatch, 2006 conducted a massive three-volume study for South Florida Water Management District by performing nearly 235 borings and geotechnical laboratory tests within the A-1 FEB to characterize subsurface conditions for embankment design, embankment stability, settlement, seepage analyses and to provide information for identifying potential borrow materials (ANNEX G-1). Some of the borings were converted to piezometers. Generalized results of the geotechnical investigation revealed the following:

*Limestone caprock that was interpreted to be top of Ft. Thompson Formation. Most thicknesses ranged from 3.5 to 6 feet although thickness to 9.2 feet is not uncommon. Unconfined compressive strengths ranged from 433 to 9,768 pounds per square inch (psi) with an average of 2,938 psi.

*Silty sand (below caprock) had averaged carbonate content of 83.6 percent.

*Lower limestone layer (below silty sand) varies 1 to 6 feet thick. Average Rock Quality Designation (RQD) was 18.5 percent.

*Shelly, fine, uniform, subrounded quartz sand (below lower limestone layer) interpreted to part of the Caloosahatchee Formation and Pinecrest Sand.

*Interpreted Ochopee Limestone (below shelly quartz sand). Average depth to top of limestone was 74 feet.

*Unnamed Sand Formation (below Ochopee Limestone) consisting of silty sand.

Because the volume of borings and laboratory testing is so great, the reader is referred to the Black and Veatch 2006 three-volume report for more details.

Ardaman and Associates, 2002 conducted one known boring within the proposed A-2 FEB footprint in the EAA to 180 feet depth (ANNEX G-1). The shallow portion of the boring indicates a massive hard limestone from 8.8 ft to -12.0 ft North American Vertical Datum of 1988 (NAVD88). Below this rock unit are interbeds of sand (poorly graded and silty) sitting on top of a thin limestone layer. From -90 ft to -131 ft NAVD is a massive sandstone unit which overlies a poorly graded sand layer.

Despite the geological information presented north of the Red Line, significant data gaps do exist. Further geological investigations are needed for the proposed A-2 FEB for the proposed structures for this area.

A.5.2.4 HTRW

The A-2 FEB is a 14,000 acres parcel of land. The land is presently dry and it is proposed to be inundated with water.

South Florida Water Management District (SFWMD) completed a draft Summary Environmental Report for the A-2 FEB, dated 21 August 2012. The Summary Environmental Report documents that all known point sources on the property have been addressed. The Florida Department of Environmental Protection (FDEP) has issued Site Rehabilitation Completion Orders (SRCO) for all known point sources within the project boundary. A copy of this report is included in the main PIR, **Annex H**.

To address the lack of sampling results for the cultivated areas of the A-2 parcel, the SFWMD conducted limited soil sampling in the winter/spring of 2013. With agreement of the USFWS, the sampling density was set at 10 percent of the 50 acre grids rather than the typical 30 to 50 percent typically specified per the *Protocol for Assessment, Remediation, and Post-Remediation Monitoring for Environmental Contamination on Everglades Restoration Projects* (the ERA Protocol), dated March 13, 2008 (A copy of this protocol is in the main PIR, **Annex H**. SFWMD analyzed 30 composite samples from the 14,000 acre site for pesticides, herbicides, total organic carbon and metals following a stratified random approach. The laboratory result indicate that some of the site soils have residual arsenic, barium, cadmium, chromium, copper, mercury, selenium, 2-4-D, atrazine, metribuzin, phorate, and dieldrin. The USFWS and FDEP have preliminarily determined that the residual agricultural chemicals found on the A-2 FEB lands do not present a risk to protected resources. Based on the results of the 2013 soil testing, the USFWS and FDEP are recommending that during the initial operations of the FEB, the SFWMD perform testing of water for several contaminants (2,4, D, atrazine, metribuzin, phorate, dieldrin, chromium, mercury, selenium, copper) as well as testing of periphyton and apple snails for copper. The FDEP also recommended the development of a soil management plan to address the fate of arsenic impacted soils during construction as well as the same start-up operations sampling program as provided by the USFWS. The FDEP and the USFWS both recommended that agrochemical best management practices be instituted during the continued cultivation of the lands.

The A-2 lands will remain in agricultural production for several years until the A-2 FEB is set for construction at which time the agricultural leases will be terminated. Once farming has ceased on the project lands, an Exit Assessment will be performed to determine the presence of any new potential sources of HTRW since the completion of the previous Phase II ESA, and to verify the concentration of contaminants in the cultivated areas at selected locations. The results of these audits will be provided to the FDEP and USFWS for their review, comment, and concurrence regarding the need for remedial actions. The assessment of the project in relation to the CERP Residual Agricultural policy is included in the main PIR **Appendix C.2.2**. Should remediation of HTRW contamination be required, it is the responsibility of the SFWMD, the non-Federal, sponsor and is not a creditable cost to the project.

A.5.3 HYDRAULIC DESIGN

A.5.3.1 General Status of Completed and Non-Executed Efforts

Features identified in the Recommended Plan have been designed to the level of detail necessary to provide cost estimates and determine feasibility of hydraulic design. All components north of the redline have been identified and sized appropriately according to available modeling data, historic information, and best engineering judgment. All project components will be optimized during PED

phase for cost efficiency and performance, incorporating updated data and information as it becomes available. General hydraulic design of all identified components north of the redline are described in the following sections.

A.5.3.2 Hydraulic Design - General

This section provides a brief overview of the hydraulic design criteria, parameters, and intent/purpose of project features. Detailed hydraulic design of individual components is described in later sections, including hydraulic design data sheets. Detailed analysis resulting from model simulations may be found separately in Appendix A, Annex A-1. Currently, all elevations are referenced to NGVD 29; elevations will be provided in both NGVD 29 and NAVD 88 when revised during PED.

The Value Engineering (VE) workshop held in February 2013 generated some new ideas, some with less cost, and some with greater cost. However, workshop results and conclusions were not addressed nor included in the hydraulic design appendix herein due to time and schedule constraints. Refer to Section A.10 Value Engineering for more information.

A.5.3.2.1 Design Criteria and Parameters

A.5.3.2.1.1 Canals

Canal side slopes are generally steeper than is found in many sandy regions. This is due to the limestone geology allowing for near vertical slopes in some locations. Generally, there is a preference for some slope in case of sand lenses and well weathered limestone that with time deteriorates to gravel and sand sizes, therefore most canal side slopes are 1V:2H.

A.5.3.2.1.1.1 Manning's Roughness Coefficient Determination

A Manning's roughness coefficient, or n value, of 0.035 was used for canal design in conveyance of design flows. The Palm Beach County region where the CEPP components and canals will be constructed has geological features characteristically described as limestone covered with a relatively thin layer of overburden (peat, marl, muck). The canals will most likely be constructed by blasting with excavation or possible dragline operations. These types of excavation methods leave a relatively coarse bottom and bank with sharp edged rocks and rubble. With canal age or maturation, some of these irregularities will become less defined resulting in a smoother perimeter with lower roughness values. Aquatic growth is expected along the upper banks where the overburden lies, but the design depths should be relatively free of plant roots extending from bottom to surface obstructing flow. Floating plants will be controlled by spray and harvest methods. The Manning's n value used was obtained from investigating various sources and noting them as follows.

In C&SF Project General Studies and Reports, Part I, Supplement 18, the following was noted; a value of at least 0.035 should be used where channels are constructed primarily in rock. This value is for channels with no appreciable erosion and with rapid-growth vegetation along the upper banks because of the organic soil overburden. Other sources provide Manning's n values within the same ranges as SCS and USGS for similar type canals. Brater and King's Handbook of Hydraulics, 7th ed., provides an n value of 0.035 for canals with rough stony beds and weeds on earth banks in fair condition. From the preceding investigations, and experience at the Jacksonville District in Florida, a Manning's n value of 0.035 appears to be appropriately applied to the design to satisfy criteria outlined by all referenced sources as the minimum acceptable value.

In detail design phase, the canal parameters may be modified for optimal benefit cost ratio.

A.5.3.2.1.2 Head Loss

Due to the relatively flat topography throughout the project area, the hydraulic head losses across many of the control structures are low, resulting in the design of larger structures (number and size of barrels, bays, etc.) than may typically be assumed for other regions. The use of pumps was avoided wherever possible to reduce operation and perpetual maintenance costs. During PED phase, USACE Jacksonville District (SAJ) expects to optimize system operations and therefore structure sizes for cost and performance efficiencies.

A.5.3.2.1.3 Flow and Velocity

Design flow rates for all water control structures were determined based on Regional Simulation Model for Basins (RSM-BN) model outputs and existing canal and structure capacities. To capture cost impact adequately, structures and canals were designed for maximum capacity scenarios. Optimization of these features will be conducted during the PED phase for performance and cost efficiency.

Canals were designed to maintain a velocity of 2.0 fps or less to avoid potential erosion damage. Given the small topographical relief of the project area, this is typically the condition under normal operations, regardless.

A.5.3.2.1.4 Water Control Structures

The proposed plan north of the redline will have multiple water control structures throughout the project areal extent (S-623, and FEB structures S-624, S-625, S-626, S-627, S-628). The function of the control structures are for impoundment inlet, impoundment outlet discharge to major canals, discharge into the adjacent A-1 FEB, and seepage return. The A-2 FEB inlet structure, S-624, was sized to match the existing in-bank capacity of the Miami Canal of 1,550 cfs when diverting flows from Lake Okeechobee into the FEB. This value was determined by using Miami Canal survey data previously collected for prior EAA studies. That capacity for the discharge structure S-625 was also determined based on this data, as well as RSM-BN model results. The inflow/outflow structure S-628, which hydraulically connects A-1 and A-2 FEBs was designed for a total capacity of 930 cfs. Structure S-623 is a gated spillway in line with the STA 3/4 Supply Canal, at the intersection with the Miami Canal. The structure will serve as a divide structure when the A-2 FEB discharges into the existing STA 3/4 Supply Canal. During these discharge periods, S-623 will be closed to prevent Miami Canal flows from mixing with pretreated FEB discharges for water quality objectives. S-623 has been sized to match the capacity of existing G-372 at 3,700 cfs. Seepage collection will be obtained using seepage pump S-626, which is sized to 700 cfs based on estimated seepage rates and design redundancy.

Hydraulic design data sheets for all structures are located at the end of the A.5.3 Hydraulic Design section. Detailed analysis of these structures can be found in Appendix A, Annex A-1.

A.5.3.2.1.4.1 Gated Culverts

The entire CEPP project includes numerous gated box culverts across the entire project area. Construction material for all culverts is to be cast in place concrete.

An entrance loss coefficient value of 0.9 (assumed due to gate-added turbulence around inlet) and exit loss coefficient of 1.0 was used for all gated culvert structures. Also, the Manning's friction or energy

loss coefficient was assigned 0.013 for all culverts. All major conveyance culverts were designed to remain submerged year round to reduce aquatic growth within, thereby better maintaining design friction head losses. All gated culvert sites were designed with a minimum of two culverts to allow maintenance activities to coincide, however with reduced capacity operations.

No attempt has been made to date in standardizing gates sizes to the extent possible due to report time and schedule constraints. For example, one box culvert structure calls for 3-9x9 gates and another nearby calls for 2-11x11 gates. Potentially, the 3-9x9 purposes can be met with 2-11x11 gates as well. This may reduce overall number of gates, reduce number of gate-types, and required spares and training; thereby, having less long-term O&M costs. During PED, the final design will include gate/culvert size optimization as much as possible to reduce long-term costs and promote efficiency in the non-Federal sponsor maintenance program.

A.5.3.2.1.4.2 Gated Spillways

The CEPP Recommended Plan includes the design of an ogee weir concrete spillway with steel vertical lift gates located in line with STA 3/4 Supply Canal, at the intersection with the Miami Canal.. The spillway was designed to be in conformity of engineering guidance found in USACE EM-1110-2-1603. All ogee spillways have vertical gates for controlled discharge operations. The spillway was designed with minimal head differential for conveyance energy. The S-623 spillway was designed with a 0.1 foot head differential. This was a design constraint supported by the following reasons: (1) flat terrain topography, and (2) Miami Canal's control stage range limitations given the proposed location of the spillway. SAJ acknowledges this low design head differential constraint and optimization will be required, including Value Engineering appropriate structure type for this function.

A.5.3.2.1.4.3 Emergency Discharge Structures

Emergency overflow spillways are non-gated non-mechanical structures that do not require human intervention for uncontrolled discharge operations. The benefits of an emergency overflow spillway for impoundments are primarily twofold: one being economics and the other being safety for the public downstream of a potential, though highly improbable dam breach. The spillway allows excess water to be discharged from the impoundment, thus lowering the maximum surcharge pool level where the superiority is measured from the design conditions applied, i.e. wind speed(s). However, the implementation of an emergency overflow spillway removes errors in human operations and mechanical failures from the equation for known causes of some historic dam failures. Also, should some particular or sequence of events unforeseen occur because of remote possibilities, it is considered far more advantageous to allow excess water out before a catastrophic breach can occur. The S-627 overflow spillway serves as the A-2 FEB emergency discharge structure.

A.5.3.2.1.4.4 Pump Stations

The CEPP Recommended Plan proposes to construct a new seepage collection pump station, S-626, for seepage management. The pumping rate of 500 cfs was established to accommodate the peak estimated seepage inflow rate of 400 cfs, as well as provide additional capacity for possible high flow events. Additionally, the G-370 and G-372 pump stations will be used to serve as FEB inflow pump stations.

A.5.3.2.1.5 Embankments

The FEB at this time carries a low hazard potential classification (HPC) per DCM-1, which is extended to embankment design. Embankment top widths are 14 feet wide per DCM-4, with dam heights based on analysis of the following criteria (ER-1110-8-2(FR), ER-1110-2-1156, DCM-2, and risk). Section A.5.3.3.2.1.5 Other Features, Emergency Overflow Spillway discusses the details of the flood routing for design in greater depth.

1. Three feet above the maximum surcharge pool elevation. The maximum surcharge pool elevation is based on the greatest elevation resulting from the following storm routings:
    a. The Inflow Design Flood (IDF), which is identified as the 100-yr 24-hr storm event for the CEPP FEB, per DCM-2;
    b. The 50% 72-hr PMP per ER-1110-8-2(FR); and

Wind setup and wave run-up analysis on critical fetch lengths with the impoundment at full pool. Wave run-up is dependent on levee slope (steeper slopes have higher run-up).

A.5.3.3 Flow Equalization Basin

A.5.3.3.1 General Information

The CEPP features north of the redline consist of the construction of an FEB and associated infrastructure. All north of the redline components are within Palm Beach County, north of Water Conservation Area (WCA) 3A.

The CEPP project features a 14,000 ac 4-foot deep, above ground flow equalization basin. Other design features include inflow canals, collection canal, outflow canal, seepage pump stations, gated culverts, gated spillway, an emergency overflow spillway, and a perimeter seepage control canal.

TABLE A-2. A-2 FEB DESIGN ELEVATIONS

Parameter	Elevation, ft NGVD (NAVD)
Top of levee	20.30 (18.9)
Average Natural Grade	9.00 (7.6)
Maximum Surcharge Pool	15.15 (13.75)
Maximum Normal Pool	13.00 (11.6)

*Levee crest elevation of 20.30 ft NGVD was used throughout the features based on available information at the time of design. Revisions made to the levee crest elevation will be incorporated into the final design during PED.

TABLE A-3. A-2 FEB STORAGE CALCULATIONS

Storage Area	14,000 acres
Maximum Normal Pool Depth	4 feet
Storage	56,000 ac-ft
Fill/Drawdown Rate at 1,550 cfs at 4 ft depth	0.22 ft/day
Time to Fill/Drawdown 4 feet at 1,550 cfs	18.2 days

A.5.3.3.1.1 Purpose

The purpose of the A-2 FEB, which will be operated in conjunction with the use of the A-1 FEB (designed and constructed by the SFWMD) is to capture additional water from Lake Okeechobee for delivery to the Everglades, while maintaining the capability to treat the existing EAA runoff and limited Lake

Okeechobee discharges. The integrated FEB operations will be able to accept and provide some water quality pre-treatment of additional water from Lake Okeechobee during off-peak times, such as the dry season, when treatment capacity is available in the downstream STAs.

A.5.3.3.1.2 Location

The A-2 FEB is located in Palm Beach County, between the Miami Canal and North New River Canal, and north of Water Conservation Area (WCA) 3A. It is adjacent to the western boundary of the A-1 FEB. The inflow to the impoundment begins about 1.5 miles east of G-372 pump station.

A.5.3.3.1.3 Features

The CEPP project has the following features north of the redline:

Structures:
S-624 Gated Culvert (DS-5)
S-625 Gated Culvert (DS-7)
S-623 Gated Spillway (DS-8)
S-628 Gated Culvert (DS-9)

Canals:
C-624 FEB Inflow Canal
C-624E FEB Spreader Canal
C-625E FEB Collection Canal
C-625W FEB Discharge Canal
C-626 FEB Seepage Collection Canal

Pump Stations:
S-626 Seepage Collection Pump

Other Features:
S-627 Emergency Overflow Spillway (CS-4)

Figure A-2 illustrates all feature locations for North of the Redline (structures and canals are not to scale or geographically referenced). Figure A-2.1 shows the A-1 FEB Final Layout. Detailed design analysis for all hydraulic components north of the redline can be found in supplemental documents located in Appendix A, Annex A-1.

FIGURE A-2. A-2 FEB LAYOUT

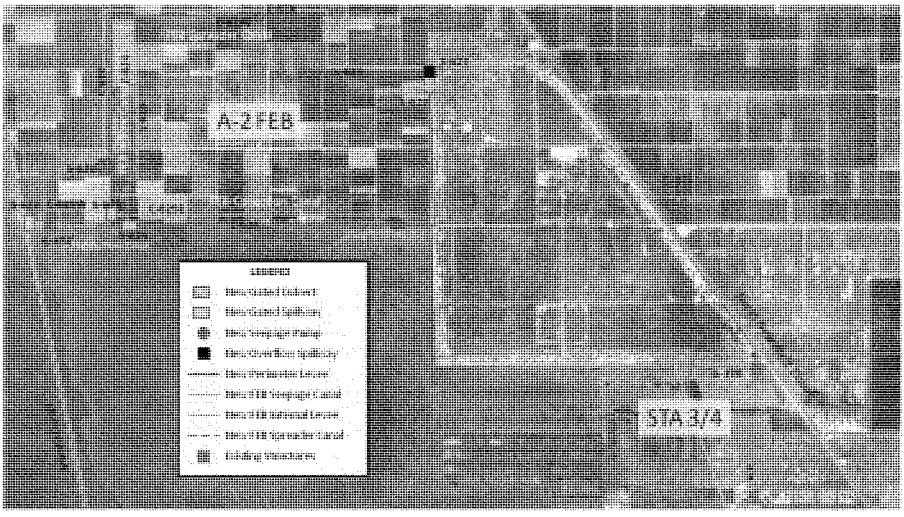
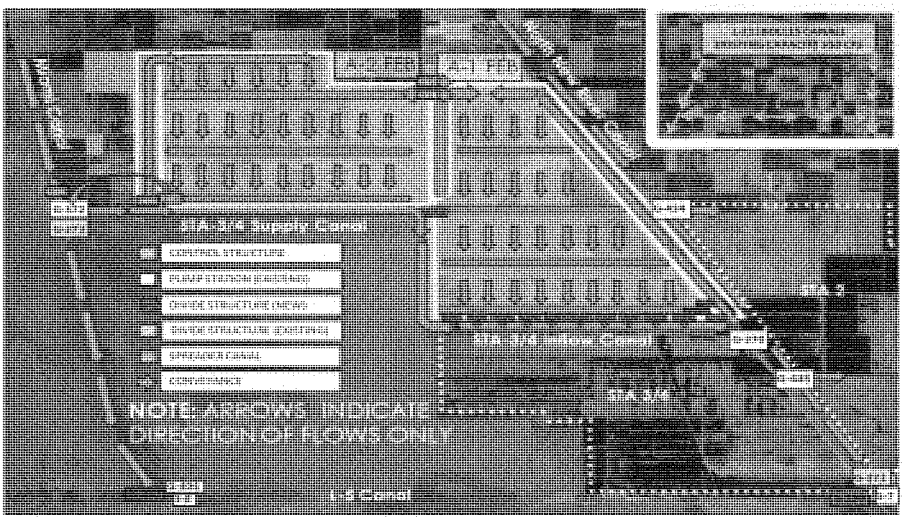


FIGURE A-2.1 FINAL A-2 FEB LAYOUT WITH EXISTING A-1 FEB



A.5.3.3.2 Hydraulic Design

A.5.3.3.2.1 Proposed Water Control Structures

A.5.3.3.2.1.1 Gated Culverts

S-624 Gated Culvert

The S-624 structure is a gated sag culvert (inverted siphon) that serves as the controlled inflow into the A-2 FEB. This structure will operate in conjunction with the existing G-372 pump station to route flows from the Miami Canal into the impoundment. The structure will open for inflow operations into the FEB from G-372, and will close during A-2 FEB by-pass operations (flow directly to STA 3/4 or the A-1 FEB) or to prevent back flow into STA 3/4 Supply Canal. S-624 is a two-barreled, gated sag culvert with four 45 degree bends. The culverts will run from the STA 3/4 Supply canal, beneath the FEB discharge/collection canal, and into the FEB inflow canal/flowway. The design flow is 1,550 cfs with a design hydraulic head of 2.5 feet resulting in a design velocity of 6.75 fps. This velocity was targeted in design to provide a scour velocity to clean out culverts, thereby reducing periodic maintenance requirements. The structure is a two barreled cast-in-place concrete box culvert with dimensions of 11 ft by 11 ft each with vertical slide gates, and a total length of approximately 350 ft. The upstream invert is set at elevation -4.50 ft NGVD, 0.5 feet above the existing bottom elevation of the STA 3/4 Supply Canal. The downstream invert is set at elevation 0.50 ft NGVD, 0.5 feet above the proposed bottom elevation of the FEB Inflow Canal. The S-624 structure is designed to cross beneath the existing collection canal (invert elev. 0.00 ft NGVD) with a vertical clearance of 3 feet, resulting in a minimum barrel sag invert of -14.00 ft NGVD. S-624 is located near the southwest corner of the A-2 FEB, east of the G-372 pump station.

S-625 Gated Culvert

S-625 is a discharge structure from the A-2 FEB. This structure will open to allow for the FEB to discharge towards the headwaters of the G-372 pump station to provide hydraulic lift for redistribution through the STA 3/4 Supply Canal and for delivery to STA 3/4. S-625 is a three barreled gated box culvert structure with dimensions of 9 ft by 9 ft with vertical slide gates, and total length of 140 feet. The upstream invert is set at elevation 0.50 ft NGVD, 0.5 feet above the invert of the existing collection canal. The downstream invert is set at elevation 0.50 ft NGVD immediately entering the FEB Outflow Canal; however the canal tapers to a bottom elevation of -5.00 ft NGVD at a slope of 1V:5H. The design flow is 1,550 cfs with a design hydraulic head of 1.0 foot. The design velocity through the structure is 6.5 fps. S-625 is located in the southwest corner of the FEB in line with the western perimeter levee.

S-628 Gated Culvert

S-628 is a bi-directional inlet and outlet structure that hydraulically connects the A-2 FEB to the A-1 FEB. This feature will allow water to be passed between the A-2 and A-1 FEBs, depending on impoundment stages and capacity. Water from the Miami Canal could potentially be routed through the A-1 FEB by use of this structure. The opposite operation can occur, using water routed through A-1 from the North New River Canal via G-370 pump station and G-15 to supplement water in A-2. S-628 is a two-barreled gated box culvert with dimensions of 9 ft by 9 ft with vertical slide gates. The design flow is 930 cfs (60% of total A-2 inflow, assuming only partial flow would be conveyed between impoundments) with a design hydraulic head of 1.0 foot. The upstream and downstream barrel inverts are set at elevation 1.50 ft NGVD. The design velocity through the structure is 5.75 fps. S-628 is located in the northeast corner of the A-2 FEB, in line with the A-2 eastern perimeter levee. During PED, the feasibility of utilizing a single 11 ft by 11 ft box or vertical sluice gates (spillway) will be investigated.

A.5.3.3.2.1.2 Gated Spillways

S-623 Gated Spillway

The S-623 spillway will serve as a divide structure to separate pre-treated FEB waters from untreated waters of the Miami Canal to maximize incidental water quality value of the flow-through impoundment. When open, S-623 will allow for the normal operations of the G-372 pump station to route Miami Canal water, or when closed can be used to route pre-treated FEB water through the STA 3/4 Supply Canal to STA 3/4. S-623 is a four-bay gated spillway. The design flow is 3,700 cfs with a design hydraulic head of 0.25 feet. The design flow was established to match the existing capacity of the G-372 pump station downstream at 3,700 cfs. The spillway consists of four gates with dimensions of 35 ft wide by 14 ft high. The crest invert elevation is set to 3.50 ft NGVD. The upstream and downstream aprons are set at an elevation of -2.00 ft NGVD, with an apron length of 36 feet. S-623 is located in line with the STA 3/4 Supply Canal, west of the G-372 pump station. During PED, a Value Engineering investigation will be performed to optimize structure type and size for this design function.

A.5.3.3.2.1.3 Canals

C-624 FEB Inflow Canal

The C-624 canal is the A-2 FEB inflow canal. The canal is located east of the G-372 pump station inside the A-2 FEB western boundary. The canal is excavated in the flowway between the exterior FEB perimeter levee and the interior levee. The canal has a bottom width of 40 feet, with 1V:2H slopes up to the top of bank at natural grade (9.00 ft NGVD), with a 20 foot wide bench on both sides. The levees extend from the bench at a slope of 1V:3H. The Manning's n value for banks and channel was 0.05 and 0.035, respectively. Design data for C-624 is summarized in **Table A-4** and **Table A-5**. The length of the canal is approximately 4 miles (21,120 feet), beginning at the FEB interior levee and ending at the northern boundary of the FEB, which transitions into C-624E Spreader Canal.

TABLE A-4. C-624 GRAVITY INFLOW CANAL

Design HW	Design TW	Length	Side Slope L/R	Canal Bottom Width	Natural Ground	Canal Bottom Elevation	Average Depth
Ft, NGVD	Ft, NGVD	Feet	1V:?H	Feet	Ft, NGVD	Ft, NGVD	Feet
14.25	13.00	21,120	1:2/1:2	40	9.00	0.00	9.00

TABLE A-5. C-624 GRAVITY INFLOW CANAL
SUMMARY OF HYDRAULIC DESIGN DATA

Station	Design Water Surface Elevation	Flow Area	Mean Channel Velocity
	Ft, NGVD	sq ft	fps
RS 0 (Downstream)	13.00	1034.00	1.74
RS 4224	13.30	1076.65	1.68
RS 8448	13.58	1115.70	1.63
RS 12672	13.83	1151.84	1.58
RS 16896	14.06	1185.56	1.55
RS 21120 (Upstream)	14.27	1217.21	1.51

C-624E FEB Spreader Canal

The C-624E canal is a spreader canal that runs along the northern boundary of the A-2 FEB for approximately 4 miles. The canal will receive flows from the FEB inflow canal and will create an even distribution of water cross the northern part of the impoundment. No head losses were assumed for this canal; the water surface profile was designed to be uniform throughout the length of the canal in order to achieve the uniform distribution. The right bank (southern bank) of the spreader canal was set at elevation 9.25 ft NGVD to provide a small berm above natural grade (9.0 ft NGVD), creating a small driving head to create sheet flow downstream at shallow depths. Design data for C-624E is summarized in **Table A-6**. Optimization of the spreader canal design will be conducted during PED.

TABLE A-6. C-624E SPREADER CANAL

Length	Side Slope L/R (N/S)	Canal Bottom Width	Average Ground	Canal Bottom Elevation	Left bank (north) elevation	Right bank (south) elevation
Feet	1V on ?H	Feet	Ft, NGVD	Ft, NGVD	Ft, NGVD	Ft, NGVD
21,120	1:2/1:2	275	9.00	-10.00	9.00	9.25

C-625E FEB Collection/Discharge Canal

The C-625E canal serves as the FEB collection canal along the southern boundary of the FEB. The canal is currently the seepage canal for the existing STA 3/4 Supply Canal. When stages in the FEB are low, sheet flow will collect in C-625E and will be conveyed to S-625 discharge structure. When the FEB experiences greater depths, the C-625E will be completely submerged, but will still provide conveyance assistance to the S-625. Existing data for C-625E is summarized in **Table A-7**. The C-625E canal template will not be modified within the FEB footprint.

TABLE A-7. C-625E COLLECTION CANAL EXI5TING CONDITION5

Length	Side Slopes	Canal Bottom Width	Canal Bottom Elevation	Left bank (south) elevation	Right bank (north) elevation
Miles	1V on ?H	Feet	Ft, NGVD	Ft, NGVD	Ft, NGVD
6.0	1:2	10	0.00	20.30	9.00

C-625W FEB Discharge Canal

The C-625W canal serves as the FEB discharge canal, extending from the S-625 discharge structure to the headwater of G-372 pump station. The existing canal currently serves as the seepage canal for the STA 3/4 Supply Canal, but will be modified to accommodate the FEB discharges. The existing canal will be extended northward and westward of the G-372 pump station to create a tie-in at the headwater of the structure. The canal will have a 1V:5H transition from elevation 0.0 ft NGVD where outlet structure S-625 ties into the canal, down to elevation -5.0 ft NGVD for conveyance capacity purposes. Design data for C-625W is summarized in **Table A-8** and **Table A-9**.

TABLE A-8. C-625W FEB DISCHARGE CANAL

Design HW	Design TW	Length	Side Slopes	Canal Bottom Width	Natural Ground	Canal Bottom Elevation	Average Depth
Ft, NGVD	Ft, NGVD	Feet	1V:?H	Feet	Ft, NGVD	Ft, NGVD	Feet
11.00	10.0	7,900	1:2	20	9.00	-5.00	14.0

TABLE A-9. C-625W FEB DISCHARGE CANAL COMPARISON OF CANAL IMPROVEMENTS

Station	Existing Canal at 1550 cfs				Improved Canal at 1550 cfs			
	WSE	Channel Invert	Mean Channel Velocity	Flow Area	WSE	Channel Invert	Mean Channel Velocity	Flow Area
	Ft, NGVD	Ft, NGVD	fps	Sq ft	Ft, NGVD	Ft, NGVD	fps	Sq ft
7900	14.61	0.0	2.55	607.58	10.94	-5.0	1.87	826.89
6000	14.04	0.0	2.75	562.87	10.73	-5.0	1.91	809.87
4000	13.26	0.0	3.07	505.60	10.51	-5.0	1.96	791.03
2000	12.15	0.0	3.61	429.15	10.26	-5.0	2.01	771.13
0	10.00	0.0	5.09	304.55	10.00	-5.0	2.07	750.0

C-626 FEB Seepage Collection Canal

The function of the perimeter canal is for seepage collection from the FEB. A series of small agricultural canals currently border the FEB configuration and will be improved to match the current design canal template. Analysis of necessary improvements will be conducted upon receipt of survey data during PED phase. The new perimeter canal will capture seepage and route to a seepage pump station near the southwest corner of the FEB. The design seepage rate is 387 ft^3/day/ft of levee at normal pool depth of 4 feet. A factor of safety of 1.5 was applied, producing a rate of 580.9 ft^3/day/ft of levee, or 0.0067 cfs/ft of levee. The total length of the seepage canal is 11 miles (58,080 ft), which translates into a maximum seepage rate of approximately 390 cfs.

In concurrence with common local agricultural operating procedures, the perimeter seepage canals will be controlled approximately 2.0 ft below average grade in the FEB, at elevation 7.0 ft NGVD. The canal has a bottom elevation of -5.5 ft NGVD, bottom width of 15 ft, side slopes of 1V:2H, and a depth of 14.5 feet. A seepage analysis has been conducted by the USACE Geotechnical Engineering Branch (EN-G) to verify the bottom depth for appropriateness.

TABLE A-10. C-626 SEEPAGE COLLECTION CANAL

Length	Side Slope L/R (S/N)	Canal Bottom Width	Canal Bottom Elevation	Left bank (south/east) elevation	Right bank (north/west) elevation
Miles	1V on ?H	Feet	Ft, NGVD	Ft, NGVD	Ft, NGVD
11.0	1:2/1:2	15.0	-5.50	9.00	9.00

TABLE A-11. C-626 SEEPAGE COLLECTION CANAL
SUMMARY OF HYDRAULIC DESIGN DATA (SEEPAGE FLOW)

Station	Channel Design Flow	Mean Channel Velocity
	Cfs	fps
RS 0	391.46	0.74
RS 14500	292.19	0.57
RS 29000	196.47	0.39
RS 43500	95.09	0.19
RS 58000	5.0	0.01

A.5.3.3.2.1.4 Pump Stations

S-626 Seepage Collection Pump

The S-626 structure is the seepage return pump for the A-2 FEB with a total pumping capacity of 700 cfs (500 cfs to accommodate seepage requirements and 200 cfs for design redundancy). The pump station is designed to pump seepage captured in the C-626 Canal. The seepage pump station will be equipped with two 150 cfs electric motor driven pumps and two 200 cfs diesel engine driven pumps that can be used as an alternative method of pumping during commercial power outages or when electric power has high peak demands. The diesel engine drive pumps can also provide additional capacity for high-flow events. Although the peak discharge through the seepage canal is approximately 400 cfs, two 150 cfs electric motor driven pumps were chosen due to the infrequency of higher FEB stages as determined by RSM-BN modeling results for Alternative 4R2 **(Figure A-3**: Depth Exceedance Plot). During times when 400 cfs is needed, a combination of electric motor driven pumps and diesel engine driven pumps can be utilized to meet those needs. The pump station will discharge into the C-625W to be conveyed to the headwater of G-372 pump station. Use of the G-372 seepage pump with an existing design capacity of 150 cfs may be considered as a potential option to reduce the size of the S-626 pump station. Further analysis and optimization of the design will be conducted during PED.

Pump Rates

The S-626 pump station will return seepage intercepted in the FEB seepage canal back to the existing G-372 pump station. The pumping rate was determined based on a seepage rate provided by EN-G, with a factor of safety of 1.5 applied to determine an adjusted seepage rate of 580.9 ft^3/day/ft of levee. The rate was applied to the total linear length of the perimeter levee and used to estimate seepage inflow rates into a Hydrologic Engineering Centers River Analysis System (HEC-RAS) model. The peak seepage inflow resulting from the model established the max pumping rate.

Pump Mix

Pump mixes for seepage management operations were based on a minimum of two bay pump stations to minimize risk of impact to private lands should a single pump fail during critical times. The seepage pump station will be equipped with two 150 cfs electric motor driven pumps and two 200 cfs diesel engine driven pumps. The two diesel engine driven pumps were sized to accommodate the required seepage rate of 400 cfs, and will serve as an alternative power source in cases of power outages and provide additional capacity for infrequent high flow events. Two diesel engine driven pumps are required per EM's, ER's and jointly developed DCM-5, Major Pumping Station Engineering Guidelines. Electric motors offer efficient operation on a 24/7 basis, such as seepage management. Diesel engines are efficient at stop-go and irregular operations. One criterion for pump mixes was to utilize duplicate pump sizes to reduce overall operation and maintenance costs (reduction in spare parts and focusing of mechanical expertise). Another criterion was to provide a pump mix that allows a smooth pump rate change interval from start-up to full capacity.

Pump Stages

Pump stages as presented in the hydraulic design data sheet were defined by the following pumping parameters:

Intake Water Surface Elevations:

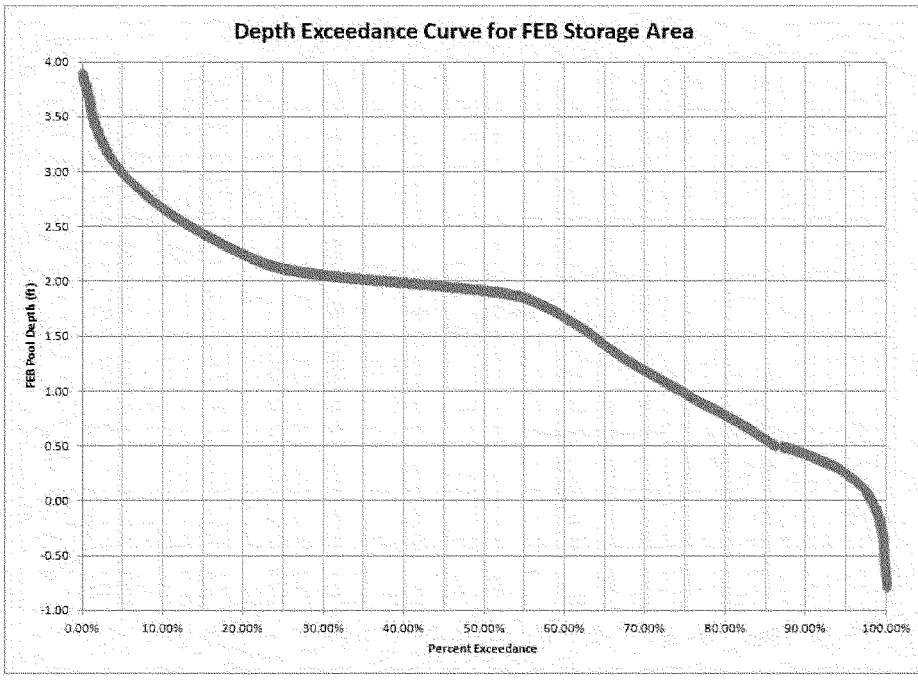
Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.

Maximum Pumping: Maximum canal or pool stage that can be pumped with any increase in stage requiring the pump to be turned off. In most cases, Maximum Non-Pumping and Maximum Pumping stages are identical.
Start Pumping: Canal or pool stage when pump may be turned on as defined by system conditions, typically on the increasing limb.
Normal Drawdown: Expected local drawdown at the pump station intake.
Minimum Drawdown: Lowest local drawdown stage before pump is required to be turned off.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions.

Discharge Water Surface Elevations:

Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.
Maximum Pumping: Maximum canal or pool stage that can be pumped to, pump is subsequently turned off until stage decreases.
Normal Pumping: Expected normal pool elevations for impoundments and design tailwater stages for conveyance canal pump stations (flood damage reduction drainage discharge).
Minimum Pumping: Lowest canal or pool stage expected when pump may be turned on.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions. In most cases, Minimum Pumping and Minimum Non-Pumping elevations are identical.

FIGURE A-3. FEB DEPTH EXCEEDANCE PLOT FOR RECOMMENDED PLAN ALTERNATIVE 4R2



A.5.3.3.2.1.5 Other Features

S-627 Emergency Overflow Spillway

An orifice-type spillway will provide uncontrolled discharge from the A-2 FEB during extreme events, when FEB discharges are required to protect the embankment integrity. The spillway will include a 265 foot long weir with crest elevation set at 13.50 ft NGVD, or 4.5 feet above the average natural ground of 9.00 ft NGVD within the A-2 FEB. The spillway will discharge into the adjacent seepage canal along the northern portions of the A-1 and A-2 FEBs. The spillway will be located in line with the northern extent of the eastern perimeter levee, adjacent to structure S-628.

To determine the weir length, an unsteady HEC-RAS model was ran using design criteria from ER 1110-2-8(FR) and DCMs 1, 2, and 3. Based on DCM-1, the FEB was determined to have a low hazard potential classification (HPC). For Low HPC, DCM-2 requires the routing of the 100-yr 24-hr storm plus 60 mph wind applied at the peak surcharge stage. DCM-3 states that the SFWMD Basis of Review for Environmental Resource Applications extends the basin permitted rate (storm implicit) to a 100-yr storm level to reduce the potential for localized basin impacts resultant from flood control releases. Under pre-project conditions, localized impacts due to flooding within the EAA basin may potentially occur when extreme rainfall amounts flood a localized area and the water remains in the localized area while not exasperating conditions elsewhere within the EAA through drainage connectivity. Under these pre-project conditions, the flood water remains on-site until downstream conditions improve, whereby the hydraulic gradient finally reaches the site of interest and the basin begins to drain. However, with

reservoir overflow spillways, water is conveyed (or spilled) "on top" of the lands already flooded and may potentially be interpreted as exasperating flood conditions. To provide clear guidance regarding what specific criteria may be construed as exasperation of flooded conditions which diminish the level of service of flood protection within a CERP reservoir basin, DCM-3 was drawn up to meet the non-Federal sponsor concerns and reflect USACE's stewardship of public safety. Within the EAA, strict interpretation of DCM-3 would most likely lead to incidental improvement of the level of service of flood protection beyond that for urban areas rather than offsetting potential impacts associated with the CEPP features, at a greater project cost. The USACE hydraulic design rationale to the proposed spillway design is provided in the following bulleted list:

- For the EAA, the (Environmental Resource Permit) ERP basin rule is 20 cfs/sq. mile (CSM) for the 5-yr (assumed 72-hr) storm event. Extending the discharge rate to the 100-yr 72-hr storm is above the DCM-2 requirement for a Low HPC impoundment/reservoir storm routing that is the 100-yr 24-hr storm. The impact of this storm-discharge extension is it would most likely lead to a higher embankment than what most would expect for a Low HPC impoundment.

- In urban areas, the ERP rule is usually near the 20 CSM discharge rate, but, it is typically combined with the 25-yr 72-hr storm event versus the 5-yr storm. Therefore, extending the ERP rule to the 100-yr 72-hr rate would provide better protection from a potential for impact than for urban areas, again, at a greater project cost.

- Since the 5-yr 72-hr storm has a total rainfall of 7 inches and the crest elevation is to be set at 6 inches above the Normal Full Storage Level (NFSL), then the impoundment will capture all but 1 inch of the total design storm depth. The additional 6 inches above the normal spillway crest setting at NFSL is to prevent overtaxing of the seepage management system with more common frequent storm events since the spillway does not directly discharge into an adjacent major canal.

- The ERP 20 CSM rule provides for a discharge of 437.5 cfs, but 1 inch head on the proposed 265 foot spillway has a discharge rate of only 19.1 cfs (see **Table A-12** for storm routing summary). By proposing to extend the 5-yr 72-hr to the 100-yr 24-hr event, the discharge nearly equates to the ERP rule with 443.4 cfs (6 cfs more).

- The use of the 100-yr 24-yr sized 265 foot long spillway allows a 3 foot freeboard on the USACE historically required 50% PMP surcharged pool peak stage on the Low HPC impoundment with the proposed minimal 9 foot embankment (nearly so, 2.85 foot freeboard actually). This freeboard lowers risk of breach with extreme storm events (50% PMP equates with 27 inches of depth).

Based on consideration of this collective rationale, USACE Jacksonville District Engineering Division believes that this minor variance from DCM-3 is maintaining the original DCM intent and demonstrates an optimal design that meets all agency requirements as intended. Since the FEB stages over the RSM-BN simulated period of record do not overtop the FEB emergency spillway, the S-627 emergency overflow spillway design details, including discharge location, were not further considered during the CEPP Savings Clause evaluation of the recommended plan (detailed in Annex B of the PIR). A more detailed flood routing using the FEB seepage collection system (including the A-1 and A-2 seepage canals) will be conducted during PED to ensure there will be no additional adverse impacts to adjacent agricultural lands. During PED, the seepage system will be refined to ensure sufficient capacity to

capture any additional discharges from S-627. It is anticipated that if necessary, water will be routed through the S-8 pump station for discharge into the Miami Canal, as it currently serves as a flood control structure for the EAA today.

TABLE A-12. EMERGENCY OVERFLOW SPILLWAY ANALYSIS

Storm	Discharge Criteria	ERP Flow rate (cfs)	Crest Elev. (ft, NGVD)	Crest Length (ft)	Max Stage (ft, NGVD)	Max Head, weir (ft)	Max Depth (ft)	Max Flow (cfs)
100-yr 24-hr	3/4"/day	440	13	110	14.13	1.13	5.13	437.01
			13.5	265	14.14	0.64	5.14	443.42
100-yr 72-hr	3/4"/day	440	13	70	14.54	1.54	5.54	442.92
			13.5	125	14.56	1.06	5.56	447.8
			13.5	265	14.52	1.02	5.52	815.38
Previous 50%, 72-hr PMP			13.5	1,500	15.03	1.53	6.03	3,007.42
			13.5	265	15.15	1.65	6.15	1,845.57

A.5.3.3.2.2 Existing Structures

G-370 Pump Station

G-370 is an existing pump station that is currently being used to deliver water from the North New River Canal to the STA 3/4 inflow structure. Stormwater runoff and Lake Okeechobee releases in the North New River Canal are pumped into the STA 3/4 distribution system. Prior to CEPP implementation, this pump station will also be used as one of the A-1 FEB's inflow structures. This is a six bay pump station with three 925 cfs diesel pumps and three 75 cfs electric driven seepage pumps. The total flood control capacity is 2,775 cfs. The pump station is located at the southwestern end of A-1 adjacent to US-27 and the North New River Canal.

G-372 Pump Station

G-372 is an existing pump station that is currently being used to deliver water from the Miami Canal to the STA 3/4 inflow structure. Stormwater runoff and Lake Okeechobee releases in the Miami Canal pass through this pump station and into the STA 3/4 distribution system. Prior to CEPP implementation, this pump station will also be used as one of the A-1 FEB's inflow structures. For CEPP, this pump station will also be used as the A-2 FEB's inflow. This is a seven bay pump station with four 925 cfs diesel pumps and three 75 cfs electric drive seepage pumps. The total flood control capacity is 3,700 cfs. For CEPP purposes, the capacity of G-372 will be reduced to 1,550 cfs when used for inflow into the FEB. The pump will operate at normal capacity operations when providing conveyance through the STA 3/4 Supply Canal.

S-7 Pump Station

S-7 is an existing pump station that is currently used to discharge runoff water via the North New River Canal, as well as provide an outlet for STA 3/4 discharges, into WCA-2A. The pump station is equipped with three 830 cfs diesel pumps for a total capacity of 2,490 cfs. For CEPP, the majority of STA 3/4 discharges will be delivered to the modified S-8 Pump Station for delivery to WCA-3A, and operation of the S-7 Pump Station will likely be limited to peak events. The pump station is located in the alignment of the North New River Canal at the northwestern corner of WCA-2A.

S-8 Pump Station

S-8 is an existing pump station that is currently used to discharge runoff water via the Miami Canal, as well as provide an outlet for STA 3/4 discharges, into WCA-3A. CEPP will maintain this existing design capacity for the S-8 complex through a combination of the following design considerations: pump station design modifications, a new hydraulic connection from S-8 to the degraded L-4 Levee (New S-8A), utilization of the existing G-404 pump station (570 cfs design capacity), and leaving the 1-2 mile segment of the Miami Canal as available getaway conveyance capacity during peak flow events. For CEPP, the S-8 pump station and/or G-404 may require design modifications (or possible replacement). The Recommended Plan cost estimate includes costs for the potential S-8 complex modifications, which are included as the new S-8A (canal connection to L-4 and two culverts structures). During PED, the following design uncertainties will be assessed/reassessed in further detail: modifications to S-8 and/or G-404, to address pump efficiency concerns; the proposed S-8A culvert and associated canal connecting the Miami Canal to the L-4 Canal; and the required length of the unmodified Miami Canal to maintain hydraulic getaway conveyance capacity. Flood control operation capability will be maintained during S-8 modification construction. S-8 is equipped with four 1,040 cfs diesel pumps for a total capacity of 4,160 cfs. The pump station is located in the alignment of the Miami Canal at the northern boundary of WCA-3A.

A.5.3.3.2.3 Existing Canals

Miami Canal

EAA runoff and Lake Okeechobee regulatory releases to the Miami Canal will be captured by the existing G-372 pump station and distributed to the A-2 FEB when operational criteria is met, including FEB stage constraints for additional inflows and availability of STA treatment capacity. Previous analysis of the existing Miami Canal conditions indicated the maximum in-bank conveyance capacity was 1,550 cfs when pulling from Lake Okeechobee during storm off-peak times. It was determined that no improvements to the Miami Canal template would be necessary and all CEPP components north of the redline receiving flow from the Miami Canal would be sized to accommodate 1,550 cfs.

North New River Canal

EAA runoff and Lake Okeechobee regulatory releases to the North New River Canal (NNR) will be captured by the existing G-370 pump station and distributed to the A-1 FEB when operational criteria is met, including FEB stage constraints for additional inflows and availability of STA treatment capacity. Previous analysis of the existing NNR Canal conditions indicated the maximum in-bank conveyance capacity was 1,350 cfs when pulling from Lake Okeechobee during storm off-peak times. It was determined that no improvements to the NNR would be necessary and all CEPP components north of the redline receiving flow from the NNR Canal would be sized to accommodate 1,350 cfs.

STA 3/4 Supply Canal

The STA 3/4 Supply Canal conveys discharge from G-370 and G-372 pump stations to the STA 3/4 intake structures. The Supply Canal is located adjacent to the northern boundary of the Holey Land Wildlife Management Area and extends from G-372 eastward (7.7 miles) and then southward (2.7 miles) before intersecting the STA 3/4 Inflow Canal at the northwest corner of the STA. For CEPP, the STA 3/4 Supply Canal will provide the inflow route for the A-2 FEB via S-624, as well as convey flows discharged from the A-2 FEB to STA 3/4 via S-625.

STA 3/4 Seepage Canal

The STA 3/4 Seepage Collection Canal is located along the northern boundaries of the STA 3/4 and the Supply Canal. Its purpose is to collect seepage and convey water to the G-370 and G-372 pump stations at the east and west ends of the canal, respectively. The segment of the Seepage Canal along the southern boundary of the A-2 FEB will be utilized in its existing condition as a collection canal to direct flows in the FEB to the S-625 discharge structure.

A.5.3.3.2.4 Embankments

A.5.3.3.2.4.1 Embankment Height Analysis

The FEB at this time carries a low hazard potential classification (HPC) per DCM-1, which is extended to embankment design. Embankment top widths are 14 feet wide per DCM-4, with dam heights determined by using the greater height based on analysis of the following criteria (ER-1110-8-2(FR), ER-1110-2-1156, DCM-2, and risk):

1. Three feet above the maximum surcharge pool elevation. The maximum surcharge pool elevation is based on the greatest elevation resulting from the following storm routings:
    a. The Inflow Design Flood (IDF), which is identified as the 100-yr 24-hr storm event for the CEPP FEB, per DCM-2;
    b. The 50% 72-hr PMP per ER-1110-8-2(FR); and

Wind setup and wave run-up analysis on critical fetch lengths with the impoundment at full pool. Wave run-up is dependent on levee slope (steeper slopes have higher run-up).

The storm routing analyses conducted for the emergency overflow spillway (section A.5.3.3.2.1.5 Other Features) were integral to the development of embankment heights. The results of the storm routings were used to determine the maximum surcharge stage. Per Table A-12, based on the selected weir length of 265 feet, the maximum surcharge stage resulted from the 50% 72-hr PMP storm at an elevation of 15.15 ft NGVD. Per ER-1110-8-2(FR), the minimum levee height should be 18.15 ft NGVD.

Wind setup and wave run-up analysis evaluated freeboard requirements for differing embankment types (earth, riprap) at varying slopes (1v:3h and 1v:4h) for the 100-yr 24-hr storm and the 50%, 72-hr PMP. Overtopping (over wash) of the earthen embankments is permitted to a maximum rate of 0.1 cfs/ft. In each scenario, the resulting freeboard is less than three feet (maximum is 2.3 ft). Therefore, the recommended freeboard is dictated by the minimum requirement for a Low HPC basin (3.0 feet) rather than the wind and wave conditions for the site. Refer to Appendix A, Annex A-1: Hydraulic Design, section A.3.8 for complete FEB Wind/Wave Analysis.

Preliminary embankment analysis recommended an embankment crest elevation of 20.3 feet NGVD, based on available data at the time. All hydraulic analysis will be revised during PED to incorporate the revised recommended elevation of 18.00 ft NGVD (rounded from 18.15 ft NGVD).

A.5.3.4 Risk and Uncertainty

This section presents qualitatively the risk and uncertainty associated with the project as designed for this PIR. Understanding that the current USACE philosophical approach to Feasibility Studies is to be quick and limit analyses to that for benefit and cost determinations, acknowledging risk and uncertainty in the hydraulic design of the project will be an important part of the risk registry. The overall approach

to the hydraulic design was to be conservative enough to capture expected costs without being unrealistic in overestimation, yet not to underestimate beyond what optimization and the savings that could be realized during PED phase efforts.

A.5.3.4.1 Hydrologic and Hydraulic Computer Software Tools

Several hydrologic and hydraulic computer software tools were utilized in the formulation of alternatives and the Recommended Plan. Interpretation of hydraulic design results should consider the inherent strengths and limitations of the underlying hydrologic and hydraulic tools. Additional descriptions of the modeling tools are provided in Appendix A, Section A.8.1 (Modeling Strategy).

A.5.3.4.2 Flow Equalization Basin

Low Hazard Potential Classification

This section discusses the risk imposed by the Flow Equalization Basin (FEB) feature during precipitation and wind storm events with current freeboard design and proposed operations. To establish how risk is to be viewed, i.e. consequences, it is necessary to first review the potential hazard that may be posed by the constructed project. The FEB carries a Low Hazard Potential Classification (Low HPC) for all the reasons listed in the following:

(1) No expected loss of life should a breach occur.

No residents nearby.

No businesses or institutions nearby.

No highways or evacuation routes at risk (US-27 nearest distance is 2.5 miles. However, the road crest elevation is 3.3 feet above FEB max pool level (50% PMP):

[18.5 crest el – (9 ground el +6.15ft deep) = 3.35ft].

(2) No high-value private properties are at risk, as the area is primarily agriculture with several quarries. Northern and western perimeter embankments are the only embankments adjacent to private lands, all agricultural. Southern perimeter embankment is adjacent to a large conveyance canal with a southern raised bank that can function as a secondary containment embankment, further south of which is natural, but disturbed wetlands (Holey Lands). Eastern perimeter embankment is adjacent to the proposed FEB to be constructed on lands formerly as the A-1 cell. Until then, this same land is non-developed former agriculture lands.

(3) Except for direct rainfall, inflow is controlled (i.e., pump inflow only)

(4) Potential volume of water storage is large because of areal size of the project; however the surrounding agricultural area is proportionally vast as well, i.e. spread of water limits depth in immediate vicinity of the FEB. Also, with primary crop being tall and thick sugar cane, the spread of breach flow will be at low velocities.

Freeboard under Design Conditions

The current FEB freeboard design is between 5.5 ft and 5.2 ft as defined by the vertical height between the IDF (100-yr and 50%PMP, respectively) pool and embankment crest elevation (normal full pool of 4 ft depth) at water surface elevation 13.00 ft NGVD. To evaluate the appropriateness of this freeboard, **Table A-13** provides minimum freeboard requirement based on historic Federal requirement and current DCM-2 joint USACE and SFWMD requirements.

TABLE A-13. EMBANKMENT RISK

Policy	Precip. Event	Starting Pool Elev.	Routed IDF	Wind Event	Setup	Full Run Up	Overwash 0.1cfs	Min. 3-foot	Min Embk Crest El
DCM-2	100-yr, 24-hr	el. 13.0	+1.14ft el. 14.14	60mph	+2.40ft el. 16.54	+0.20	el. 16.60 (rnded)	el. 17.14	el. 17.78
USACE ER 1110-8-2	50% PMP, 72-hr	el. 13.0	+2.15ft el. 15.15	60mph*	+2.09ft el. 17.24	+0.24	el. 17.30 (rnded)	el. 18.15	el. 18.00

Note: * denotes not defined, but what was assumed. All elevations are referenced to NGVD 29.

1. Stages, setup, run up, and overwash are not identical to that provided in wind-wave stand-alone report located in the Appendix A, Annex A-1, but are approximations based on same report for modified design stages. The result of minimum required embankment height ultimately remains the same. Absolute numbers for modified stages will be provided in DDR on authorization.
2. This table will be updated in PED to provide accurate numbers versus approximations as provided here.

Current design crest elevation is set at 20.30 ft NGVD (based on available data at the time of design; will be updated during PED), or 11.3 ft above average natural ground of 9.00 ft NGVD. The very low wave run up is due to emergent vegetation being the primary cover, as in the case of SFWMD stormwater treatment areas (STA) and other shallow storm water impoundments. For the FEB with the high loading of phosphorous expected, cattails will likely be the prominent species, which are characteristically tall in excess of 8 feet and typically dense, with shedding of elongated leaves. These characteristics reduce shear stresses between the air-water interface that leads to wave generation/growth. Additionally, the actual wind setup is not expected to be as high as modeled because of the wave mitigating effects of vegetation growth. Therefore, the embankment is of sufficient height to minimize risk of structure loss due to wave overtopping/overwash activity in accordance to the Low HPC assigned to the structure and established policies, including the current ER 1110-2-1156.

A.5.3.5 HYDRAULIC DESIGN DATA SHEETS

TABLE A-14. S-623 GATED SPILLWAY
Hydraulic Design Data Sheet

Location	STA 3/4 Supply Canal, approx. 800 feet upstream of G-372; x= 718,541 y = 764,032		
Purpose	S-623 is a divide structure between Miami Canal water and FEB discharges.		
Design Conditions	Discharge	3,700	cfs
	Headwater Elevation	10.25	feet, NGVD 29
	Tailwater Elevation	10.00	feet, NGVD 29
Crest Data	Shape	Ogee	
	Design Head (Hd)	6.75	feet
	Net Crest Length	140.0	feet
	Crest Elevation	3.50	feet, NGVD 29
	Approach Apron Elevation	-2.00	feet, NGVD 29
	Weir Control	Vertical Slide	
Gates	Number of Gates	4	
	Gate Width	35.0	feet
	Gate Height	14.0	feet
	Clearance Elevation	15.00	feet, NGVD 29
	Breastwall Elevation	TBD	feet, NGVD 29
	Intermediate Pier Width	3.25	feet
Stilling Basin	Design Discharge	3,700	cfs
	Apron Elevation	-2.00	feet, NGVD 29
	Apron Length/Width	36.0/149.75	
	End Sill Elevation	-1.50	feet, NGVD 29
	Top of Baffle Block Elevation	0.00	feet, NGVD 29
	Dist from crest toe to 1st row of blocks/2nd row	18.00	feet
	Velocity over End Sill	2.15	fps
	Training Wall Elevation	TBD	feet, NGVD 29
Canal Data (US/DS)	Invert - Thalweg	-13.5	feet, NGVD 29
	Top of Bank (E/W)	15.5/12.0	feet, NGVD 29
	Bottom Width	150.0	feet
	Top Width	252.0	feet
	Side Slope (V:H)	1 on 2	
Revetment	Riprap Extent (Downstream)	TBD	feet
	Riprap Size (D50)	TBD	feet
	Riprap Specific Weight	TBD	lb/ft3
	Max Velocity Riprap Can Withstand	TBD	fps

TABLE A-15. 5-624 GATED CULVERT
Hydraulic Design Data Sheet

Location	STA 3/4 Supply Canal, approx. 1.5 miles east of G-372; x = 727,613 y = 764,144		
Purpose	S-624 is a fully submerged gated sag culvert that conveys flow from G-372 into the A-2 FEB. The culvert invert is set such that it is below natural grade elevation. When closed, obstructs flow from G-372 from entering the FEB to allow flow through the STA 3/4 Supply Canal.		
Design Conditions	Discharge	1,550	cfs
	Headwater Elevation	16.75	feet, NGVD 29
	Tailwater Elevation	14.25	feet, NGVD 29
Culvert Data	Number of Barrels	2	
	Barrel Type	Concrete Box Culvert	
	Box Width	11	feet
	Box Height	11	feet
	Culvert Length	350	feet
	Upstream Invert	-4.50	feet, NGVD 29
	Downstream Invert	-4.50	feet, NGVD 29
	Number of Bends	4	
	Bend Angle	45	degrees
	Sag Invert Elevation	-14.00	feet, NGVD 29
	Natural Water Table	9.00	feet, NGVD 29
	Headwall - HW Elevation	TBD	feet, NGVD 29
	Headwall - TW Elevation	TBD	feet, NGVD 29
	Wingwall - HW Elevation	TBD	feet, NGVD 29
	Wingwall - TW Elevation	TBD	feet, NGVD 29
Canal Data	Side Slopes (V:H)	1 on 2	
	Upstream Bottom Width	40	feet
	Upstream Bottom Elevation	-5.00	feet, NGVD 29
	Downstream Bottom Width	40	
	Downstream Bottom Elevation	0.00	feet, NGVD 29
Energy Dissipation	**Riprap Requirements**		
	Rip Rap Design Velocity	6.75	fps
	Upstream Length	TBD	feet
	Upstream Protection Elevation	TBD	feet, NGVD 29
	Downstream Length	TBD	feet
	Downstream Protection Elevation	TBD	feet, NGVD 29

TABLE A-16. S-625 GATED CULVERT
Hydraulic Design Data Sheet

Location	A-2 FEB western perimeter levee; x= 726,458 y = 764,793		
Purpose	S-625 conveys flows from the A-2 FEB to the G-372 pump station via a new discharge canal (C-625W) from the FEB. S-625 will only discharge into G-372 if flow from the Miami Canal is blocked via use of S-623 gated spillway.		
Design Conditions	Discharge	1,550	cfs
	Headwater Elevation	12.00	feet, NGVD 29
	Tailwater Elevation	11.00	feet, NGVD 29
Culvert Data	Number of Barrels	3	
	Barrel Type	Concrete Box Culvert	
	Box Width	9	feet
	Box Height	9	feet
	Culvert Length	140	feet
	Upstream Invert	0.50	feet, NGVD 29
	Downstream Invert	0.50	feet, NGVD 29
	Natural Grade	9.00	feet, NGVD 29
	Natural Water Table	9.00	feet, NGVD 29
	Headwall - HW Elevation	TBD	feet, NGVD 29
	Headwall - TW Elevation	TBD	feet, NGVD 29
	Wingwall - HW Elevation	TBD	feet, NGVD 29
	Wingwall - TW Elevation	TBD	feet, NGVD 29
Canal Data	Side Slopes (V:H)	1 on 2	
	Upstream Bottom Width	45	feet
	Upstream Bottom Elevation	0.00	feet, NGVD 29
	Downstream Bottom Width	45	
	Downstream Bottom Elevation	-5.00	feet, NGVD 29
	DS Slope from Invert to Canal Bottom	1 on 5	
Energy Dissipation	**Riprap Requirements**		
	Rip Rap Design Velocity	6.5	fps
	Upstream Length	TBD	feet
	Upstream Protection Elevation	TBD	feet, NGVD 29
	Downstream Length	TBD	feet
	Downstream Protection Elevation	TBD	feet, NGVD 29

TABLE A-17. S-626 PUMP STATION
Hydraulic Design Data Sheet

Location	Western boundary of the A-2 FEB, north of the S-625 discharge structure.			
	Seepage Control, Non-Flood Control			
Purpose/Operational Intent:	Provides seepage control for the A-2 FEB impoundment by the backpumping of collected seepage from the FEB into G-372 via C-625W Discharge Canal.			
Design Condition:			500	cfs
Design Capacity:			700	cfs
Pump Station Capacity Criteria:				
	The design pump rate was determined by seepage rate analysis and incorporating a safety factor of 1.5.			
Number of Pumps			4	
Pump Mix Type and Size		Electric	2@ 150	cfs
		Diesel	2@ 200	cfs
Mix Criteria:				
	1. The pump station will have 4 bays; two identical 150 cfs electric motor driven pumps, and two 200 cfs diesel engine driven pumps 2. The pump mix allows for increased capacity during peak storm events, while having duplicate pumps throughout the system for operation and maintenance consideration			
Control			TBD	
Design Heads				
	Normal (HW=13.0 NGVD, TW=7.0 NGVD)		6.0	ft
	Maximum (HW=15.15 NGVD, TW=7.0 NGVD)		8.15	ft
Intake Water Surface Elevations				
	Maximum Non-Pumping Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Start Pumping		TBD	ft, NGVD
	Normal Drawdown		TBD	ft, NGVD
	Minimum Drawdown Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		-5.50	ft, NGVD
Discharge Water Surface Elevations				
	Maximum Non-Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Normal Pumping		TBD	ft, NGVD
	Minimum Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		-5.50	ft, NGVD

TABLE A-18. S-627 EMERGENCY OVERFLOW SPILLWAY
Hydraulic Design Data Sheet

Location	A-2 FEB northeast corner; adjacent to the S-628 structure			
Purpose	The S-627 emergency overflow spillway will provide uncontrolled discharge from the A-2 FEB during extreme events into the adjacent seepage canal along the northern perimeter of the A-1 and A-2 FEBs.			
Design Conditions	Discharge		1,845	cfs
	Headwater Elevation		15.15	feet, NGVD 29
	Tailwater Elevation		9.00	feet, NGVD 29
Maximum Expected Stages				
	Headwater Elevation		15.25	feet, NGVD 29
	Tailwater Elevation		10.00	feet, NGVD 29
Maximum Head Differential				
	Headwater Elevation		15.25	feet, NGVD 29
	Tailwater Elevation		9.00	feet, NGVD 29
Weir Design Data				
	Weir Type		Broad-crest	
	Crest Elevation		13.50	feet, NGVD 29
	Crest Length		265.00	feet
	Minimum Tieback Elevation		TBD	feet, NGVD 29
	Weir Control		Passive, none	
Canal Data	A-2 FEB			
		Side Slope Cotangent	3	
		Bottom Width	Pool	
		Bottom Elevation	9	feet, NGVD 29
	Combined Seepage/Spillway Conveyance			
		Side Slope Cotangent	2	
		Bottom Width	15	feet
		Bottom Elevation	-5.5	feet, NGVD 29
Apron/Riprap Requirements - to be verified with final geotechnical design				
	Apron Length		30	feet
	Minimum Riprap Size		TBD	feet

TABLE A-19. S-628 GATED CULVERT
Hydraulic Design Data Sheet

Location	Northeast corner of A-2 FEB on eastern perimeter; x = 757,854 y = 778,977		
Purpose	Conveys flows from A-2 FEB into A-1 FEB, or vise versa, from A-1 into A-2.		
Design Conditions	Discharge	930	cfs
	Headwater Elevation	12.5	feet, NGVD 29
	Tailwater Elevation	11.5	feet, NGVD 29
Culvert Data	Number of Barrels	2	
	Barrel Type	Concrete Box Culvert	
	Box Width	9	feet
	Box Height	9	feet
	Culvert Length	140	feet
	Upstream Invert	1.50	feet, NGVD 29
	Downstream Invert	1.50	feet, NGVD 29
	Natural Grade	9.00	feet, NGVD 29
	Natural Water Table	9.00	feet, NGVD 29
	Headwall - HW Elevation	TBD	feet, NGVD 29
	Headwall - TW Elevation	TBD	feet, NGVD 29
	Wingwall - HW Elevation	TBD	feet, NGVD 29
	Wingwall - TW Elevation	TBD	feet, NGVD 29
Canal Data	Side Slopes (V:H)	1 on 2	
	Upstream Bottom Width	35	feet
	Upstream Bottom Elevation	1.50	feet, NGVD 29
	Downstream Bottom Width	35	
	Downstream Bottom Elevation	1.50	feet, NGVD 29
	Slope from invert to natural grade (V:H)	1 on 5	
Energy Dissipation	**Riprap Requirements**		
	Rip Rap Design Velocity	5.8	fps
	Upstream Length	TBD	feet
	Upstream Protection Elevation	TBD	feet, NGVD 29
	Downstream Length	TBD	feet
	Downstream Protection Elevation	TBD	feet, NGVD 29

A.5.4 STRUCTURAL DESIGN

A.5.4.1 General Status of Completed and Non-Executed Efforts

Structural design of S-623, S-624, S-625, S-626, S-627 and S-628 will be completed during the design phase. During design phase the structural calculations will be completed after survey, hydraulic design, and geotechnical investigations are performed. The structural design will conform with the appropriate Engineering Manuals (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM).

A.5.4.2 Pumping Stations

S-626 is a seepage pump station that will be similar in design to S-357, but with the new layout of the Miller (S-488) pump station.

A.5.4.3 Overflow Spillways

S-623 is a gated structure similar to S-65EX1, using a two-phased approach and offsetting the structure will not require a bypass canal to be designed for construction of the structure.

A.5.4.4 Culverts

S-624, S-625, and S-628 are gated box culverts that will be designed similar to the (S-276 (C-4A)) culverts on Herbert Hover Dike (HHD).

A.5.4.5 Weirs

S-627 is an overflow weir that will have the same crest width as the levee of 14 feet. The design will be similar to the overflow weir design in the C-111 South Dade S-327.

A.5.5 MECHANICAL AND ELECTRICAL DESIGN

A.5.5.1 General

The pumping station mechanical design shall be in accordance with Hydraulic Institute Standards, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout), and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations). The design will also follow the guidance of ETL 1110-2-313 (Hydraulic Design Guidance for Rectangular Sumps of Small Pumping Stations with Vertical Pumps and Ponded Approaches).

The seepage pumping station will have a required pumping capacity of 500 cfs.

The pump mix will be further developed during the design phase of the project, but it will likely have a mix similar to having two 200-cfs diesel engine driven pumps and two 150-cfs electric motor-driven pumps.

The pump intakes will likely be suction bell type. The use of formed suction intakes at the pumps shall be evaluated during preparation of the plans and specifications for the pumping station and shall be based upon the channel intake design.

Axial flow pumps will be used for the pumping station. The decision on whether the pumps will have either a conventional or siphon discharge will be determined during the preparation of the plans and specifications.

The pumping station electrical design shall be in accordance with NEC, NFPA, IESNA, TIA/IEA, IEEE, and recommended practice. Also, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout) and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations) will be used.

Although the capacity of this station is low enough that SFWMD's Major Pumping Station Engineering Guidelines is not applicable, we will follow the applicable portions of these guidelines.

A.5.5.2 General Status of Completed and Non-Executed Efforts

Mechanical and electrical design of S-623, S-624, S-625, S-626, S-627 and S-628 will be completed during the design phase. During design phase the mechanical and electrical calculations will be completed after survey, hydraulic design, and geotechnical investigations are performed. Conceptual design is developed for use for cost assumptions.

A.5.5.3 Pumping Station S-626

The larger pumps will likely be designed with a suction bell intake. These pumps may be conventional-discharge or siphon-discharge type. Each pump will be driven by a diesel engine through a right-angle reduction gear.

The smaller pumps will be axial-flow-type vertical-shaft pumps. The pumps will be driven by direct-drive electric motors.

The pumps are expected to run at less than 500 rpm with an efficiency of about 80%. The diesel engine pump drives for the 200-cfs pump should be about 600 horsepower each.

The pumping station will include various support items, including the following:

a. Diesel fuel system, including vaulted double-wall aboveground fuel storage tanks capable of holding enough fuel to operate the engine driven pumps and an emergency generator continuously for seven days.
b. Hoisting system for maintenance or repair of the pumping equipment.
c. Toilet facility with a water closet and a lavatory.
d. Kitchen-type sink.
e. Potable water system and a septic system for the plumbing fixtures.
f. Ventilation system to provide fresh air in the pump bays, generator area, and toilet room.
g. Air-conditioning system for the office.
h. Stilling wells containing float switches to be used for pump operations and water level monitoring.

A.5.5.3.1 Pumping Station Features

Pump Drives
The diesel engines will be standard model full-diesel type, 2 or 4 cycle, with mechanical injection and cooling provided by keel coolers. Diesel engine horsepower will be about 600 hp each.

Engine Auxiliary System
Cooling of the engines will be by means of a closed system consisting of keel coolers, overhead expansion tanks, and engine-driven jacket water and aftercooler water circulating pumps with proper heat balance maintained by the thermostatically controlled proportioning valves. The main lubricating oil pump for each engine will be driven directly by the engine.

Speed Reduction Gear
Power will be transmitted from the engines to the pumps by means of right-angle type gear reducers. The units will be designed for an application factor of 2.0 times the maximum input power. Thrust load due to hydraulic unbalance and an anti-friction type bearing located within each reducer unit will carry the weight of pump rotating elements. Connection between each reducer and engine will be by flexible coupling to compensate for misalignment and vibration or shock transmission. Each reducer will be provided with forced lubrication from a direct connected positive displacement pump with cooling of the oil by an external system. To prevent reverse rotation, the transmission would be fitted with an anti-reverse rotation clutch.

Fuel Oil Storage System and Supply
Aboveground Storage Tanks (ASTs) will be located at a safe distance from the station. ASTs shall be concrete-vaulted and have a dual containment feature. Multiple tanks may share the total capacity for the station. Fuel capacity should be for seven days, 24-hour/day continuous operation at maximum fuel consumption rate. The tanks will be filled from fuel trucks. The tanks will be connected to the station supply header. The fuel system for the engines will consist of day tanks (typically up to 250 gallons capacity each) to supply each diesel engine. The day tanks will have automatic operation in sending and receiving fuel and controlling the level of the fuel inside of the day tank. A similar day tank will be provided for the engine generator set.

Station Crane/Hoist
An overhead bridge-type electric crane will be provided. The crane/hoist shall be capable of handling up to 15-ton loads. The crane/hoist will handle pumping station equipment, such as the diesel engines, reduction gears, or pump components during initial installation, as well as for general service thereafter.

Diesel Engine-Generator Sets
A diesel engine-driven generator set with capacities up to 500 kW may be provided. This generator must provide general standby power, but it also may be required to provide sufficient power to operate one of the electric motor driven pumps for as long as seven days.

Potable Water and Plumbing
A potable water supply and plumbing system will be provided. This will include a septic system. A filtered water system will be necessary for the station to supply water to a Toilet (lavatory, shower, and water closet) and small kitchen area.

Air Conditioning
Small split-system air conditioning systems will be provided for the control room, telecommunications room, and the break room.

Ventilation System
A system of air inlet openings and exhaust fans will be provided for ventilation of the operating floor area. The air inlet louvers will be the type commonly referred to as Miami-Dade louvers. Bird screening will also be provided over the openings. The wall type exhaust fans will have motor-operated dampers.

Trash Rake
Trash rake/rack system will be one of two types: an automatic, continuously rolling, flex rake and trash rack system such as that manufactured by Duperon, or a powered rail-mounted traveling trash rake and hoist car assembly with a telescoping arm used to grip and remove debris. This system is similar to ones that are manufactured by Hydro Component Systems. The system selected shall be similar to those that have proven satisfactory at previously completed pumping stations.

Pump Model Tests
The specifications will require that a series of model tests be performed to verify performance and cavitation limits of the proposed pump. The contractor will be required to construct one complete pumping system for each size pump to the necessary scale model. The pumping system will include the forebay, pump, and discharge tube. All tests for determination of compliance with guarantees of capacity and/or efficiency will be accomplished using prototype heads.

A.5.5.3.2 Electrical Features

Electric Service and Backup Generator
A 480-volt, three phase, electrical service shall be provided. The local utility company shall provide the power. The diesel engine-generator unit shall be provided to supply 480-volt, three phase electrical power when utility power is not available or not reliable. Transient Voltage Surge Suppression (TVSS) shall be provided at the service entrance. The backup generator and automatic transfer switch will be sized sufficiently to power diesel engine auxiliaries, trash rakes, exhaust fans, lights and SCADA equipment.

Interior Electrical Distribution
Switchgear rated for 480 volt, three phase with a main breaker will be connected to the incoming service and will feed engine control centers, motor control centers, lighting panels, power panels and station equipment defined in the Pumping Station Features above. Each engine control center will house starters and controls for auxiliary equipment for the engine unit. The main switchboard will also feed transformers to supply 120/208 or 480/277 volt loads as necessary.

Interior and Exterior Lighting
High intensity discharge, industrial high bay luminaries will be used for the main pumping station area with industrial fluorescent fixtures with electronic ballasts for office and general type areas. Exterior lighting for security purposes would be automatically controlled by photo-electric cells and contactors.

Wiring and Conduit
Insulated copper conductors will generally be installed in either PVC coated rigid galvanized steel conduit or schedule 80 rigid plastic conduit. Conductors will be rated for 600 volt insulated types XHHW or XHHW-2. All wiring will conform to UFGS Guide Specifications.

Instrumentation and Controls
The pumping station will have a centralized monitoring and control room. Each diesel engine pump drive will have a separate motor control center to supply power and house controls for the engine auxiliaries, such as jacket water pump, engine lube pump, fuel filter pump, etc. Each diesel engine will also be equipped with a separate instrument panel and will house engine start/stop controls and pressure and temperature indicators to indicate engine performance. Programmable logic controllers (PLCs) will be used to monitor and control the engine and station auxiliaries. An Ethernet network will connect the PLCs and station computer. Ethernet based IP cameras will also connect to the Ethernet network. The station computer will allow for operation of the station via SFWMD's preferred SCADA software.

SCADA and Telemetry
The controls systems shall include manual, automatic and telemetry capabilities for the pumps and auxiliary systems. The engine start/stop controls shall operate locally at each engine, remotely from the control room, and from the central control station. The automation components of all pumping stations and structures that will eventually be operated and maintained by South Florida Water Management District (SFWMD) must conform to SFWMD standards in order to (1) achieve cost efficiency in design, construction, and operation and maintenance, (2) meet safety, reliability, and performance requirements during routine and emergency operations. The automation components are broadly defined to include hardware, software, communications, and user interface elements.

A.5.5.4 Gated Spillways and Culverts

Gate Operators
Gate operators will be designed based on the size, weight, and hydraulic loading on the gates. The operators will either be electric motor driven through a drum and pulley system or via as an actuator on a stem screw.

Electrical Service
A control center will house a main breaker, combination starter for the gate motor, lighting panel, relay compartment, and a circuit for exterior lighting. Surge suppression will be provided for each electrical/electronic system within or outside the structure.

Control and Monitoring
Duplicate open-close push button station in the control house and at the spillway or culvert structure will be provided for manual gate control. Necessary open, close, automatic control relays, and limit switches will be incorporated in the gate control circuit. Power and control circuits for water level recorders and gate position recorders will be provided.

A.5.5.5 Weir

Water Level Indication
Stilling wells with water level monitoring equipment will be provided on both sides of the weir. Power for the monitoring equipment will be provided by either commercial power or by solar power, depending on the final location of the weir.

A.5.5.6 Telemetry

Each spillway or culvert site that requires remote automation will be equipped with an RTU compatible with the existing SFWMD telemetry system. RTU software will be in accordance with the SFWMD standard load set. The construction plans will contain plans for a fully functioning telemetry system capable of connecting to and communicating with the SFWMD existing system. Additional coordination during the development of plans and specifications will finalize the telemetry requirements.

A.6 SOUTH OF THE REDLINE – DIVERSION & CONVEYANCE

A.6.1 CIVIL - SITE DESIGN

Features identified in the Recommended Plan have been designed to the level of detail necessary to provide cost estimates. Best professional judgment as well as previous project design knowledge for DECOMP were used during plan formulation alternative development and design efforts. Components south of the redline have been identified and sized appropriately according to available data, historic information, and best engineering judgment. All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and information as it becomes available.

A.6.1.1 General Status of Completed and Non-Executed Efforts

The following civil site project efforts remain either incomplete or were not initiated:
evaluation of alignments,
site grading,
aesthetics,
relocation of facilities,
required improvements on lands to enable proper construction of components and disposal of material,
requirements of lands for construction, operation and maintenance of the project,
identification of methods for accomplishing relocations to include appropriate lands,
site selection and project development, and
design with respect to recent Levee Safety criteria.

These analyses will be completed in PED.

A.6.1.2 Surveying Mapping Geospatial data

Historical hydrographic and topographic surveys exist for the project area. All survey data collected was performed using conventional means and methods. The existing surveys are 02-019, 02-037, 02-047, 02-142, 07-058, 08-195 and 11-106. Datum's utilized for data collection is as follows: Horizontal coordinates are referenced to the State Plane Coordinate System North Atlantic Datum (NAD) 83 (2007), Florida East Zone (0901). Elevations are in US Survey Feet and referenced to North Atlantic Vertical Datum (NAVD) 88 vertical datum. See Appendix A, Annex C-1 for data points.

A.6.1.3 Access

Access to this project area is primarily from US 27 along the existing L-5 northern access road westward to existing S-8, L-4 and Miami Canal. Access to L-6 is from US 27 along the existing S-7 complex and L-6 areas.

Due to the remote nature of the Miami Canal, site access limitations will be a significant consideration for the CEPP project construction. The limited engineering design information that was incorporated into the development of the final array planning-level cost estimates is documented in the main PIR document Appendix B Cost Engineering.

A.6.1.4 Material Balance and Disposal

Cut and fill quantities will be completed during PED phase to balance the design as much as possible. Material from the construction of canal, from Miami Canal to L-4 and the L-5 conveyance improvements, not suitable to fill in the Miami Canal will be hauled to a certified land fill. Material from onsite earthwork is the source for backfilling the Miami Canal and creation of tree islands mounds.

A.6.1.5 Utility Relocations

Utility impacts, including potential relocations, will need further assessment during the project design phase. Utilities will also have to be provided for S-620, S-621, S-622, S8A, S8W, and S-630. The type and length of utilities will be determined during PED.

A.6.2 GEOTECHNICAL DESIGN

Widening and Deepening of L-5 from S-8 to S-622

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The preliminary design parameters are presented in **Table A-20**.

TABLE A-20. PRELIMINARY SHEAR STRENGTH AND HYDROGEOLOGIC PARAMETERS FOR SOIL AND ROCK AT CEPP

Material	Saturated Unit Weight, pcf	Drained Friction Angle, degrees	Rock Friction Angle, degrees	Rock Cohesion, psf	Horizontal Hydraulic Conductivity, ft/sec	Vertical Hydraulic Conductivity, ft/sec
Peat/Organic Silt	70	25	-	-	1.7E-5	5.7E-6
Caprock	158	-	53	2930	7.3E-4	2.4E-4
Weathered Limestone	131	-	23	1100	2.0E-2	6.7E-3
Deep Sands	124	35	-	-	3.0E-5	1.0E-5
Sand Fill	126	36	-	-	3.4E-6	8.3E-7
Pervious Fill	126	30	-	-	6.6E-4	6.6E-4

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater investigations have been performed in the vicinity of this feature to date, nor are any anticipated during future design.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. South Florida is considered to be one of the most seismically stable locations in the United States (Petersen, Mark D. et. al, 2008). Historically, only minor shocks have occurred, with only one that resulted in minor damage. Additional shocks of suspect origin have been recorded that were felt in the Everglades area. The three Florida shocks of doubtful seismic origin rumbled through the Everglades, La Belle/Fort Myers area in July 1930, Tampa in December 1940, and the Miami/Everglades/Fort Myers area in January 1942. Most authorities attributed these incidents to blasting, but a few contend that they were seismic.

Uniform Building Code Seismic Zone Map (The Disaster Center, 1991) indicated that the entire State of Florida is in Seismic Zone 0 (areas with least potential for seismic activity). Since no capable faults or recent earthquake epicenters are known to exist near the project site and there is no dam impoundment included in this project feature, per Design Criteria Memorandum (DCM) No. 6, evaluation of liquefaction is not required.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The slopes shall be cut to a shallower or equal angle than currently that of the original design cut slope. Typical original design cut slopes in soils were 1V:2H and 1V:1H in rock.

g. Excavatability analysis. Rock rippability will be evaluated based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the canal can be widened and deepened by standard long arm hydraulic excavator, dredge or by dragline excavation equipment within the layers of peat and organic materials in the top 4-6 feet from the bank. Below this level excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or underwater blasting may be required to remove unrippable rock strata. Excavated cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks by rubber-tired loaders and hauled off to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. The canal is the borrow area for inorganic material destined to be delivered to the Miami Canal filling area. The organics are to be disposed to a designated area to be determined during the design phase.

j. Seepage and groundwater control. There is a possibility that widening and deepening of the canal may induce higher toe hydraulic gradients depending on the design headwater and tailwater conditions. A seepage analysis may be conducted during the design phase to verify the adequacy against internal erosion of the underlying silts.

S-620 and S-621 Gated spillways on L-5

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater investigations have been performed in the vicinity of this feature to date, nor are any anticipated during future design.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the spillway structure foundations will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the spillway structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks by rubber-tired loaders and hauled off to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the Miami Canal filling area. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab

permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

S-620 gated spillway on L-6

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater investigations have been performed in the vicinity of this feature to date, nor are any anticipated during future design.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the spillway structure foundations will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this

h. Anticipated construction techniques. It is anticipated that the spillway structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks by and hauled off to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be used at the Miami Canal filling area. The organic materials will then be disposed in an area to be determined during the design phase.

Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Miami Canal new spillway S-623

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date. However, a dewatering evaluation will be performed with seepage analysis during the design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the spillway structure foundations will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the spillway structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For

harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled off to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be delivered to and used at the Miami Canal filling area. The organics will be disposed of in an area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Deepen S-8 for extra capacity

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date. However, a dewatering evaluation will be performed with seepage analysis during the design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the pump structure foundation will be founded on underlying limestone. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the pump structure area can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled off to the Miami Canal for canal filling. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the Miami Canal filling area. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. A sheetpile cofferdam with tremie concrete slab to facilitate dewatering and dry construction is typically incorporated into the construction of these types of features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

L-4 Degrade

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The slopes shall be cut to a shallower or equal angle than currently that of the original design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavation can be conducted by standard excavating equipment of dozers, loaders, and dump trucks, as this is a degrade of an existing levee. Some excavation may be under wet conditions. No rippability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and hauled off to the Miami Canal as fill. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement in the Miami Canal. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be destined to be delivered to the Miami Canal filling area. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

A.6.2.1 General Status of Completed and Non-Executed Efforts

Despite the geological information presented here, some data gaps do exist which require further investigation. Portions of the Miami Canal from S-339 to S-8 need more exploratory borings to verify the thickness of the peat and top of limestone for the various alternatives. The south side of L-4 would also require further exploratory borings and perhaps hydraulic testing.

A.6.2.2 Soils

Three major soil types are found in the Everglades: 1) peat soils, which are high in organic content and are comprised of partially decayed plant material (two types of peat can be found in the Everglades: Everglades and Loxahatchee peat types), 2) marl soils, which have lower organic content and are comprised of calcitic mud deposited from calcareous periphyton (Gleason and Spackman 1974) and 3), tree island soils that have greater portions of mineral components than peat soils, but are very similar in that their origins are both plant material. The origin and development of peat and marl soils are greatly dependent upon water depth and resulting wetland vegetative communities. Alteration of the hydroperiod and diminished surface water inundation may also alter the vegetation communities and subsequent changes in soil type and depth or elevation could occur.

A.6.2.3 Geology

South of central Broward County to the Blue Line, the composition of the Fort Thompson Formation mixed clastic carbonates (poorly consolidated marine limestone, quartz sandstone, and sandy limestone) changes to predominately marine limestone that were deposited in marine platform margin and open marine tropical conditions similar to those observed in the present-day southern Florida Keys. The oolitic Miami Limestone often outcrops at the surface near the Blue Line and forms approximately 10 to 15 ft. of caprock overlying the Fort Thompson Formation. At the Blue Line, the Fort Thompson Formation is a karstic limestone in southern Broward/Miami-Dade Counties and has been characterized by Cunningham et. al (2006) into 16 distinct lithofacies representing freshwater, platform margin, ramp, and open marine carbonate depositional environments. Subsequent dissolution of these limestones during low sea levels resulted in the development of karst with extensive vugs and conduits throughout the vertical sequence of rock. Thus, the gradation of lithologies from mixed clastic-carbonates near the Red Line to karstic marine carbonates at the Blue Line affects the porosity and permeability of the sedimentary package.

Geologic information gathered from the pre-widening area of L-5 in 2000 by Nodarse and Associates (Figures ANNEX-3 and ANNEX-4), the subsurface characterization of L-5/L-4 for the Decompartmentalization and Hydrologic Sheetflow study (DECOMP) (U.S. Army Corps of Engineers, 2011) and the Wolff WPC, 2009 study of the Miami Canal south of S-339 yielded the following results from top to bottom (ANNEX G-2):

***Layer I: Fill**. This layer consists of localized areas of fill adjacent to existing canals at the time of the construction of these canals. The material is predominately sandy fill with some gravel, trace clay, some gravel and some shell in L-4 and L-5. By the Miami Canal (L-23) in Broward County, the fill is predominately limestone (crushed rock) fill. Both fill material varies in thickness from 0.5 foot to 6 feet. The fill has standard penetration N-values between 8 and 84 blows per foot depending upon the degree of material compaction. If groundwater is present in the fill, it occurs between 2 and 4.5 feet below grade.

***Layer 2: Interbeds of Organic Sand and Clay Including "Peaty" Clay.** This layer consists of alternating beds of organic sand and clay. Sand unit is predominately well-graded (poorly sorted) with some shell fragments and trace clay. Thickness ranges from 0.1 to 9 feet. In the L-5/L-4 area, standard penetration N-values varies between 2 and 68 blows per foot. The clay unit has trace gravel, sand and some shell fragments. In some places, the clay unit is carbonaceous or "peaty" (fibrous) and in some places, "fat" clay is present. Thickness ranges from 0.2 to 4.5 feet for the clay unit. Standard penetration N-values range from 0 to 11 blows per foot in the northern hydropattern restoration area. In Broward County, this clay unit appears to be laterally continuous. If groundwater is present, it occurs between 6.6 and 8.5 feet below grade within these units.

***Layer 3: Limestone**. Underlying the unconsolidated material of fill/organic sand and clay is limestone that is fossiliferous, vuggy, moderately to intensely weathered that is also slightly to highly fractured. Clay infilling of the voids is apparent in some areas. No unconfined compressive strength tests were conducted. Rock quality designations ranged from 0 to 77 percent with an average value of 25 percent. In some places, the limestone is interbedded between the organic sand/clay units.

A.6.2.4 HTRW

The Corps will review the HTRW condition of the affected parcels and ensure that the proper due diligence is performed in accordance with ER 1165-2-132 prior to certifying lands for construction. Should remediation of HTRW contamination be required, it is the responsibility of the SFWMD, the non-Federal, sponsor and is not a creditable cost to the project.

A.6.3 HYDRAULIC DESIGN

A.6.3.1 General Status of Completed and Non-Executed Efforts

Features identified in the Recommended Plan have been designed to the level of detail necessary to provide cost estimates and determine feasibility of hydraulic design. All components at the redline have been identified, sized appropriately according to available modeling data, historic information, and best engineering judgment. All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and information as it becomes available. General hydraulic design of all identified components south of the redline are described in the following sections.

A.6.3.2 Hydraulic Design – General

This section provides a brief overview of the hydraulic design criteria, parameters, intent/purpose of project features. Detailed hydraulic design of individual components is described in later sections, including hydraulic design data sheets. Detailed data resulting from model simulations may be found separately in Appendix A, Annex A-1. Currently, all elevations are referenced to NGVD 29; elevations will be provided in both NGVD 29 and NAVD 88 when revised during PED.

A.6.3.2.1 Design Criteria and Parameters

A.6.3.2.1.1 Canals

Canal side slopes are generally steeper than is found in many sandy regions. This is due to the limestone geology allowing for near vertical slopes in some locations. Generally, there is a preference for some slope in case of sand lenses and well weathered limestone that with time deteriorates to gravel and sand sizes, therefore most canal side slopes are 1V:2H.

A.6.3.2.1.1.1 Manning's Roughness Coefficient Determination

A Manning's roughness coefficient, or n value, of 0.035 was used for canal design in conveyance of design flows. The Palm Beach County region where the CEPP components and canals will be constructed has geological features characteristically described as limestone covered with a relatively thin layer of overburden (peat, marl, muck). For cost purposes, it is assumed that blasting will be the method of excavation for canals; however, the final method (blasting, ripping, etc.) will be determined in PED. These types of excavation methods leave a relatively coarse bottom and bank with sharp edged rocks and rubble. With canal age or maturation, some of these irregularities will become less defined resulting in a smoother perimeter with lower roughness values. Aquatic growth is expected along the upper banks where the overburden lies, but the design depths should be relatively free of plant roots extending from bottom to surface obstructing flow. Floating plants will be controlled by spray and harvest methods. The Manning's n value used was obtained from investigating various sources and noting them as follows.

In C&SF Project General Studies and Reports, Part I, Supplement 18, the following was noted; a value of at least 0.035 should be used where channels are constructed primarily in rock. This value is for channels with no appreciable erosion and with rapid-growth vegetation along the upper banks because of the organic soil overburden. Other sources provide Manning's n values within the same ranges as SCS and USGS for similar type canals. Brater and King's Handbook of Hydraulics, 7th ed., provides an n value of 0.035 for canals with rough stony beds and weeds on earth banks in fair condition. From the preceding investigations, and experience at the Jacksonville District in Florida, a Manning's n value of 0.035 appears to be appropriately applied to the design to satisfy criteria outlined by all referenced sources as the minimum acceptable value.

In detail design phase, the canal parameters may be modified for optimal benefit cost ratio.

A.6.3.2.1.2 Head Loss

Due to the relatively flat topography throughout the project area, the hydraulic head losses across many of the control structures are low, resulting in the design of larger structures (number and size of barrels, bays, etc.) than may typically be assumed for other regions. The use of pumps was avoided wherever possible to reduce operation and perpetual maintenance costs. During PED phase, SAJ expects to optimize system operations and therefore structure sizes for cost and performance efficiencies.

A.6.3.2.1.3 Flow and Velocity

Design flow rates for all water control structures were determined based on RSM-BN model outputs and existing canal and structure capacities. To capture cost impact adequately, structures and canals were designed for maximum capacity scenarios. Optimization of these features will be conducted during the PED phase for performance and cost efficiency.

Canals were designed to maintain a velocity of 2.0 fps or less to avoid potential erosion damage. Given the small topographical relief of the project area, this is typically the condition under normal operations, regardless.

A.6.3.2.1.4 Water Control Structures

The CEPP proposed plan will have multiple water control structures (S-620, S-621, S-622, and S-630). The function of the control structures are to convey deliveries from the L-6 Canal westward through the L-5 Borrow Canal to the S-8 pump station. The conveyance structure S-620 will be gated culverts replacing the existing plug at the downstream extent of the L-6 Canal, just upstream of the S-7 pump station. S-620 is sized to a capacity of 500 cfs, matching the existing L-6 canal conveyance capacity. The S-621 gated spillway is located in the STA 3/4 Outflow Canal, and will be used to block flows from the STA 3/4 from entering the L-5 Canal when L-6 deliveries are being made. The S-621 structure was sized to 2,500 cfs, matching the capacity of the S-7 pump station. The S-622 gated spillway will replace the existing plug in the L-5 Canal, located near the rock pits at the southwest corner of the STA 3/4. The spillway was sized to match the L-6 deliveries quantity of 500 cfs. The S-630 pump station is located along the L-4 Canal, west of the S-8 pump station, to provide water supply deliveries to the Seminole Tribe of Florida's Big Cypress Reservation via the G-409 pump station and water supply deliveries to STA-5 and STA-6, as well as to act as a divide structure to stage up water surface elevations in the L-4 Canal to flow over the proposed degrade of the L-4 Levee. The pump is sized to 360 cfs to provide concurrent water supply deliveries to the G-409 pump station (190 cfs) and water supply deliveries to STAs 5 and 6.

A.6.3.2.1.4.1 Gated Culverts

The entire CEPP project includes numerous gated box culverts across the entire project area. Construction material for all culverts is to be cast in place concrete.

An entrance loss coefficient value of 0.9 (assumed due to gate-added turbulence around inlet) and exit loss coefficient of 1.0 was used for all gated culvert structures. Also, the Manning's friction or energy loss coefficient was assigned 0.013 for all culverts. All major conveyance culverts were designed to remain submerged year round to reduce aquatic growth within, thereby better maintaining design friction head losses. All gated culvert sites were designed with a minimum of two culverts to allow maintenance activities to coincide, however with reduced capacity operations.

A.6.3.2.1.4.2 Gated Spillways

The CEPP Recommended Plan includes the design of two ogee weir concrete spillways with steel vertical lift gates located in line with the STA 3/4 Outflow Canal and in the L -5 Canal to replace the existing plug. The spillways were designed to be in conformity of engineering guidance found in USACE EM-1110-2-1603. All ogee spillways have vertical gates for controlled discharge operations. The spillways were designed with minimal head differential for conveyance energy. The S-621 spillway was designed with a 0.2 foot head differential. This design constraint is based on the assumption that the combination of L-5 Canal conveyance improvements and proposed S-8 pump station replacement/improvements will provide the ability to move the current maximum capacity of the STA 3/4 Outflow Canal. The S-622 spillway was designed with a 0.1 foot head differential. The structure's intent is to replace the plug existing in the L-5 Canal, and to have a little head differential as possible. The spillway is designed for 500 cfs to match the incoming deliveries from the L-6 Canal. SAJ acknowledges this low head differential constraint and accepts optimization will be required, including Value Engineering appropriate structure type for this function.

A.6.3.2.1.4.3 Pump Stations

The CEPP Recommended Plan proposes to construct a new pump station, S-630, for conveyance to the Seminole Tribe of Florida's Big Cypress Reservation and to provide flow over the degraded L-4 Levee. Additionally, the S-7 and S-8 pump stations will be utilized to provide L-6 and L-5 conveyances.

A.6.3.3 L-6 Diversion and Conveyance

A.6.3.3.1 General Information

The CEPP features at the redline include new structures and canal modifications to convey flows from the L-6 Canal westward to the modified S-8 pump station to distribute along L-4. A portion of the L-4 southern levee will be degraded to create an outlet for flow distribution into WCA-3A. All south of the redline components are within Palm Beach County, north of Water Conservation Area (WCA-3A).

A.6.3.3.1.1 Purpose

The purpose of the L-6 diversion and conveyance component of the CEPP project is to be able to move additional outflows from STA 3/4 and STA 2 from the L-6 to provide hydropattern restoration to the northwest WCA 3A. By making the proposed improvements to the L-5 Canal, available flow from either L-6 Canal or STA 3/4, or both, can be moved westward to the L-4 Canal, where the proposed levee degrade will provide flows to northwest WCA 3A.

A.6.3.3.1.2 Location

The L-6 diversion and conveyance component begins along the L-6 Canal, near the eastern intersection of STA 2 and Compartment B. The component spatial extent includes the L-5 Canal and the L-4 Canal. The component boundaries are located on the Palm Beach/Broward County line.

A.6.3.3.1.3 Features

The CEPP project has the following L-6 diversion features south of the redline:

Structures:

- S-620 Gated Culvert (CS-1)
- S-621 Gated Spillway (CS-2)
- S-622 Gated Spillway (CS-3)
- S-630 Pump Station

Canals:

- L-5 Canal

Figure A-4 and **Figure A-5** illustrate all feature locations for South of the Redline (structures and canals are not to scale or geographically referenced). Detailed design analysis for hydraulic components south of the redline pertaining to L-6 diversion and conveyance can be found in supplemental documents located in Appendix A, Annex A-1.

FIGURE A-4. NORTH OF REDLINE/AT REDLINE LOCATION MAP

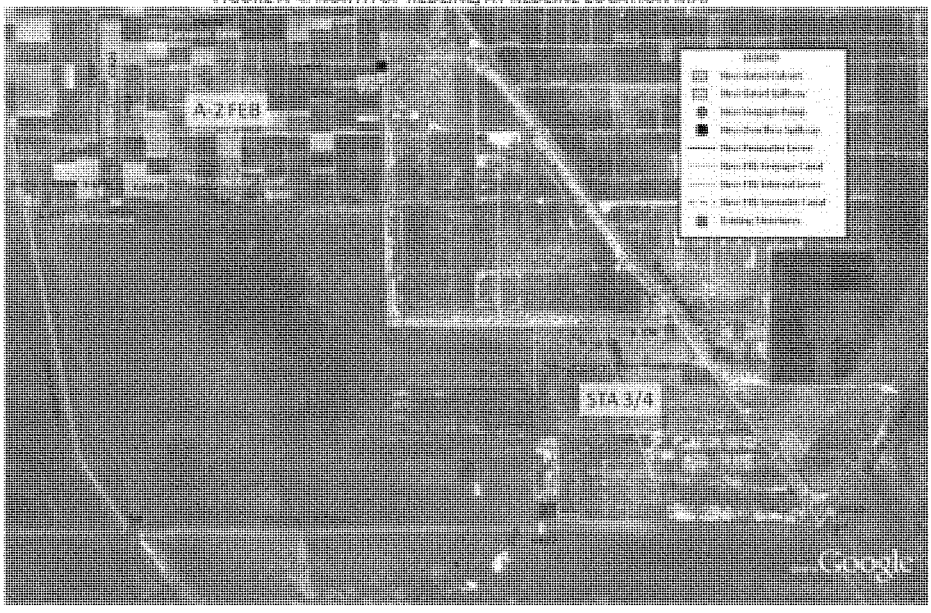


FIGURE A-5. L-4 LOCATION MAP

A.6.3.3.2 Hydraulic Design

A.6.3.3.2.1 Proposed Water Control Structures

A.6.3.3.2.1.1 Gated Culverts

S-620 Gated Culvert (CS-1)

The structure is an outlet control structure to allow conveyance from the L-6 Canal to the eastern (remnant) L-5 Canal, replacing the existing plug at the most southern end of the L-6 Canal. S-620 is a two-barreled gated box culvert structure. The design flow is 500 cfs with a design hydraulic head of 0.5 ft. The structure is a typical box culvert with dimensions of 8 ft by 8 ft with vertical slide gates and a total length of 75 ft. The upstream and downstream inverts are set at elevation -3.5 ft NGVD. The design velocity through the structure is 4.0 fps.

A.6.3.3.2.1.2 Gated Spillways

S-621 Gated Spillway (CS-2)

S-621 is a gated spillway that will serve as a divide structure to separate STA 3/4 outflows from the eastern (remnant) L-5 Canal when L-6 deliveries are being made to the L-5 Canal. When open, S-621 will allow for a portion of the STA 3/4 outflow discharges to be delivered to the S-7 pump station. During normal operations, including L-6 diversion flows, CEPP will direct the majority of STA 3/4 discharges westward to the modified S-8 pump station, and operation of S-7 pump station to deliver STA 3/4 discharges to WCA-2A is anticipated primarily during peak discharge events. S-621 is a three-bay gated spillway. The design flow is 2,500 cfs with a design hydraulic head of 0.2 feet. The design flow was set to match that of the S-7 pump station. The spillway consists of three gates with dimensions of 23 ft wide by 12.5 ft high. The crest elevation is set to 1.0 ft NGVD. The upstream and downstream aprons are set at an elevation of -5.0 ft NGVD, with apron lengths of 30 ft. S-621 is located in line with the STA 3/4 Outflow Canal, just north of the L-5 Canal. During PED, the design requirements for S-621 will be revisited, and this structure may be removed from the CEPP project.

S-622 Gated Spillway (CS-3)

S-622 is a gated spillway that will replace the existing plug in the L-5 Canal to hydraulically connect the eastern and western portions of the canal. S-622 is a three-bay gated spillway. The design flow is 500 cfs with a design hydraulic head of 0.1 feet. The spillway consists of three gates with dimensions of 15 ft wide by 10 ft high. The crest elevation is set to 5.00 ft NGVD. The approach apron and discharge apron inverts are set at an elevation of 0.00 ft NGVD with lengths of 33 ft. S-622 is located in line with the L-5 Canal, just south of the former Griffin rock pits near the southwest corner of STA 3/4.

A.6.3.3.2.1.3 Canals

L-5 Canal Improvements

In order to accommodate the proposed flows through the L-5 Canal, conveyance improvements must be made to both the eastern (remnant canal) and western portions. An existing plug located about midway along the canal (south of the former Griffin rock pits) will be removed and replaced with gated spillway S-622 in order to divide flows for varying conveyance scenarios. The CEPP modifications to the eastern remnant L-5 Canal will accommodate 500 cfs, and the CEPP modifications to the west L-5 Canal will accommodate 3,000 cfs. The design HW and TW for the improved canal were 12.00 ft NGVD and 10.00 ft NGVD, respectively.

TABLE A-21. L-5 REMNANT CANAL IMPROVEMENTS

Length	Side Slope L/R	Canal Bottom Width	Canal Bottom Elevation	Average Depth
Feet	V:H	Feet	Ft, NGVD	Feet
31,000	1:1.5	50	-5.1	14.6

TABLE A-22. L-5 WESTERN CANAL IMPROVEMENTS

Length	Side Slope L/R	Canal Bottom Width	Canal Bottom Elevation	Average Depth
Feet	V:H	Feet	Ft, NGVD	Feet
45,000	1:1.5	100	-5.6	16.0

TABLE A-23. L-5 CANAL IMPROVEMENTS COMPARISON

	Station	Existing Canal at 1,550 cfs				Improved Canal at 1,550 cfs		
		WSE	Channel Invert	Mean Channel Velocity	Flow Area	WSE	Channel Invert	Mean Channel Velocity
		Ft, NGVD	Ft, NGVD	fps	Sq ft	Ft, NGVD	Ft, NGVD	fps
Eastern Canal	77189.11	14.49	-2.94	0.27	1828.74	11.96	-5.1	0.31
	71197.72	14.46	-2.1	0.60	1075.69	11.94	-5.1	0.39
	65198.22	14.4	-0.8	0.61	1036.59	11.93	-5.1	0.39
	59196.34	14.34	-0.29	0.71	934.25	11.91	-5.1	0.39
	52199.00	14.26	0.4	0.66	965.65	11.89	-5.1	0.39
	47693.76	14.2	0.13	0.65	923.57	11.87	-5.1	0.39
Western Canal	44696.79	14.06	-4.2	1.63	1929.01	11.82	-5.6	1.36
	39196.49	13.82	-5.0	1.61	1933.16	11.63	-5.6	1.38
	30697.78	13.25	-0.6	1.67	1861.23	11.34	-5.6	1.40
	21692.23	12.45	-4.9	1.85	1657.15	11.01	-5.6	1.45
	12690.65	11.55	-6.69	2.11	1460.62	10.46	-5.6	1.48
	691.9784	10.11	-5.1	1.99	1511.01	10.02	-5.6	1.56

A.6.3.3.2.1.4 Pump Stations

S-630 Pump Station

The S-630 structure is a small 360 cfs pump station on the L-4 Canal, used to maintain existing water supply deliveries to the Seminole Tribe of Florida's Big Cypress Reservation, STA-5, and STA-6, and to stage up water in the L-4 Canal to allow discharge over the L-4 Levee degrade. Currently, water supply deliveries can be made from the G-404 pump station (at the eastern terminus of L-4) through the existing gap in the south L-4 Levee. The seepage pump will be equipped with four 90 cfs electric motor driven pumps and a liquefied petroleum gas (LPG) generator, which will serve as an alternative power source in case of power outages.

Pump Rates

The S-630 pump station will be located west of the L-4 levee degrade, with the intent to provide water supply deliveries to meet the demands of the G-409 pump station (190 cfs) and to provide water supply to STA-5/6. The S-630 pump station will also be used to provide lift to allow water to overflow the L-4 southern levee degrade. The pumping rate of 360 cfs was established to provide concurrent water supply deliveries to the existing G-409 pump station (190 cfs) and to provide water supply demands to STA-5 and STA-6.

Pump Mix

Pump mixes were based on a minimum of two bay pump stations to minimize risk of impact to private lands should a single pump fail during critical times. All small pump stations will be equipped with electric motor driven pumps that have diesel generators or pumps for an alternative power source in cases of power outages. One criterion for all pump mixes was to utilize duplicate pump sizes as much as possible to reduce operation and maintenance costs. This is accounted for through a reduction in different spare parts required and focusing mechanical expertise. Another criterion was to provide a pump mix that allows a smooth pump rate change interval from start-up to full capacity. The S-630 pump station will be equipped with four 90 cfs electric motor driven pumps for normal operations and an LPG generator to provide backup power.

Pump Stages

Pump stages were defined by the following pumping parameters:

Intake Water Surface Elevations:

Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.
Maximum Pumping: Maximum canal or pool stage that can be pumped with any increase in stage requiring the pump to be turned off. In most cases, Maximum Non-Pumping and Maximum Pumping stages are identical.
Start Pumping: Canal or pool stage when pump may be turned on as defined by system conditions, typically on the increasing limb.
Normal Drawdown: Expected local drawdown at the pump station intake.
Minimum Drawdown: Lowest local drawdown stage before pump is required to be turned off.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions.

Discharge Water Surface Elevations:

Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.
Maximum Pumping: Maximum canal or pool stage that can be pumped to, pump is subsequently turned off until stage decreases.
Normal Pumping: Expected normal pool elevations for impoundments and design tailwater stages for conveyance canal pump stations (flood damage reduction drainage discharge).
Minimum Pumping: Lowest canal or pool stage expected when pump may be turned on.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions. In most cases, Minimum Pumping and Minimum Non-Pumping elevations are identical.

A.6.3.3.2.2 Existing Structures

S-7 Pump Station

S-7 is an existing pump station that is currently used to discharge runoff water via the North New River Canal, as well as provide an outlet for STA 3/4 discharges, into WCA-2A. The pump station is equipped with three 830 cfs diesel pumps for a total capacity of 2,490 cfs. For CEPP, the majority of STA 3/4 discharges will be delivered to the modified S-8 Pump Station for delivery to WCA 3A, and operation of the S-7 Pump Station will likely be limited to peak events. The pump station is located in the alignment of the North New River Canal at the northwestern corner of WCA-2A.

S-8 Pump Station

S-8 is an existing pump station that is currently used to discharge runoff water via the Miami Canal, as well as provide an outlet for STA 3/4 discharges, into WCA-3A. CEPP will maintain this existing design capacity for the S-8 complex through a combination of the following design considerations: pump station design modifications, a new hydraulic connection from S-8 to the degraded L-4 Levee (New S-8A), utilization of the existing G-404 pump station (570 cfs design capacity), and leaving the 1-2 mile segment of the Miami Canal as available getaway conveyance capacity during peak flow events. For CEPP, the S-8 pump station and/or G-404 may require design modifications (or possible replacement). The Recommended Plan cost estimate includes costs for the potential S-8 complex modifications, which are included as the new S-8A (canal connection to L-4 and two culverts structures). During PED, the following design uncertainties will be assessed/reassessed in further detail: modifications to S-8 and/or G-404, to address pump efficiency concerns; the proposed S-8A culvert and associated canal connecting the Miami Canal to the L-4 Canal; and the required length of the unmodified Miami Canal to maintain hydraulic getaway conveyance capacity. Flood control operation capability will be maintained during S-8 modification construction. S-8 is equipped with four 1,040 cfs diesel pumps for a total capacity of 4,160 cfs. The pump station is located in the alignment of the Miami Canal at the northern boundary of WCA-3A.

A.6.3.3.2.3 Existing Canals

L-4 Canal

The L-4 Canal is located west of the S-8 pump station and currently conveys water from the Miami Canal and the L-5 Canal to the G-409 pump station where it is provides water supply to the Seminole Tribe of Florida's Big Cypress Reservation, to STA 5/6, or to Northwest WCA-3A via the L-4 gap and the L-3 Extension Canal.

L-6 Canal

The existing L-6 Canal currently conveys water from the STA-2 via outflow structure G-335. Currently available information suggests the in-bank capacity of the canal can adequately convey the 500 cfs required for L-6 delivers to the L-5 Canal. If the existing conditions do not meet required criteria, operational stage changes or modifications may be required. Further survey analysis will be conducted during PED to verify the existing conditions.

A.6.3.4 Risk and Uncertainty

This section presents qualitatively the risk and uncertainty associated with the project as designed for this PIR. Understanding that the current USACE philosophical approach to Feasibility Studies is to be quick and limit analyses to that for benefit and cost determinations, acknowledging risk and uncertainty in the hydraulic design of the project will be an important part of the risk registry. The overall approach to the hydraulic design was to be conservative enough to capture expected costs without being

unrealistic in overestimation, yet not to underestimate beyond what optimization and the savings that could be realized during PED phase efforts.

A.6.3.4.1 Computer Software Tools

Several hydrologic and hydraulic computer software tools were utilized in the formulation of alternatives and the Recommended Plan. Interpretation of hydraulic design results should consider the inherent strengths and limitations of the underlying hydrologic and hydraulic tools. Additional descriptions of the modeling tools are provided in Appendix A, Section A.8.1 (Modeling Strategy).

A.6.3.4.2 Hydraulics and Hydrology Lowering Risk in Design

S-8 Pumping Station Tailwater Impact with Miami Canal Backfill

The Miami Canal affords discharge capacity for the S-8 Pump Station when it is operated for flood protection purposes. The canal provides length necessary for the discharge to flow from clear canal path into the emergent marsh vegetation with relatively high hydraulic head loss. To offset the potential tailwater impact, three additional features are provided: (1) routing or diversion of a portion of the discharge will be made to the west with discharge into WCA-3A with L-4 levee degrade, (2) inclusion of the 360 cfs S-630 Pump Station that pumps water further west out of the western diversion conveyance, and (3) leaving a designed section of non-backfilled length of the Miami Canal from the S-8 Pump Station. With CEPP implementation, there is little risk that flood protection will not be able to be maintained as it functions and is operated today. Also, lowering the risk even further is the construction of the FEB(s) that function as surge tanks within the basin that uptake excess runoff before triggering the S-8 Pump Station, reducing the pumping to large precipitation events or when the FEB is full with no storage availability.

For CEPP, the S-8 pump station and/or G-404 may require design modifications (or possible replacement). The Recommended Plan cost estimate includes costs for the potential S-8 complex modifications, which are included as the new S-8A (canal connection to L-4 and two culverts structures). During PED, the following design uncertainties will be assessed/reassessed in further detail: modifications to S-8 and/or G-404, to address pump efficiency concerns; the proposed S-8A culvert and associated canal connecting the Miami Canal to the L-4 Canal; and the required length of the unmodified Miami Canal to maintain hydraulic getaway conveyance capacity.

Miami Canal Backfill to Sheetflow Characteristics

The Miami Canal is cut nearly perpendicular to topographical contours through WCA-3A. As such, water is "short-circuited" through the wetlands versus historic shallow sheetflow across the floodplain. To investigate how backfilling the canal may impact flow, a 2-dimenisional model using the Adaptive Hydraulics Modeling (AdH) computing software was constructed and simulation of various "plug" or backfill lengths were made with various configurations. It was found that a plug length of simple configuration, e.g. no berm lateral extensions into the marsh, of 4,000 feet caused canal flows to leave the canal, enter the marsh, and continue southerly as sheetflow. Since the design backfill is of longer length, there is little risk that the planned feature will not work as intended.

A.6.3.5 HYDRAULIC DESIGN DATA SHEETS

TABLE A-24. S-620 GATED CULVERT
HYDRAULIC DESIGN DATA SHEET

Location Southern extent of L-6 Canal; x = 807,929 y = 728,365

Purpose S-620 is proposed to be a two-barreled 8 ft by 8 ft gated box culvert to control outflow from the L-6 Canal to the L-5 Canal. The structure will replace the existing plug. S-620 will be located at the southern end of the L-6 Canal, approximately 0.15 miles north of S-7.

Design Conditions	Discharge	500	cfs
	Headwater Elevation	12.50	feet, NGVD 29
	Tailwater Elevation	12.00	feet, NGVD 29
Culvert Data	Number of Barrels	2	
	Barrel Type	Concrete Box Culvert	
	Box Width	8	feet
	Box Height	8	feet
	Culvert Length	75	feet
	Upstream Invert	-3.50	feet, NGVD 29
	Downstream Invert	-3.50	feet, NGVD 29
	Natural Water Table	9.00	feet, NGVD 29
	Headwall - HW Elevation	TBD	feet, NGVD 29
	Headwall - TW Elevation	TBD	feet, NGVD 29
	Wingwall - HW Elevation	TBD	feet, NGVD 29
	Wingwall - TW Elevation	TBD	feet, NGVD 29
Canal Data	Side Slopes (V:H)	1 on 2	
	Upstream Bottom Width	28	feet
	Upstream Bottom Elevation	-4.00	feet, NGVD 29
	Downstream Bottom Width	28	
	Downstream Bottom Elevation	-4.00	feet, NGVD 29
Energy Dissipation	**Riprap Requirements**		
	Rip Rap Design Velocity	4	fps
	Upstream Length	TBD	feet
	Upstream Protection Elevation	TBD	feet, NGVD 29
	Downstream Length	TBD	feet
	Downstream Protection Elevation	TBD	feet, NGVD 29

TABLE A-25. S-621 GATED SPILLWAY
HYDRAULIC DESIGN DATA SHEET

Location Near intersection of STA 3/4 Outflow Canal and L-5; x = 804,442 y = 729,629

Purpose S-621 controls flows from STA 3/4 Outflow Canal into the L-5 Canal

Design Conditions	Discharge	2,500	cfs
	Headwater Elevation	12.20	feet, NGVD 29
	Tailwater Elevation	12.00	feet, NGVD 29
Crest Data	Shape	Ogee	
	Design Head (Hd)	11.2	feet
	Net Crest Length	69.0	feet
	Crest Elevation	1.00	feet, NGVD 29
	Approach Apron Elevation	-5.00	feet, NGVD 29
	Weir Control	Vertical Slide	
Gates	Number of Gates	3	
	Gate Width	23.0	feet
	Gate Height	12.5	feet
	Clearance Elevation	13.50	feet, NGVD 29
	Breastwall Elevation	TBD	feet, NGVD 29
	Intermediate Pier Width	3.25	feet
Stilling Basin	Design Discharge	2,500	cfs
	Apron Elevation	-5.00	feet, NGVD 29
	Apron Length/Width	51.0/75.5	feet
	End Sill Elevation	-4.50	feet, NGVD 29
	Top of Baffle Block Elevation	-2.00	feet, NGVD 29
	Dist from crest toe to 1st row of blocks/2nd row	25.00	feet
	Velocity over End Sill	2.01	fps
	Training Wall Elevation	TBD	feet, NGVD 29
Canal Data (US/DS)	Invert - Thalweg	-7.0/-7.0	feet, NGVD 29
	Top of Bank	Varies, avg = 18.5	feet, NGVD 29
	Bottom Width	75.5	feet
	Top Width	205.0	feet
	Side Slope (V:H)	1 on 2.5	
Revetment	Riprap Extent (Downstream)	TBD	feet
	Riprap Size (D50)	TBD	feet
	Riprap Specific Weight	TBD	lb/ft3
	Max Velocity Riprap Can Withstand	TBD	fps

TABLE A-26. S-622 GATED SPILLWAY
HYDRAULIC DESIGN DATA SHEET

Location L-5 Canal south of the Griffin rock pits; x = 775,938 y = 726,388

Purpose S-622 replaces the existing plug to allow conveyance from L-6 Canal to S-8 pump station

Design Conditions	Discharge	500	cfs
	Headwater Elevation	11.93	feet, NGVD 29
	Tailwater Elevation	11.83	feet, NGVD 29
Crest Data	Shape	Ogee	
	Design Head (Hd)	6.9	feet
	Net Crest Length	45.0	feet
	Crest Elevation	5.00	feet, NGVD 29
	Approach Apron Elevation	0.00	feet, NGVD 29
	Weir Control	Vertical Slide	
Gates	Number of Gates	3	
	Gate Width	15.0	feet
	Gate Height	10.0	feet
	Clearance Elevation	11.00	feet, NGVD 29
	Breastwall Elevation	TBD	feet, NGVD 29
	Intermediate Pier Width	3.25	feet
Stilling Basin	Design Discharge	500	cfs
	Apron Elevation	0.00	feet, NGVD 29
	Apron Length/Width	33.0/51.5	feet
	End Sill Elevation	0.50	feet, NGVD 29
	Top of Baffle Block Elevation	2.00	feet, NGVD 29
	Dist from crest toe to 1st row of blocks	20.00	feet
	Velocity over End Sill	0.85	fps
	Training Wall Elevation	TBD	feet, NGVD 29
Canal Data (US/DS)	Invert - Thalweg	-5.10	feet, NGVD 29
	Top of Bank		feet, NGVD 29
	Bottom Width	50.0	feet
	Top Width		feet
	Side Slope (V:H)	1 on 2	
Revetment	Riprap Extent (Downstream)	TBD	feet
	Riprap Size (D50)	TBD	feet
	Riprap Specific Weight	TBD	lb/ft3
	Max Velocity Riprap Can Withstand	TBD	fps

TABLE A-27. S-630 PUMP STATION
HYDRAULIC DESIGN DATA SHEET

Location	L-4 Canal, east of the G-409 Pump Station			
Purpose/Operational Intent:	Water Supply Provides water to the G-409 Pump Station in order to continue deliveries to the Seminole Tribe of Florida's Big Cypress Reservation, and STAs 5 and 6 once L-4 Levee degrade is implemented.			
Design Condition:			360	cfs
Pump Station Capacity Criteria:				
Number of Pumps			4	
Pump Mix Type and Size		Electric	4@ 90	cfs
Mix Criteria:				
	1. The pump station will have 4 bays; four 90 cfs electric motor driven pumps 2. The pump mix allows for duplicate pumps throughout the system for operation and maintenance consideration			
Control			TBD	
Design Heads				
	Normal (HW=13.0 NGVD, TW=7.0 NGVD)		TBD	ft
	Maximum (HW=15.15 NGVD, TW=7.0 NGVD)		TBD	ft
Intake Water Surface Elevations				
	Maximum Non-Pumping Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Start Pumping		TBD	ft, NGVD
	Normal Drawdown		TBD	ft, NGVD
	Minimum Drawdown Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		TBD	ft, NGVD
Discharge Water Surface Elevations				
	Maximum Non-Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Normal Pumping		TBD	ft, NGVD
	Minimum Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		TBD	ft, NGVD

A.6.4 STRUCTURAL DESIGN

A.6.4.1 General Status of Completed and Non-Executed Efforts

Structural design of S-620, S-621, S-622, S-630, and S-8A will be completed during the design phase. During design phase the structural calculation will be completed after survey, hydraulic design, and geotechnical investigations are performed. The structural design will conform with the appropriate Engineering Manuals (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM).

A.6.4.2 Pumping Stations

S-630 is a pump station that will be similar in design to S-357, but with the new layout of the Miller (S-488) pump station.

A.6.4.3 Overflow Spillways

S-621 and S-622 are gated structures similar to S-65EX1, using a two-phased approach offsetting the structure and existing plugs, will not require a bypass canal to be designed for construction of the structures.

A.6.4.4 Culverts

S-620 is a gated box culvert that will be designed similar to the (S-276 (C-4A)) culverts on Herbert Hover Dike (HHD).

A.6.5 MECHANICAL AND ELECTRICAL DESIGN

A.6.5.1 General

The pumping station mechanical design shall be in accordance with Hydraulic Institute Standards, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout), and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations). The design will also follow the guidance of ETL 1110-2-313 (Hydraulic Design Guidance for Rectangular Sumps of Small Pumping Stations with Vertical Pumps and Ponded Approaches).

The seepage pumping station will have a required pumping capacity of 360 cfs.

The pump mix will be further developed during the design phase of the project, but it will likely have a mix similar to having four 90-cfs electric motor-driven pumps.

The pump intakes will likely be suction bell type. The use of formed suction intakes at the pumps shall be evaluated during preparation of the plans and specifications for the pumping station and shall be based upon the channel intake design.

Axial flow pumps will be used for the pumping station. The decision on whether the pumps will have either a conventional or siphon discharge will be determined during the preparation of the plans and specifications.

The pumping station electrical design shall be in accordance with NEC, NFPA, IESNA, TIA/IEA, IEEE, and recommended practice. Also, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout) and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations) will be used.

Although the capacity of this station is low enough that SFWMD's Major Pumping Station Engineering Guidelines is not applicable, we will follow the applicable portions of these guidelines.

A.6.5.2 General Status of Completed and Non-Executed Efforts

Mechanical and electrical design of S-620, S-621, S-622, S-630, and S-8A will be completed during the design phase. During design phase the mechanical and electrical calculations will be completed after survey, hydraulic design, and geotechnical investigations are performed. Conceptual design used for cost assumptions.

A.6.5.3 Pumping Station S-630

The four 90-cfs pumps will be axial-flow-type vertical-shaft pumps. The pumps will be driven by direct-drive electric motors.

The pumps are expected to run at 600 rpm with an efficiency of about 80%.

The pumping station will include various support items, including the following:

a. An LPG fuel system sized to operate an emergency generator continuously for seven days.
b. Hoisting system for maintenance or repair of the pumping equipment.
c. Toilet facility with a water closet and a lavatory.
d. Kitchen-type sink.
e. Potable water system and a septic system for the plumbing fixtures.
f. Ventilation system to provide fresh air in the pump bays, generator area, and toilet room.
g. Air-conditioning system for the office.
h. Stilling wells containing float switches to be used for pump operations and water level monitoring.

A.6.5.3.1 Pumping Station Features

Station Crane/Hoist
An overhead bridge-type electric crane will be provided. The crane/hoist shall be capable of handling up to 15-ton loads. The crane/hoist will handle pumping station equipment such as the electric motor pump drive or the pump components during initial installation, as well as for general service thereafter.

LPG Generator Set
An LPG-driven generator set with capacities up to 500 kW may be provided. This generator must provide general standby power, but it also may be required to provide sufficient power to operate one of the electric motor driven pumps for as long as seven days.

Potable Water and Plumbing
A potable water supply and plumbing system will be provided. This will include a septic system. A filtered water system will be necessary for the station to supply water to a Toilet (lavatory, shower, and water closet) and small kitchen area.

Air Conditioning
Small split-system air conditioning systems will be provided for the control room, telecommunications room, and the break room.

Ventilation System
A system of air inlet openings and exhaust fans will be provided for ventilation of the operating floor area. The air inlet louvers will be the type commonly referred to as Miami-Dade louvers. Bird screening will also be provided over the openings. The wall type exhaust fans will have motor-operated dampers.

Trash Rake
Trash rake/rack system will be one of two types: an automatic, continuously rolling, flex rake and trash rack system such as that manufactured by Duperon, or a powered rail-mounted traveling trash rake and hoist car assembly with a telescoping arm used to grip and remove debris. This system is similar to ones that are manufactured by Hydro Component Systems. The system selected shall be similar to those that have proven satisfactory at previously completed pumping stations.

Pump Model Tests
The specifications will require that a series of model tests be performed to verify performance and cavitation limits of the proposed pump. The contractor will be required to construct one complete pumping system for each size pump to the necessary scale model. The pumping system will include the forebay, pump, and discharge tube. All tests for determination of compliance with guarantees of capacity and/or efficiency will be accomplished using prototype heads.

A.6.5.3.2 Electrical Features

Electric Service and Backup Generator
A 480-volt, three phase, electrical service shall be provided. The local utility company shall provide the power. Transient Voltage Surge Suppression (TVSS) shall be provided at the service entrance. A backup LPG-generator unit shall be provided to supply 480-volt, three phase electrical power when utility power is not available or not reliable. The backup generator and automatic transfer switch will be sized sufficiently to power exhaust fans, lights and SCADA equipment.

Interior Electrical Distribution
Switchgear rated for 480 volt, three phase with a main breaker will be connected to the incoming service and will feed engine control centers, motor control centers, lighting panels, power panels and station equipment defined in the Pumping Station Features above. Each engine control center will house starters and controls for auxiliary equipment for the engine unit. The main switchboard will also feed transformers to supply 120/208 or 480/277 volt loads as necessary.

Interior and Exterior Lighting
High intensity discharge, industrial high bay luminaries will be used for the main pumping station area with industrial fluorescent fixtures with electronic ballasts for office and general type areas. Exterior lighting for security purposes would be automatically controlled by photo-electric cells and contactors.

Wiring and Conduit
Insulated copper conductors will generally be installed in either PVC coated rigid galvanized steel conduit or schedule 80 rigid plastic conduit. Conductors will be rated for 600 volt insulated types XHHW or XHHW-2. All wiring will conform to UFGS Guide Specifications.

Instrumentation and Controls
The pumping station will have a centralized monitoring and control room Programmable logic controllers (PLCs) will be used to monitor and control the station auxiliaries. An Ethernet network will connect the PLCs and station computer. Ethernet based IP cameras will also connect to the Ethernet network. The station computer will allow for operation of the station via SFWMD's preferred SCADA software.

SCADA and Telemetry
The controls systems shall include manual, automatic and telemetry capabilities for the pumps and auxiliary systems. The automation components of all pumping stations and structures that will eventually be operated and maintained by South Florida Water Management District (SFWMD) must conform to SFWMD standards in order to (1) achieve cost efficiency in design, construction, and operation and maintenance, (2) meet safety, reliability, and performance requirements during routine and emergency operations. The automation components are broadly defined to include hardware, software, communications, and user interface elements.

A.6.5.4 Gated Spillways and Culverts

Gate Operators
Gate operators will be designed based on the size, weight, and hydraulic loading on the gates. The operators will either be electric motor driven through a drum and pulley system or via as an actuator on a stem screw.

Electrical Service
A control center will house a main breaker, combination starter for the gate motor, lighting panel, relay compartment, and a circuit for exterior lighting. Surge suppression will be provided for each electrical/electronic system within or outside the structure.

Control and Monitoring
Duplicate open-close push button station in the control house and at the spillway or culvert structure will be provided for manual gate control. Necessary open, close, automatic control relays, and limit switches will be incorporated in the gate control circuit. Power and control circuits for water level recorders and gate position recorders will be provided.

A.6.5.5 Weir

Water Level Indication
Stilling wells with water level monitoring equipment will be provided on both sides of the weir. Power for the monitoring equipment will be provided by either commercial power or by solar power, depending on the final location of the weir.

A.6.5.6 Telemetry

Each spillway or culvert site that requires remote automation will be equipped with an RTU compatible with the existing SFWMD telemetry system. RTU software will be in accordance with the SFWMD standard load set. The construction plans will contain plans for a fully functioning telemetry system capable of connecting to and communicating with the SFWMD existing system. Additional coordination during the development of plans and specifications will finalize the telemetry requirements.

A.7 BLUE/GREEN/YELLOW LINES – DISTRIBUTION, CONVEYANCE & SEEPAGE MANAGEMENT

A.7.1 CIVIL - SITE DESIGN

Features identified in the Recommended Plan have been designed to the level of detail necessary to provide cost estimates. Best professional judgment as well as previous project design knowledge for DECOMP DPM, MWD and L-31NSMPP was used during plan formulation alternative development and design efforts. Components of the blue, green and yellow line have been identified, sized appropriately according to available data, historic information, and best engineering judgment. All project components will be optimized during PED phase for cost efficiency and performance, incorporating updated data and information as it becomes available.

The levee in the Recommended Plan has a crown of 14 feet with one on three side slopes. The levee will be seeded to prevent erosion. All levees will have a 15 foot clear zone at the toe as required by EM 1110-2-1913, Design and Construction of Levees. For the new levee (L-67D), a waiver or variance will be requested to permit marsh type vegetation within the 15 foot clear zone. Upon completion of construction, the levee will be entered into the National Levee Data Base for regular inspections as required by P. L. 84-99 to be part of the Federal Emergency Management System. See Annex C-2 for general plate of L-67D.

A.7.1.1 General Status of Completed and Non-Executed Efforts

The following civil site project efforts remain either incomplete or were not initiated:
evaluation of alignments,
site grading,
aesthetics,
relocation of facilities,
required improvements on lands to enable proper construction of components and disposal of material,
requirements of lands for construction, operation and maintenance of the project,
identification of facility/utility relocations and methods for accomplishing relocations to include appropriate lands,
site selection and project development, and
detailed design with respect to recent Levee Safety criteria.

These analyses will be completed in PED.

A.7.1.2 Surveying Mapping Geospatial data

Historical hydrographic and topographic surveys exist for the project area. All survey data collected was performed using conventional means and methods. The existing surveys are 90-177, 90-190, 91-180, 95-116, 97-006, 98-218, 02-019, 02-037, 02-046, 02-047, 02-77, 02-142, 03-132, and 08-195. Datum's

utilized for data collection is as follows: Horizontal coordinates are referenced to the State Plane Coordinate System North Atlantic Datum (NAD) 83 (2007), Florida East Zone (0901). Elevations are in US Survey Feet and referenced to North Atlantic Vertical Datum (NAVD) 88 vertical datum. See Annex C-1 for data points.

A.7.1.3 Access

Access to the project site will be from US 41 (Tamiami Trail) by S-333 along L-67A, L-67C, L-29 and L-31 levees. Northern access into WCA3B is from S-9 Pump Station or by Holliday Camp along the L67-A canal.

A.7.1.4 Material Balance and Disposal

L-67 extension (ext.) removal may place the material in the adjacent canals. Old Tamiami Trail road removal will stockpile the material within the project area, or, if suitable, the material may be used in the construction of L-67D. L-67C material may be used in the construction of L-67D or may be stockpiled adjacent to the L-67C canal. L-67D will be completed with material from onsite levee degrades (L-67C, L-67 ext removal and old Tamiami Trail road, if suitable) within the vicinity of the project area first, then from L-31 N Spoil Mound, L-29 removal or from an approved Borrow source. All peat material will be placed in either L-67 ext. or used to dress side slopes. Unsuitable material will be hauled to a certified land fill.

A.7.1.5 Utility Relocations

Florida Power and Light, and Quest Communications lines will have to be relocated where the L-29 is being removed. The removal of Old Tamiami Trial will require relocation of the Florida Power and Light line. Utilities will have to be supplied to S-631, S-632, S-633, S-333N, S-355W, and S-356.

A.7.2 GEOTECHNICAL DESIGN

Between Red and Green Lines:

S-630 divide structure at western terminus of L-4

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are any groundwater studies planned during the future design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the divide structure foundation will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the culvert and siphon structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled off the L-67D site for use as levee fill. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the L-67D area for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with a tremie concrete slab to facilitate dewatering and dry construction are typically incorporated into the construction of these type features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Backfill Miami Canal

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are future groundwater studies anticipated during design.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slopes shall be filled shallower or equal angle than 1V:3H.

g. Excavatability analysis. An excavatability analysis is not required for this feature, as it will be a fill operation.

h. Anticipated construction techniques. Some stripping of organics and vegetation off the canal side slopes will be required prior to fill placement. Organic material shall be disposed of in an area designated during the design phase. Stockpiles of borrow containing cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement in the canal. To avoid settlement, material shall be separated into pervious materials (<5% fines) for submerged fill placement and satisfactory fill for above the groundwater table in the canal. Material above the groundwater table shall be compacted and graded. Pervious materials will be placed in loose lifts starting along the canal bottom followed by compacted lifts of satisfactory fill above the groundwater table. Fill will not be allowed to be stacked on the canal slopes as this may induce slope instability.

i. Potential borrow and disposal sites. Excavated inorganic material from other feature areas will be delivered to stockpiles prior to processing in the Miami Canal. The organics are to be disposed to a designated area to be determined during the design phase.

j. Seepage and groundwater control. Seepage control other than controlled placement in wet conditions is not anticipated.

Between Green and Yellow Lines:

Increase S-333 capacity by deepening or widening (S-333N)

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the pump structure foundations will be founded on underlying limestone. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the pump station structure area can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled to the L-67D levee for fill. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the new L-67D levee area for fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. A sheetpile cofferdam with a tremie concrete slab to facilitate dewatering and dry construction is typically incorporated into the construction of this type of feature. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Two new gated structures on L-67A west of L-67D (S-632 and S-633)

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are future groundwater investigations anticipated.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, these spillway structure foundations will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the spillway structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled to the L-67D levee for use as fill. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the L-67D levee for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via

well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

One new gated structure on L-67A east of L-67D (S-631)

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, this spillway structure foundation will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability has been estimated at this time and these estimates will be evaluated further based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the spillway structure area can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 3 inches in effective diameter can be loaded onto dump trucks and hauled to the L-67D levee for use as fill. Larger cobbles and boulders can be crushed and mixed with the minus 3 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the L-67D levee for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from

offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. Sheetpile cofferdams with tremie concrete slabs to facilitate dewatering and dry construction are typically incorporated into the construction of these features. Discharge of dewatering effluent will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Degrade 8 Miles of L-67C between L-67D and S-333 and Export the Material

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are future groundwater studies anticipated during the design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slopes shall be cut to a shallower or equal angle than currently that of the original design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavatation can be conducted by standard excavating equipment of dozers, loaders, and dump trucks, as this is a degrade of an existing levee. Some excavation may be under wet conditions. No rippability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and hauled off to the new L-67D levee for use as fill. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement in the L-67D. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be destined to be delivered to the L-67D levee area for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will

be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Degrade 6000 feet of L-67C just east of L-67D and export material

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are future groundwater studies anticipated during the design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slopes shall be cut to a shallower or equal angle than currently that of the original design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavatation can be conducted by standard excavating equipment of dozers, loaders, and dump trucks, as this is a degrade of an existing levee. Some excavation may be under wet conditions. No rippability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and hauled off to the new L-67D levee for use as fill. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement in the Miami Canal. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be destined to be delivered to the L-67D levee area for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Construct new levee L-67D

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-28**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date. Field and laboratory hydraulic testing of the subsurface materials such as specific capacity and/or constant head recharge are to be used to estimate the horizontal hydraulic conductivity of the limestone foundation material along with double ring infiltrometer tests to estimate the vertical hydraulic conductivity.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. The levee will be founded on underlying limestone after stripping and removal of surficial organic peats and organic silts. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. Slope stability analyses during the design phase will be required for the steady state and end-of-construction cases and potentially for the rapid drawdown case. A preliminary slope stability analysis using the SLOPE/W program has been performed for the levee with results for the steady state seepage case presented in **Figure A-6**. A table of input parameters used in the analysis is contained in **Table A-28**. The computed factor of safety is 3.2.

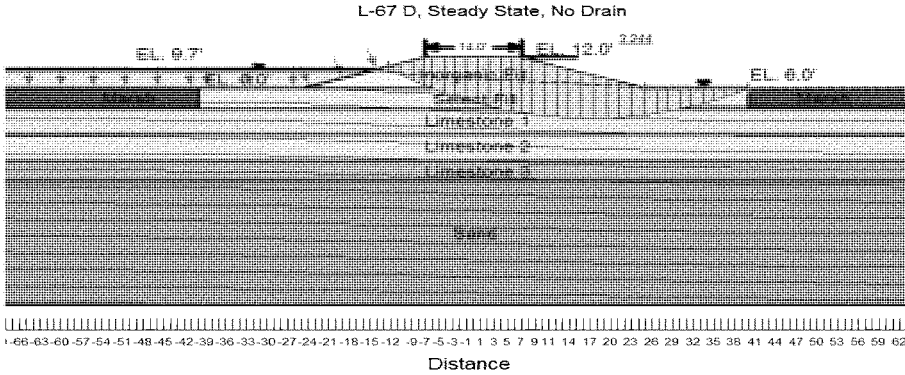


FIGURE A-6. CRITICAL CASE FOR STEADY STATE SLOPE STABILITY ANALYSIS FOR L-67D

TABLE A-28. INPUT PARAMETERS FOR THE SLOPE/W MODEL FOR L-67D

Material	Unit Weight (pcf)	Friction Angle, (°)	Elevation of Layer (ft)
Inorganic Fill	115	32	12.0 to 6.0
Marsh Organics	70	27	6.0 to 2.0
Select Fill	115	32	6.0 to 2.0
Limestone 1	120	33	2.0 to -3.0
Limestone 2	130	36	-3.0 to -7.0
Limestone 3	125	33	-7.0 to -12.0
Sand	120	32	-12.0 to -36

g. Excavatability analysis. It is anticipated that foundation materials are readily excavated with standard excavation equipment. Excavation will stop at the limestone horizon.

h. Anticipated construction techniques. It is anticipated that the levee foundation can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank. Embankment fill will be imported from many outside sources, so blending and processing will probably be required to yield a somewhat homogeneous levee. Excavated inorganic cobbles and grains less than 3 inches in effective diameter can be processed and stockpiled for use as levee fill. Larger cobbles and boulders can be crushed and mixed with the minus 6 inches of soil and rock. Excavation of the top organic layers in the foundation is anticipated to be in a wet condition. As the fill materials are primarily cohesionless, vibratory steel wheeled are pneumatic tired rollers are the expected equipment to be used on this site.

i. Potential borrow and disposal sites. Stockpiled inorganic materials from other features of this project will be processed, compacted and placed as fill for the inner and exterior dikes. Pervious fill (<5% fine grained material) will be used as the bridging lift between the underlying foundation limestone and the groundwater surface. The bridging lift will be placed loosely into the excavated pit and pushed forward with dozers until satisfactory bearing is achieved for dry placement. The pervious material can either be

imported or derived from processing canal borrow material. Above the groundwater level, satisfactory fill from the canal borrow material shall be placed in compacted lifts in the dry. Oversize particles greater than 3 inches in nominal diameter shall be crushed into satisfactory fill or used for erosion protection features. Excess inorganic material will be stored in a designated disposal area which will be identified during the design phase. The organic soils are to be disposed to a designated area to be determined during the design phase. These may be used later for mixing and seeding of embankment erosion protection. Riprap and bedding materials required for erosion protection will be obtained from offsite sources unless suitable rock is found on-site. Rip rap and bedding will be sized during the design phase based on design water velocities. Access roads and the levee crest road will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. From previous studies and core boring logs from L-67A/C to the west, solution cavities are expected to be encountered in foundation grade for the levee. Field and laboratory tests are planned to characterize the subsurface material hydraulic characteristics for the purpose of minimizing seepage losses and to protect against piping losses of embankment material from beneath the levee foundation. A preliminary 2D seepage analysis was performed on an idealized levee cross section using the finite element method contained in the SEEP/W software. The numeric model is shown in **Figure A-7**. Hydraulic material properties used in the analysis are presented in **Table A-29.** The levee geometry is based on the Recommended Plan idealized section. Maximum headwater was modeled at elevation 9.7' NAVD88 with the tailwater fixed at the ground surface elevation of 6' NAVD 88. Seepage quantities through the levee under these hydraulic loading conditions indicate underseepage at about 18 cubic feet per day. From previous investigations it is anticipated that the levee will be founded on weathered limestone which may contain vugs and solution cavities. If the cavities are large enough, some sort of filter may be required between the embankment and the foundation to prevent piping of the embankment materials. Geologic mapping of the levee foundation using conventional methods would be impractical in a wet environment. Stochastic mapping of rock core voids and/or geophysical methods may be required to estimate the pore size distribution of the limestone foundation.

Blue Line and South:

Gated Spillway just east of L-67D (S-355W)

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are any groundwater studies planned during the future design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the spillway structure foundation will be founded on underlying limestone or compacted cohesionless fill. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

TABLE A-29. INPUT PARAMETERS FOR SEEP/W MODEL FOR L-67D

Material	Anisotropy, K_w/K_h	Saturated Hydraulic Conductivity, K_h (ft/day)	Top and Bottom Elevation of Layer (ft)
Inorganic Fill	0.25	0.3	12.0 to 6.0
Marsh Organics	0.7	33	6.0 to 2.0
Select Fill Sand	1	50	6.0 to 2.0
Limestone 1	0.5	11	2.0 to -3.0
Limestone 2	0.33	63	-3.0 to -7.0
Limestone 3	0.5	11	-7.0 to -12.0
Sand	0.5	11	-12.0 to -36

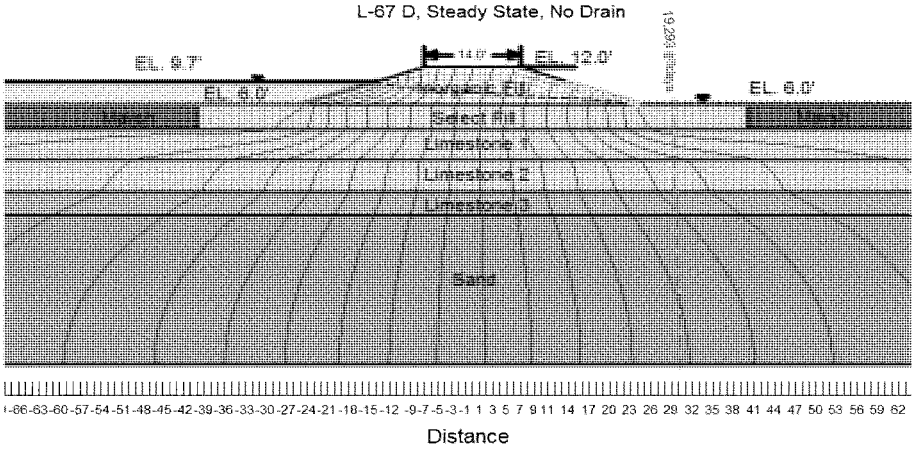


FIGURE A-7. PRELIMINARY STEADY STATE SEEPAGE ANALYSIS OF L-67D

g. Excavatability analysis. Rock rippability will be evaluated based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the culvert and siphon structure areas can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 6 inches in effective diameter can be loaded onto dump trucks by rubber-tired loaders and hauled off the L-67D site for use as levee fill. Larger cobbles and boulders can be crushed and mixed with the minus 6 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the L-67D area for use as fill. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. A sheetpile cofferdam with a tremie concrete slab to facilitate dewatering and dry construction is typically incorporated into the construction of these type features. Discharge will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows. Other methods for dewatering may be utilized for construction efficiency and cost savings.

Remove L-67 Extension and backfill adjacent canal

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are any groundwater studies planned during the future design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Per paragraph A.6.2.e above, earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slope shall be cut to a shallower or equal angle than currently that of the original design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavation can be conducted by standard excavating equipment of dozers, loaders, and dump trucks, as this is a degrade of an existing levee. Some excavation may be under wet conditions. No rippability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and placed in the adjacent borrow canal. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement in the canal. To avoid settlement, material shall be separated into pervious materials (<5% fines) for submerged fill placement and satisfactory fill for above the groundwater table in the canal. Material above the groundwater table shall be compacted and graded. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be delivered to the adjacent borrow canal. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Remove Six miles of Tamiami Trail Road from L-67 Extension to Tram Road

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are any groundwater studies planned during the future design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slopes shall be cut to a shallower or equal angle than currently that of the original

design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavatation can be conducted by standard excavating equipment of dozers, loaders, and dump trucks, as this is a degrade of an existing levee. Some excavation may be under wet conditions. No rippability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and hauled off to the new L-67D levee for use as fill or placed in a designated disposal area which will be established during the design phase. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement on the L-67D levee. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be destined to be delivered to the L-67D levee area for use as fill or to a designated disposal site. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Increase S-356 pump station capacity by deeper pumps or lateral extent.

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. It is anticipated that, the pump structure foundations will be founded on underlying limestone. These foundation materials are typically adequate in regards to bearing capacity and settlement. A bearing capacity evaluation and settlement analysis will be performed during the design phase after collection of geotechnical exploration data during the design phase. A heave or uplift evaluation will be required to design the tremie concrete slabs during

the design phase. Slope stability analyses other than temporary cut slope evaluation during the design phase will not be required.

g. Excavatability analysis. Rock rippability will be evaluated based on available engineering design and construction records and new test pits during the geotechnical exploration activities during the design phase for this feature.

h. Anticipated construction techniques. It is anticipated that the pump station structure area can be excavated by standard hydraulic excavator within the layers of peat and organic materials in the top 4-6 feet from the bank and through the existing embankments. Below the lowest level of these materials excavators with ripping buckets should be able to break through the underlying limestone layers. For harder rock, pneumatic picks and/or blasting may be required to remove unrippable rock strata. Backfill will be accomplished with compacted layers of granular backfill with rewatering. Excess excavated inorganic cobbles and grains less than 6 inches in effective diameter can be loaded onto dump trucks by rubber-tired loaders and hauled off to the L-67D levee for fill or to a designated disposal area. Larger cobbles and boulders can be crushed and mixed with the minus 6 inches of soil and rock.

i. Potential borrow and disposal sites. Excavated inorganic materials will be processed, compacted and placed as backfill for the structures. Excess inorganic material will be destined to be delivered to the new L-67D levee area for fill or to a designated disposal area. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Access roads will be surfaced with a minimum of 6 inches of limestone base course.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration. A sheetpile cofferdam with a tremie concrete slab to facilitate dewatering and dry construction is typically incorporated into the construction of this type of feature. Discharge will be to the canal after appropriate treatment. Dewatering is typically accomplished by sump pumps within the excavation pit with supplemental groundwater lowering via well point rows.

j. Seepage and groundwater control. A dewatering evaluation will be performed with seepage analysis during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Degrade 4.3 miles of L-29 in Blue Shanty flow way

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date nor are any groundwater studies planned during the future design phase.

d. Recommended Instrumentation. Geotechnical instrumentation is not forecasted for this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. There is no foundation to design for with this feature. The end slopes shall be cut to a shallower or equal angle than currently that of the original design levee side slopes of 1V:3H. A riprap blanket with bedding may be needed on each cut face depending on design flow velocities through the gap which will be determined during the design phase.

g. Excavatability analysis. Excavatation can be conducted by standard excavating equipment of consisting of dozers, loaders, and dump trucks as this is simply the degrading of an existing levee. Some excavation may be under wet conditions. No rip ability evaluation is anticipated.

h. Anticipated construction techniques. Levee material will be removed by excavators and hauled off to the new L-67D levee for use as fill or placed in a designated disposal area which will be established during the design phase. Cobbles and boulders greater than 6 inches nominal diameter from the levee may need to be processed before placement on the L-67D levee. Riprap and bedding may be required to be placed on the end cuts of the breach for erosion protection.

i. Potential borrow and disposal sites. Excavated inorganic material will be destined to be delivered to the L-67D levee area for use as fill or to a designated disposal site. The organics are to be disposed to a designated area to be determined during the design phase. Riprap and bedding materials required for erosion protection will be obtained from offsite sources and will be sized during the design phase based on design water velocities. Riprap and bedding will be imported from offsite sources.

j. Seepage and groundwater control. There may be excavation in a wet condition and placement of riprap in the wet or dewatered condition. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase geotechnical exploration.

Partial depth seepage cutoff wall along L-31N with no new canals

a. Selection of preliminary design parameters. The preliminary geotechnical design parameters for this project are established based on typical values for similar materials on COE projects in South Florida, empirical relationships form literature and from data from previous projects in the study area. The tentative design parameters are presented in **Table A-20**.

b. Geophysical Investigations. No geophysical investigations have been performed in the vicinity of this feature to date.

c. Groundwater Studies. No groundwater studies have been performed in the vicinity of this feature to date.

d. Recommended Instrumentation. Vibrating wire piezometers upstream and downstream of the cutoff wall may be required as part of the design of this feature.

e. Earthquake Studies. Earthquake studies will not be required for this feature of work due to the extremely low seismicity of South Florida.

f. Preliminary foundation design and slope stability analyses. No bearing capacity is required for this feature. A settlement evaluation will be conducted on a soil-cement-bentonite wall, if used, during the design phase. A slope stability analysis will be performed during the design phase because the wall will change the hydraulic loading conditions on the embankment of L-31N.

g. Excavatability analysis. Rock rippability will be not be evaluated explicitly as the two candidate wall types are a vinyl sheetpile or SBC wall. Soft rock can be driven through with driving shoes and harder rock can be broken up with a chisel beam. The SBC wall installation techniques such as the Trench-cutting and Remixing Deep (TRM), the Cutter Soil Mix (CSM) and the hydromill methods are capable of grinding the rock into soil so that it can be integrated in the wall mix as it is being pulverized.

h. Anticipated construction techniques. The SBC wall installation techniques such as the Trench-cutting and Remixing Deep (TRM), the Cutter Soil Mix (CSM) and the hydromill methods can be used to install the cutoff wall. All three walls method types have been used successfully at the Herbert Hoover Dike project. They all involve to one extent or another in-situ mixing of subsurface materials with injected bentonite, cement and water to form portions of a continuously formed wall along the levee alignment. The vinyl sheetpile method can also be used. A cost analysis should be performed to select the most cost effective option. The SBC walls need a sufficient source of water during production. Prior to production installation of the wall, a test panel should be constructed and evaluated for compliance with the performance criteria. Periodic testing along the wall during production is essential to assure compliance with specified permeability, uniformity and strength criteria.

i. Potential borrow and disposal sites. Soils materials for the SBC mixes are taken from the embankment rock and soil. If there is an excess of organic material in the wall area subsurface materials, replacement select fill can be imported for replacement of the organic soils. Cement and bentonite materials are obtained from outside sources. Water is to be obtained from the adjacent canals, wells or can be imported, if necessary. Excess and waste materials will be placed in a designated disposal area which will be identified during the design phase.

j. Seepage and groundwater control. As a minimum, a 2D seepage analysis will be conducted during the design phase. Sufficient hydraulic conductivity data from specific capacity tests, lab permeability tests, constant head recharge tests, and/or slug tests will be conducted during design phase of geotechnical exploration. Wall water tightness during construction will be continually checked against the permeability criteria. Piezometers will be installed during construction to monitor the phreatic surface before and after installation of the wall. A 3D seepage numeric model of the wall and levee system is recommended during the design phase to quantify acceptable seepage losses under around the ends of the wall system and establish wall permeability criteria and establish wall dimensions.

k. Summary of additional geotechnical exploration for the L-31N partial cutoff wall. Extremely limited or minimal geotechnical data is available at this location in this project. This cutoff wall will be constructed, in part, below the groundwater table. The wall shall receive a core boring at the crest and at the embankment toe on a spacing of tentatively 1000 feet. These core borings will consist of standard split

spoon sampling and auger drilling in soil and rock core barrel drilling in rock. At least one boring shall be deep enough to identify subsurface layers and to establish the hydrogeologic and physical properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests.

A.7.2.1 General Status of Completed and Non-Executed Efforts

Summary of additional geotechnical exploration for all CEPP levee degrading and canal backfilling. Extremely limited or minimal geotechnical data is available for the site specific location of the degrading and canal backfilling features in this project. However, embankment degrading will require only enough exploration to confirm the character of the embankment materials for bidding purposes. For canals probes within the canal bottom should be sufficient to characterize the canal bottom muck and underlying sands or rock to minimize subsidence of the backfill. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling.

Summary of additional geotechnical exploration for the L-67D levee. Extremely limited or minimal geotechnical data is available for the site specific location of the levee. Much of the available subsurface data was obtained outside the footprint of levee. It is foreseen that the surficial organic materials under the levee footprint will be removed and replaced with a pervious fill bridging lift below the groundwater table. Therefore, geotechnical explorations need to encompass dewatering features in addition to data required for facilities constructed at ground level. The levee embankment will receive a minimum core boring at the crest and toe at a tentative spacing of 1000 feet. These borings shall consist of standard split spoon sampling and auger drilling in soil and rock core barrel drilling in rock. Borings shall be deep enough to identify suitable soft layers in the foundation and establish the hydro geologic properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests. Samples from stockpiles from other project features will be of a wide range of particle distributions. Excavated stockpiled material will have laboratory index testing performed during the design phase to determine fill processing requirements. Geophysical testing may be used to identify and map solution cavities in the levee footprint. A test fill for embankment construction feasibility in the wet and a breakdown analysis of excavated limestone and soil after compaction will also be evaluated during the exploration program. Rock core samples may be mapped by digital photography to stochastically estimate porosity, permeability and filtration characteristics of limestone layers.

Summary of additional geotechnical exploration for the L-31N partial cutoff wall. Extremely limited or minimal geotechnical data is available at this location in this project. This cutoff wall will be constructed, in part, below the groundwater table. The wall shall receive a core boring at the crest and at the

embankment toe on a spacing of tentatively 500 feet. These core borings will consist of standard split spoon sampling and auger drilling in soil and rock core barrel drilling in rock. At least one boring shall be deep enough to identify subsurface layers and to establish the hydrogeologic and physical properties of underlying strata for modeling purposes. Undisturbed Shelby tube samples shall be obtained for cohesive materials encountered during drilling. Laboratory index tests for soil and rock will be performed on samples obtained from the drilling. Waxed rock core samples shall be obtained to determine the rock strength parameters. Companion borings will be drilled alongside the core borings to conduct field hydraulic tests of the underlying strata. Laboratory tests shall also be performed on remolded samples to determine the vertical permeability of soils. In place field hydraulic tests will include specific capacity, constant head recharge and possibly slug tests.

A.7.2.2 Soils

The area of the Blue Line, where it borders Miami-Dade County, is the Biscayne Gravelly Marl (U.5.Department of Agriculture 1996). Soils of this type are poorly drained and situated on broad, low flats, in sloughs, and in transverse glades that extend from the Pineland Ridge. Typically, the surface layer is about 7 inches of dark gray gravelly marl that has a texture of silt loam.

The agricultural areas of the Yellow Line (Miami-Dade and Broward Counties) (as well as the Blue Line), it is common to encounter "mixed" soils called "rock plowed" soil such as Chekika and Krome (U.S. Army Corps of Engineers, 2009c). This soil is a manmade material created by farmers excavating and crushing the soft underlying Miami Limestone, and mixing/tilling it along with the natural overburden soils. Consequently, the overburden thickness is somewhat higher in these areas. In most cases, the underlying Miami Limestone controls the infiltration of rain or introduced stormwater due to the high permeability of the rock-plowed soils.

A.7.2.3 Geology

Rocks formed in a shallow marine depositional environment under tropical and subtropical environmental conditions exist in the Blue Line area. Three geological formations comprise this sedimentary package: the Pamlico Sand, the Miami (Oolite) Limestone, and the Fort Thompson Formation. This sedimentary package rests unconformably on quartz sands of the Pliocene Tamiami Formation, which serves as basement for this area. The thickness of the Quaternary marine sediment package increases north to south from approximately 40 feet at the Red Line to approximately 100 feet at the Blue Line.

Blue Line

The oolitic Miami Limestone, the upper portion of the Biscayne Aquifer, often outcrops at the surface near the Blue Line and forms approximately 10 to 15 feet of caprock overlying the Fort Thompson Formation. The Blue Line is characteristic of karstic marine carbonates of the Fort Thompson Formation.

In 1950, a series of 3-inch diameter core borings were drilled at depths 18 to 35 feet a one or two-mile centers along the L-29 (the Blue Line Boundary). Geology shows peat and/or organic sediments are between one or two feet thick. A marl underlies these sediments. The marl ranges in thickness from one to two feet thick. Below the marl is a limestone which ranges in thickness from approximately 7 to 45 feet thick. Below the limestone layer is some interbeds of shell and sand (U.S. Army Corps of Engineers, 1951).

Recharge tests were made simultaneously with many of the core borings along the levee alignment of L-29 (U.S. Army Corps of Engineers, 1951). The results of the tests typically ranged from 2-3 gallons per minute (gpm) on the western side of the levee to 40-84 gpm on the eastern side. Borings logs with recharge test data can be found in the 1951 U.S. Army Corps of Engineers report.

Green Line

Previously, local geologic investigations of the L-67A and L-67C have been completed by the U.S. Army Corps of Engineers Jacksonville District (ANNEX G-3). The 14 test pit excavations in 2002 (U.S. Army Corps of Engineers, 2002) to the top of limestone show three distinctive lithologies in the L-67 area from top to bottom: fill material of gravel to cobble-sized limestone up to 10 feet thick, peat up to 4 feet thick, and hard limestone.

A subsequent 4-boring investigation of the L-67 area by the U.S. Army Corps of Engineers in 2009b as part of the DECOMP Phase I study indicates basically the same three lithologies mentioned above except the peat appeared to be embedded in a silt layer below the fill material.

Yellow Line

Several U.S. Army Corps of Engineers geological investigations have been conducted of the L-30 and L-31N to address seepage management issues in these areas as well as to characterize the subsurface lithology (ANNEX G-3). These include the 2006 L-30 seepage management pilot project, the 2008 follow-up L-30 seepage geotechnical data report, and the 2011 Plans and Specifications for the construction of the L-31N seepage barrier.

Challenge Engineering and Testing performed three initial borings in 2006 for the L-30 area for the U.S. Army Corps of Engineers (Challenge Engineering and Testing, 2006). Results of the boring investigation indicate thick fill material overlies a massive limestone interpreted to be the Fort Thompson Formation. Below the limestone are interbeds of shell, sand, and minor clay.

Wolf WPC 2008 performed three additional borings and came up with similar lithologies like those of Challenge except minor peat and clay layers are situated between the fill material and the limestone.

Finally, AMEC 2011 prepared the L-31N Seepage Barrier Phase I Plans and Specifications which they show some cross-section lithology where a section of L-31N runs into the Tamiami Trail roadway. The cross-sections show fill resting on top of limestone (the limestone varies from oolitic to dense to marine to freshwater).

A.7.2.4 HTRW

The Corps will review the HTRW condition of the affected parcels and ensure that the proper due diligence is performed in accordance with ER 1165-2-132 prior to certifying lands for construction. Should remediation of HTRW contamination be required, it is the responsibility of the SFWMD, the non-Federal, sponsor and is not a creditable cost to the project.

A.7.3 HYDRAULIC DESIGN

A.7.3.1 General Status of Completed and Non-Executed Efforts

A.7.3.2 Hydraulic Design - General

This section provides a brief overview of the hydraulic design criteria, parameters, intent/purpose of project features. Detailed hydraulic design of individual components is described in later sections, including hydraulic design data sheets. Currently, all elevations are referenced to NGVD 29; elevations will be provided in both NGVD 29 and NAVD 88 when revised during PED.

A.7.3.2.1 Design Criteria and Parameters

This section includes criteria and parameters that were used in the hydraulic design of the Blue/Green/Yellow line components.

A.7.3.2.1.1 Head Loss

Due to the relatively flat topography throughout the project area, the hydraulic head losses across many of the control structures are low, resulting in the design of larger structures (number and size of barrels, bays, etc.) than may typically be assumed for other regions. The use of pumps was avoided wherever possible to reduce operation and perpetual maintenance costs. During PED phase, SAJ expects to optimize system operations and therefore structure sizes for cost and performance efficiencies.

A.7.3.2.1.2 Flow and Velocity

Design flow rates for all water control structures were determined based on RSM-BN model outputs and existing canal and structure capacities. To capture cost impact adequately, structures and canals were designed for maximum capacity scenarios. Optimization of these features will be conducted during the PED phase for performance and cost efficiency.

A.7.3.2.1.3 Water Control Structures

The proposed plan for the area encompassed by the blue/green/yellow lines includes S-631, S-632, and S-633 culverts, and S-333N and S-355W spillways. The function of the control structures is to provide a direct hydrologic connection between WCA-3A, WCA-3B, and Northeast Shark River Slough. These structures will improve hydrologic conditions in WCA-3A, WCA-3B, and ENP by improving the timing and spatial distribution for the increased WCA-3A inflows provided by CEPP, while also providing increased outlet capacity to help manage WCA-3A high water events more effectively. The S-631, S-632, and S-633 are duplicate structures along the L-67A Canal, with S-631 north of the proposed L-67D Levee, and S-632 and S-633 south of the levee within the CEPP flowway. The design capacity for all three culverts is 500 cfs. The S-333N gated spillway was designed to operate in conjunction with the existing S-333 spillway for a total capacity of 2,500 cfs. The purpose of this expansion was to increase deliveries into the ENP Northeast Shark River Slough and to provide increased outlet capacity for southern WCA-3A. The S-355W spillway was designed to convey flows from the west to east within L-29 Canal with the intent of aiding in meeting ecological objectives in Everglades National Park by maintaining water deliveries to the eastern MWD 1-mile bridge. The spillway was sized to 1230 cfs to match the conveyance capacity of the existing S-334 spillway to the east and in ENP.

A.7.3.2.1.3.1 Gated Culverts

The entire CEPP project includes numerous gated box culverts across the entire project area. Construction material for all culverts is to be cast in place concrete.

An entrance loss coefficient value of 0.9 (assumed due to gate-added turbulence around inlet) and exist loss coefficient of 1.0 was used for all gated culvert structures. Also, the Manning's friction or energy loss coefficient was assigned 0.013 for all culverts. All major conveyance culverts were designed to remain submerged year round to reduce aquatic growth within, thereby better maintaining design friction head losses. All gated culverts sites were designed with a minimum of two culverts to allow maintenance activities to coincide, however with reduced capacity operations.

A.7.3.2.1.3.2 Gated Spillways

The CEPP Recommended Plan for the blue/green/yellow lines includes the design of two ogee weir concrete spillways with steel vertical lift gates. The spillways were designed to be in conformity of engineering guidance found in USACE EM-1110-2-1603. All ogee spillways have vertical gates for controlled discharge operations. The spillways were designed with minimal head differential for conveyance energy. The S-355W spillway was designed with 1.0 foot head differential. The S-333N spillway head differential was chosen to match that of the existing S-333 spillway, at 0.5 feet.

A.7.3.2.1.3.3 Pump Stations

The CEPP Recommended Plan proposes to replace the existing temporary S-356 pump station with a permanent structure. The current temporary structure has a capacity of 575 cfs. The design condition of the new structure will be increased to 1,000 cfs. The design capacity will be increased to 1,650 cfs to accommodate design requirements and design redundancy. S-356 will be a four-bay pump station with three 500 cfs diesel engine driven pumps (one redundant) and one 150 cfs electric motor driven pump, for a total capacity of 1,650 cfs. The S-356 provides seepage management for increased CEPP stages in eastern WCA-3B and eastern ENP, with return to Northeast Shark River Slough.

A.7.3.2.1.4 Levees

The proposed plan includes a new levee, L-67 D (Blue Shanty Levee) to be constructed between the L-29 and L-67A Canals to provide a boundary for the Blue Shanty Flowway. The levee is designed for a top of bank height of 12.00 ft NGVD.

Detailed design analysis for hydraulic components along the Blue/Green/Yellow lines can be found in supplemental documents located in Appendix A, Annex A-1.

A.7.3.3 Blue/Green/Yellow Lines – Distribution, Conveyance & Seepage Management

A.7.3.3.1 General Information

A.7.3.3.1.1 Purpose

The purpose of the project features along the blue/green/yellow lines is to provide additional distribution and conveyance to areas in WCA-3B and ENP. The installation of the proposed L-67D Levee, S-632, S-633 culverts, and the partial degrade of the L-29 Levee in the adjacent area will hydrologically connect WCA-3A to these southern areas by way of a new flowway (Blue Shanty Flowway). At times when capacity is available, the proposed S-333N and existing S-333 spillways will provide additional conveyance to ENP. S-631 is located north of the L-67D Levee in order to provide conveyance to eastern WCA-3B to improve hydroperiods. The S-355W spillway will convey water from the Blue Shanty Flowway, S-333, and S-333N eastward toward the existing S-334 spillway when needed to provide conveyance to meet ecological objectives.

A.7.3.3.1.2 Location

The proposed CEPP features encompassed by the blue/green/yellow lines lie within Miami-Dade County. The S-631, S-632, and S-633 gated culverts are located on the southern portion of the L-67A Canal, with S-333N south of the intersection of the L-67A and L-67C Canals. The proposed L-67D Levee is located between the L-67A and the L-29 Canals, eastward of the L-67 Extension. The S-355W spillway is located in the L-29 Canal at the intersection of the Blue Shanty Levee and the L-29 Canal.

A.7.3.3.1.3 Features

The CEPP project has the following hydraulic features within the blue/green/yellow line boundaries:

Structures:

- S-631 Gated Culvert
- S-632 Gated Culvert
- S-633 Gated Culvert
- S-333N Gated Spillway
- S-355W Gated Spillway
- S-356 Pump Station

Levees:

- L-67D Blue Shanty Levee

Figure A-8 illustrates all feature locations for the Blue/Green/Yellow Line areas (structures and canals are not to scale or geographically referenced). Design analysis for the gated spillways within the blue, green, and yellow line boundaries can be found in supplemental documents located in Appendix A, Annex A-1.

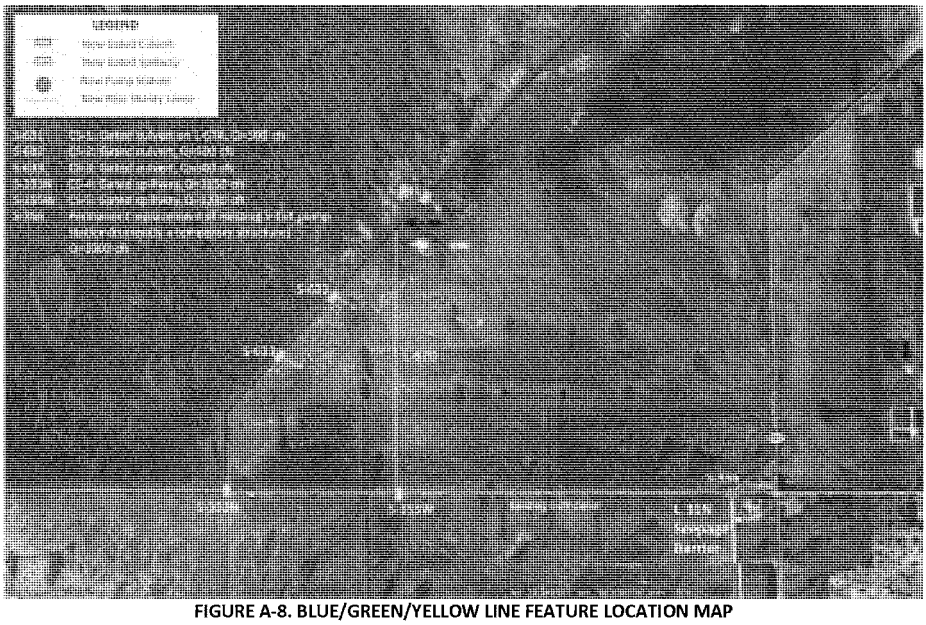


FIGURE A-8. BLUE/GREEN/YELLOW LINE FEATURE LOCATION MAP

A.7.3.3.2 Hydraulic Design

A.7.3.3.2.1 Proposed Water Control Structures

A.7.3.3.2.1.1 Gated Culverts

S-631, S-632, and S-633 Gated Culverts

The S-631, S-632 and S-633 structures are identical gated culverts used for increased conveyance from WCA-3A to WCA-3B through the L-67A Levee and proposed gapping in L-67C Levee. The three structures are located along the southern portion of the existing L-67A Canal, with S-631 located north of the proposed L-67D Levee and S-632 and S-633 located south of L-67D. The three structures are single-barreled gated box culverts with dimensions of 11 ft by 11 ft each with vertical slide gates, and a total length of 100 feet. The upstream and downstream inverts were determined based on historical low TW elevations (7.50 ft NGVD in the gap between L-67A and L-67C Canals) and adjusted to accommodate the height of the barrel plus one foot of clearance. The upstream and downstream inverts were set to -4.50 ft NGVD. Since the barrel inverts are below the bottom of canal elevation, the canal will taper at a slope of 1V:5H to match grade. The design flow for the three structures is 500 cfs with a design hydraulic head of 0.5 feet. The design velocity through the structures is 4.13 fps.

A.7.3.3.2.1.2 Gated Spillways

S-333N Gated Spillway

The S-333N structure is a gated spillway structure that will work in conjunction with the existing S-333 spillway to increase hydraulic connectivity between WCA-3A and Everglades National Park. S-333N is a complimentary structure to the existing S-333 spillway. The structure is a one-bay gated spillway with a design flow of 1,150 cfs and hydraulic head of 0.5 feet. The design flow was established in order to reach a combined conveyance with the existing S-333 spillway (1,350 cfs) of 2,500 cfs. The spillway gate is 29 ft wide by 14.6 ft high, with a crest elevation at -3.10 ft NGVD. The upstream and downstream apron elevations are set at -6.00 ft NGVD with apron lengths and widths of 39.0 ft and 29.0 ft, respectively. The S-333N structure is located south of the intersection of L-67A and L-67C Canals.

S-355W Gated Spillway

The S-355W structure is a gated spillway in the L-29 Canal, located at the southern extent of the proposed L-67D levee. The purpose of the S-355W is to convey water from the L-29 Canal within the Blue Shanty Flowway, eastward towards the existing S-334 spillway to provide assistance in meeting ENP ecological objectives. The structure is a three-bay gated spillway with a design capacity of 1,230 cfs and hydraulic head of 1.0 foot. The design flow was set to match the capacity of S-334. The spillway consists of three bays with dimensions of 12 ft wide by 8 ft high. The crest invert elevation is set to 4.00 ft NGVD. The upstream and downstream aprons are set at elevation -4.00 ft NGVD with a width and length of 36.0 feet and 42.5 feet, respectively.

A.7.3.3.2.1.3 Pump Stations

The CEPP Recommended Plan proposes to replace the existing temporary S-356 Pump Station with a permanent structure. The current temporary structure has a capacity of 575 cfs. The capacity of the new structure will be increased to 1,000 cfs, with a total pumping capacity of 1,650 cfs including design redundancy. The S-356 provides seepage management for increased CEPP stages in eastern WCA-3B and eastern ENP, with return to Northeast Shark River Slough.

Pump Rates

The pump station is designed to work in conjunction with the proposed seepage barrier south of the Tamiami Trail along L-31N. The pumping rate of 1,000 cfs was determined based on CEPP screening and formulation efforts to prevent increased flooding impacts. The collected seepage will be returned to Northeast Shark River Slough.

Pump Mix

Pump mixes were based on a minimum of two bay pump stations to minimize risk of impact to private lands should a single pump fail during critical times. All small pump stations will be equipped with electric motor driven pumps that have diesel generators or pumps for an alternative power source in cases of power outages. One criterion for all pump mixes was to utilize duplicate pump sizes as much as possible to reduce operation and maintenance costs. This is accounted for through a reduction in different spare parts required and focusing mechanical expertise. Another criterion was to provide a pump mix that allows a smooth pump rate change interval from start-up to full capacity. The S-356 is

designed to be a four-bay pump station with three 500 cfs diesel engines and one 150 cfs electric motor driven pump. The design condition of 1,000 cfs will be achieved with two 500 cfs diesel engine driven pumps, with one 500 cfs diesel engine to serve as a redundant pump unit, per EM's, ER's and jointly developed DCS-5, Major Pumping Station Engineering Guidelines.

Pump Stages

Pump stages were defined by the following pumping parameters:

Intake Water Surface Elevations

Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.
Maximum Pumping: Maximum canal or pool stage that can be pumped with any increase in stage requiring the pump to be turned off. In most cases, Maximum Non-Pumping and Maximum Pumping stages are identical.
Start Pumping: Canal or pool stage when pump may be turned on as defined by system conditions, typically on the increasing limb.
Normal Drawdown: Expected local drawdown at the pump station intake.
Minimum Drawdown: Lowest local drawdown stage before pump is required to be turned off.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions.

Discharge Water Surface Elevations

Maximum Non-Pumping: Highest canal or pool stage that can be expected to occur.
Maximum Pumping: Maximum canal or pool stage that can be pumped to, pump is subsequently turned off until stage decreases.
Normal Pumping: Expected normal pool elevations for impoundments and design tailwater stages for conveyance canal pump stations (flood damage reduction drainage discharge).
Minimum Pumping: Lowest canal or pool stage expected when pump may be turned on.
Minimum Non-Pumping: Lowest canal or pool stage that can be expected to occur under non-pumping conditions. In most cases, Minimum Pumping and Minimum Non-Pumping elevations are identical.

A.7.3.3.2.2 Levees

The proposed plan includes a new levee, L-67D (Blue Shanty Levee) to be constructed between the L-29 and L-67A Canals to provide a boundary for the Blue Shanty Flowway. The current L-67D freeboard is designed at 2.24 ft, as defined by vertical height between WCA 3B maximum historical recorded stage (9.76 ft NGVD) and embankment crest of 12.00 ft NGVD. Approximately 300 feet of the southern extent of the L-67D Levee will be constructed to the same crest elevation as the existing L-29 Levee to prevent rounding should a breach occur in the southern portion of the levee.

A.7.3.3.2.3 Existing Structures

S-333 Gated Spillway

S-333 is an existing gated spillway that is primarily used to make water deliveries from WCA-3A to Northeast Shark River Slough, with additional capability to deliver to the South Dade Conveyance System (SDCS) when required by the WCA-3A Regulation Schedule. The current capacity of S-333 is

1,350 cfs. The structure will be used with the proposed S-333N structure to increase the total conveyance capacity from southern WCA-3A to the L-29 Canal and ENP to a total of 2,500 cfs.

S-356 Temporary Pump Station

The S-356 structure is an existing temporary pump station located on the L-29 Canal, approximately one mile west of Krome Avenue. The current capacity of the structure is 575 cfs. As part of the CEPP project components, the current temporary S-356 pump station will be replaced with a permanent 1,000 cfs structure (1,650 cfs with redundant pumps) to contribute to project objectives. Should design components change for the permanent structure, further hydraulic analysis will be conducted in PED phase.

A.7.3.3.2.4 Existing Canals

L-29 Canal

The L-29 Canal delivers water from WCA-3A to the ENP Northeast Shark River Slough, where water is conveyed from the canal through a series of existing culverts and future bridges south into the ENP.

A.7.3.4 Risk and Uncertainty

This section presents qualitatively the risk and uncertainty associated with the project as designed for this PIR. Understanding that the current USACE philosophical approach to Feasibility Studies is to be quick and limit analyses to that for benefit and cost determinations, acknowledging risk and uncertainty in the hydraulic design of the project will be an important part of the risk registry. The overall approach to the hydraulic design was to be conservative enough to capture expected costs without being unrealistic in overestimation, yet not to underestimate beyond what optimization and the savings that could be realized during PED phase efforts.

A.7.3.4.1 Hydrologic and Hydraulic Computer Software Tools

Several hydrologic and hydraulic computer software tools were utilized in the formulation of alternatives and the Recommended Plan. Interpretation of hydraulic design results should consider the inherent strengths and limitations of the underlying hydrologic and hydraulic tools. Additional descriptions of the modeling tools are provided in Appendix A, Section A.8.1 (Modeling Strategy).

A.7.3.4.2 L-67D Blue Shanty Levee Feature

The L-67D Levee, known as the Blue Shanty Levee, is a true levee with a non-impounding flowway. The L-67D Levee height was initially estimated at six feet based on input from the project delivery team (PDT). The final levee height and footprint will be based on more detailed future analyses during PED that agrees with both agencies requirements, even though variances to typical requirements may be submitted with reasons based on PED analyses. Approximately 300 feet of the southern extent of the L-67D Levee will be constructed to the same crest elevation as the existing L-29 Levee to prevent rounding should a breach occur in the southern portion of the levee.

Potential Hazard

The L-67D Levee does not provide the function of a water impoundment barrier, but as a levee forming a boundary of a flowway that opens up into a vast floodplain (ENP). The potential risk associated with the levee, should the low probability of failure occur, remains low for the following reasons:

(1) The stage differences between WCA-3A, the flowway formed by L-67D, and eastern WCA-3B are low in magnitude, typically only a half foot to one foot between the flowway and WCA-3B under peak stage conditions. This stage relationship between the compartments is reflected today with the area between L-67A and L-67C, known as the "pocket", that functions as a seepage step-down to prevent seepage out of WCA-3A from raising stages in eastern WCA-3B to the point of increasing flood risk to lands east of the C&SF East Coast Protective Levee System. Therefore, from an operational stage perspective (not volume rate of flow), the L-67D Levee will replace the function of the L-67C in the area of the flowway, thus not adding any additional risk to the C&SF system nor private lands that are within influence of water levels in the system.

(2) The new volume rate of flow is not expected to increase any potential of risk to the C&SF system nor private lands as it will flow unimpeded into a vast floodplain (ENP), which is the desired target for the additional water.

Freeboard under Design Conditions

The current Blue Shanty Levee freeboard as designed is 2.24 ft as defined by vertical height between the WCA-3B maximum historical recorded stage of 9.76 ft NGVD and embankment crest elevation of 12.00 ft NGVD. The embankment crest height was determined based on evaluating the maximum historical recorded stage at Site 71 in WCA-3B (9.76 ft NGVD), the maximum period of record stage modeled in the Blue Shanty Flowway (9.70ft NGVD for Alt 4R2), and applying an assumed Standard Project Flood (SPF) depth. The chosen maximum stage used for preliminary design was 9.7 ft NGVD, which is consistent with the Alt 4R2 operational stage constraint used for the L-29 Canal and for the S-632/S-633 inflows to the Blue Shanty Flow-way, with an assumed SPF depth of 17.5 inches (1.46 feet). The crest elevation was then rounded to 12.0 ft NGVD for conservative cost purposes.

Other Considerations in Determining Crest Elevation

(1) The main objective and purpose of CEPP is the restoration of the Everglades. One of the design goals is to minimize adverse impacts on the wetlands by providing the minimum levee footprint that provides an acceptable risk of conditions that may breach the levee.

(2) Stages in WCA-3A would be expected to top the Blue Shanty Levee crest, however, the L-67A Levee and structures will provide control over all inflows with the exception of seepage and direct rainfall.

(3) There will be little head differential between the area enclosed by Blue Shanty Levee and WCA-3B. In times of high stages within WCA-3A, seepage is of a magnitude that there always remains a small head differential (less than 3ft) between the two WCAs, and would be the same with the newly enclosed area. Additionally, since there would be a water depth inundating the toe, there would be no change in slope or a slope break, which is predominantly where headcutting actions begin that often lead to structure failure.

(4) As shown with the FEB wind-wave presentation, wind and waves could contribute to overtopping under combined extreme precipitation events. However, as stated previously, there are no lives at risk and no privately owned properties that may be damaged or at risk, should a breach occur. The area enclosed between L-67A and the proposed levee, as well as WCA-3B, is comprised of emergent marsh-type vegetation, especially near the canals (e.g. L-67A canal) where cattails are mainly found where phosphorous continues to remain high in the water column. Because of the vegetation, wind setup and wave generation would be minimal, e.g. FEB wind-wave effects presented in preceding section. With a shorter effective fetch than the FEB, the wind setup would be smaller and wave generation negligible.

L-67D Blue Shanty Levee Conclusion

Upon consideration of the following: (1) goal of minimizing impact with footprint, (2) Low HPC, (3) ability to endure extreme events, but perhaps not the superlative event such as a PMP or 100-yr stage with Category 5 Hurricane, (4) small head differential offering little to overtopping erosive action, and (5) that the Blue Shanty Levee poses no additional risk to the system, thereby offering no additional risk to the public, the PDT believes that the levee crest elevation is appropriate and within acknowledged acceptable risk.

A.7.3.4.3 Hydrologic and Hydraulic Lowering Risk Design

Gated Culverts in L-67A Levee

The USACE Engineering team utilized earlier culvert designs from the Modified Water Deliveries to Everglades National Park (MWD) project (Conveyance and Seepage component) that have been previously QA/QC. The previously designed structures have a larger capacity, 750 cfs versus CEPP capacity of 500 cfs. Therefore, risk to project function has been minimized. These gated culverts will be optimized during PED phase.

Seepage from WCA-3B to East

Seepage to the east from WCA-3B is one of the larger uncertainties. CERP, CEPP and all modeling before and in-between show that this is a major concern with proposed seepage management projects along L-30 (north of US-41) and L-31N (south of US-41). Too much seepage to the east toward private lands produces an adverse impact on flood damage reduction and thereby violating the Savings Clause in WRDA 2000. Many alternatives have been reviewed, all expensive, e.g. sheet pile. One alternative that has been implemented at a large scale is the use of "step-down" buffer areas (C-111 South-Dade project). Still, the expense and limited land availability makes complete implementation of such a system impractical for CEPP. Until seepage management is fully implemented, higher wet seasonal stages in WCA-3B will have to be constrained within tolerance of this known adverse impact. To ensure that seepage impacts to the east remain unchanged, CEPP proposed to increase the pumping capacity of the temporary 500 cfs S-356 Pumping Station to a permanent 1,000 cfs Pump Station. This pump station will take excess seepage collected in the L-30 and L-31N borrow canals and pump to the west so it may flow under US-41 into the ENP.

L-29 Removal with Bridge

The L-29 Levee is a necessary feature along the WCA-3B southern perimeter to prevent higher stages from impacting the US-41 (Tamiami Trail) highway. High stages in the L-29 borrow canal can impact the road sub-bed and cause the roadway to undulate. Prior to completion of the MWD Tamiami Trail Modifications project, there was limited conveyance under US-41 through the existing culverts, mostly because of limited head (i.e. L-29 borrow canal stage), sizing and minimum discharge due to vegetation and near topographical gradient. To improve conveyance and natural habitat connectivity, bridge(s) and

associated Tamiami Trail roadway modifications have been proposed as part of both the MWD project and the DOI Tamiami Trail Next Steps (TTNS) project. Construction of the MWD project 1-mile eastern bridge and roadway modifications to accommodate L-29 Canal stages up to 8.5 feet NGVD was recently completed in December 2013.The TTNS project will accommodate L-29 Canal stages up to 9.7 feet NGVD.

If the MWD and TTNS bridges and the associated Tamiami Trail roadway modifications are constructed and completed as expected, then the L-29 Levee can be degraded with minimum, but acceptable, risk to US-41. However, if these projects are not constructed, then L-29 Levee degrading is at risk because of potential damage to US-41. If the L-29 Levee cannot be degraded, then stages within the L-29 borrow canal will remain controlled with a maximum operating stage limit between 7.5 and 8.5 feet NGVD (operational constraints will be determined with the MWD Final Operating Plan) to minimize potential damage to US-41.

This also impacts the operation of the flowway created with construction of the Blue Shanty Levee feature. Since the Blue Shanty Levee is a levee and is not constructed to impound water, the benefits to be gained with flowing of water through the area enclosed by L-67A and the Blue Shanty Levee may not be realized until the TTNS bridges and roadway modifications are constructed.

A.7.3.5 Hydraulic Design Data Sheets

TABLE A-30. S-631, S-632, S-633 GATED CULVERTS

HYDRAULIC DESIGN DATA SHEET

Location Along southern portion of L-67A
S-631: x = 766,105 y = 543,464
S-632: x = 771,712 y = 543,479
S-633: x = 788,604 y = 568,318

Purpose S-631 conveys flows from the WCA-3A to through the Blue Shanty Flowway to provide flows to the Shark River Slough.

Design Conditions	Discharge	500	cfs
	Headwater Elevation	8.60	feet, NGVD 29
	Tailwater Elevation	8.10	feet, NGVD 29
Culvert Data	Number of Barrels	1	
	Barrel Type	Concrete Box Culvert	
	Box Width	11.0	feet
	Box Height	11.0	feet
	Culvert Length	100.0	feet
	Upstream Invert	-4.50	feet, NGVD 29
	Downstream Invert	-4.50	feet, NGVD 29
	Natural Grade	9.00	feet, NGVD 29
	Natural Water Table	9.00	feet, NGVD 29
	Headwall - HW Elevation	TBD	feet, NGVD 29
	Headwall - TW Elevation	TBD	feet, NGVD 29
	Wingwall - HW Elevation	TBD	feet, NGVD 29
	Wingwall - TW Elevation	TBD	feet, NGVD 29
Canal Data	Side Slopes (V:H)	1 on 2	
	Upstream Bottom Width	40.0	feet
	Upstream Bottom Elevation	1.40	feet, NGVD 29
	Downstream Bottom Width	40.0	feet
	Downstream Bottom Elevation	1.40	feet, NGVD 29
Energy Dissipation	**Riprap Requirements**		
	Rip Rap Design Velocity	4.13	fps
	Upstream Length	TBD	feet
	Upstream Protection Elevation	TBD	feet, NGVD 29
	Downstream Length	TBD	feet
	Downstream Protection Elevation	TBD	feet, NGVD 29

TABLE A-31. S-333N GATED SPILLWAY
HYDRAULIC DESIGN DATA SHEET

Location L-67 Canal south of the L-67A and L-67C intersection; XY coordinates TBD

Purpose Works in conjunction with S-333 to increase flow capacity (total of 2500 cfs) from WCA 3A to Northeast Shark River Slough.

Design Conditions	Discharge	1150	cfs
	Headwater Elevation	7.50	feet, NGVD 29
	Tailwater Elevation	7.00	feet, NGVD 29
Crest Data	Shape	Ogee	
	Design Head (Hd)	10.6	feet
	Net Crest Length	29.0	feet
	Crest Elevation	-3.10	feet, NGVD 29
	Approach Apron Elevation	-6.00	feet, NGVD 29
	Weir Control	Vertical Slide	
Gates	Number of Gates	1	
	Gate Width	29.0	feet
	Gate Height	14.6	feet
	Clearance Elevation	15.60	feet, NGVD 29
	Breastwall Elevation	TBD	feet, NGVD 29
	Intermediate Pier Width	3.25	feet
Stilling Basin	Design Discharge	1,150	cfs
	Apron Elevation	-6.00	feet, NGVD 29
	Apron Length/Width	39.0/29.0	
	End Sill Elevation	-5.50	feet, NGVD 29
	Top of Baffle Block Elevation	-5.00	feet, NGVD 29
	Dist from crest toe to 1st row of blocks/2nd row	19.50	feet
	Velocity over End Sill	3.17	fps
	Training Wall Elevation	TBD	feet, NGVD 29
Canal Data (US/DS)	Invert - Thalweg	-10.0	feet, NGVD 29
	Top of Bank	15	feet, NGVD 29
	Bottom Width	35.0	feet
	Top Width	135.0	feet
	Side Slope (V:H)	1 on 2	
Revetment	Riprap Extent (Downstream)	TBD	feet
	Riprap Size (D50)	TBD	feet
	Riprap Specific Weight	TBD	lb/ft3
	Max Velocity Riprap Can Withstand	TBD	fps

TABLE A-32. S-355W GATED SPILLWAY
HYDRAULIC DESIGN DATA SHEET

Location L-29 canal, adjacent to the proposed L-67D Levee; x = 785,915 y = 519,337

Purpose Convey flows from Blue Shanty Flowway eastward to help meet ecological objectives.

Design Conditions	Discharge	1,230	cfs
	Headwater Elevation	9.70	feet, NGVD 29
	Tailwater Elevation	8.70	feet, NGVD 29
Crest Data	Shape	Ogee	
	Design Head (Hd)	5.7	feet
	Net Crest Length	36.0	feet
	Crest Elevation	4.00	feet, NGVD 29
	Approach Apron Elevation	-4.00	feet, NGVD 29
	Weir Control	Vertical Slide	
Gates	Number of Gates	3	
	Gate Width	12.0	feet
	Gate Height	8.0	feet
	Clearance Elevation	9.00	feet, NGVD 29
	Breastwall Elevation	TBD	feet, NGVD 29
	Intermediate Pier Width	3.25	feet
Stilling Basin	Design Discharge	1,230	cfs
	Apron Elevation	-4.00	feet, NGVD 29
	Apron Length/Width	36.0/42.5	
	End Sill Elevation	-3.50	feet, NGVD 29
	Top of Baffle Block Elevation	-2.00	feet, NGVD 29
	Dist from crest toe to 1st row of blocks/2nd row	18.00	feet
	Velocity over End Sill	2.37	fps
	Training Wall Elevation	TBD	feet, NGVD 29
Canal Data (US/DS)	Invert - Thalweg	-7.6	feet, NGVD 29
	Top of Bank	15	feet, NGVD 29
	Bottom Width	50.0	feet
	Top Width	140.0	feet
	Side Slope (V:H)	1 on 2	
Revetment	Riprap Extent (Downstream)	TBD	feet
	Riprap Size (D50)	TBD	feet
	Riprap Specific Weight	TBD	lb/ft3
	Max Velocity Riprap Can Withstand	TBD	fps

TABLE A-33. S-356 PUMP STATION
HYDRAULIC DESIGN DATA SHEET

Location	L-29 canal; vicinity of the existing temporary S-356 pump station; x = 820,014 y = 519,597			
Purpose/Operational Intent:	Seepage Control and Water Supply S-356 Pump station will replace the existing temporary S-356 pump to provide permanent seepage return to Northeast Shark River Slough.			
Design Condition:			1,000	cfs
Design Capacity :			**1,650**	**cfs**
Pump Station Capacity Criteria:				
	Required estimated seepage collection rate			
Number of Pumps			4	
Pump Mix Type and Size		Electric	(1) 150	cfs
		Diesel	(3) 500	cfs
Mix Criteria:				
	1. The pump station will have 4 bays; one 150 cfs electric motor, and three 500 cfs diesel engines.			
	2. The pump mix allows for a range of seepage rates, while having duplicate pumps for operation and maintenance consideration			
Control			TBD	
Design Heads				
	Normal		TBD	ft, NGVD
	Maximum (HW=5.5 NGVD, TW = 8.5 NGVD)		3.00	ft, NGVD
Intake Water Surface Elevations				
	Maximum Non-Pumping Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Start Pumping		TBD	ft, NGVD
	Normal Drawdown		TBD	ft, NGVD
	Minimum Drawdown Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		TBD	ft, NGVD
Discharge Water Surface Elevations				
	Maximum Non-Pumping		TBD	ft, NGVD
	Maximum Pumping		TBD	ft, NGVD
	Normal Pumping		TBD	ft, NGVD
	Minimum Pumping		TBD	ft, NGVD
	Minimum Non-Pumping		TBD	ft, NGVD
	Channel Invert		TBD	ft, NGVD

A.7.4 STRUCTURAL DESIGN

A.7.4.1 General Status of Completed and Non-Executed Efforts

Structural design of S-631, S-632, S-633, S-333N, S-355W and S-356 will be completed during the design phase. During design phase the structural calculation will be completed after survey, hydraulic design, and geotechnical investigations are performed. The structural design will conform with the appropriate Engineering Manuals (EM), Engineering Regulations (ER), and Design Criteria Memorandums (DCM).

A.7.4.2 Pumping Stations

S-356 is a seepage pump station that will be similar in design to Miller (S-486)/Merritt (S-488) pump stations.

A.7.4.3 Overflow Spillways

S-333N and S-355W are gated structures similar to S-65EX1, using a two-phased approach and offsetting the structures will not require a bypass canal to be designed for construction of the structures.

A.7.4.4 Culverts

S-631, S-632, and S-633 are gated culverts that will be designed similar to the culverts on Decomp. Since the culverts have to be placed submerged, during design phase these may be changed.

A.7.5 MECHANICAL AND ELECTRICAL DESIGN

A.7.5.1 General

The pumping station mechanical design shall be in accordance with Hydraulic Institute Standards, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout), and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations). The design will also follow the guidance of ETL 1110-2-313 (Hydraulic Design Guidance for Rectangular Sumps of Small Pumping Stations with Vertical Pumps and Ponded Approaches).

The existing Pumping Station 356 will be removed and a new, larger pumping station will replace it. The new station will have a required pumping capacity of 1,000 cfs.

The pump mix will be further developed during the design phase of the project, but it will likely have a mix similar to having three 500-cfs diesel engine driven pumps and one 150-cfs electric motor-driven pump.

The pump intakes will likely be suction bell type. The use of formed suction intakes at the pumps shall be evaluated during preparation of the plans and specifications for the pumping station and shall be based upon the channel intake design.

Axial flow pumps will be used for the pumping station. The decision on whether the pumps will have either a conventional or siphon discharge will be determined during the preparation of the plans and specifications.

The pumping station electrical design shall be in accordance with NEC, NFPA, IESNA, TIA/IEA, IEEE, and recommended practice. Also, EM 1110-2-3102 (General Principles of Pumping Station Design and Layout) and EM 1110-2-3105 (Mechanical and Electrical Design of Pumping Stations) will be used.

Although the capacity of this station is low enough that SFWMD's Major Pumping Station Engineering Guidelines is not applicable, we will follow the applicable portions of these guidelines.

The pumping station will be similar in design to two of the stations for the Picayune Strand Project, Merritt Pumping Station (S-488) and Miller Pumping Station (S-486). Information on these two stations is provided in **Table A-34**. Plates M-1 through M-4, in Appendix A, Annex D-1, show plan and section views of Merritt Pumping Station, along with a plan view of its diesel fuel system.

TABLE A-34. PICAYUNE STRAND PUMPING STATIONS

Picayune Strand Pumping Stations				
Name	Capacity cfs	Diesel Engine Driven Pumps	Electric Motor Driven Pumps	# of Bays
Miller (S-486)	1,560	6 – 235 cfs	2 – 75 cfs	8
Merritt (S-488)	1,030	4 – 220 cfs	2 – 75 cfs	6

A.7.5.2 General Status of Completed and Non-Executed Efforts

Mechanical and electrical design of S-631, S-632, S-633, S-333N, S-355W and S-356 will be completed during the design phase. During design phase the mechanical and electrical calculations will be completed after the hydraulic design is performed, the pump mix is determined, and the structures' normal and emergency operating parameters are finalized.

A.7.5.3 Pumping Station S-356 Replacement Features

The larger pumps may be designed with a Formed Suction Intake (FSI) and have rectangular pipe for the intake and discharge. These pumps may be conventional-discharge or siphon-discharge type. The pumps will be driven by diesel engines through right-angle reduction gears. One of the pumping systems for this station is a redundant system as required per EM's, ER's and jointly developed DCM-5 Major Pumping Station Engineering Guidelines.

The smaller pump is intended for seepage control. Its flow rate is not included in the total flow capacity of the station. The pump will be an axial-flow-type vertical-shaft pump. The pump will be driven by a direct-drive electric motor.

The diesel engine driven pumps are expected to run at less than 500 rpm with an efficiency of about 80%. The diesel engine pump drives for the 500-cfs pumps should be about 1,200 horsepower each.

The pumping station will include various support items, including the following:

a. Diesel fuel system, including vaulted double-wall aboveground fuel storage tanks capable of holding enough fuel to operate two of the engine driven pumps and an emergency generator continuously for seven days.
b. Hoisting system for maintenance or repair of the pumping equipment.
c. Toilet facility with a water closet and a lavatory.
d. Kitchen-type sink.
e. Potable water system and a septic system for the plumbing fixtures.
f. Ventilation system to provide fresh air in the pump bays, generator area, and toilet room.
g. Air-conditioning system for the office.
h. Stilling wells containing float switches to be used for pump operations and water level monitoring.

A.7.5.3.1 Pumping Station Features

Pump Drives
The diesel engines will be standard model full-diesel types, 2 or 4 cycle, with mechanical injection and cooling provided by keel coolers. Diesel engine horsepower will be about 1,200 hp.

Engine Auxiliary System
Cooling of each main engine will be by means of a closed system consisting of keel coolers, overhead expansion tanks, and engine-driven jacket water and aftercooler water circulating pumps with proper heat balance maintained by the thermostatically controlled proportioning valves. The main lubricating oil pump for each main engine will be driven directly by the engine.

Speed Reduction Gears
Power will be transmitted from the engines to the pumps by means of right-angle type gear reducer units. These units will be designed for an application factor of 2.0 times the maximum input power. Thrust load due to hydraulic unbalance and an anti-friction type bearing located within the reducer unit will carry the weight of pump rotating elements. Connection between reducer and engine will be by flexible coupling to compensate for misalignment and vibration or shock transmission. The reducer will be provided with forced lubrication from a direct connected positive displacement pump with cooling of the oil by an external system. To prevent reverse rotation, the transmission would be fitted with an anti-reverse rotation clutch.

Fuel Oil Storage System and Supply
Aboveground Storage Tanks (ASTs) will be located at a safe distance from the station. ASTs shall be concrete-vaulted and have a dual containment feature. Fuel capacity may be as much as 36,000 gallons and several tanks may share this capacity. Fuel capacity should be for seven days, 24-hour/day continuous operation at maximum fuel consumption rate. The tanks will be filled from a fuel truck. The tanks will be connected to the station supply header. The fuel system for each main engine will consist of a day tank (typically up to 250 gallons capacity) to supply the diesel engine. The day tank will have automatic operation in sending and receiving fuel and controlling the level of the fuel inside of the day tank. A similar day tank will be provided for the engine generator sets.

Station Crane/Hoist
An overhead bridge-type electric crane will be provided. The crane/hoist shall be capable of handling up to 30-ton loads. The crane/hoist will handle pumping station equipment, such as diesel engines, reduction gears, or pump components during initial installation, as well as for general service thereafter.

Diesel Engine-Generator Sets
Two diesel engine-driven generator sets with capacities up to 500 kW each may be provided. These generators must provide sufficient power to operate the station at full capacity, including running all auxiliary equipment continuously for as long as seven days. One genset may also provide general standby power.

Potable Water and Plumbing
A potable water supply and plumbing system will be provided. This will include a septic system. A filtered water system will be necessary for the station to supply water to a Toilet (lavatory, shower, and water closet) and small kitchen area.

Air Conditioning
Small split-system air conditioning systems will be provided for the control room, telecommunications room, and the break room.

Ventilation System
A system of air inlet openings and exhaust fans will be provided for ventilation of the operating floor area. The air inlet louvers will be the type commonly referred to as Miami-Dade louvers. Bird screening will also be provided over the openings. The wall type exhaust fans will have motor-operated dampers.

Trash Rake
Trash rake/rack system will be one of two types: an automatic, continuously rolling, flex rake and trash rack system such as that manufactured by Duperon, or a powered rail-mounted traveling trash rake and hoist car assembly with a telescoping arm used to grip and remove debris. This system is similar to ones that are manufactured by Hydro Component Systems. The system selected shall be similar to those that have proven satisfactory at previously completed pumping stations.

Pump Model Tests
The specifications will require that a series of model tests be performed to verify performance and cavitation limits of the proposed pump. The contractor will be required to construct one complete pumping system for each size pump to the necessary scale model. The pumping system will include the forebay, pump, and discharge tube. All tests for determination of compliance with guarantees of capacity and/or efficiency will be accomplished using prototype heads.

A.7.5.3.2 Electrical Features

Electric Service and Backup Generator
A 480-volt, three phase, electrical service shall be provided using the existing power lines that run alongside Tamiami Trail. Transient Voltage Surge Suppression (TVSS) shall be provided at the service entrance. The local utility company shall provide the power. Diesel engine-generator units shall be provided to supply 480-volt, three phase electrical power when utility power is not available or not reliable. Backup generators and automatic transfer switches shall be sized sufficiently to power diesel engine auxiliaries, trash rakes, exhaust fans, lights and SCADA equipment.

Interior Electrical Distribution
Switchgear rated for 480 volt, three phase with a main breaker will be connected to the incoming service and will feed engine control centers, motor control centers, lighting panels, power panels and station equipment defined in the Pumping Station Features above. Each engine control center will house starters and controls for auxiliary equipment for each respective engine unit. Main switchboard will also feed transformers to supply 120/208 or 480/277 volt loads as necessary.

Interior and Exterior Lighting
High intensity discharge, industrial high bay luminaries will be used for the main pumping station area with industrial fluorescent fixtures with electronic ballasts for office and general type areas. Exterior lighting for security purposes would be automatically controlled by photo-electric cells and contactors.

Wiring and Conduit
Insulated copper conductors will generally be installed in either PVC coated rigid galvanized steel conduit or schedule 80 rigid plastic conduit. Conductors will be rated for 600 volt insulated types XHHW or XHHW-2. All wiring will conform to UFGS Guide Specifications.

Instrumentation and Controls
The pumping station will have a centralized monitoring and control room. Each diesel engine pump drive will have a separate motor control center to supply power and house controls for engine auxiliaries, such as jacket water pump, engine lube pump, fuel filter pump, etc. Diesel engines will also be equipped with a separate instrument panel and will house engine start/stop controls and pressure and temperature indicators to indicate engine performance. Programmable logic controllers (PLCs) will be used to monitor and control the engines and station auxiliaries. An Ethernet network will connect the PLCs and station computer. Ethernet based IP cameras will also connect to the Ethernet network. The station computer will allow for operation of the station via SFWMD's preferred SCADA software.

SCADA and Telemetry
The controls systems shall include manual, automatic and telemetry capabilities for the pumps and auxiliary systems. The engine start/stop controls shall operate locally at the engine, remotely from the control room, and from the central control station. The automation components of all pumping stations and structures that will eventually be operated and maintained by South Florida Water Management District (SFWMD) must conform to SFWMD standards in order to (1) achieve cost efficiency in design, construction, and operation and maintenance, (2) meet safety, reliability, and performance requirements during routine and emergency operations. The automation components are broadly defined to include hardware, software, communications, and user interface elements.

A.7.5.4 Gated Spillways

Gate Operators
Gate operators will be designed based on the size, weight, and hydraulic loading on the gates. The operators will either be electric motor driven through a drum and pulley system or via as an actuator on a stem screw.

Electrical Service
A control center will house a main breaker, combination starter for the gate motor, lighting panel, relay compartment, and a circuit for exterior lighting. Surge suppression will be provided for each electrical/electronic system within or outside the structure.

Control and Monitoring
Duplicate open-close push button station in the control house and at the spillway structure will be provided for manual gate control. Necessary open, close, automatic control relays, and limit switches will be incorporated in the gate control circuit. Power and control circuits for water level recorders and gate position recorders will be provided.

A.7.5.5 Telemetry

Each spillway site that requires remote automation will be equipped with an RTU compatible with the existing SFWMD telemetry system. RTU software will be in accordance with the SFWMD standard load set. The construction plans will contain plans for a fully functioning telemetry system capable of connecting to and communicating with the SFWMD existing system. Additional coordination during the development of plans and specifications will finalize the telemetry requirements.

A.8 HYDROLOGIC MODELING

A.8.1 Modeling Strategy and Tools

The primary application of models in the CEPP is for the assessment of regional-level hydrologic planning. More detailed models were also applied to address specific questions related to hydraulic and water quality constraints. The CEPP modeling tools were jointly selected by the USACE Jacksonville District (SAJ) and the South Florida Water Management District (SFWMD) in October-November 2011 based on their collective capability to provide adequate hydrologic information to conduct evaluations of the entire south Florida system for the needs of the CEPP. Due to the time required to complete prerequisite model documentation, documentation review, and compilation of this model validation review package, the expedited CEPP schedule did not afford the opportunity to submit the proposed modeling tools for USACE Engineering software validation evaluation prior to execution of the modeling strategy and application of the initial recommended modeling tool suite, which initiated in January 2012. However, prior to implementation of the CEPP modeling, the CEPP modeling strategy was vetted through USACE at the SAJ District, South Atlantic Division (SAD), and Headquarters (HQ) levels through the prior CEPP periodic in-progress reviews (IPR-1 in December 2010; IPR-2 in January 2012) and CEPP Decision Point 1 vertical coordination meeting (January 2012). Prior to completion of the hydrologic modeling of the CEPP final array of alternatives, all CEPP modeling tools were reviewed and approved for use through either the USACE Engineering software validation process or through the CEPP Agency Technical Review (ATR) process, as further documented in Section A.8.1.1.

The CEPP modeling strategy centered around use of a decoupled link-node model Regional Simulation Model for Basins (RSM-BN) for the EAA, Stormwater Treatment Areas (STAs) and the northern estuaries, in combination with a detailed meshed Regional Simulation Model for the Glades and Lower East Coast Service Areas (RSM-GL) for the Water Conservation Areas (WCAs), Everglades National Park (ENP) and the Lower East Coast (refer to section A.8.1.2 for additional documentation of the RSM models). The CEPP modeling strategy provides an overview of the modeling tools, including maps of the model domains, applied throughout the plan formulation process and how the tools were applied in support of the CEPP planning process (refer to Reference 1, included with the Hydrologic Modeling Annex A-2).

Preliminary screening assessments for Lake Okeechobee, the northern estuaries, and the impoundment storage within the EAA, collectively referred to as the "North of the Red Line components," utilized the Reservoir Sizing and Operations Screening (RESOPS) model, the Lake Okeechobee Operations Screening (LOOPS) model, and the C-43 Spreadsheet Model. Preliminary screening assessments for the Water Conservation Areas (WCAs) and Everglades National Park (ENP), collectively referred to as the "South of the Red Line components" (including the components at the EAA/WCA Red Line boundary, in addition to the Green/Blue/Yellow Line components) utilized the iModel optimization tool and limited-scope sensitivity simulations using the RSM-GL. For the final array of alternatives, analysis of the North of Red Line components and the South of the Red Line components were conducted using the RSM-BN and the RSM-GL, respectively. The RSM-GL model was also used for performance evaluation within the Lower East Coast Service Areas, areas which were not encompassed within the domain of the iModel used during preliminary screening. The Hydrologic Engineering Centers' River Analysis System (HEC-RAS) modeling tools were utilized for hydraulic design efforts to evaluate potential canal conveyance modifications and structural modifications identified with the CEPP Recommended Plan components. The Dynamic Model for Stormwater Treatment Areas, Version 2 (DMSTA2) was utilized during preliminary screening and final array modeling to confirm compliance with required State of Florida water quality standards.

Additional technical descriptions for the RSM-BN, RSM-GL, and HEC-RAS hydrologic and hydraulic modeling tools applied to evaluation of the CEPP final array of alternatives are provided in Sections A.8.1.2 through A.8.1.4. From initial formulation through selection of the Recommended Plan (Alternative 4R2), the CEPP modeling strategy has not included the application of detailed flood event modeling (or hydrodynamic levee assessment). It is expected that higher resolution hydrologic and hydraulic modeling tools will be required to further analyze localized and possibly regional-scale effects of specific components of the CEPP Recommended Plan, with the scope of these analyses further identified during the Pre-Construction Engineering and Design (PED) phase of the project.

A.8.1.1 Overview of USACE Model Validation Process and CEPP Approach

The USACE model certification process distinguishes between "Engineering" and "Planning" models. One of the goals of the Scientific and Engineering Technology (SET) initiative is to inventory and evaluate the software used by the Corps' scientific and engineering community, to ultimately achieve a manageable and cost-effective USACE corporate tool set. Each piece of software is inventoried, reviewed, and ultimately listed in one of five categories: Enterprise Tools, Community of Practice (CoP) Preferred, Allowed for Use, Retired, and Not Allowed for Use. It is expected that the lists will continue to evolve as new software is introduced.

Current USACE guidance (ES-0801: June 2011) regarding software validation for the Hydrology, Hydraulics, and Coastal Community of Practice (HH&C CoP) indicate that both the District and Division need to recommend the software for evaluation. The recommendation should state whether the software will be used nationally, regionally, or locally, and should include why the software is needed, an explanation as to what it does and how it does it, why any of the other corporate software already on the list doesn't meet the needs, who within the Corps has knowledge of this software, what type of peer review has it received, what Area of Expertise (AoE) software list should it be included with, and what documentation, training and support can be found. The goal of the SET program is to manage the number of pieces of software so the Corps doesn't have to support multiple pieces of software that do roughly the same thing. The USACE should use "well-known and proven" software unless a new piece of software does something one of the "validated" pieces of software does not.

Based on ES-0801 guidance, the following general information (items 1 through 9) is typically requested to support a request for USACE "Engineering" model validation evaluation.

- Model Classification (Area of Expertise);
- Requested Model Application Area;
- General model documentation/description of model capabilities (include web site links or documentation reports);
- Why the model software is needed? (consider other approved corporate software);
- External peer review (requested by?; Conducted by?; Model version and date?; final reports should be provided);
- Internal technical review by Interagency Modeling Center (model version and date?; final report should be provided);
- Previous applications of the model (specific projects and sponsor agency);
- Additional applicable reports or documentation, if any (other agency peer reviews, project specific applications of model, model users' guide, etc.);
- USACE knowledge base for this software.

The RSM-BN, RSM-GL, and DMSTA models were reviewed through the HH&C CoP validation process for engineering software, as part of the CEPP project. The RSM (including RSM-BN and RSM-GL) and DMSTA models were both classified as "allowed for use" for South Florida applications in August 2012 and January 2013, respectively. The Hydrologic Engineering Centers' River Analysis System (HEC-RAS), developed by the USACE HEC, has been previously reviewed and classified as a "CoP Preferred" hydraulic design and river hydraulics modeling tool.

ES-0801 also provides guidance regarding "model building pieces of software." While they are used frequently in USACE planning and engineering processes they are pieces of software that can be used to create any type of model. Therefore, they are impossible to pre-certify through the standard engineering software validation process. However, the HH&C CoP believes these tools are fine for building models and thus they are "validated" as "Allowed for Use". Still, the HH&C CoP cautions the user that the Agency Technical Review (ATR) and the Independent External Peer Review (IEPR) must include a much more thorough review of the inner workings of the model, as the basic assumptions, equations and output used or created for the model have not been pre-validated. It is also important to note that an application built using these tools needs to be created by someone knowledgeable about the software and that experienced users must review the application during the review process, ATR and IEPR, if required, to ensure the validity of any equations and/or algorithms built into the tool. The Project Review Plan should reflect and detail technical requirements for individuals reviewing these tools.

For the CEPP, based on coordination with the USACE South Atlantic Division (SAD) and subsequent coordination with the CEPP USACE ATR team, it was determined that four model building software tools used during the initial CEPP screening process would be reviewed as part of the CEPP ATR: the RESOPS, LOOPS, and C-43 spreadsheet model tools; and the iModel optimization tool. ATR review and approval of these modeling tools for CEPP application was completed in November 2012. Additional descriptions of these modeling tools are provided in the CEPP modeling strategy (Reference 1, included with the Hydrologic Modeling Annex A-2).

A.8.1.2 Modeling Tool Overview: Regional Simulation Model (RSM-BN and RSM-GL)

South Florida is a unique environment requiring specialized models to simulate regional operations. South Florida has a complex regional hydrologic system that includes thousands of miles of primary and secondary networked canals, nearly 300 man-made flow-regulation structures, thousands of square miles of nearly flat terrain much of which are wetlands, and permeable surficial soils that enhance groundwater-surface water interactions. Hydrologic and hydraulic analyses of this complex system require a computational model that can run quickly, offer flexibility, and generate output that can be clearly interpreted. Because of the region's highly variable hydrology (extreme rain events and periods of extended droughts), it is imperative that models be capable of running regional simulations of decades covering wet, dry and average rainfall conditions. Finally, land use changes and water demands for this extended period of time requires the user to easily modify input data sets, as well as an ability to use generalized data sets to optimize performance.

The Regional Simulation Model (RSM) was developed by the South Florida Water Management District (SFWMD) to overcome these limitations, beginning in 1994. RSM provides the computational framework for developing more complete and numerically sound integrated surface water and groundwater models where both components receive equal attention. The RSM was developed to eventually replace the SFWMD South Florida Water Management Model (SFWMM) for simulating the water management in the Central and Southern Florida Flood Control Project (C&SF Project). The RSM simulates the hydrology and water management of the South Florida region, providing modeling support to regional restoration, flood control, and water supply planning efforts. The same RSM program executable is used by the link-node RSM-BN and the mesh-based RSM-GL (or any other mesh-based sub-regional RSM models). The RSM is an implicit, finite-volume, continuous, distributed, and integrated surface-water and ground-water model.

Development of a regional South Florida RSM (SFRSM) model, as originally envisioned, has not been completed at this time. Due to this limitation, the RSM currently is applied to sub-regions within the south Florida domain. Each of the sub-regional models was created to address specific water resource management issues or to support alternative plan formulations for the CERP. Prior to the CEPP, the RSM model has been utilized to develop sub-regional models to support modeling evaluations for both SFWMD projects and USACE/SFWMD CERP projects: CERP WCA-3A Decomp (USACE/SFWMD); CERP Biscayne Bay Coastal Wetlands (SFWMD); Lake Okeechobee Watershed Construction Project (SFWMD); and the Caloosahatchee River Watershed Protection Plan (SFWMD). The following RSM sub-regional model applications had been previously developed and applied: Biscayne Bay Coastal Wetlands/C-111 (refer to Figure A.8-1 for model domain), Glades and Lower East Coast Service Areas (Glades-LECSA, or RSM-GL; refer to Figure A.8-2 and Figure A.8-3), and Northern Everglades (NERSM; refer to Figure A.8-4 and Figure A.8-5) models.

A.8.1.2.1 Regional Simulation Model for Basins (RSM-BN)

Although RSM is principally applied for irregular triangular mesh models, RSM can be used as a node-link model when implemented in a study area that can be conceptualized as a lumped system, as in the case RSM-BN. The RSM-BN model domain covers Lake Okeechobee, the EAA, and three major watersheds: the Kissimmee, the St. Lucie River, and the Caloosahatchee River. The link-node based model is designed to simulate the transfer of water from a pre-defined set of watersheds, lakes, reservoirs or any "waterbody" that either receives or transmits water to another adjacent waterbody. The watersheds are further divided into sub-watersheds until fundamental waterbodies can be considered as separate model nodes. RSM produces complete water budgets given appropriate boundary conditions and

simplified operating rules. The NERSM was the precursor model to the RSM-BN; the RSM-BN is NERSM with added explicit simulation of the EAA, which is a critical component for the CEPP as the proposed FEB is located within the EAA footprint. The node link representations of the EAA in the RSM-BN baseline conditions and the CEPP alternatives 1 through 4R2 are provided in Figures A.8-6 through A.8-7; Figures A.8-4 through A.8-8 collectively represent the model domain and node-link assumptions utilized for the RSM-BN CEPP application.

Prior to the CEPP, the RSM-BN model was used by the SFWMD to support the SFWMD River of Grass (ROG) planning effort (2008-2009) and the SFWMD northern Everglades planning process, and the model was well-received by the public stakeholders. Limitations of the RSM-BN model are consistent with limitations previously documented for the precursor NERSM:

- A formal model calibration was not conducted for the NERSM or RSM-BN models; the original NERSM application, for the SFWMD Lake Okeechobee Watershed Construction Project, conducted a simplified model validation through comparison of NERSM results with current base and future base simulations represented with the SFWMM and Upper Kissimmee Model (UKISS).
- More advanced capabilities of RSM such as 1-dimensional canal flow routing and 2-dimensional overland flow/groundwater flow calculations were not used in RSM-BN. Groundwater hydrology is not explicitly represented within the RSM-BN.
- Within an RSM node-link model, the following framework applies: each node represents a waterbody (hydrologic basin, lake, reservoir, STA, etc.); each link acts like a conduit only, with no hydrologic/hydraulic simulation for the links; and individual operating and management rules at each structure define the linkage of all nodes within the modeling domain (hydrologic processes are simulated for each node at varying complexities).
- For the CEPP application, the RSM-BN model domain includes a simplified model representation of the L-4, L-5, and L-6 Canals located along the CEPP red line interface; discharges from STA-2, STA-3/4, and STA-5/6 are routed directly to the downstream WCAs per CEPP operating protocols, where these WCA inflows are captured by the RSM-GL model.
- For the CEPP application, water is routed through storage features assuming a level pool with negligible slope in the water surface. The assumption is valid as long as the volume entering a storage feature during the 1-day time step is small relative to the volume of water in storage. Sloped water surfaces can be simulated as an option within the RSM-BN (for example, for representation of the Kissimmee River flood plain).
- The model simulates the management of the system according to a set of operational criteria referred to as management rules. These rules are expressed in regulation schedules, gate-operation criteria, and established rules governing the operation of the structures. It is assumed that the management rules prescribed for the various simulation scenarios are reasonable for the variety of hydrologic conditions represented by the period of simulation.
- A daily time step is assumed to be adequate for planning purposes and the evaluation of RSM-BN performance measures. Most measures are expressed in terms of annual, monthly, and weekly statistics.
- Historical flow patterns from the adjacent sub-watersheds contributing into Lake Okeechobee are assumed to be preserved while simulating management measures. Rainfall-runoff relationships and drainage/routing characteristics within a sub-watershed are assumed not to change from before to after management measures are operational.

- It is assumed that a change in management rules will not change the historical hydrologic variables.
- Other than the footprint associated with management measures considered in the future base and alternative scenarios, it is assumed that there are no other changes in land use or land cover within the RSM-BN for the CEPP application. Variable land uses can be assumed in the EAA and Kissimmee River watershed domains of the RSM-BN via model input pre-processing.
- The lower Kissimmee River and floodplain between consecutive water control structures is assumed to be hydrologically similar to a level-pool reservoir with a unique stage-volume relationship. Lock operations are not simulated.

A.8.1.2.2 Regional Simulation Model for Glades and Lower East Coast Service Areas (RSM-GL)

The RSM-GL model domain covers an area of 5,825 square miles and encompasses a total of thirteen basins (Figure A.8-2): 1) L-28 Interceptor; 2) L-28 Gap; 3) Feeder Canal; 4) East Collier; 5) Everglades National Park (ENP); 6) Water Conservation Area 1 (WCA-1) ; 7) WCA-2A; 8) WCA-2B; 9) WCA-3A; 10) WCA-3B; 11) Lower East Coast Service Area 1; 12) Lower East Coast Service Area 2;and, 13) Lower East Coast Service Area 3. The southern, eastern and southwestern boundaries of the model are comprised of Florida Bay, the Atlantic Ocean/Biscayne Bay and the Gulf of Mexico coastlines, respectively.

The RSM-GL can simulate one-dimensional canal/stream flow and two-dimensional overland and groundwater flow using a variable triangular mesh. The overland and groundwater flow components are fully coupled in the RSM and RSM-GL for a more realistic representation of runoff generation. The RSM-GL has physically-based formulations for the simulation of overland and groundwater flow, evapotranspiration, infiltration, levee seepage, and canal and structure flows. The model uses the diffusive wave approximation of Saint-Venant's equation to simulate canal and overland flows. This model is capable of simulating features that are unique to South Florida such as low-relief topography, high water tables, saturation-excess runoff, depth-dependent roughness and very permeable soils. The RSM-GL model simulates an extensive canal network. This network includes all primary canals that are maintained by the SFWMD. It also includes several secondary canals that are of importance. In addition, the model uses the Water Control District (WCD) feature available in the RSM to simulate some secondary and tertiary canals as well. Relevant structure operations associated with the WCDs and the canal network are simulated using the functionality available in the model. Only the surficial aquifer is simulated in the RSM-GL model. The RSM-GL was not developed to simulate deep groundwater flows. Other surface water models, including the SFWMM, have used similar approaches. The WCAs and ENP contain a significant peat layer that affects stages within those areas. This surficial peat layer is simulated explicitly in the RSM-GL using a stage-volume converter feature that is unique to the RSM. The model-domain contains several hundred Public Water Supply (PWS) wells that tap the surficial aquifer. The model-domain contains several roads and levees that act as overland flow barriers. The canal and regional groundwater seepage contributions across these levees are explicitly simulated in the RSM-GL model.

The RSM-GL application of the RSM was specifically calibrated to support the evaluation of proposed project features for the CERP WCA-3 Decompartmentalization and Sheetflow Enhancement project (Decomp). The RSM-GL model has been previously applied by the SFWMD/USACE to support base condition modeling and evaluations of the final array of alternatives for the Decomp Project Implementation Report 1 (PIR 1) during 2010-2011. Both the Decomp and CEPP projects are components of the CERP, and the features of the prior Decomp project are central components to the

CEPP. The Decomp modeling strategy selection of RSM-GL as a preferred sub-regional hydrologic modeling tool was significantly leveraged during identification of the CEPP modeling strategy.

An extensive modeling strategy development and review effort was used by the Decomp project delivery team (PDT) to identify the RSM-GL model as the preferred sub-regional modeling tool to support Decomp PIR 1 alternative evaluations. The comprehensive Decomp modeling strategy was endorsed by the CERP Interagency Modeling Center (IMC) in 2008; the IMC, under its responsibility to serve as a central point to coordinate CERP and CERP-related modeling activities, is routinely consulted to implement peer reviews of models and their applications. In addition, IMC peer review of the available sub-regional hydrologic modeling tools resulted in an IMC recommendation for Decomp application of the RSM-GL model. As with other peer review requests for CERP applications, the peer review scope requested the peer review panel to judge the adequacy of the RSM-GL model with respect to model data needs, model spatial and temporal resolutions, model documentation, model capabilities, model limitations, and the theory upon which it is based. The goals of this IMC peer review request were two-fold: (1) to ensure that the RSM-GL model was developed and implemented based on sound science and modeling principles; and (2) to determine the suitability of the RSM-GL to support Decomp PIR 1 plan formulation and evaluation.

The IMC peer review report recognized that the RSM-GL as: (1) an improvement over the SFWMM with respect to model methodology (surface flow, canal flow, sub-surface flow, evaporation, evapotranspiration, infiltration and seepage), especially when considered as a sub regional tool for implementation of the hydrologic portion of the DECOMP modeling strategy; (2) an improvement over the SFWMM with respect to the model grid density and local grid refinement capabilities, and modeler control of adding, removing, or modifying canals, structures, and structure operation rules; (3) able to distinguish between spatial and temporal differences in water depths/stage (including recession rates), and overland and canal flow adequately for CERP evaluations; and (4) if used with caution and adequate interpretation of the model output, able to show some important differences between the varying degrees of Miami Canal backfill or plugging that may be proposed for Decomp PIR 1 alternatives.

The IMC peer review report summarized the overall strengths of the RSM-GL, focusing on Decomp PIR 1 model needs:

- The model is capable of predicting the intricate results of implementing physical and operational alternatives. It can be used to simulate the complexity of integrated surface water and groundwater systems under natural conditions and to support decision-making and management operations.
- The model is capable of simulating rainfall, evapotranspiration, irrigation, crop water demand, and groundwater withdrawals in the surficial aquifer system. These processes are critical to South Florida.
- The model has physically-based formulations for the simulation of overland/ sheet flow, groundwater flow, evapotranspiration, infiltration, levee seepage, irrigation, urban water use, storm water detention, river/canal flows, and structure flows.
- The model is capable of simulating the unique features of low-relief topography in south Florida, including the interactions between surface water and groundwater, levee-canal systems, and complex structure operations such as well pumping rate, gate opening and closing, and flow diversion between management water control units according to established management rules.

- The model uses an irregular triangular mesh so the model boundaries and features can be accurately defined. The triangular mesh system can be designed to conform to all important features, boundaries, roads and levees.

The IMC peer review report also summarized the overall weaknesses of the RSM-GL, focusing on Decomp PIR 1 model needs:

- The results of model calibration and verification indicate large errors in flow computation at structures. The model also performs poorly in predicting canal stages at several of these locations.
- Water quality is also an important issue in CERP projects. At this time, the RSM model is not capable of simulating water quality.
- In the current setup, most of the structure flows are imposed as internal boundary conditions. Therefore, the model cannot be considered calibrated to surface water flows.
- The current mesh discretization, while fine for regional-scale modeling, may not be adequately detailed to evaluate the features of Decomp PIR 1. It should be noted that the RSM Glades LECSA Model was not developed solely for the DECOMP project application, but rather for broader CERP applications. Therefore the need for such refinements is to be expected.
- The model does not recognize separate aquifer layers and emulates groundwater flow processes as one hydrologic unit, which may be acceptable only for coarse spatial discretization and flow regimes with hydrostatic pressure distributions. This may or may not be a significant weakness depending on the nature of the Decomp PIR 1 alternative scenarios to be evaluated. It should also be mentioned that the model assumes a no-flow boundary condition at the base of either the Biscayne / Gray Limestone aquifer in the Lower East Coast area or the surficial aquifer in Lower West Coast area. This assumption is generally acceptable, but may yield significant error in localized areas of significant hydrologic stresses (e.g., well fields).
- Although the model is generally well-calibrated to water levels, the model seems to have problems predicting extreme low and high water levels, especially the low stages. Considering these low stages over extended time periods could be critical to aquatic life and the ecological system, this weakness is of importance and should be improved if possible. Or at a minimum, this weakness should be considered when interpreting model results.

Key priority recommendations from the IMC peer review panel for enhancements to the RSM-GL model and the calibration/validation report content, as agreed upon following a May 2008 meeting with SFWMD, USACE, IMC managers, and the IMC peer review panel, were implemented for the final version of the RSM-GL that was applied for Decomp PIR 1 regional modeling and, ultimately, CEPP. As a result of the RSM peer review recommendations, a finer resolution mesh was developed for the Decomp PIR 1 project area, and additional sensitivity testing and model output statistics were completed for incorporation into the RSM-GL calibration/verification report. The peer review recommendations and IMC endorsement of the RSM-GL model also initiated a significant two year coordination effort between the Decomp Ecological and Water Quality sub-team and the SFWMD RSM model developers to develop a robust Decomp PIR 1 evaluation methodology, including efforts to port existing SFWMM performance measure tools to RSM, development of new indicator regions and aggregation methods, and extensive performance measure testing and validation.

The final Decomp RSM-GL calibration/verification report includes documentation of model enhancements which were recommended by the IMC model peer review panel and subsequently agreed to by the SFWMD RSM development team. The complete RSM-GL model calibration and verification report, which was completed in December 2011 as part of the Decomp PIR 1 project modeling effort, is posted with the Decomp project documentation report (Annex A-1, Appendix B-11): http://www.evergladesplan.org/pm/projects/docs_12_decomp_doc_report.aspx. The reader should refer to this documentation for a more complete review of the RSM-GL model development, calibration methods, and calibration/verification performance and statistics. The CEPP utilized the RSM-GL model version that was developed and thoroughly documented for the Decomp PIR 1 project, while additionally utilizing an extended 1965-2005 period of simulation (Decomp modeling used 1965-2000; no additional verification was completed for the 2001-2005 period for CEPP application of the RSM-GL). Some minor localized improvements to the Decomp RSM-GL model were also included to improve the capability of the RSM-GL to more effectively represent critical CEPP project components, with these enhancements extensively tested and confirmed to not significantly alter the previous calibration and verification performance; details of these improvements and testing results are documented in the CEPP Model Documentation Report (MDR) for the CEPP Model Supported Screening Efforts (MDR 1), which is included in the CEPP Final PIR as Annex A-3 of this Appendix. CEPP MDRs were jointly prepared developed by the SFWMD Hydrologic and Environmental Systems Modeling (HESM) and the IMC.

Following the CEPP announcement in October 2011, the USACE SAJ and the SFWMD decided to integrate the previous Decomp planning effort into the CEPP. SAJ prepared a documentation Report to summarize the Decomp plan formulation and evaluation efforts, information obtained by the planning team, engineering work efforts, and lessons learned to date. The Decomp documentation report was used by the CEPP team and is available to staff and managers involved in the interagency state-federal Everglades restoration program as a resource to guide future planning efforts. The report documents the plan formulation and evaluation of seven alternatives (subset of final array), all plan formulation activities leading up to the development of the final array of alternatives, recommendations for an adaptive management strategy, and application of extensive hydrologic modeling (including RSM-GL application) conducted to support the formulation and evaluation efforts. The Decomp documentation report can be reviewed at the following location:

http://www.evergladesplan.org/pm/projects/docs_12_decomp_doc_report.aspx

The Hydrology and Hydraulics Annex to the Engineering Appendix (Annex A-1) of the Decomp documentation report provides comprehensive documentation of the technical support provided by the SAJ Water Resources Engineering Branch: hydrologic data collection and analyses; development and application of numerical modeling tools to support PDT evaluations; preliminary hydraulic design efforts; and additional work-in-progress technical information for consideration by future CERP planning efforts.

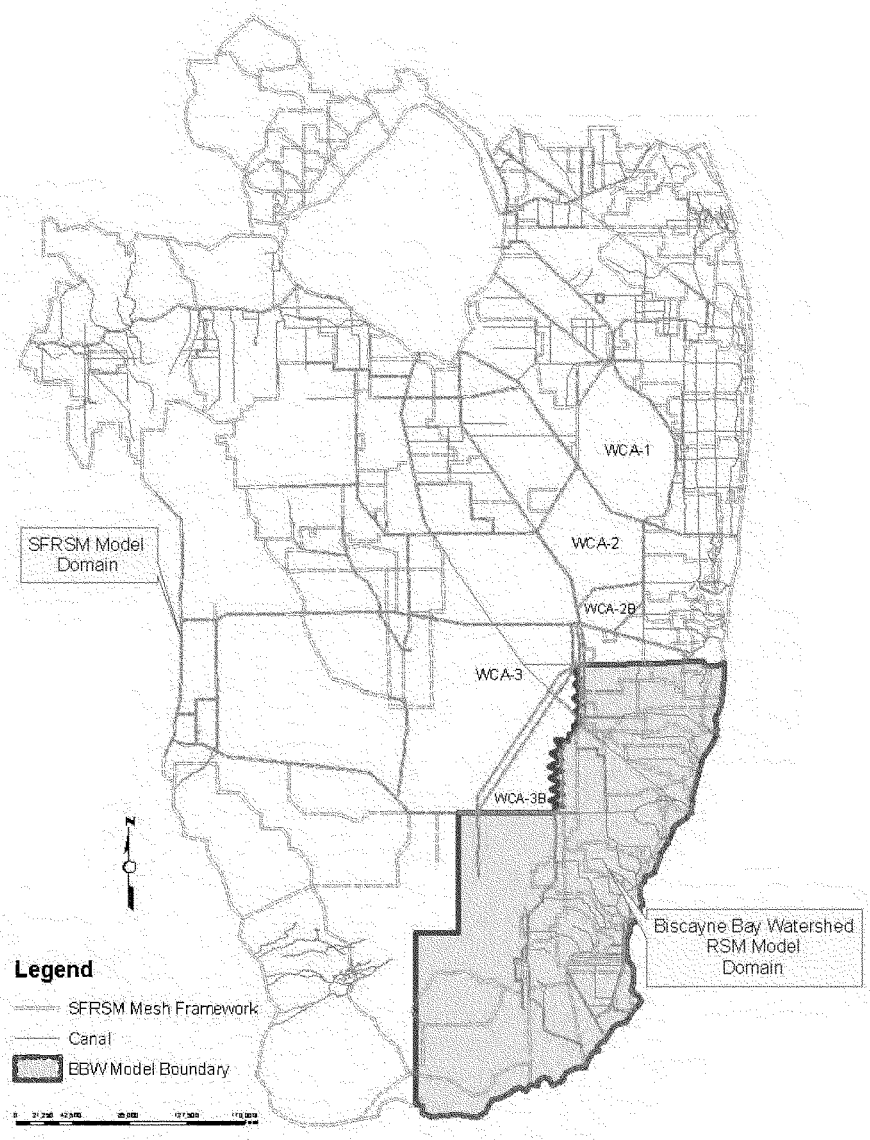


FIGURE A.8- 1: BBCW/C111 RSM MODEL DOMAIN

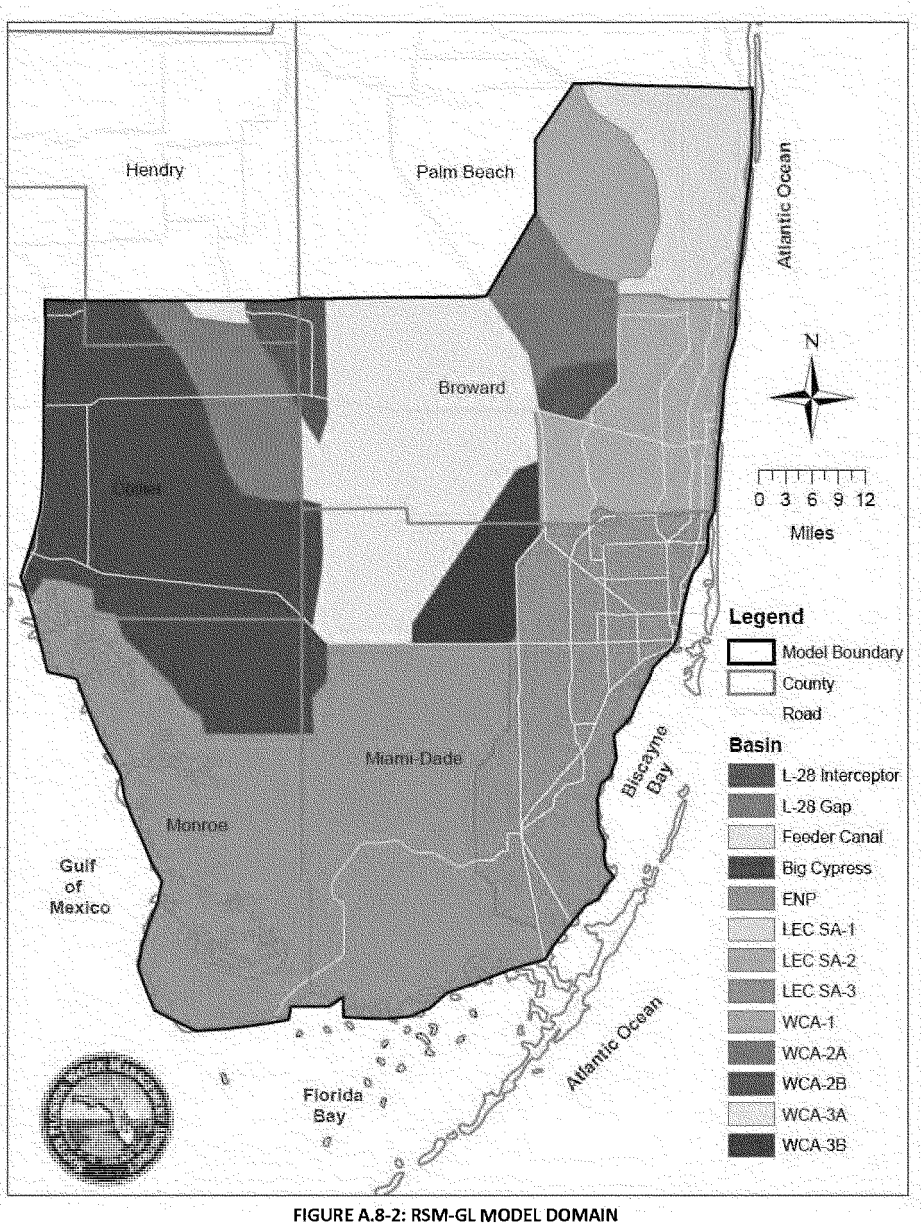


FIGURE A.8-2: RSM-GL MODEL DOMAIN

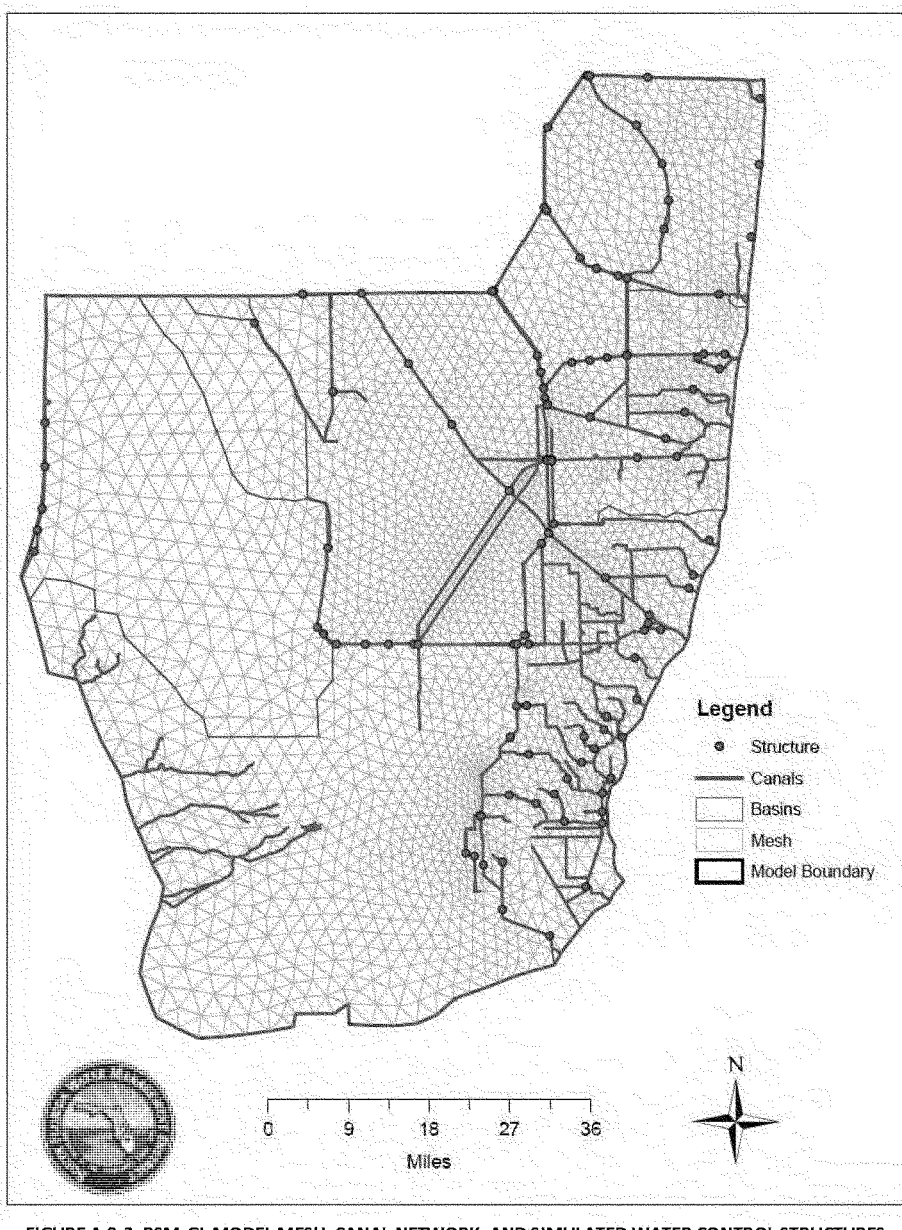


FIGURE A.8-3: RSM-GL MODEL MESH, CANAL NETWORK, AND SIMULATED WATER CONTROL STRUCTURES

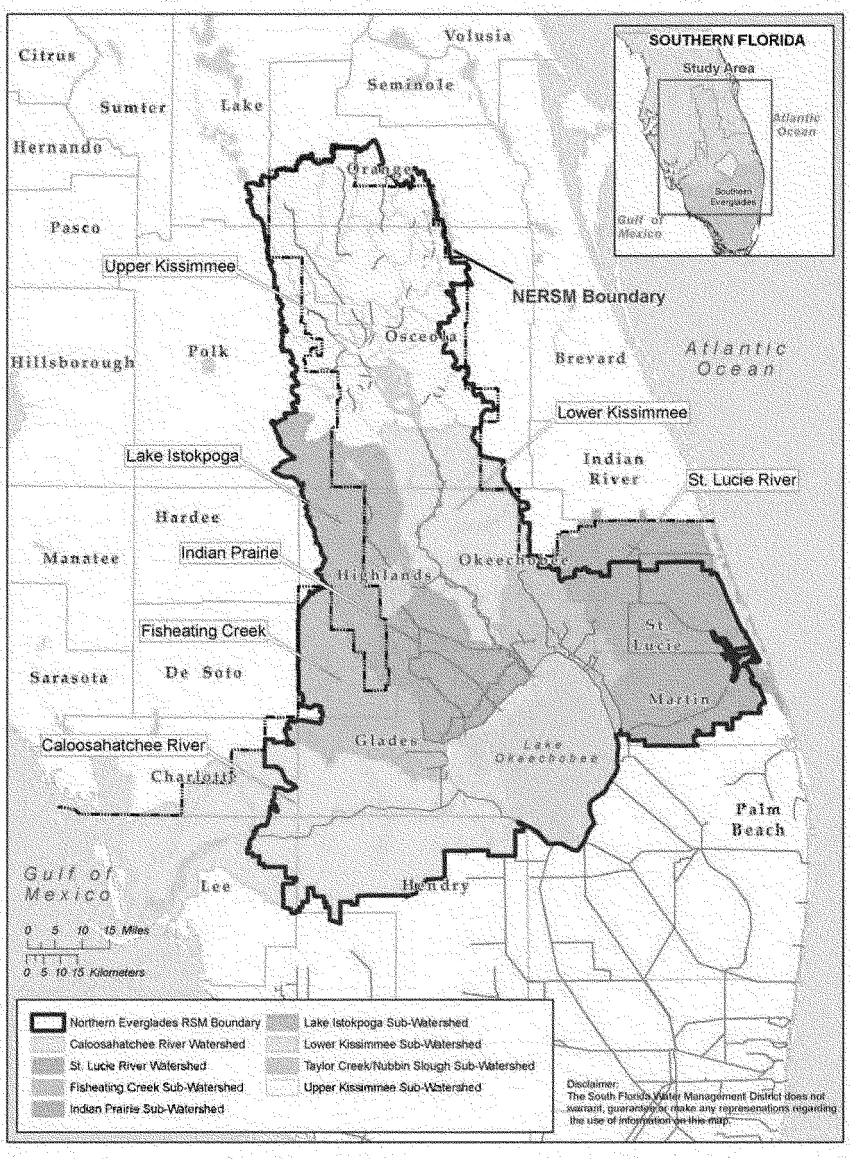


FIGURE A.8-4: NERSM MODEL DOMAIN

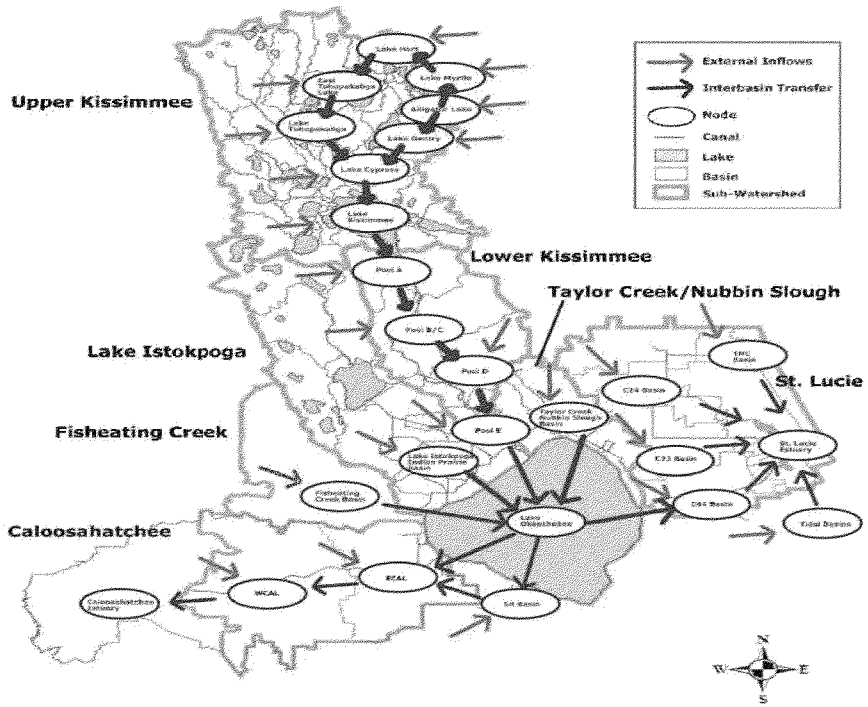


FIGURE A.8-5: NODE-LINK DIAGRAM REPRESENTATION OF NERSM (RSM-BN NORTHERN DOMAIN)

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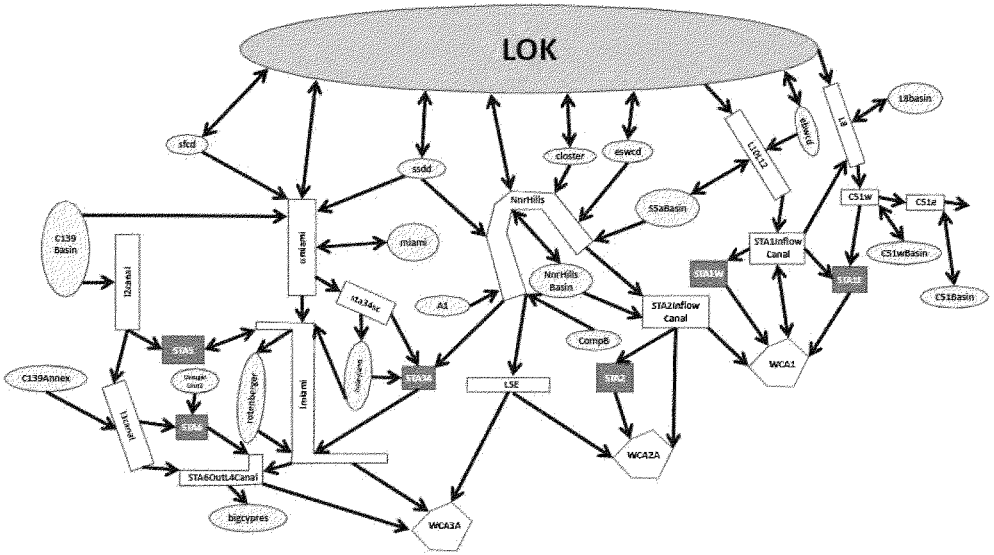

FIGURE A.8-6: NODE-LINK DIAGRAM REPRESENTATION OF EAA FOR RSM-BN EXISTING CONDITION BASELINE

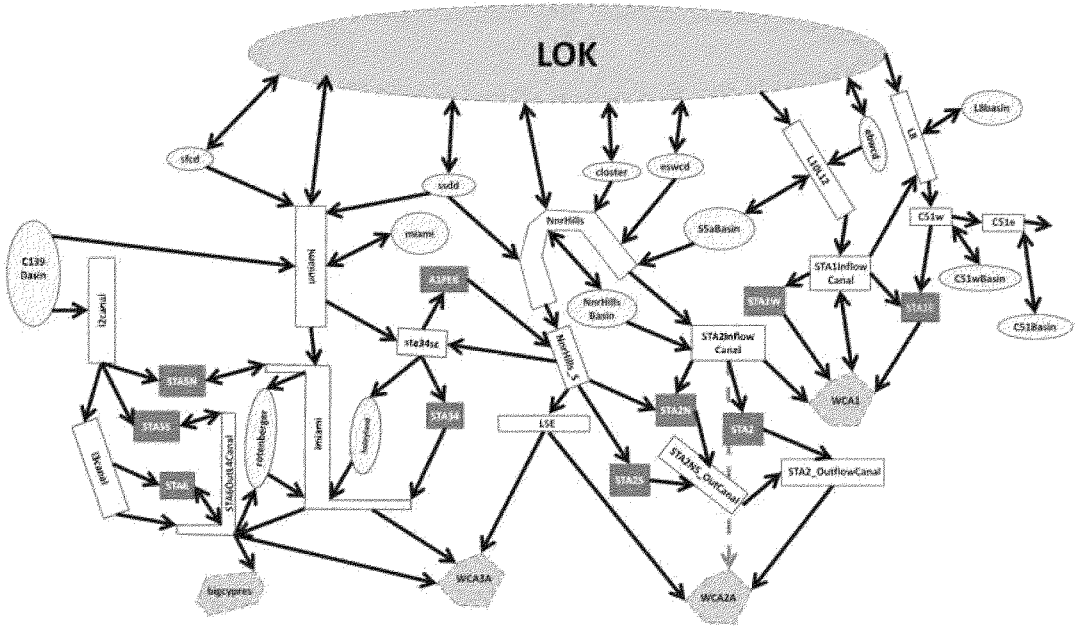

FIGURE A.8-7: NODE-LINK DIAGRAM REPRESENTATION OF EAA FOR RSM-BN FUTURE WITHOUT PROJECT CONDITION BASELINE

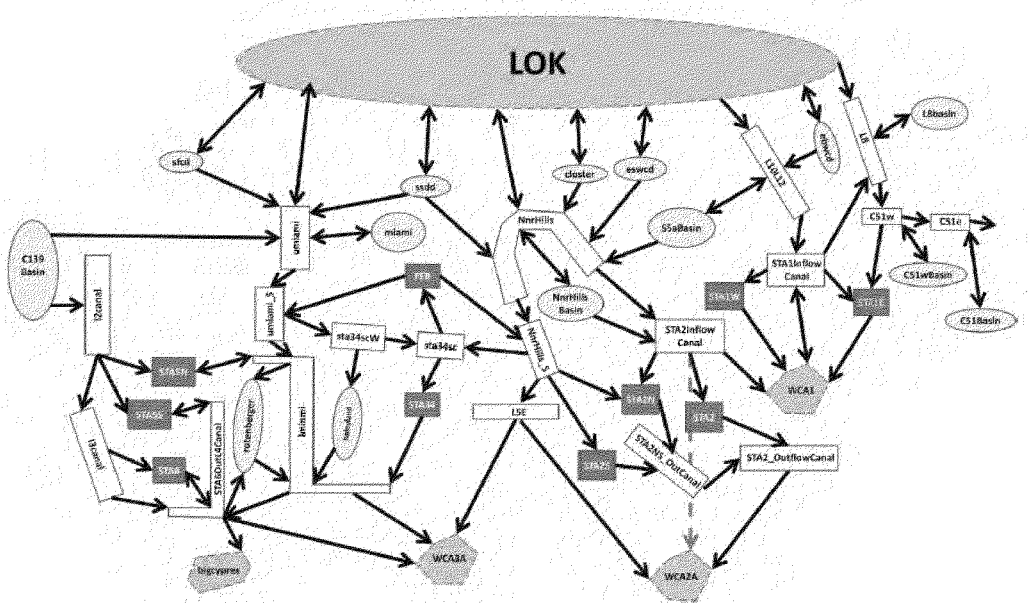

FIGURE A.8-8: NODE-LINK DIAGRAM REPRESENTATION OF EAA FOR RSM-BN ALTERNATIVES

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A.8.1.3 Modeling Tool Overview: Hydrologic Engineering Centers' River Analysis System (HEC-RAS)

HEC-RAS modeling tools are utilized to evaluate potential canal conveyance modifications and structural modifications identified with the CEPP Recommended Plan components. HEC-RAS is also applied as a hydraulic design tool to aid with design of new gravity water control structures. Detailed documentation of the CEPP hydraulic design methods and results are provided in Sections A.5.3, A.7.3, and A.7.3 of the Engineering Appendix.

HEC-RAS is an integrated package of hydraulic analysis programs, in which the user interacts with the system through the use of a Graphical User Interface (GUI). The system is capable of performing steady and unsteady flow water surface profile calculations, sediment transport/movable boundary computations, water quality analysis, and several hydraulic design computations. Hydraulic losses through the channel, bridge, culverts, spillways and other hydraulic structures can be modeled in both the steady state and unsteady state modules. The unsteady flow component is capable of simulating one-dimensional unsteady flow through a full network of open channels. Special features of the unsteady flow component include dam break analysis, levee breaching and overtopping, pumping stations, navigation dam operations and pressurized pipe systems. These model features can be useful in identifying conveyance deficiencies in canals and structures under steady state or dynamic flow conditions for particular flood events.

The HEC-RAS includes capabilities that allow the model to apply complex operation of gated structures and pump stations. HEC-RAS is capable of simulating interaction between 1-dimensional channel flow and 2-dimensional floodplain flow, allowing for more accurate floodplain mapping. In areas where the interaction of open channel flow and aquifer groundwater needs to be explicitly modeled, a new integrated tool based on the original HEC-RAS and MODFLOW models can also be used to accurately simulate the aquifer/canal flow exchange.

For an Unsteady Flow analysis, there are several different boundary conditions available including flow hydrographs, stage hydrographs, stage and flow hydrographs, and rating curves. Boundary conditions must be imposed at all external model cross sections and can be added to any desired internal location.

Boundary conditions for stage and flow are available from either historical data or from the RSM-BN or RSM-GL sub-regional hydrologic models; however, HEC-RAS simulations developed for CEPP will be steady state and not reliant on time series output from the hydrologic modeling efforts.

For CEPP, the HEC-RAS computer software model was utilized for all 1-dimensional hydraulic routings at the localized scale, where necessary to develop hydraulic design criteria for cost estimating design purposes and further engineering design in PED. Cost estimating design purposes examples include the following: (1) identifying type and size of water control structure, (2) geometry of canals and other conveyances, (3) pump head requirements, (4) levee crest elevations, and (5) miscellaneous requirements for civil, geotechnical, and structure designs. The strength of HEC-RAS is the continual updates made as the science of computational hydraulic engineering progresses, which adds additional accuracy, precision, and stability, thereby confidence with consistent peer reviewed model results, dependent on input. HEC-RAS is currently used worldwide for these reasons. The one real weakness of HEC-RAS is that it is constrained to 1-dimensional flows versus 2-dimensional or 3-dimensional flows. During PED, where determined necessary, a 2-dimensional computer software model (likely ERDC's Adaptive Hydraulic model, AdH-2D) will be used to model conveyance paths to determine final hydraulic

design details; such areas include structure discharge basins, the FEB interior levee (baffle), and others to be identified later.

A.8.2 Preliminary Screening

A.8.2.1 Summary of Screening Tools and PIR Documentation

Execution of the CEPP modeling strategy and application of the initial recommended modeling tool suite initiated in January 2012. Preliminary screening assessments for Lake Okeechobee, the northern estuaries, and the impoundment storage within the EAA, collectively referred to as the "North of the Red Line components," utilized the RESOPS model, the LOOPS model, and the C-43 Spreadsheet Model. The CEPP plan formulation approach, screening methods, and results for the North of Red Line components, which ultimately identified the ~14,000 acre Flow Equalization Basin (FEB) on the EAA A-2 site for inclusion in the CEPP Recommended Plan, are summarized in **Section 3** of the CEPP PIR main report. Formulation and screening analysis for the EAA storage component of CEPP was completed between January and July of 2012. Preliminary screening assessments for the WCAs and ENP, collectively referred to as the "South of the Red Line components," utilized the iModel optimization tool and limited-scope sensitivity simulations using the RSM-GL. The CEPP plan formulation approach, screening methods, and results for the South of Red Line components, which ultimately identified the remaining CEPP Recommended Plan components for the L-4/L-5 Levees, Miami Canal, L-67A/L-67C Levees, L-29 Levee, L-67 Extension Levee, and L-31N Canal within WCA-3 and ENP, are also summarized in **Section 3** of the CEPP PIR main report. Formulation and screening for the Red, Green, Blue, and Yellow Line CEPP components were primarily completed between June and November of 2012. Further documentation of the CEPP screening results and formulation approach is not included in the Engineering Appendix. The CEPP modeling strategy provides an overview of the modeling tools, including maps of the model domains, applied throughout the plan formulation process and how the tools were applied in support of the CEPP planning process (refer to Reference 1, included in the Hydrologic Modeling Annex A-2).

For the final array of alternatives, analysis of the North of Red Line components and the South of the Red Line components were conducted using the RSM-BN and the RSM-GL, respectively. This Engineering Appendix and the supporting Hydrologic Modeling Annex A-2 provide documentation of USACE SAJ performance analysis of the hydrologic modeling results for the CEPP final array of alternatives only, with specific emphasis on engineering design considerations that were actively tracked throughout the CEPP formulation, preliminary screening, and alternative development efforts. HESM/IMC Model MDR 1 (Annex A-3) reviews the various model-supported feature screening efforts undertaken at various points in the planning process.

A.8.2.2 Decomp RMA-2 Screening of Miami Canal Plug Configurations

General overview information and summary conclusions from the Decomp RMA-2 screening analysis, which were utilized by the CEPP plan formulation efforts, are documented in this section, with further detailed information provided in the Hydrologic Modeling Annex A-2.

The Decomp project conducted a screening model evaluation of numerous Miami Canal plug configurations (plug length and spacing) to identify the optimal configuration(s) which most closely mimic the performance of a complete/full Miami Canal backfill within WCA 3A. The analysis considered both the use of existing fill onsite and importing additional fill to the project from offsite. Due to the

limitations of the RMA-2 screening tool, plug configurations were also evaluated with the higher resolution model RSM-GL as part of the final array of alternatives.

The RMA-2 and RSM-GL modeling efforts conducted for Decomp indicated that plugs along the Miami Canal may have the potential to work as effectively hydrologically as full backfill to reduce drainage and the disruption of sheetflow caused by the Miami Canal. RSM-GL final array modeling during Decomp also revealed that potential benefits from backfilling the Miami Canal south of I-75 were limited under Decomp PIR 1 assumptions (particularly redistribution of existing inflows to WCA-3A only and limited MWD outlet modifications for WCA-3A), probably due to the limited conveyance out of WCA 3A resulting in continued ponded conditions in southern WCA 3A. The 2012 Decomp PIR 1 project documentation report recommended that proposed alterations to the Miami Canal south of I-75 should be reevaluated if the ponding conditions within southern WCA 3A were altered or alleviated.

Although the CEPP Recommended Plan proposes significant increased conveyance between WCA-3A, WCA-3B, and ENP as compared to the Decomp formulation assumptions, and although the CEPP final array modeling indicates significant reduction to the frequency and magnitude of ponded conditions within southern WCA-3A, no meaningful plan formulation effort was given to modifications to the Miami Canal south of I-75 because the CEPP plan formulation for the WCA-3A hydropattern restoration and Miami Canal components significantly leveraged the previous Decomp formulation efforts. Given consideration of CEPP schedule limitations and based on the results of the CEPP preliminary screening efforts (refer to **Section 3** of the CEPP PIR main report for detailed discussion of the formulation methodology), CEPP preliminary screening modeling conducted with the RSM-GL in July 2012 evaluated only one option for Miami Canal modifications south of I-75 – inclusion of a 4000 foot long plug centered at S-340 and an 8000 foot long plug starting south of the C-11 Extension. The CEPP RSM-GL screening modeling additionally was conducted as a sensitivity analysis starting with the final array modeling from Decomp with WCA-3A inflows increased to account for the approximately 20 percent increase assumed for CEPP. Therefore, since the CEPP screening modeling assumptions incorporated the MWD project outlet modifications for WCA-3A, the screening modeling results did not demonstrate the expected significant reduction to the frequency and magnitude of ponded conditions within southern WCA-3A that would be realized if the CEPP components identified along the Green Line and Blue Line had been included for the CEPP screening. A different set of CEPP screening assumptions may have demonstrated increased benefits associated with the Miami Canal modifications south of I-75, but these analyses will instead be shifted for future consideration in future CEPP increments. .

The plug proposed in the southern reach of the Miami Canal was intended to reduce the drainage effect of the Miami Canal, south of the existing S-340 structure. The Miami Canal south of S-340 and the L-67A Canal currently provides approximately 30 miles of unobstructed southerly canal flow towards the WCA-3A outlet structures along Tamiami Trail (S-333 and the S-12s), and the Miami Canal is aligned parallel to the northwest-to-southeast direction of flow within WCA 3A. In addition, initial screening modeling conducted during Decomp indicated that hydrologic performance improvements within Northeast WCA-3A were generally best achieved through backfill of the South Miami Canal Segment. Effects to recreational access were considered during CEPP formulation of the Miami Canal southern plugs, and the proposed plug location was south of the junction of the Miami Canal/C-11 Extension and north of the Holiday Trail from Everglades Holiday Park. Recreational access from Everglades Holiday Park to the Miami Canal between S-340 and the proposed plug, to the Miami Canal south of the proposed plug, and to the L-67A Canal would be maintained with this proposed configuration. Based on review of aerial photographs, the plug length was proposed at 8000 feet, starting south of the C-11 Extension. The source of backfill material for the proposed plug was envisioned as the nearby spoil mounds along the

Miami Canal and the then CEPP-proposed spoil mound degrade/gaps along the C-11 Extension (this component was subsequently excluded with the CEPP final array), with the proximity of the C-11 Extension spoil material serving as a factor in the plug location selection. Based on preliminary surveys of the Miami Canal spoil mound material under Decomp, a maximum of approximately 5.5 of the 9.7 miles (57%) of the Miami Canal between S-340 and the L-67A Canal could be backfilled with the on-site spoil material.

The Miami Canal plug configuration was ultimately screened out from the CEPP final array components because the RSM-GL screening modeling demonstrated only localized dry year benefits for the single evaluated plug configuration, which could not justify the additional incremental cost of approximately $13 million. However, consistent with the Decomp report conclusions, the final conclusions identified from the CEPP screening assessment should include consideration of the assumptions related to limited relief for the ponding conditions in southern WCA-3A and the limited spatial extent of plugs which were evaluated. Given recognition of this context, consideration of Miami Canal modifications south of I-75 will likely warrant further detailed evaluation for future CERP/CEPP increments.

Beyond the insights afforded by hydrologic modeling, as further summarized in the Decomp report, questions remain regarding the ability of plugged canals to function ecologically as the pre-drainage ridge and slough landscape, especially in low flow conditions, and what the continuing effect of deep holes (spaces between plugs) in the canal have on Everglades flora and fauna, including providing pathways for invasive exotic species. These uncertainties would need further assessment for consideration of future plug options for canals within the Greater Everglades, although additional information may also be realized through CEPP adaptive management strategies.

Although the Miami Canal plugs were not included in the components for the CEPP final array (all final array alternatives included complete backfill of the Miami Canal to I-75, starting from either approximately 1.5-2.0 miles south of S-8 (Alternative 1, Alternative 4R, and Alternative 4R2) or immediately downstream of S-8 (Alternatives 2 through 4)), information from the Decomp RMA-2 plug analysis was additionally utilized to establish the initial proposed spacing between Miami Canal mounds because the Miami Canal backfill to bedrock grade will leave remnant open water segments between the mounds that are expected to behave hydrologically similar to the plug options that were evaluated with RMA-2 for Decomp. As further documented in Hydrologic Modeling Annex A-2, overall plug performance (compared to the full backfill condition) is significantly diminished for plug spacing scenarios greater than approximately 4000-6000 feet, whereas no observed similar trend is observed for plug length. The initial proposed spacing between Miami Canal mounds was selected at 1 mile (5280 feet), given consideration of the insights from the Decomp RMA-2 modeling and overall CEPP project cost considerations (increased cost with reduced distance between mound features).

The Decomp modeling strategy proposal recommended a limited modeling effort, utilizing a fine resolution hydraulic modeling tool, to allow evaluation of the potential near-field effects for Miami Canal backfill options and yield enhanced understanding about the effectiveness and impacts of each type of canal backfilling option. The need to simulate three dimensional flow fields was not a critical element of the Miami Canal local feature modeling effort; two-dimensional flow fields with depth-averaged velocity parameters (including within open canal segments) were determined to provide sufficient analysis for the stated scope of this effort, noting the shallow depths representative of typical overland flow in the project area. RMA2 was recommended by the USACE within the Decomp modeling strategy as the most appropriate tool for this analysis. RMA2, developed by the Resource Management

Associates (RMA), has been previously reviewed and classified by the HH&C CoP as a "CoP Preferred" hydraulic design and river hydraulics modeling tool.

A.8.3 Evaluation of the Final Array of Alternatives

A.8.3.1 Baseline Condition Modeling

The study area for the CEPP encompasses Lake Okeechobee, the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), a portion of the EAA, the WCAs, ENP, the Southern Estuaries (Florida Bay and Biscayne Bay), and the Lower East Coast (LEC). **Section 2.4** of the CEPP PIR main report provides a summary description of the existing and future without project conditions within the study area. Detailed documentation of existing and future without project conditions is further provided in Appendix C.1 to the CEPP PIR main report, including detailed documentation of hydrology, regional water management, flood control, and water supply performance for each base condition. Selected graphics are included to illustrate the performance of each baseline condition.

Hydrologic modeling simulations of the existing condition baseline (ECB) and the CEPP future without project condition (FWO) were developed with the RSM-BN and RSM-GL sub-regional modeling tools, to provide baseline conditions for plan formulation and the assessment of CEPP project benefits and the preliminary assessment of CEPP alternative performance for the level-of-service for flood protection and water supply (ECB). The ECB was developed to represent the system-wide infrastructure and operations that were in place at the time CEPP plan formulation was initiated, approximately January 2012. The FWO for CEPP assumes the construction and implementation of currently authorized C&SF and non-CERP projects, and other Federal, state or local projects constructed or approved under existing governmental authorities that occur in the CEPP study area; the CEPP FWO therefore included first generation CERP projects already authorized and under construction (Indian River Lagoon-South Project, Picayune Strand Restoration Project, Site 1 Impoundment Project), second generation CERP projects authorized by Congress in WRRDA 2014 (Biscayne Bay Coastal Wetlands Project, Broward County Water Preserve Areas Project, Caloosahatchee River (C-43) West Basin Storage Reservoir, C-111 Spreader Canal Western Project), and non-CERP projects currently in progress (SFWMD Restoration Strategies, C&SF C-51 West End Flood Control Project, the C-111 South Dade Project, the Kissimmee River Restoration Project, Modified Water Deliveries, and the Department of Interior (DOI) Tamiami Trail Modifications Next Steps Project. Documentation of RSM-BN and RSM-GL assumptions for the ECB and FWO baseline conditions are provided in Reference 2 of the Hydrologic Modeling Annex A-2, respectively.

The CEPP PIR report documentation and two complete sets of RSM-BN and RSM-GL hydrologic model performance measure output are posted on the Everglades Plan public web site for the CERP: http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

The following complete performance measure data sets are provided to facilitate additional review of the hydrologic modeling output for the baselines and the Recommended Plan, Alternative 4R2:

- ECB, FWO, Alternative 4R, Alternative 4R2 (comparison used for NEPA evaluation in Section 5 of the main PIR report)
- ECB, 2012EC, IORBL1,Alternative 4R2 (comparison used for the Savings Clause and Project Assurances evaluation in Annex B of the PIR report)

For additional discussion of the final array modeling and the baseline updates to support the Savings Clause evaluation, refer to **Section A.8.3.2** and **Section A.8.3.2.5**, respectively. HESM/IMC MDR 2 (Annex A-3) reviews the model representations of existing conditions and the future without project conditions used throughout the CEPP plan formulation efforts.

Final CEPP hydrologic modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. CEPP modeling products in MMS can be accessed directly at the MMS project page through the Everglades Plan public web site: http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

A.8.3.2 Final Array Modeling

CEPP plan formulation efforts identified the final array of four alternatives (Alternatives 1 through 4) in November 2012, and the corresponding RSM-BN and RSM-GL simulations of the alternatives was subsequently completed in December 2012. HESM/IMC MDR 3 (Annex A-3) reviews these four proposed with-CEPP project model representations examined during this first round of CEPP plan formulation. As documented in **Section 4.6** of the CEPP PIR main report, modifications to the final array were identified during January-February 2013 that resulted in the identification of Alternative 4M as the National Ecosystem Restoration (NER) Plan. The evaluation also identified the need to revise the operations for Alternative 4M, which was not evaluated with hydrologic modeling, to ensure the project savings clause constraints are met, to minimize localized adverse ecological effects, and to identify additional opportunities to provide for other water related needs.

Three additional modeling scenarios were conducted in the following months to identify project effects resulting from the identified operational changes: Alternative 4R (completed February 2013), Alternative 4R1 (May-June 2013), and Alternative 4R2 (June 2013). The first refinement, Alternative 4R, focused on operational changes to avoid potential impacts to water supply levels of service in the Lake Okeechobee Service Area (LOSA) and the LEC. Refinements included alleviating potential ecological impacts from lowered water depths in WCA 2B by retaining a small portion of the water in WCA 2B that Alternative 4M had diverted to WCA 3A. Increases in low flow events to the St. Lucie Estuary, minimized reductions in freshwater flows to Biscayne Bay, and improved water depths in eastern WCA 3B for purposes of improving environmental conditions were also considered. The Alt 4R refinement resulted in an alternative that lessened concerns over violating constraints yet there remained room for improvement in LOSA water supply and the spatial distribution of groundwater and canal discharges in the LEC to provide greater confidence in meeting legal requirements of the savings clause. Building on the performance improvements achieved with the Alternative 4R operational changes, Alternatives 4R1 and 4R2 increased public water supply demand for Lower East Coast Service Area 2 (LECSA 2 - Broward County) and Lower East Coast Service Area 3 (LECSA 3 - Miami-Dade County) to determine whether there was a threshold for increased public water supply demand that would be capable of balancing increased water supply demands for LECSA 2 and LECSA 3 with maintaining the natural system performance of Alternative 4R. Alternative 4R1, which increased public water supply demand by 19 million gallons per day (MGD) for LECSA 2 and 53 MGD for LECSA 3, was not assessed in detail in the PIR report due to significant performance concerns identified with the observed reductions in discharges to Biscayne Bay and increased risk of saltwater intrusion at several wellfield locations. Based on information gained during the modeling of Alternative 4R1 and related RSM-GL sensitivity simulations, the subsequent Alternative 4R2 simulation limited the increase to public water supply demand by 12

MGD for LECSA 2 and 5 MGD for LECSA 3 and was determined to be successful with maintaining the ecological performance of Alternative 4R without the negative effects to LEC groundwater and Biscayne Bay that Alt 4R1 realized. Alternative 4R2 was identified in the PIR main report as the Recommended Plan. HESM/IMC MDR 4 (Annex A-3) reviews the model representation of the CEPP Recommended Plan and refinements of the NER plan during final plan formulation and project assurance planning.

Completion of the model documentation reports (MDRs) for the model assumptions and performance overviews of the CEPP preliminary screening modeling, CEPP base condition modeling, and Alternatives 1 through 4R2 was deferred to following completion of the CEPP final array and Project Assurances/Savings Clause modeling, and the MDRs were therefore not available to be included with the Draft PIR. The CEPP MDRs were completed concurrent with the Draft PIR public review process, and the Final CEPP MDRs are included as Annex A-3 of this Appendix. Prior to the availability of the complete MDRs, RSM-BN and RSM-GL model assumption tables for Alternative 4R and Alternative 4R2 were provided in Reference 2 of the Draft PIR Hydrologic Modeling Annex A-2 to this Appendix; to maintain consistency within the Final PIR, these tables remain included in Reference 2 of the Final PIR. The following four MDR reports, which sequentially track the CEPP plan formulation and evaluation efforts, are included in Annex A-3:

- MDR 1: CEPP Model Supported Screening Efforts
- MDR 2: CEPP Baseline Runs
- MDR 3: CEPP Final Array of Alternatives (Alternatives 1 through 4)
- MDR 4: CEPP Recommended Plan (including NER refinement modeling)

The study area for the CEPP encompasses Lake Okeechobee, the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), a portion of the EAA, the WCAs, ENP, the Southern Estuaries (Florida Bay and Biscayne Bay), and the LEC. **Section 5** of the CEPP PIR main report provides a performance evaluation for the final array of alternatives. Detailed documentation of the effects of the alternatives 1 through 4 on regional hydrology and water supply and flood control, compared to the future without project base condition, are provided in **Section 5.1.8** and **Section 5.1.15.2** and **Appendix C.2.1** of the CEPP PIR main report. Detailed documentation of the effects of the operational refinements of the Recommended Plan (Alternative 4R and Alternative 4R2) on regional hydrology and water supply and flood control, compared to the future without project base condition, are provided in Sections **5.2.8**, Section **5.2.15.2** and **Appendix C.2.2** of the CEPP PIR main report. Selected graphics are included to illustrate the performance of each alternative.

An enormous amount of output is generated from each RSM-BN and RSM-GL simulation and the accompanying post-processed performance measures. Reference maps to assist with user navigation of RSM-GL indicator regions, performance measure zones, transects, reference gauges, and viewing window spatial locations are included in Reference 3 of the Hydrologic Modeling Annex A-2. The monitoring gauge location map is provided in Figure A.8-9. Complete detailed descriptions of the RSM-BN and RSM-GL simulation output are provided in the Hydrologic Modeling Annex A-2.

The CEPP final array modeling output included two performance measure sets that include: (1) concurrent performance measure display of the CEPP FWO outputs and Alternative 1 through 4, including combined outputs for both the RSM-BN and RSM-GL models; and (2) concurrent performance measure display of the CEPP FWO outputs, Alternative 4R, and Alternative 4R2, including combined outputs for both the RSM-BN and RSM-GL models.

The CEPP PIR report documentation and two complete sets of RSM-BN and RSM-GL hydrologic model performance measure output are posted on the Everglades Plan public web site for the CERP: http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

The following complete performance measure data sets are provided to facilitate additional review of the hydrologic modeling output for the baselines and the Recommended Plan Alternative 4R2:

- ECB, FWO, Alternative 4R, Alternative 4R2 (comparison used for NEPA evaluation in Section 5 of the main PIR report)
- ECB, 2012EC, IORBL1,Alternative 4R2 (comparison used for the Savings Clause and Project Assurances evaluation in Annex B of the PIR report)

Final CEPP hydrologic modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. CEPP modeling products in MMS can be accessed directly at the MMS project page through the Everglades Plan public web site: http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

Sections 3.2.1 through 3.2.4 of the Hydrologic Modeling Annex A-2 provide documentation of USACE SAJ performance analysis of the hydrologic modeling results for the CEPP final array of alternatives, including operational refinements to the NER plan, with specific emphasis on engineering design considerations that were actively tracked throughout the CEPP formulation, preliminary screening, and alternative development efforts. Summary information is typically provided in this Engineering Appendix for the Recommended Plan, Alternative 4R2, only. In some cases, comparisons are additionally provided for Alternatives 4 and 4R, since Alternative 4 was the alternative selected for further optimization and subsequently refined through Alternative 4R and, ultimately the Recommended Plan, Alternative 4R2. Detailed analyses for all final array alternatives are available only in the Hydrologic Modeling Annex A-2.

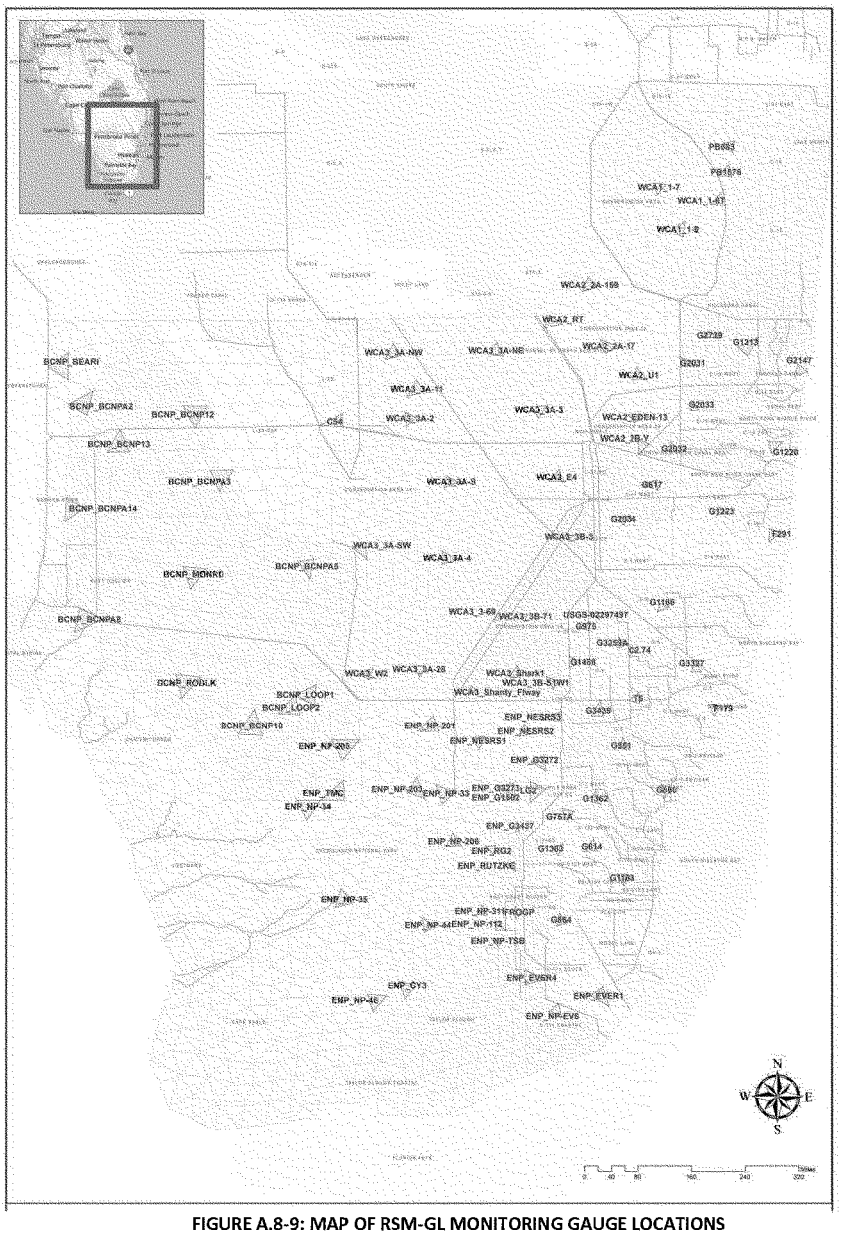

FIGURE A.8-9: MAP OF RSM-GL MONITORING GAUGE LOCATIONS

A.8.3.2.1 WCA-3A High Water Performance Criteria

The USACE Final Everglades Restoration Transition Plan (ERTP) EIS and Record of Decision (ROD signed on 19 October 2012) identified the 1960 WCA-3A 3A 9.5 to 10.5 feet, NGVD Regulation Schedule as an interim measure water management criterion for WCA-3A Zone A. This change to Zone A, compared to the previous Interim Operational Plan (IOP) for WCA-3A regulation, was necessary to mitigate for the observed effects, including discharge limitations of the S-12 spillways. The preliminary USACE Water Resources Engineering Branch (EN-W) analysis of WCA-3A high water levels, which was integrated into the ERTP EIS, also recommended further consideration of additional opportunities to reduce the duration and frequency of Water Conservation Area 3A high water events (ERTP Final EIS, Appendix A-5).

The ERTP analysis of WCA-3A high water events indicated that, based on current system conditions as simulated in the water budget spreadsheet, the IOP infrastructure and operational configuration of WCA-3A would result in a predicted increase in the Standard Project Flood (SPF) stage for WCA-3A of between 1.3 and 1.4 feet compared to the WCA-3A design assumptions (1960 General Design Memorandum (GDM), C&SF Project for Flood Control and Other Purposes, Part I, Supplement 33). Predicted SPF stages are increased from 12.40 to 13.76 feet NGVD and from 13.90 to 15.20 feet NGVD for the S-12 headwater stage and the WCA-3A three-gauge average stage, respectively. The ERTP analysis also illustrated, through the use of current USGS rating curves for the S-12 spillways, that the peak SPF stage is increased over the original design due to a reduction in outlet capacity from WCA-3A through the S-12s. This significant change to the original design assumptions, with the additional diminished extent of emergent vegetation within WCA-3A, led the USACE to identify WCA-3A high water stages as a potential cause for concern. Due to the simplistic nature (i.e., volumetric and not hydraulic routing) of the ERTP (Phase 1) analysis, the level of flood protection afforded by WCA-3A was not completely addressed during the initial assessment under ERTP; additional analyses, as identified for inclusion under a subsequent detailed study phase (termed Phase 2 in the ERTP Final EIS), are required to investigate and specify the level of protection afforded by the WCA-3A water management regime and levee configuration. A more complete documentation of the ERTP analysis, assumptions, conclusions, and recommended additional analyses is included in the Hydrologic Modeling Annex A-2.

The information on which the USACE relied on to require the ERTP WCA-3A Zone A as an interim risk reduction measure for WCA-3A high water levels has not changed prior to CEPP formulation, and no new information is currently available compared to the July 2010 assessment included as Appendix A-5 of the ERTP Final EIS. Throughout CEPP formulation, the EN-W advocated that CEPP formulation efforts attempt to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP Future Without Project (FWO) condition, which includes ERTP, given recognition of the WCA-3A high water concerns identified with ERTP; prior to CEPP formulation, the January 2012 CEPP Risk Register explicitly recognized that the ERTP constraint precluded raising of the top of the WCA-3A Regulation Schedule, while simultaneously recognizing that substantial benefits were still expected and that goals to further lower stages in WCA-3A were consistent with the constraint. EN-W also indicated that it would continue to rely on the WCA-3A three-gauge average stages for assessment of WCA-3A high water frequency, durations, and peak stages, consistent with the original WCA-3A design assumptions and the ERTP assessment (average of stages at the monitoring gauges of 3A-3, 3A-4, and 3A-28); increased weight would not be considered for a single gauge, such as 3A-28 (Site 65). It was further noted that if CEPP can provide operational assurances of additional WCA-3A outlet capacity under high water conditions, including adequate consideration of potential WCA-3B seepage

management and/or ecological operational limitations, the EN-W may be able to further consider proportional relaxation of the WCA-3A FWO high water duration and frequency targets.

Preliminary CEPP formulation efforts for the Green and Blue Line components, which relied on the iModel, were not able to demonstrate achievement of the FWO frequency of time within Zone A of the ERTP WCA-3A Regulation Schedule, based on the system-wide optimization of ecological targets and consideration of the additional ~220 kAF of inflows to WCA-3A available from the Flow Equalization Basin (FEB) and associated water quality treatment (refer to section 3.2.3 of the CEPP PIR main report and Appendix E.1 for additional discussion). Significant increases in WCA-3A regulatory discharge capacity were also not identified during the preliminary iModel screening.

The requirements to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP Future Without Project (FWO) condition were actively integrated into the formulation efforts to identify the CEPP final array of alternatives, and the assessment of the final array demonstrated levels of performance consistent with this requirement. The EN-W assessment relied on additional post-processing of the RSM-GL model results, as subsequently discussed.

To establish the WCA-3A high water performance criteria to assist with CEPP formulation and to provide technical recommendations to the CEPP formulation efforts, EN-W developed comparisons between the ERTP Recommended Plan modeling (Alternative 9E1 in the ERTP Final EIS), which was simulated with the SFWMM, and the RSM-GL base conditions representations that were developed for CEPP starting in May 2012. Based on the results of these comparisons, EN-W recommended in July 2012 that CEPP formulation efforts should identify alternative configurations which maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP FWO condition. Additional details and results of this comparison are provided in the Hydrologic Modeling Annex A-2.

Compared to the CEPP FWO (final December 2012 release), the CEPP alternative 4R2 stages are lowered by approximately 0.1-0.3 feet in the upper 10 percent of the stage duration curve for the WCA-3A three-gauge average stage, as shown in Figure A.8-10 (full stage duration curve) and Figure A.8-11 (upper 25 percent of the stage duration curve). In order to consider potential differences during specific years, the EN-W assessment also considered the annual duration of exceedance of the ERTP WCA-3A Zone A stage levels for the complete period of simulation (Figure A.8-12). The annual durations were also displayed and assessed as a frequency curve (Figure A.8-13). The total number of days above Zone A is summarized as follows for the CEPP FWO and CEPP alternatives (with percent of total period of simulation, 14975 days, in parentheses): CEPP FWO – 2718 days (18.15%); Alternative 1 – 3206 days (21.41%); Alternative 2 – 3034 days (20.26%); Alternative 3 – 3285 days (21.94%); Alternative 4 – 3227 days (21.55%); Alternative 4R – 3307 days (22.08%); and Alternative 4R2 – 3323 days (22.19%).

The EN-W performance assessment for the final array of alternatives also included review of the WCA-3A stage hydrographs for individual years in which the number of days above Zone A increased by more than 20 percent between the CEPP FWO and any of the CEPP alternatives, as shown highlighted in Table A.8-1. In the Hydrologic Modeling Annex A-2, annual hydrographs are provided for each of the twelve years which triggered this further detailed assessment (Figures 25 through 38 in Annex A-2): 1969, 1980, 1983-1985, 1993-1996, 1999, 2003, and 2005.

Annual stage hydrograph statistical distribution plots were developed to assist with the general characterization of differences in intra-annual stage variability, to facilitate comparisons between the CEPP FWO baseline condition (Figure A.8-14) and CEPP Alternative 4R2 (Figure A.8-15). For the 41-year

period of simulation, the graphics illustrate the maximum and minimum stage, 90th and 10th percentile stages, 75th and 25th percentile stages, median stage, and mean stage at a daily time step. The graphics also include the ERTP WCA-3A Regulation Schedule Zone A reference line, the FWS MSTS recommended seasonal range for January 1 and May 1-31, and the average ground surface elevation (GSE) for the WCA-3A 3-gauge average at 8.34 feet NGVD (3A-3 GSE 9.08 feet NGVD; 3A-4 GSE 8.49 feet NGVD; 3A-28 GSE 7.44 feet NGVD). Compared to the CEPP FWO, the following general trends are noted for Alternative 4R2: increased stages through the dry season, particularly January through May (most evident for the 75th and 90th percentiles); increased stages at the end of the dry season in May (most evident for 10th through 90th percentiles); increased stages at the beginning of the wet season in June-July (evident under all conditions); increased stages through the wet season and start of the dry season during average to dry years (evident for minimum to median stages); reduced stages at the end of the wet season in September-October during wet years (90th percentile and maximum stage); and reduced stages at the beginning of the dry season in November and December during wet years (90th percentile and maximum stages). These graphics illustrate that the increased durations within Zone A with the CEPP alternatives, as compared to the CEPP FWO, are the combined result of higher stages at the end of the dry season (along the Zone A recession) and higher antecedent stages at the beginning of the wet season (June 1) with the resulting effects of early wet season rainfall events. Peak stages and durations of Zone A exceedance at the end of the wet season, when WCA-3A design limitations are most critical due to the maximum stages, do not increase and, in many instances, are significantly reduced compared to the FWO condition. This conclusion is consistent with detailed review of the annual hydrographs presented in the Hydrologic Modeling Annex A-2.

The detailed EN-W assessment of the frequency, duration, and peak stages of high water levels within WCA-3A concluded: (1) WCA-3A peak stages are lowered (these stages are most critical for WCA-3A design limitations); (2) the frequency and durations of Zone A exceedance are increased; (3) the increased frequency and durations occur during periods of the year when WCA-3A water levels are below peak critical levels; (4) CEPP infrastructure modifications (increased WCA-3A outlet capacity) and operations demonstrate that increased WCA-3A stages at the end of the dry season and start of the wet season can be effectively managed to avoid exacerbating high water conditions at the end of the wet season when Zone A levels off at 10.5 feet NGVD; and (5) CEPP infrastructure and operations utilized to achieve these performance levels need to be codified in the CEPP Project Operating Manual (POM). The requirements to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP FWO were, therefore, successfully achieved based on EN-W assessment of the overall performance of the CEPP final array, including the Recommended Plan.

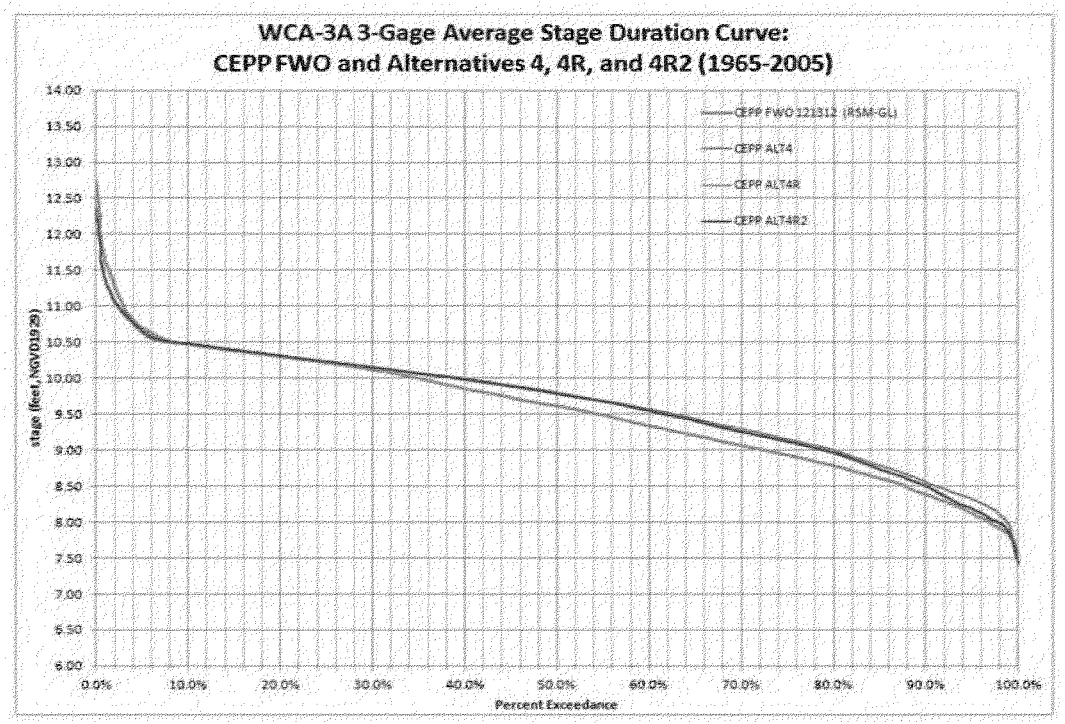

FIGURE A.8-10: WCA-3A 3-GAUGE AVERAGE STAGE DURATION CURVE FOR CEPP FWO AND CEPP ALTERNATIVES 4, 4R, AND 4R2

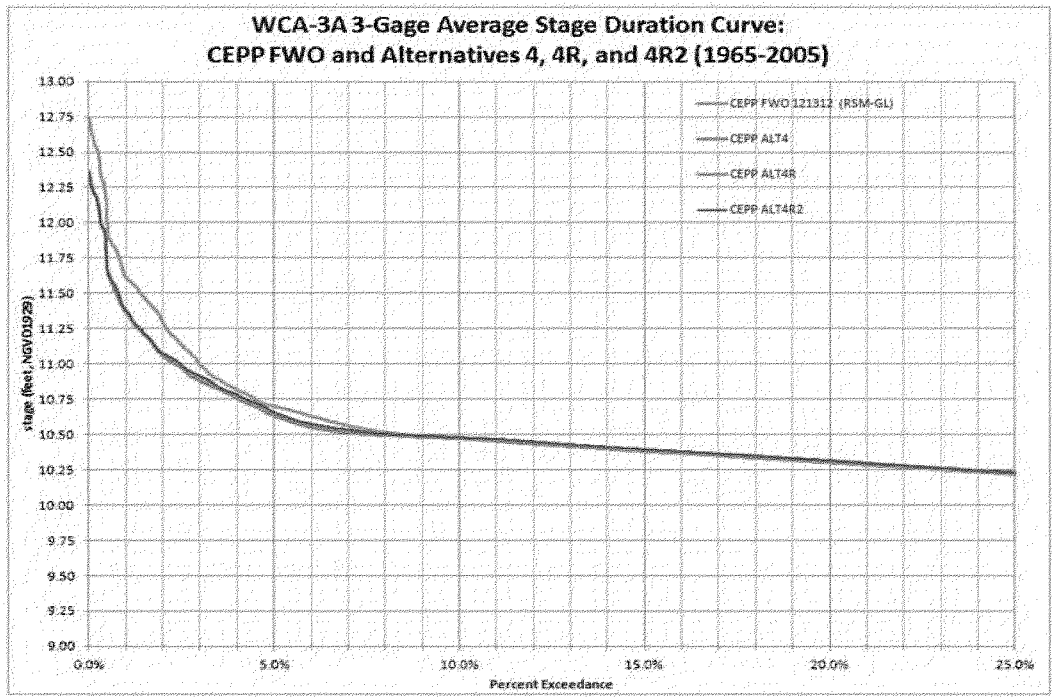

FIGURE A.8-11: WCA-3A 3-GAUGE AVERAGE STAGE DURATION CURVE FOR CEPP FWO AND CEPP ALTERNATIVES 4, 4R, AND 4R2 (UPPER 25%)

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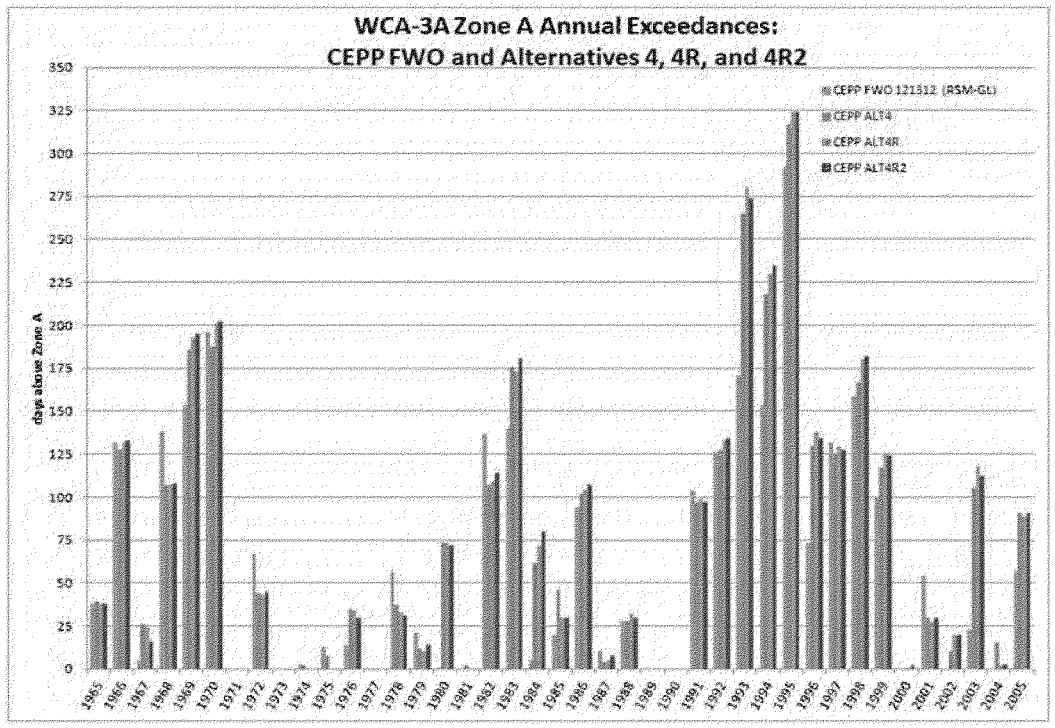

FIGURE A.8-12: WCA-3A 3-GAUGE AVERAGE ANNUAL ZONE A EXCEEDANCE FOR CEPP FWO AND CEPP ALTERNATIVES 4, 4R, AND 4R2

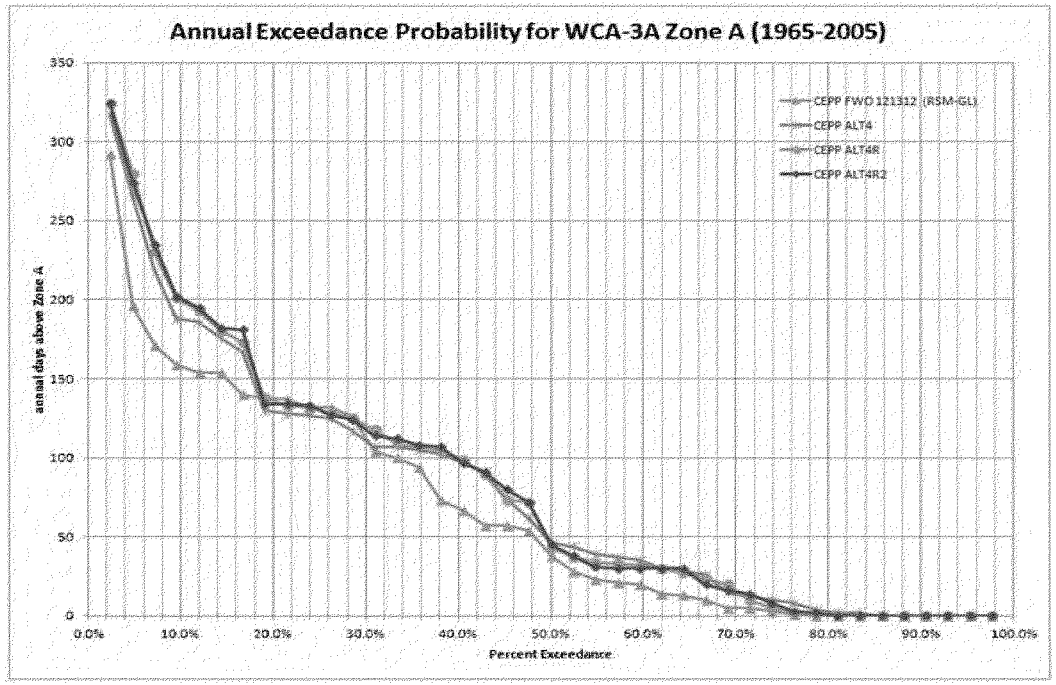

FIGURE A.8-13: WCA-3A 3-GAUGE AVERAGE PROBABILITY EXCEEDANCE PLOT FOR ANNUAL ZONE A EXCEEDANCE FOR FWO AND CEPP ALTERNATIVES 4, 4R, AND 4R2

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TABLE A.8-1: ANNUAL ZONE A EXCEEDANCE DAYS (WCA-3A 3-GAUGE AVERAGE) FOR FWO AND CEPP ALTERNATIVES 4, 4R, AND 4R2

	Summary Table: WCA-3A Zone A Annual Exceedance Duration (days)			
Year	CEPP FWO 121312	CEPP ALT4	CEPP ALT4R	CEPP ALT4R2
1965	38	39	37	38
1966	132	128	132	133
1967	5	26	24	18
1968	138	107	107	108
1969	154	195	189	195
1970	196	188	201	202
1971	0	0	0	0
1972	57	44	43	46
1973	0	0	0	0
1974	3	2	0	0
1975	13	8	0	0
1976	14	35	34	30
1977	0	0	0	0
1978	57	37	33	31
1979	21	12	10	14
1980	1	74	73	72
1981	0	2	0	0
1982	137	107	109	114
1983	140	176	173	181
1984	5	82	72	80
1985	20	48	30	30
1986	94	102	104	107
1987	10	4	5	8
1988	28	28	32	30
1989	0	0	0	0
1990	0	0	0	0
1991	104	97	99	97
1992	126	127	133	134
1993	171	285	280	274
1994	154	218	220	236
1995	292	317	324	324
1996	73	130	136	134
1997	132	125	129	127
1998	159	167	180	182
1999	100	117	125	124
2000	0	0	1	2
2001	54	30	27	30
2002	0	10	20	20
2003	23	105	115	112
2004	0	15	2	3
2005	57	91	89	91
	Summary Table: WCA-3A Zone A Annual Exceedance Duration			
	CEPP FWO 121312	CEPP ALT4	CEPP ALT4R	CEPP ALT4R2
total (1965-2005 POR; 14975 days)	2718	3227	3307	3323
total (percent of POR)	18.15	21.55	22.08	22.19
percent increase vs FWO	–	18.73	21.67	22.26

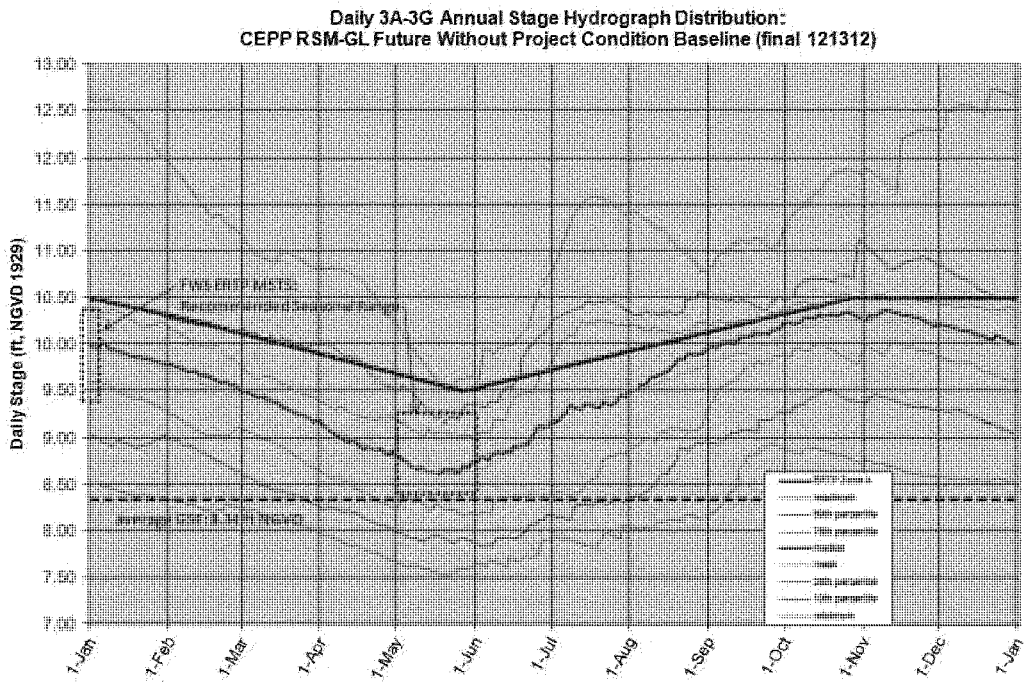

FIGURE A.8-14: WCA-3A 3-GAUGE AVERAGE ANNUAL AVERAGE STAGE HYDROGRAPHS FOR CEPP FWO

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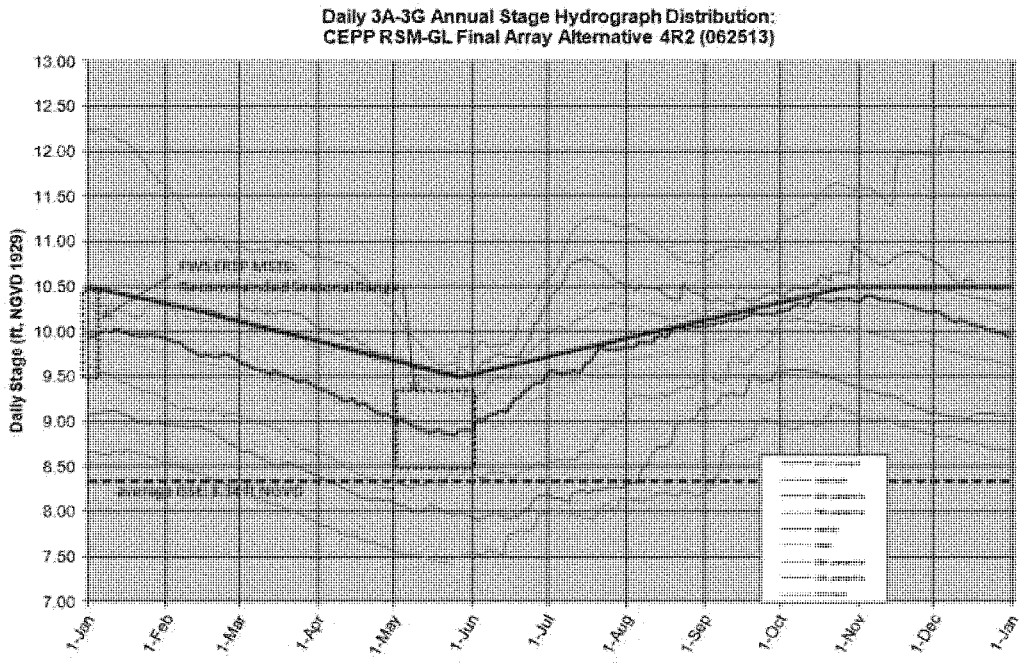

FIGURE A.8-15: WCA-3A 3-GAUGE AVERAGE ANNUAL AVERAGE STAGE HYDROGRAPHS FOR CEPP ALTERNATIVE 4R2

A.8.3.2.2 WCA-3B Design Considerations

Subsequent to completion of the L-67A Levee in 1962 (the adjacent L-67C Levee was completed in 1966), WCA-3B water levels have been highly managed. The S-151 gated culvert (1105 cfs design capacity) currently provides the only structural connection between WCA-3A and WCA-3B. The SPF stage for WCA-3B, based on Site 71 (refer to the Figure A.8-9 map), was initially established in the 1960 GDM for WCA-3 (C&SF Part 1, Supplement 33) at 8.50 feet NGVD based on an assumed 5-day, 16.5-inch rainfall event; detailed SPF flood routing information for WCA-3B is not provided in the GDM. Starting in 1985, the C&SF Experimental Program for Water Deliveries to ENP established S-151 operational criteria that discontinued S-151 regulatory releases from WCA-3A if stages at Site 71 exceed 8.5 feet NGVD. The Site 71 constraint at 8.5 feet NGVD was also used for the 1994-1995 L-67 gap tests, which were conducted as design tests for the MWD to ENP Project. The IOP and ERTP WCA-3A Regulation Schedules specify operation of S-151 for water supply only during Column 1 operations (no WCA-3A regulatory releases to the South Dade Conveyance System (SDCS)) and S-151 regulatory inflows to WCA-3B during Column 2 operations (WCA-3A regulatory releases to the SDCS), contingent on the Site 71 stage being below 8.5 feet NGVD.

The USACE has not conducted a comprehensive review of the previously-established SPF stages for WCA-3B, pending consideration of modified inflow infrastructure for WCA-3B. SFWMM modeling conducted for the 1993 MWD to ENP Feature Design Memorandum (FDM), based on the 1992 MWD GDM default operational plan, identified a revised SPF stage of 11.6 feet NGVD at Site 71 for the MWD Project condition; however, despite subsequent multiple interagency efforts, a final configuration for WCA-3B inflow structures and an associated MWD operational plan, has not been identified prior to the conclusion of CEPP formulation efforts.

Concurrent with CEPP alternative formulation and modeling efforts, EN-W conducted a review of WCA-3B high water levels compared to the WCA-3B design criteria and independent of any previous SPF stage considerations. WCA-3B is currently bounded by the L-29 Levee (Section 3) to the south, the L-67A Levee and the L-67C Levee to the west, and the L-30 Levee to the east; the design grades for these WCA-3B perimeter levees range between 13.0 feet NGVD for the L-29 Levee (note: typical sections range from 13.5-17.5 feet NGVD, due to subsequent stockpiling of spoil material from L-29 Canal improvements, and all L-29 Section 3 Levee sections meet or exceed the design grade) to 20.0 feet NGVD for the L-30 Levee (the design grades for the L-67A and L-67C Levees are 17.5 and 12.5 feet NGVD, respectively), such that the L-29 Levee design grade represents the limiting factor for peak WCA-3B stages for CEPP. Stage duration curves (upper 25%) for the CEPP ECB, CEPP FWO, Alternative 4, Alternative 4R, and Alternative 4R2 are provided in Figures A.8-16 and A.8-17 for the two RSM-GL monitoring gauge locations within WCA-3B at Site 71 and Shark-1 (also alternatively referred to as SRS-1) that are produced with the model standard output information; corresponding RSM-GL model GSE elevations for these gauges are 6.64 and 6.61 feet NGVD, respectively. For CEPP alternative 4R2, peak stages within WCA-3B (outside of the Blue Shanty Flow-way in Alternative 4R2) were 9.25 and 9.24 feet NGVD at Site 71 and Shark-1, respectively, or approximately 0.20 feet greater than the CEPP ECB and CEPP FWO baselines (9.05-9.06 feet NGVD); however, the WCA-3B peak stages for the CEPP Recommended Plan remains approximately 3.75 feet below the L-29 Section 3 design grade of 13.0 feet NGVD. The SPF rainfall for WCA-3B is approximately 1.5 feet (17.5 inches; based on the localized 3-day, 100-year maximum rainfall event of 14 inches). Based on EN-W assessment of these WCA-3B peak water depths less than 3 feet (2.61-2.63 feet peak depth for Alternative 4R2

stages), maximum wind and wave run-up potentials would not be expected to exceed 1-2 feet. For this preliminary EN-W assessment (further analysis will be conducted during PED), a presumed worst-case scenario was defined for the CEPP Recommended Plan, with peak Alternative 4R2 stages exacerbated by the additional SPF rainfall and maximum wind and wave run-up depths. Under this assumed worst-case scenario (9.25 feet NGVD stage + 1.5 feet SPF rainfall + 2.0 feet run-up potential), the L-29 Section 3 Levee would not be expected to be overtopped at the two lowest elevation points (with approximately 0.25 feet of remaining freeboard, compared to the minimum L29 Section 3 Levee elevation of 13.0 feet NGVD). Given no predicted L-29 Section 3 Levee overtopping for this conservative assumed combination of events and recognition that CEPP inflows to WCA-3B (both within the Blue Shanty flow-way and eastern WCA-3B) will utilize controllable structures that may be closed in anticipation of extreme rainfall events, the EN-W preliminary assessment of the WCA-3B design criteria concluded that the proposed CEPP water levels of Alternative 4R2 would not adversely affect the flood control capability of the unmodified eastern segment of the L-29 Levee (or other perimeter levees, which have higher design elevations) bordering WCA-3B. The USACE currently anticipates revisiting the WCA-3B SPF stage during PED, pending final authorization of the CEPP and the establishment of operating criteria for WCA-3B water management structures for a System Operating Manual revision for CEPP implementation.

Maximum stages within the WCA-3B Blue Shanty flow-way and maximum head differential across the L-67D Levee are utilized for the hydraulic, geotechnical, and civil design of the L-67D Levee for the CEPP Recommended Plan, Alternative 4R2. Stage duration curves for the interior of the Blue Shanty flow-way, external to the flow-way at the Shark 1 gauge in WCA-3B, and within the L-29 Canal, both west of the CEPP-proposed S-355W L-29 gated spillway structure (within the flow-way, following CEPP removal of this section of the L-29 Levee) and east of the S-355W structure, are shown in Figure A.8-18 for Alternative 4R2. The head differential across the L-67D Levee for the CEPP Recommended Plan is shown in Figure A.8-19 and Figure A.8-20 in both time series format and frequency curve format. The maximum head differential across the CEPP-proposed L-67D Levee is approximately 1.50 feet during the 1965-2005 RSM-GL period of simulation.

For additional reference, the L-29 Canal stage duration curves for the ECB, FWO, Alternative 4, Alternative 4R, and Alternative 4R2 are shown in Figure A.8-21 and Figure A.8-22 (stages correspond to the western reach of the L-29 Canal for Alternatives 4, 4R, and 4R2, west of the S-355W structure). Peak L-29 Canal stages for CEPP will need to be considered for future implementation of the DOI TTNS roadway modifications, including the potential need to further raise the eastern portion of the Tamiami Trail roadway, east of the CEPP-proposed S-355W L-29 gated spillway structure. Peak simulated L-29 Canal stages for Alternative 4R2 are 9.59 feet NGVD west of the S-355W structure and 9.50 feet NGVD east of the S-355W structure (refer to Figure A.8-18).

Annual stage hydrograph statistical distribution plots for the L-29 Canal across the 1965-2005 period of simulation are provided for the IORBL1 updated future without project condition baseline and Alternative 4R2 in Figure A.8-23, Figure A.8-24, and Figure A.8-25. Since Alternative 4R2 includes the proposed S-355W structure within the L-29 Canal, the L-29 Canal statistical plots are separately reported for the West L-29 Canal in Figure A.8-24 (west of the S-355W structure) and the East L-29 Canal in Figure A.8-25 (east of the S-355W structure). The mean daily L-29 stage hydrograph, maximum daily L-29 stage hydrograph, and maximum daily L-29

stage hydrograph for the 2012Ec updated Existing Condition Baseline, IORBL1 and Alternative 4R2 are comparatively shown in Figure A.8-26, Figure A.8-27, and Figure A.8-28, respectively. These additional graphics have been included in the Final PIR to demonstrate the effects of the CEPP on the L-29 Canal, between the southern boundary of WCA 3B and the northern boundary of the ENP NESRS, for the complete range of hydrologic condition included in the period of simulation (1965-2005).

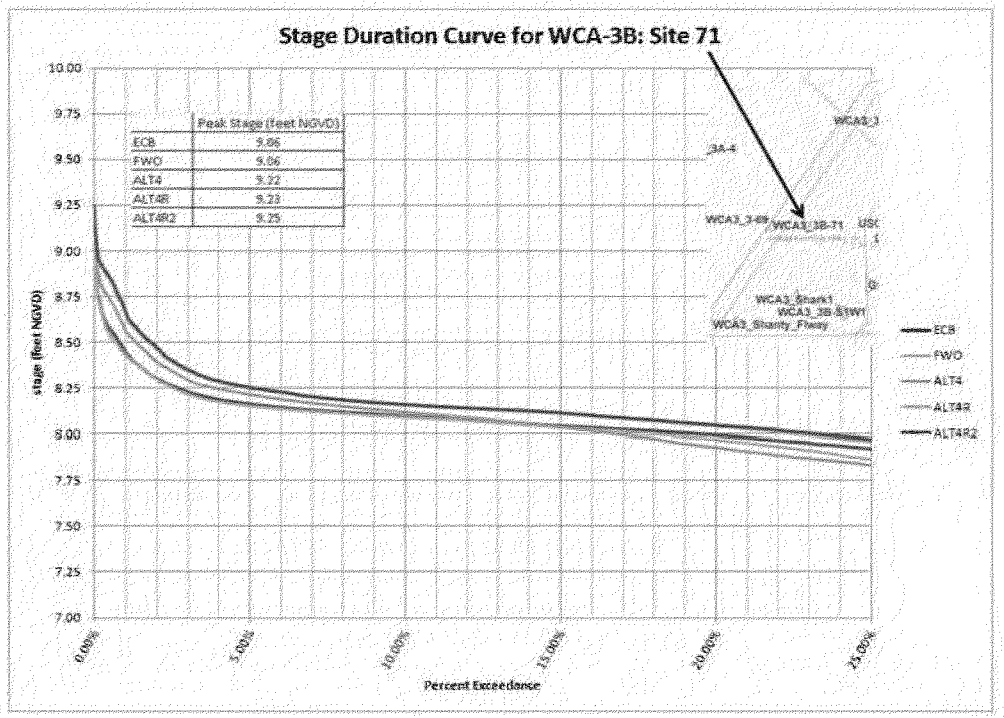

FIGURE A.8-16: WCA-3B SITE 71 STAGE DURATION CURVES FOR CEPP BASELINES AND CEPP ALTERNATIVES 4, 4R, AND 4R2 (UPPER 25%)

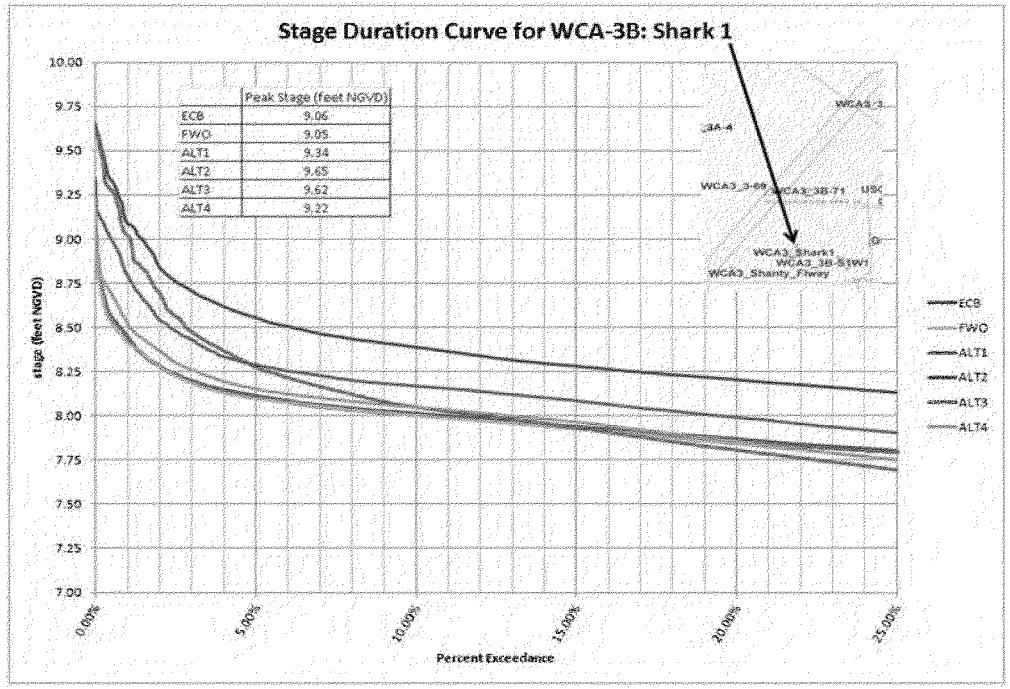

FIGURE A.8-17: WCA-3B SHARK-1 STAGE DURATION CURVE5 FOR CEPP BASELINES AND CEPP ALTERNATIVES 4, 4R, AND 4R2 (UPPER 25%)

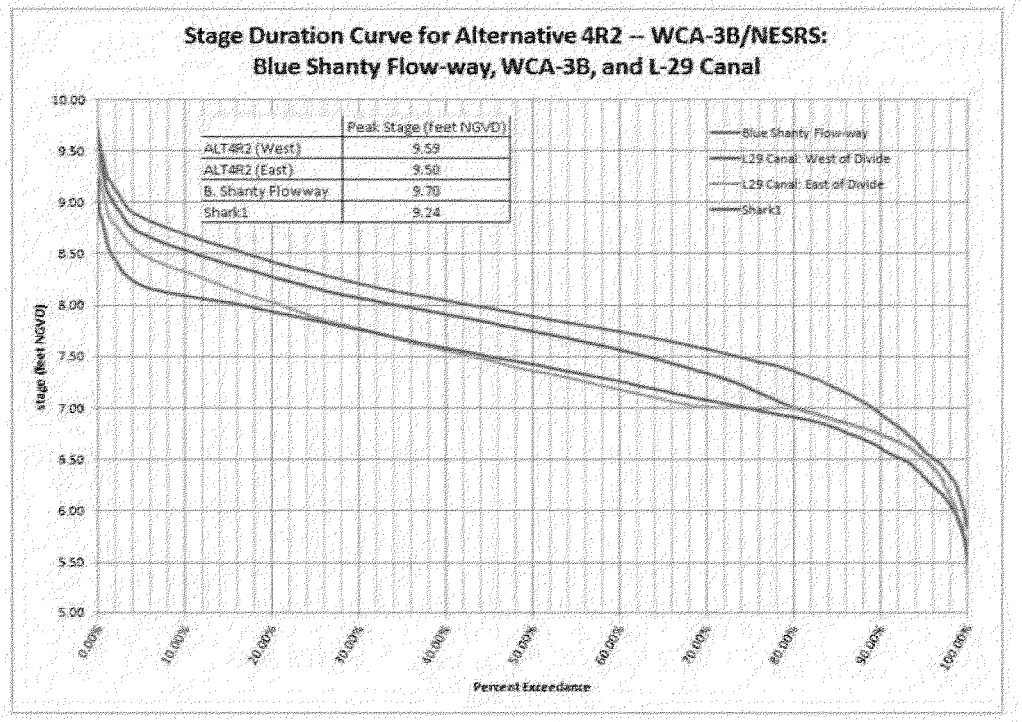

FIGURE A.8-18: L-29 CANAL AND BLUE SHANTY FLOW-WAY STAGE DURATION CURVES FOR CEPP ALTERNATIVE 4R2

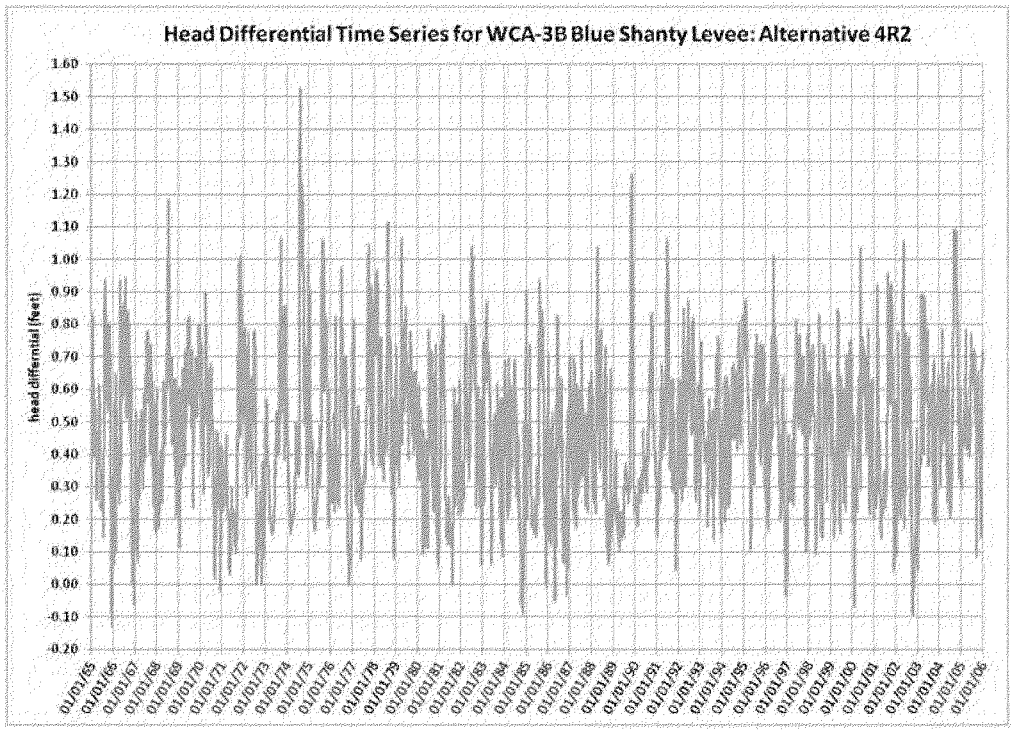

FIGURE A.8-19: L-67D HEAD DIFFERENTIAL TIME SERIES FOR CEPP ALTERNATIVE 4R2

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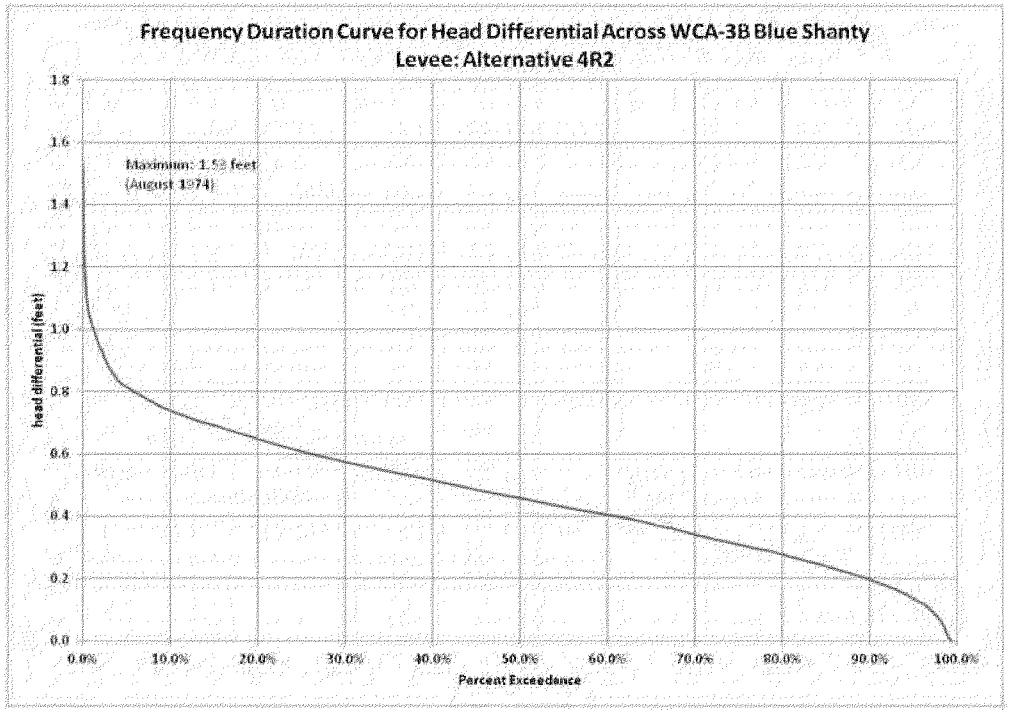

FIGURE A.8-20: L-67D HEAD DIFFERENTIAL FREQUENCY CURVE FOR CEPP ALTERNATIVE 4R2

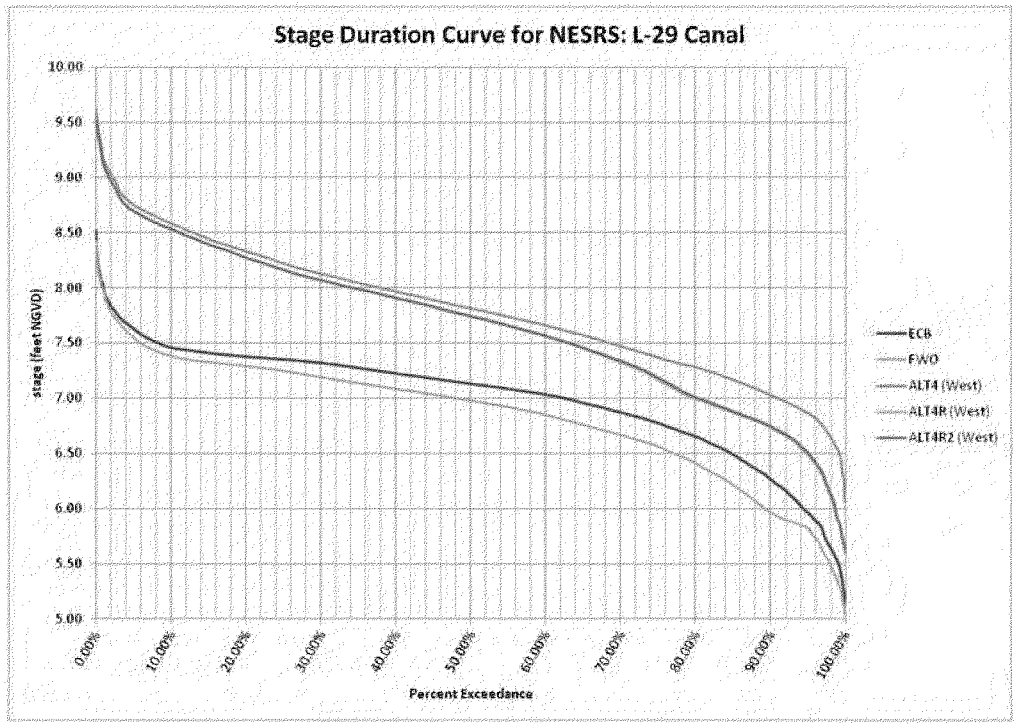

FIGURE A.8-21: L-29 CANAL STAGE DURATION CURVES FOR CEPP BASELINES AND CEPP ALTERNATIVES 4, 4R, AND 4R2

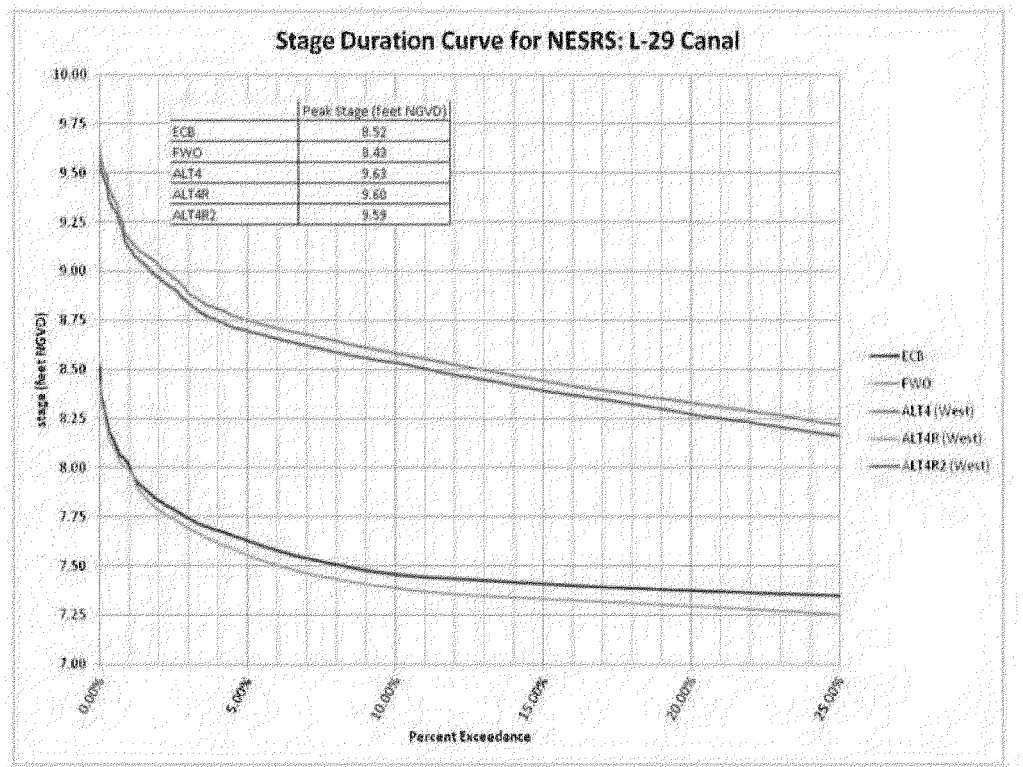

FIGURE A.8-22: L-29 CANAL STAGE DURATION CURVES FOR CEPP BASELINES AND CEPP ALTERNATIVES 4, 4R, AND 4R2 (UPPER 25%)

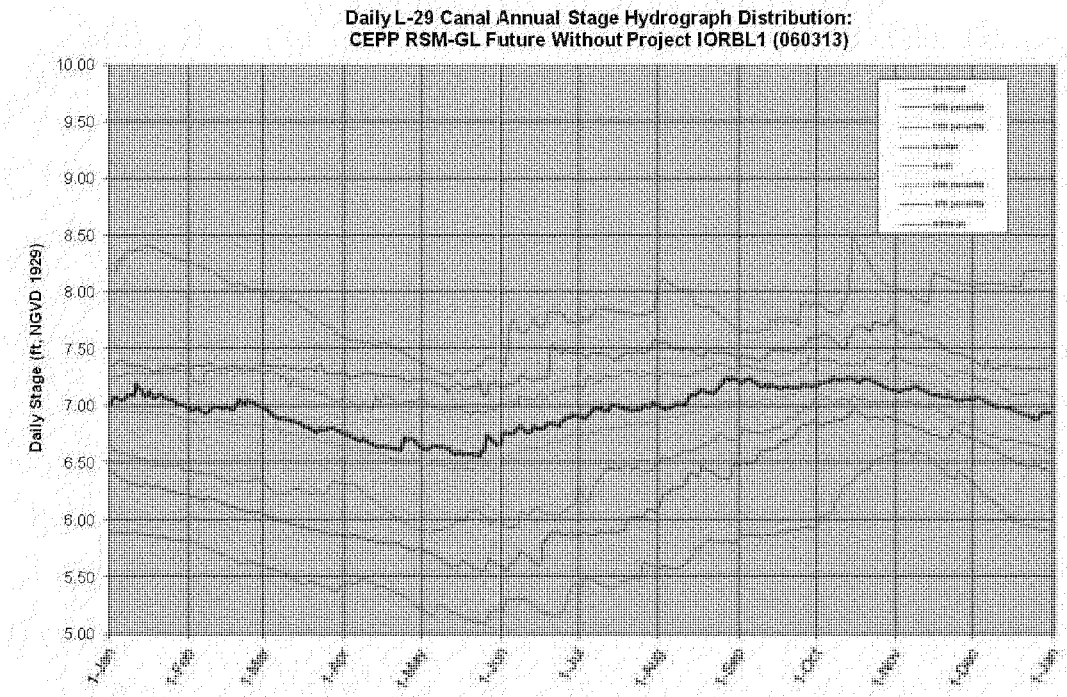

FIGURE A.8-23: L-29 CANAL ANNUAL AVERAGE STAGE HYDROGRAPHS FOR CEPP IORBL1 FUTURE WITHOUT PROJECT BASELINE

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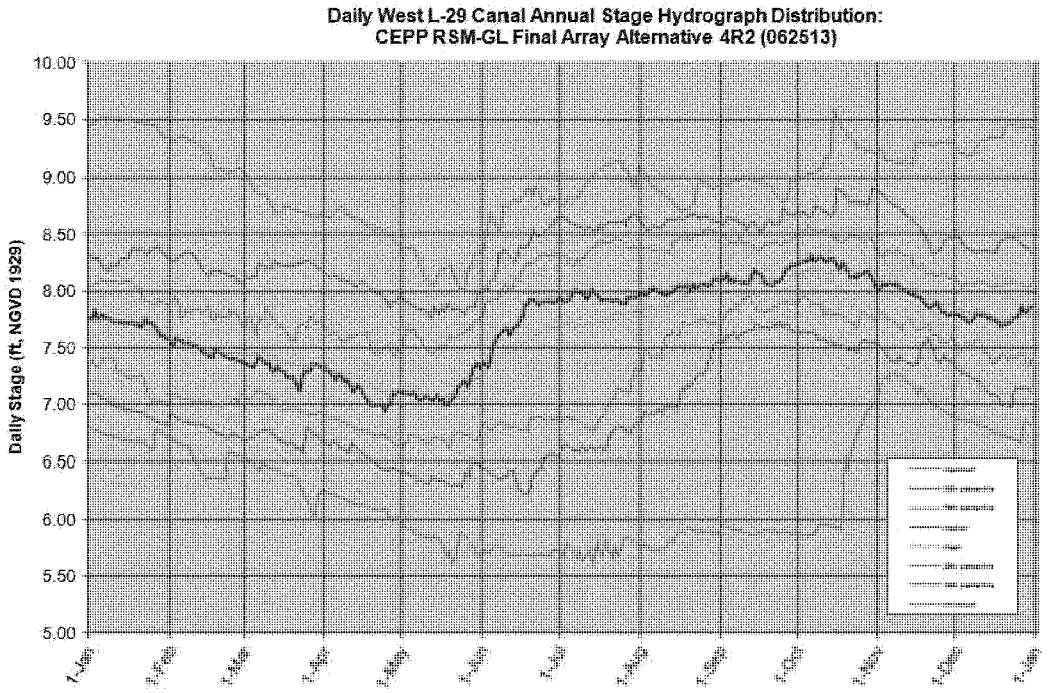

FIGURE A.8-24: WEST L-29 CANAL ANNUAL AVERAGE STAGE HYDROGRAPHS FOR CEPP ALTERNATIVE 4R2

544

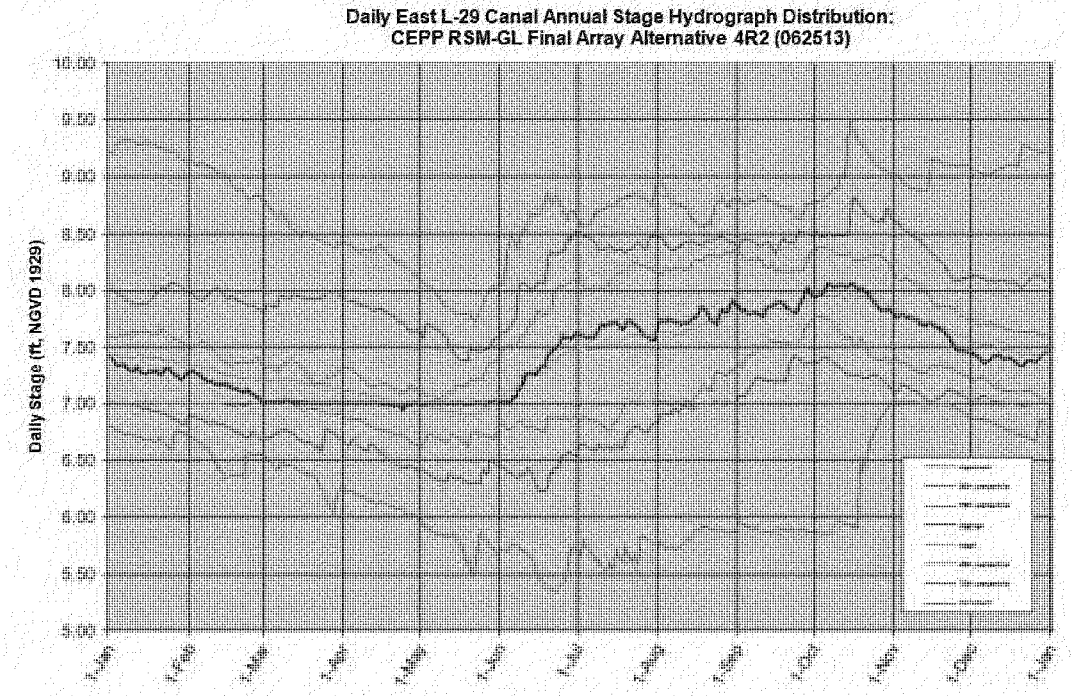

FIGURE A.8-25: EAST L-29 CANAL ANNUAL AVERAGE STAGE HYDROGRAPHS FOR CEPP ALTERNATIVE 4R2

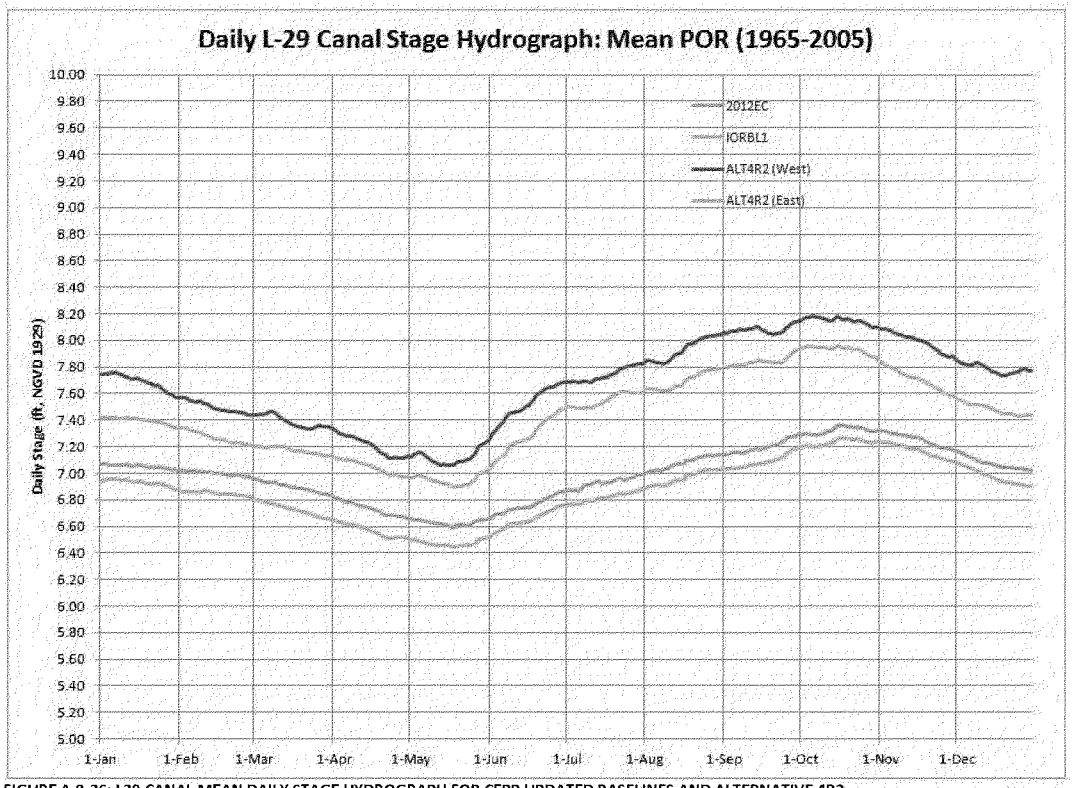

FIGURE A.8-26: L29 CANAL MEAN DAILY STAGE HYDROGRAPH FOR CEPP UPDATED BASELINES AND ALTERNATIVE 4R2

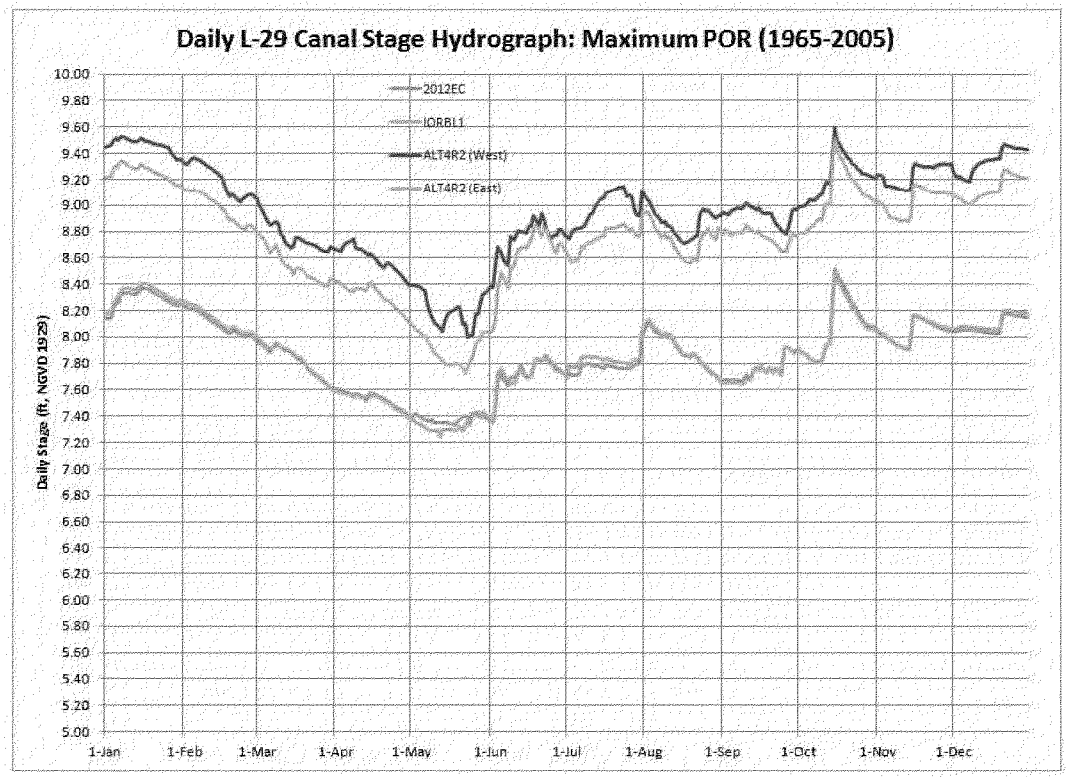

FIGURE A.8-27: L29 CANAL MAXIMUM DAILY STAGE HYDROGRAPH FOR CEPP UPDATED BASELINES AND ALTERNATIVE 4R2

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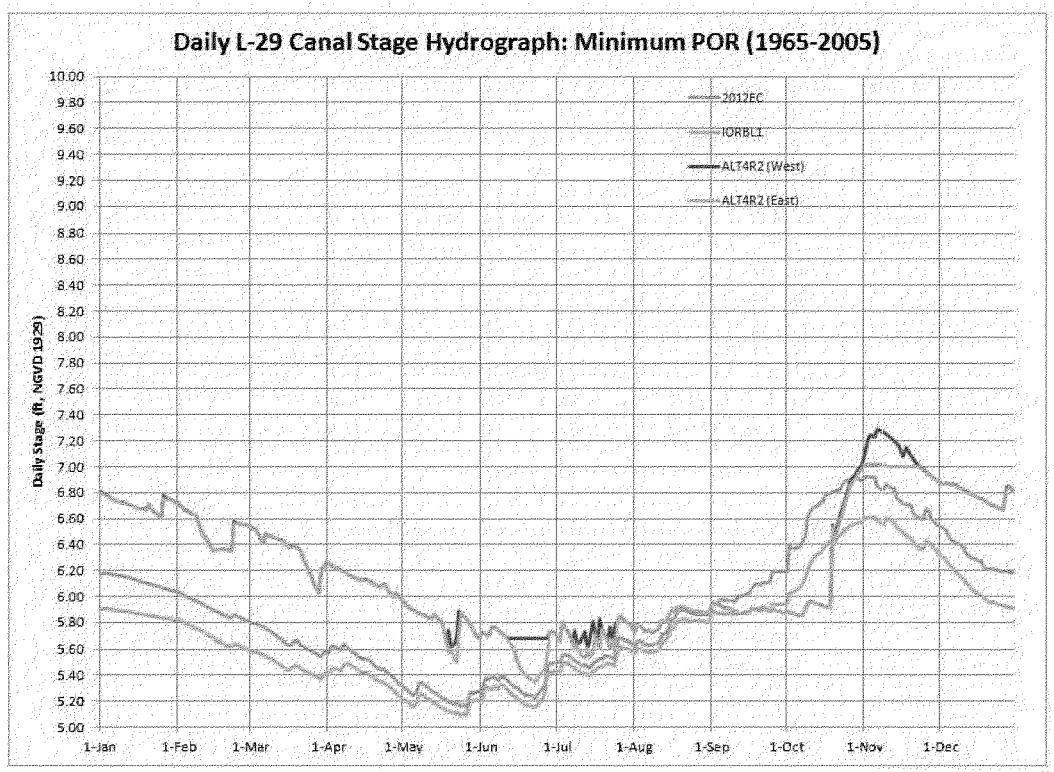

FIGURE A.8-28: L29 CANAL MINIMUM DAILY STAGE HYDROGRAPH FOR CEPP UPDATED BASELINES AND ALTERNATIVE 4R2

A.8.3.2.3 Lake Okeechobee Herbert Hoover Dike Design Considerations

A.8.3.2.3.1 Lake Okeechobee Assumptions for CEPP Future Without Project Condition

The CEPP existing condition and future without project condition assumption for the operation of Lake Okeechobee is 2008 Lake Okeechobee Regulation Schedule (2008 LORS); the complete existing condition and future without project condition assumptions for CEPP are documented in **Section 2** of the CEPP main PIR report. When it was approved in April 2008, the 2008 LORS was identified as an interim schedule. Independent of CEPP implementation, there is an expectation that revisions to the 2008 LORS will be needed following the implementation of other CERP projects and Herbert Hoover Dike infrastructure remediation. USACE expects to operate under the 2008 LORS until there is a need for revisions due to the earlier of either of the following actions: (1) system-wide operating plan updates to accommodate CERP "Band 1" Projects (described in Section 6.1.3.2 of the main PIR report) or (2) completion of sufficient HHD remediation for reaches 1, 2, and 3 and associated culvert improvements, as determined necessary to lower the DSAC rating from Level 1. The future Lake Okeechobee Regulation Schedule which may be developed in response to actions (1) and/or (2) is unknown at this time. At the start of the CEPP plan formulation process, the future without project condition adopted the 2008 LORS as a reasonable assumption since it would be speculation to change the operations plan based on future actions occurring independent of CEPP (e.g. HHD rehabilitation or CERP Band 1 project construction. The USACE had also determined during CEPP scoping that the expedited CEPP planning process and PIR would not be the mechanism to propose or conduct the required NEPA evaluation of modifications to the Lake Okeechobee Regulation Schedule. Until a new operating schedule is developed under a future study, the 2008 LORS is the best estimate for operations in the future without project condition.

Hydrologic modeling conducted for the CEPP future without project condition (FWO), which assumes no modifications to 2008 LORS and completion of the Kissimmee River Restoration, CERP C-43, and CERP C-44 restoration projects, indicated minor to moderate adverse effects due to increased frequency of low Lake Okeechobee stages and increased water supply cutbacks within the Lake Okeechobee Service Area (LOSA) and the Lower East Coast Service Areas (moderate improvements were also indicated for reduced frequency of high Lake Okeechobee stages).

The Herbert Hoover Dike (HHD) surrounds Lake Okeechobee, which is 720 square miles in size. The HHD was first authorized in 1930 and built by hydraulic dredge and fill methods. HHD has 143 miles of embankment with 5 spillway inlets, 5 spillway outlets, 32 Federal culverts, 9 navigation locks and 9 pump stations. There are structural integrity concerns with the embankment and internal culvert structures that resulted in a Dam Safety Action Classification (DSAC) risk rating of Level 1. DSAC Level 1 represents the highest USACE dam risk of failure rating and requires remedial action. The Major Rehabilitation Report (MRR) from 2000 divided the 143 mile dike into eight (8) Reaches with the initial focus on Reach 1. The current approved and planned remediation measures will address the highest points of potential failure in the system based on known areas of concern. These efforts are intended to lower the DSAC rating from Level 1. The CEPP future without project condition will assume the planned remediation of HHD will lower the DSAC risk rating and be completed by 2022. The following text provides the basis for this assumption.

Historically, the majority of embankment and foundation issues have occurred in Reaches 1, 2, and 3 related to one of the following primary potential failure modes: internal erosion through the embankment and internal erosion through the foundation. The additional failure modes associated with the culvert structures are: internal erosion along the conduits and internal erosion into the conduits.

Current approved HHD remediation measures consist of cutoff wall in Reach 1: cutoff wall task orders 1 through 9 are scheduled for completion in 2013, and 32 culvert replacements or removal around the lake are scheduled for completion in 2018. Planned remediation measures consist of cutoff wall and/or a seepage management system in Reaches 2 and 3. These actions are scheduled for completion in 2022. These remediation measures will not resolve all issues with the dam, nor will all current design criteria be met. To assess other issues and address future modifications with HHD, a comprehensive potential failure mode analysis and risk assessment is being performed and will be included in the ongoing Dam Safety Modification Report (DSMR). This report is scheduled for completion/approval in 2015.

Prior to the 2008 LORS, Lake Okeechobee operated under the Water Supply and Environmental Regulation Schedule (WSE). The 2006-2008 LORS study was initiated because of adverse environmental impacts that WSE had on the lake ecology. Dam safety was later added as a performance criterion since lowering of the lake, as the LORS study was pursuing, is one of the basic Interim Risk Reduction Measures implemented for deficient dams until appropriate remediation is effectuated. The WSE held Lake Okeechobee stages approximately 1.0 – 1.5 feet higher than the 2008 LORS under wet conditions. Studies for the remediation of HHD are based on the 2008 LORS, which was used as the basis for the development of the Standard Project Flood (SPF) condition. The SPF is the design condition used for the risk assessment and remediation to address internal erosion failure modes.

A.8.3.2.3.2 Lake Okeechobee Assumptions for CEPP Future With Project Condition

Lake Okeechobee is currently operated in accordance with the 2008 LORS and the 2008 Lake Okeechobee and EAA Water Control Plan. Independent of CEPP implementation, there is an expectation that revisions to the 2008 LORS will be needed following the implementation of other CERP projects and Herbert Hoover Dike infrastructure remediation. USACE expects to operate under the 2008 LORS until there is a need for revisions due to the earlier of either of the following actions: (1) system-wide operating plan updates to accommodate CERP "Band 1" Projects (described in Section 6.1.3.2 of the main PIR report) or (2) completion of sufficient HHD remediation for reaches 1, 2, and 3 and associated culvert improvements, as determined necessary to lower the DSAC rating from Level 1. The future Lake Okeechobee Regulation Schedule which may be developed in response to actions (1) and/or (2) is unknown at this time. In balancing the multiple project purposes, USACE will timely shift from the interim 2008 LORS to a new schedule with the intent to complete any necessary schedule modification or deviations concurrent with the completion of (1) or (2). The occurrences of both events (1) and (2) are assumed for the CEPP future with project condition and are expected to allow for greater operational flexibility of Lake Okeechobee, potentially including higher lake levels for increased water storage. CERP envisioned that changes to system operations may be required as groups of restoration components come on line and that updates to the system operating manual may be required at certain intervals of overall CERP implementation. The CEPP is composed of increments of project components that were identified in the CERP.

As a result of the CEPP preliminary screening process, the hydrologic modeling conducted for all CEPP alternatives (including the Recommended Plan Alternative 4R2) to optimize system-wide performance incorporated the current Regulation Schedule management bands of the 2008 LORS. The hydrologic modeling of the CEPP alternatives included proposed revisions to the 2008 LORS flow chart guidance of maximum allowable discharges, which are dependent on the following criteria:

- Class limits for Lake Okeechobee inflow and climate forecasts, including tributary hydrologic conditions, seasonal climate outlook, and multi-seasonal climate outlook;

- Stage level, as delineated by the Regulation Schedule management bands;
- Stage trends (whether water levels are receding or ascending).

Most of the 2008 LORS refinements applied in the CEPP modeling lie within the bounds of the operational limits and flexibility available in the current 2008 LORS, with the exception of the adjustments made to the class limits for the Lake Okeechobee inflow and climate forecasts. Under some hydrologic conditions, the class limit adjustments made to the Lake Okeechobee inflow and climate forecasts reduced the magnitude of allowable discharges from the Lake, thereby resulting in storage of additional water in the Lake in order to optimize system-wide performance and ensure compliance with Savings Clause requirements. However, these class limit changes represent a change in the flow chart guidance that extends beyond the inherent flexibility in the current 2008 LORS. Additional information and summary documentation of these assumptions can be found in Section A.8.3.2.3.3 and with the MDRs in Annex A-3 (LORS assumptions are described in Appendix B of each pertinent MDR).

CEPP benefits gained from sending new water south from Lake Okeechobee are derived in part from operational refinements that can take place within the existing, inherent flexibility of the 2008 LORS, and in part with refinements that are beyond the schedule's current flexibility. Modifications to 2008 LORS will be required to optimally utilize the added storage capacity of the A-2 FEB to send the full 210,000 ac-ft/yr of new water available in CEPP south to the Everglades, while maintaining compliance with Savings Clause requirements for water supply and flood control performance levels.

It is anticipated that the need for modifications to the 2008 LORS will be initially triggered by non-CEPP actions and that these actions will occur earlier than implementation of CEPP. Therefore, the CEPP PIR, including the Project Operating Manual (POM), will not be the mechanism to propose or conduct the required NEPA evaluation of modifications to the Lake Okeechobee Regulation Schedule. However, depending on the ultimate outcome of these future Lake Okeechobee Regulation Schedule revisions, including the level of inherent operational flexibility provided with these revisions, CEPP implementation may still require further Lake Okeechobee Regulation Schedule revisions to optimize system-wide performance and ensure compliance with Savings Clause requirements.

Consistent with this rationale for Lake Okeechobee operational modifications within the CEPP future with project alternatives, ecological performance measures for Lake Okeechobee were not included as part of the habitat unit ecological benefits evaluation for CEPP (peer reviewed and approved by the ECO-PCX). The environmental effects to Lake Okeechobee are assumed to be approximately equivalent across the CEPP future with project alternatives, and the simulated hydrologic and ecological effects to Lake Okeechobee are included as part of the environmental effects documentation in the CEPP PIR.

A.8.3.2.3.3 Lake Okeechobee Modeling Assumptions and Performance Results

Lake Okeechobee stage duration curves for the RSM-BN model representation of the CEPP ECB (LORS 2008), CEPP FWO (LORS 2008, plus additional CERP and non-CERP projects), and CEPP alternatives 1 through 4R2 (LORS 2008, additional CERP and non-CERP projects, and prescribed assumed operational flexibility) are included as Figure A.8-29 and Figure A.8-30. A single RSM-BN simulation was originally completed for all of the CEPP components north of the red line for the final array of alternatives 1 through 4 However, during the modeling effort for the Alt 4R and Alt 4R2, revised RSM-BN simulations were completed for these alternative simulations to address performance shortfalls observed with Alt 4 and Alt 4M, including to avoid potential impacts to water supply levels of service in the LOSA and the

LEC and to avoid increases in the number of low flow events to the St. Lucie Estuary. The revised RSM-BN simulations resulted in updated boundary conditions for the RSM-GL modeling of Alt 4R and Alt 4R2. A summary of the Alt 4R2 modeling assumptions for the Lake Okeechobee Regulation Schedule releases, compared to the 2008 LORS, are indicated on Figure A.8-31 and Tables A.8-2 through A.8-5 (note: breakpoints for the 2008 LORS Regulation Schedule zones/bands were not otherwise modified for Alt 4R2 and remain consistent with Figure A.8.32); complete documentation is provided in the Hydrologic Modeling Annex A-2. Peak stages for the CEPP baselines and the CEPP final array of alternatives are summarized as follows: 17.54 feet NGVD for the ECB; 17.50 feet NGVD for the FWO; 17.64 for the CEPP alternatives 1 through 4, 4R, and 4R2; and 17.66 for CEPP Recommended Plan Alternative 4R2. The CEPP baselines and the CEPP alternatives all show simulated stages above 17.25 feet NGVD: 18 days for the ECB; 9 days for the FWO; 23 days for the CEPP alternatives 1 through 4; and 29 days for Alternative 4R and Alternative 4R2 (note: 14,975 days in the RSM-BN 41-year period of simulation). The LORS 2008 EIS assessment recognized that minimizing the frequency of exceedance of the 17.25 feet elevation offers additional protection for public safety and the HHD, for the condition prior to completion of the current approved and planned HHD remediation measures, and this criterion was evaluated as a LORS project performance measure. Significant increases in the frequency, duration, and magnitude of Lake Okeechobee peak stages do not result from the assumed operational flexibility with the CEPP alternatives (including Alternative 4R2), despite the assumed completion of HHD remediation measures, because the adverse ecological effects associated with increased lake stages and the associated increases in high volume releases to the estuaries were effectively balanced during the CEPP preliminary screening (for additional discussion of screening metrics, refer to **Section 3** of the PIR main report). Following completion of the HHD remediation of Reaches 1, 2, and 3, the degree to which higher maximum lake stages and increased frequency and duration of high lake stages would be considered as potentially viable by the USACE, if at all, will be contingent on the conclusions identified in the 2015 DSMR (note: this process is independent and separate from the CEPP project).

Given recognition of the DSMR uncertainty and the continued utilization of the LORS 2008 Lake Okeechobee Regulation Schedule for CEPP, EN-W assessment of the Lake Okeechobee high water performance with CEPP (Alternatives 1 through 4R2) indicated consistency with the HHD formulation assumptions established for the CEPP FWO condition, which included general consideration of potential risk and uncertainty associated with increased lake stages. Lake Okeechobee high water performance requirement will likely need to be revisited following completion of the 2015 DSMR, but the CEPP stage duration curve trends for increased high water conditions appear reasonable based on the USACE current best available information and current expectations for the HHD remediation.

Extreme high lake stages have also been documented to adversely impact the plant and animal communities, through processes which include the following: physical uprooting of emergent and submerged plants; reduced light levels in the water column due to increased suspended sediment; and littoral zone exposure to increased nutrient levels from the water column. The frequency of occurrence for lake stages above 16.0 feet, 16.5 feet, 17.0 feet, and 17.25 feet are summarized in Figure A.8-33. Lake Okeechobee stages between 16.0 and 17.25 feet NGVD correspond to the seasonal range of the top zone of the 2008 LORS Regulation Schedule, and this performance metric was considered by the USACE during the LORS Regulation Schedule study.

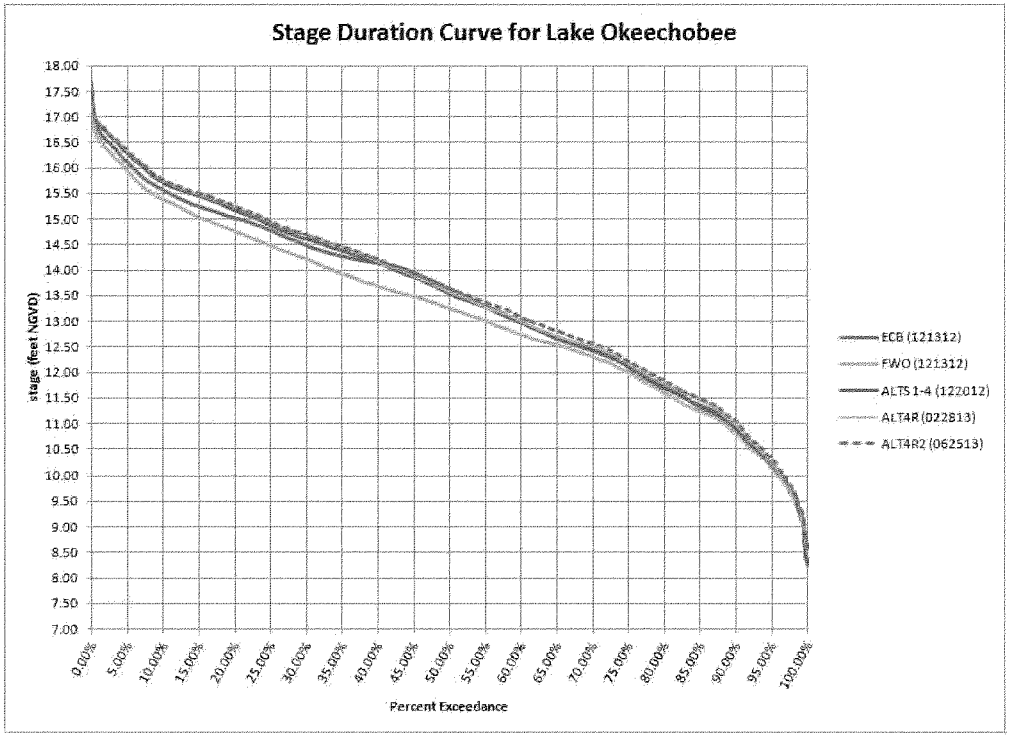

FIGURE A.8-29: LAKE OKEECHOBEE STAGE DURATION CURVES FOR CEPP BASELINES AND CEPP ALTERNATIVES 1 THROUGH 4R2

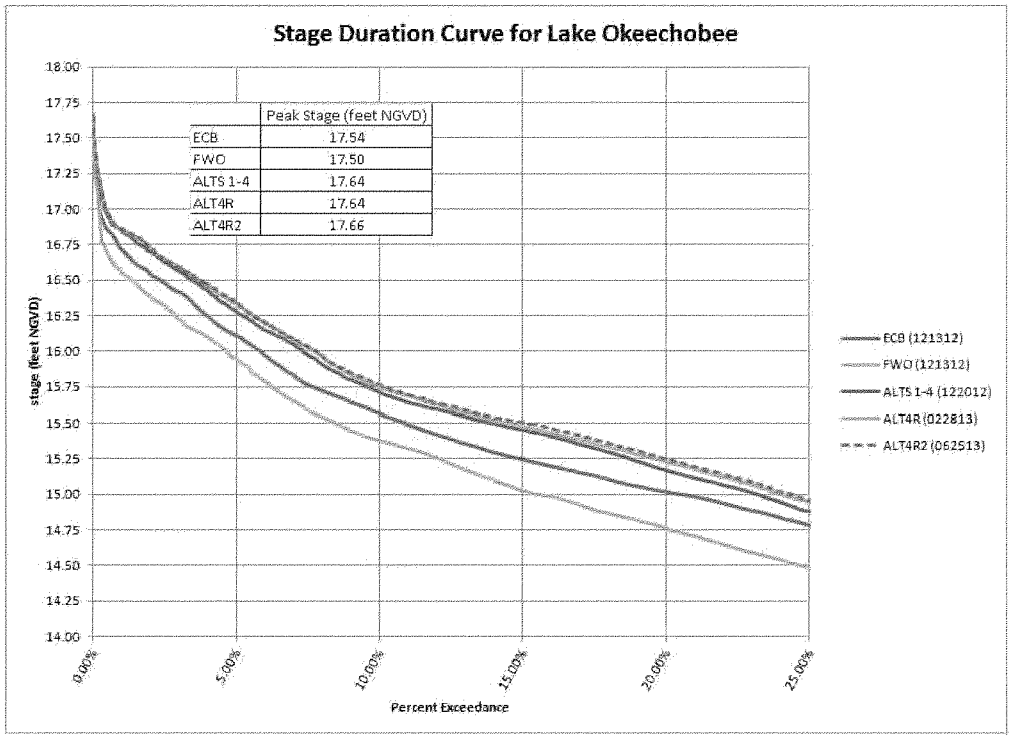

FIGURE A.8-30: LAKE OKEECHOBEE STAGE DURATION CURVES FOR CEPP BASELINES AND CEPP ALTERNATIVES 1 THROUGH 4R2 (UPPER 25%)

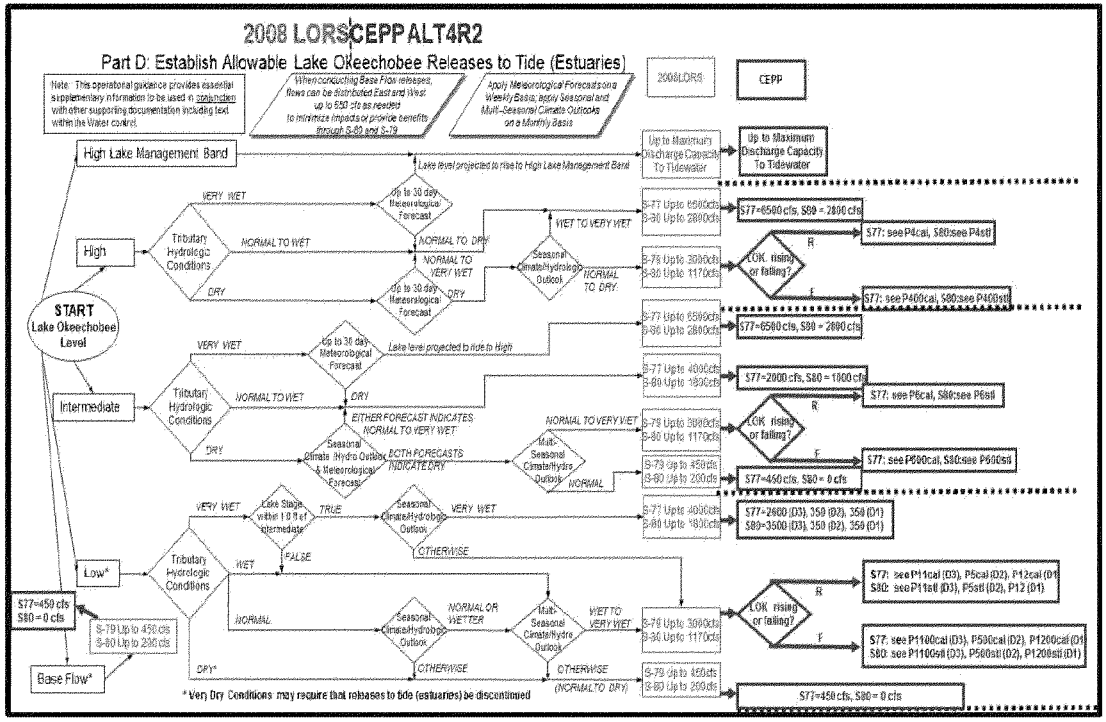

FIGURE A.8-31: LAKE OKEECHOBEE REGULATION SCHEDULE RELEASE ASSUMPTIONS FOR ALT 4R2

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TABLE A.8-2: LAKE OKEECHOBEE REGULATION SCHEDULE CLASSIFICATION ASSUMPTIONS FOR ALT 4R2 TRIBUTARY HYDROLOGIC CONDITIONS

LORS2008

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.0	>= 6000 cfs	Very Wet
1.5 to 2.99	2500 - 5999 cfs	Wet
-1.49 to 1.49	500 - 2499 cfs	Near Normal
-2.99 to -1.5	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry

*use the wettest of the two indicators

CEPP-RSMBN

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.3	>= 8700 cfs	Very Wet
0.01 to 3.29	1000 - 8699 cfs	Wet
-0.49 to 0.0	500 - 999 cfs	Near Normal
-2.99 to -0.50	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry

*use the wettest of the two indicators

TABLE A.8-3: LAKE OKEECHOBEE REGULATION SCHEDULE CLASSIFICATION ASSUMPTIONS FOR ALT 4R2 NET INFLOW SEASONAL OUTLOOK

LORS2008

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 0.93	> 2.0	Very Wet
0.71 to 0.93	1.51 to 2.0	Wet
0.35 to 0.70	0.75 to 1.5	Normal
< 0.35	< 0.75	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 1.43	> 3.06	Very Wet
0.91 to 1.43	1.93 to 3.06	Wet
0.46 to 0.90	0.98 to 1.92	Normal
< 0.46	< 0.98	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

TABLE A.8-4: LAKE OKEECHOBEE REGULATION SCHEDULE CLASSIFICATION ASSUMPTIONS FOR ALT 4R2 NET INFLOW MULTI-SEASONAL OUTLOOK

LORS2008

Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.5 to 1.17	1.1 to 2.5	Normal
< 0.5	< 1.1	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

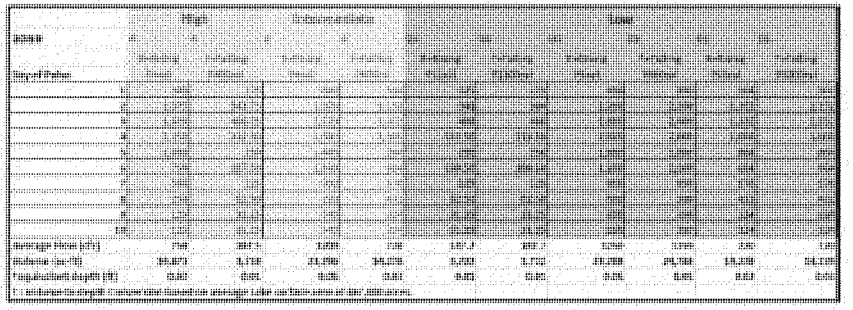
Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.6 to 1.17	1.3 to 2.5	Normal
< 0.6	< 1.3	Dry

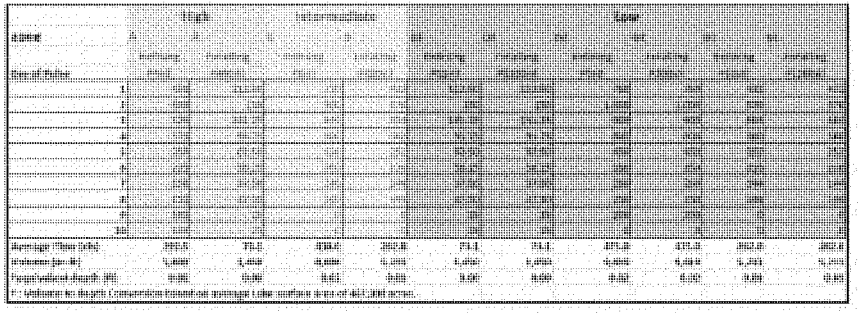
**volume-depth conversion based on average lake surface area of 467,000 acres.

TABLE A.8-5: LAKE OKEECHOBEE REGULATION SCHEDULE CLASSIFICATION ASSUMPTIONS FOR ALT 4R2 PULSE RELEASES TO CALOOSAHATCHEE ESTUARY AND SAINT LUCIE ESTUARY

CEPP-RSMBN ALT4R2: Pulse releases (as a function of Lake level) from Lake Okeechobee into Caloosahatchee estuary in cubic feet per second (cfs).



CEPP-RSMBN ALT4R2: Pulse releases (as a function of Lake level) from Lake Okeechobee into St Lucie estuary in cubic feet per second (cfs).



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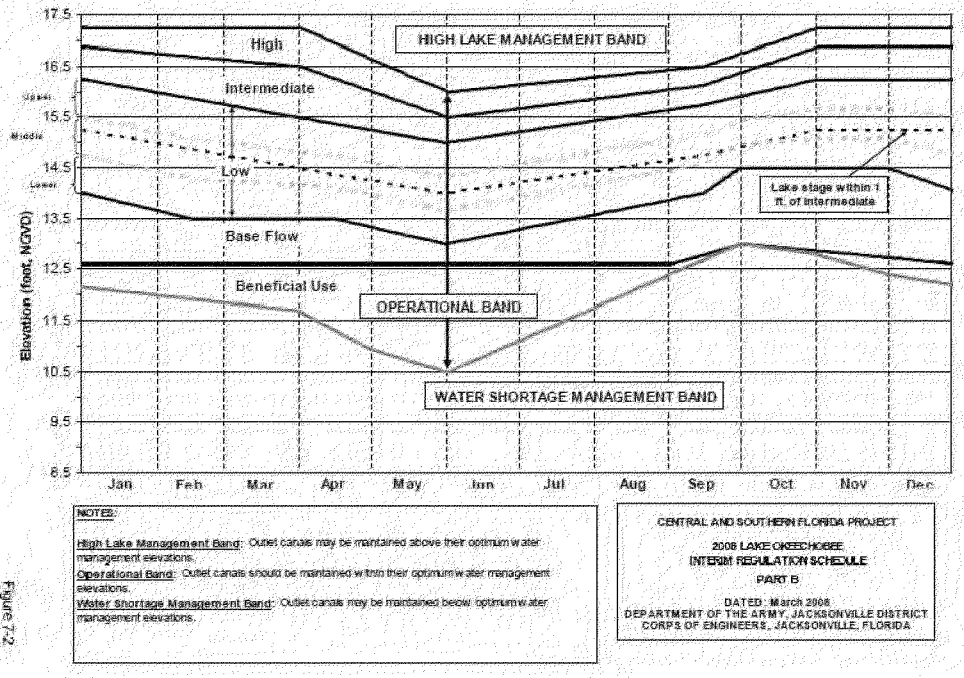

FIGURE A.8-32: LORS 2008 LAKE OKEECHOBEE REGULATION SCHEDULE

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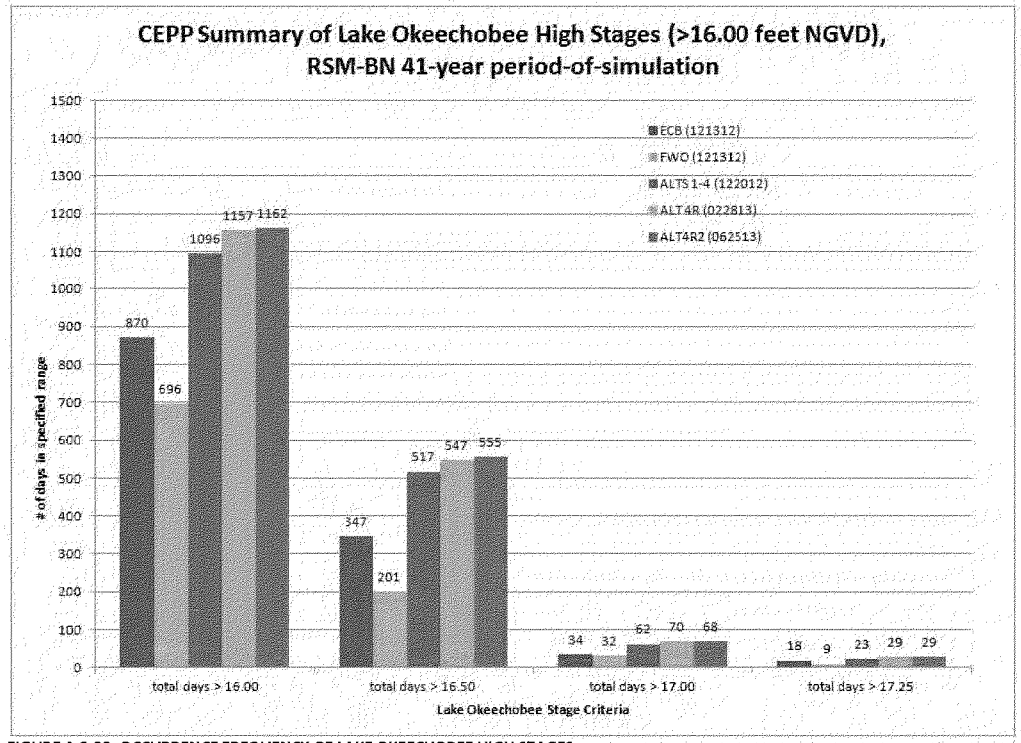

FIGURE A.8-33: OCCURRENCE FREQUENCY OF LAKE OKEECHOBEE HIGH STAGES

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A.8.3.2.4 Flow Equalization Basin Design Considerations

Consistent with CEPP modeling assumptions for the action alternatives, operational stages for the EAA FEB storage feature were typically managed between 1 and 3 feet depth, with no additional structural inflows from Lake Okeechobee allowed when the FEB depth exceeded 3.8 feet. Structural inflows to the FEB would be discontinued when depths exceed 4 feet, although additional rainfall may further increase stages. Hydraulic design of the FEB perimeter levee system included consideration of the stage variability for FEB operations. Within the RSM-BN modeling conducted to support the CEPP preliminary screening and alternative evaluations, the SFWMD Restoration Strategies FEB located on the EAA A-1 parcel and the CEPP FEB on the EAA A-2 parcel are represented as a single storage feature. The purpose of the A-2 FEB, which will be operated in conjunction with the use of the A-1 FEB is to capture additional water from Lake Okeechobee for delivery to the Everglades, while maintaining the pre-project capability to provide water quality treatment for the existing EAA runoff and limited Lake Okeechobee discharges. The integrated FEB operations will be able to accept and provide some limited water quality pre-treatment of additional water from Lake Okeechobee during off-peak times, such as the dry season, when treatment capacity is available in the downstream STAs.

Stage duration curves for the CEPP FEB are shown in Figure A.8-34 for the updated FWO (IORBL1; 14k acre A-1 FEB only), and the CEPP final array alternatives (28k acre combined A-1 and A-2 FEB): Alternatives 1-4, Alternative 4R, and Alternative 4R2. The FWO results for stage in the FEB are not displayed since the RSM-BN modeling was not yet consistent with the project intent; additional details regarding the assumptions for the IORBL1 are provided in Section A.8.2.5. Ground surface elevations within the FEB were assumed at 9.63 feet NGVD for the RSM-BN modeling (note: the CEPP hydraulic design of the A-2 FEB assumed a different natural marsh grade of 9.0 feet NGVD for the A-2 FEB; however, RSM-BN model-simulated stages within the FEB were not utilized during the CEPP hydraulic design).

A.8.3.2.5 Quantification of Redline Flow Volumes and Timing

The recommended plan will provide approximately 214,000 ac-ft per year of additional water flow (based on comparison of Alternative 4R2 against the IORBL1) to the Everglades by redirecting through the EAA water which is currently being discharged to tide via the St. Lucie and Caloosahatchee Estuaries and providing FEB storage to attenuate flow rates, prior to water quality treatment using available, off-peak capacity of the state-operated STA-2 and STA-3/4; note that a flow increase of 210,000 ac-ft was identified during CEPP formulation, based on comparison of Alternative 4R2 against the FWO. Following water quality treatment, this additional flow quantity will be re-distributed as inflows to WCA 2A and WCA 3A, and the recommended plan features will modify the quantity, quality, timing, and spatial distribution of flows into and through WCA 3A, WCA 3B, and ENP to Florida Bay in order to meet the project objectives. This plan would be accomplished by a combination of modifications to the existing Central and South Florida project components, construction of additional components, and modifications to current approved water control manuals. Several proposed or existing levees, canals, and culverts, and pump stations would be constructed, modified, or removed to improve the flow of water through the system as the first increment of CEPP.

Features in the EAA (North of the Redline) include construction of the 14,000 acre A-2 FEB (L-624 perimeter levee and L-625 interior levee; C-624, C-624E, C-626 internal distribution channels; S-623, S-624, S-628 inlet structures; S-625 outlet structures, and C-625E, C-625W

canals and channels connecting the FEB to the Miami Canal). Operation of the A-2 FEB would be integrated with the operation of the A-1 FEB, a state-funded and state-constructed FEB.

Conveyance features in WCA 2A and northern WCA 3A (South of the Redline) include: S-620, a gated culvert to deliver water from the L-6 Canal to the remnant L-5 Canal; S-622, a new gated spillway to deliver water from the remnant L-5 canal to the western L-5 canal (during L-6 diversion operations); S-621, a new gated spillway to deliver water from STA 3/4 to the S-7 pump station during peak discharge events (eastern flow route is not typically used during normal operations, including L-6 diversion operations; conveyance improvements to approximately 13.6 miles of the L-5 Canal; degrade approximately 2.9 miles of the southern L-4 Levee along the northwest boundary of WCA-3A; S-630, a 360 cfs pump station to maintain water supply deliveries west of the L-4 Canal to the Seminole Tribe of Florida's Big Cypress Reservation and STA-5/6; S-8A new gated culverts to deliver water from the Miami Canal (downstream of S-8, which pulls water from the L-5 Canal) to the L-4 Canal; and backfill approximately 13.5 miles of the Miami Canal and include upland mounds, between a point approximately 1.5 miles south of the S-8 pump station and Interstate Highway I-75.

The base condition assumptions for the CEPP ECB and FWO were established during the preliminary screening process from approximately December 2011 through February 2012, with the first preliminary base condition simulations with RSM-BN and RSM-GL released in May 2012. In order to maintain a consistent set of base conditions through the screening and alternative development process during CEPP, the base condition assumptions were not modified through the CEPP formulation process, although corrections were incorporated as necessary through periodic updated releases of the base conditions throughout the formulation process. Notably, SFWMD modeling updates for the operational assumptions of the A-1 FEB, STA-2, and STA-3/4 within the SFWMD Restoration Strategies project (included in the CEPP FWO baseline) which were developed concurrent with CEPP final array modeling (USACE draft EIS was released in February 2013, with the final EIS released in July 2013) was not incorporated into the CEPP FWO base condition assumptions. Additionally, the USACE implementation of the Everglades Restoration Transition Plan (ERTP) and associated WCA-3A Regulation Schedule changes (Record of Decision in October 2012) were not incorporated into the CEPP ECB base condition assumptions. However, following identification of the Recommended Plan Alternative 4R2, the CEPP base condition assumptions were updated to reflect best available information as of June 2013. The revised 2012 Existing Condition Baseline (2012EC) updated the ECB to include implementation of ERTP operations for WCA-3A and the South Dade Conveyance system, in addition to minor localized corrections to improve RSM-GL representation of the S-9/S-9A operations and the L-28 weir (all other ECB assumptions remain unchanged; the complete assumptions tables for the ECB and 2012EC are provided in Annex A-2, Reference 2). The revised Initial Operating Regime Baseline (IORBL1) updated the FWO to include final SFWMD proposed operational intent for the Restoration Strategies project, the 2.6 mile western Tamiami Trail bridge proposed with the initial increment of the DOI Tamiami Trail Next Steps Project (based on best available phased implementation information from DOI), operational updates to the CERP Indian River Lagoon South (IRLS) project (based on best available information from the IRLS project team), and operational refinements to the CERP Broward County Water Preserve Area project (to reduce excess discharges to tide via S-29, including accounting for the effects of the Lake Belt expansion assumed in the CEPP FWO condition), in addition to the same minor localized corrections included with the 2012EC to improve RSM-GL representation of the S-9/S-9A operations and the L-28 weir (all other FWO assumptions remain unchanged; the complete

assumptions tables for the FWO and IORBL1 are provided in Annex A-2, Reference 2). The 2012EC and the IORBL1 represent the existing condition baseline and future without project baseline assumptions for purposes of completing the CEPP assessments for the Savings Clause and Project Assurances, as documented in Annex B of the main PIR report. The quantification of Redline flow volumes and timing in the Engineering Appendix therefore utilizes the 2012EC and IORBL1 base conditions as the basis for comparison to the with-project Recommended Plan Alternative 4R2, since this information reflects the best available set of assumptions and corresponds to the information analyzed in Annex B; the revised base conditions do not significantly alter the results or conclusions that are summarized in Section A.8 of the Engineering Appendix and the Hydrologic Modeling Annex A-2.

Due to the high degree of inter-annual and intra-annual variability to rainfall and other climatic parameters in South Florida, as well as the resulting differences in antecedent conditions from one year to the next, the annual surface water inflows to WCA-2A and WCA-3A are similarly variable from year to year. Total average annual water year surface water inflows to WCA-2A and WCA-3A across the Redline are summarized in Table A.8-6 for the base conditions and the Recommended Plan Alternative 4R2; for this computation, the water year was defined as May of year 1 through April of year 2 (water year is denoted as year 2). Surface water inflows along the redline to WCA-2A correspond to the sum of structure inflows from the S-7 pump station and STA-2 outflows to WCA-2A. Surface water inflows along the redline to WCA-3A correspond to the sum of structure inflows from the S-8 pump station to the Miami Canal within WCA-3A, the S-150 gated culvert, and STA-5/STA-6 outflows to northwest WCA-3A for the 2012EC and IORBL1 base conditions; for Alternative 4R2, the combined flows from the S-8 pump station discharges to the Miami Canal and discharges to the S-8A gated culvert (which diverts water to the L-4 Levee degrade gap) are included in addition to S-150 and STA-5/STA-6 outflows to WCA-3A. Water supply deliveries to the regional system from S-150 (Alternative 4R2 only), the S-8 pump station (2012EC and IORBL1 only), and the S-7 pump station (2012EC, IORBL1, and Alternative 4R2), which total a combined 44-45 kAF average annual for the 2012EC and IORBL1 and 70 kAF average annual for Alternative 4R2, were not included in the quantification of total redline flows because this volume allocated for regional water supply deliveries does not represent water made available by the CEPP project for the natural system, which is the purpose of the redline quantification for project assurances.

The average annual water year data is provided in time series and probability exceedance (volume probability curve) formats in Figure A.8-35 and Figure A.8-36, respectively. The annual water year differences (Alternative 4R2 minus 2012EC; Alternative 4R2 minus IORBL1) were rank sorted and plotted in probability exceedance format in Figure A.8-37. The intra-annual average annual water year variability across the redline is shown in Figures A.8-38 through A.8-40 for WCA-2A redline flows, WCA-3A redline flows, and total redline flows, respectively.

The L-6 diversion and associated infrastructure, which is included in Alternative 4R2, provides a means to redirect treated inflows from WCA-2A (STA-2 outflows) to northwest WCA-3A, to achieve CEPP objectives and desired depths and durations within both WCA-2A and WCA-3A. The L-6 diversion daily flow data is provided in time series and probability exceedance formats in Figure A.8-41 and Figure A.8-42, respectively.

TABLE A.8-6: AVERAGE ANNUAL FLOWS AT THE CEPP REDLINE

	Average Annual Water Year Inflows along CEPP Redline (kAF/year)		
	2012EC	IORBL1	ALT4R2
WCA 2A	329	437	290
WCA 3A	658	538	900
	Average Annual Water Year Inflows along CEPP Redline (kAF/year)		
	2012EC	IORBL1	ALT4R2
Redline total	987	976	1190
Redline total maximum	1745	1723	2074
Redline total minimum	471	473	465
Redline total std. dev.	318	319	450

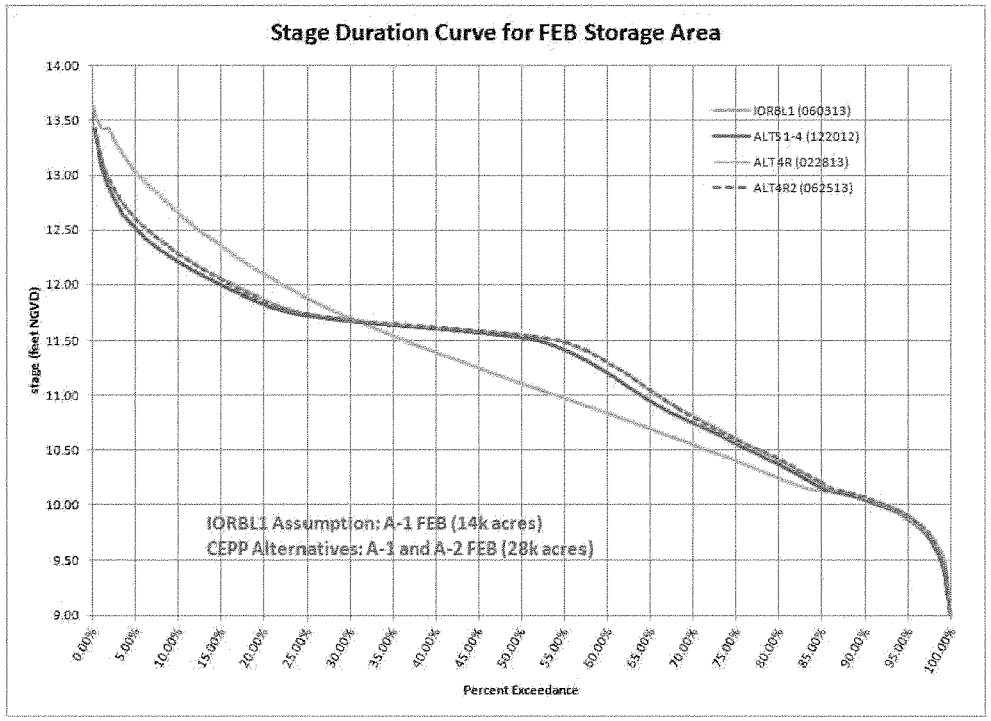

FIGURE A.8-34: FLOW EQUALIZATION BASIN STAGE DURATION CURVES FOR CEPP ALTERNATIVES 4, 4R, AND 4R2

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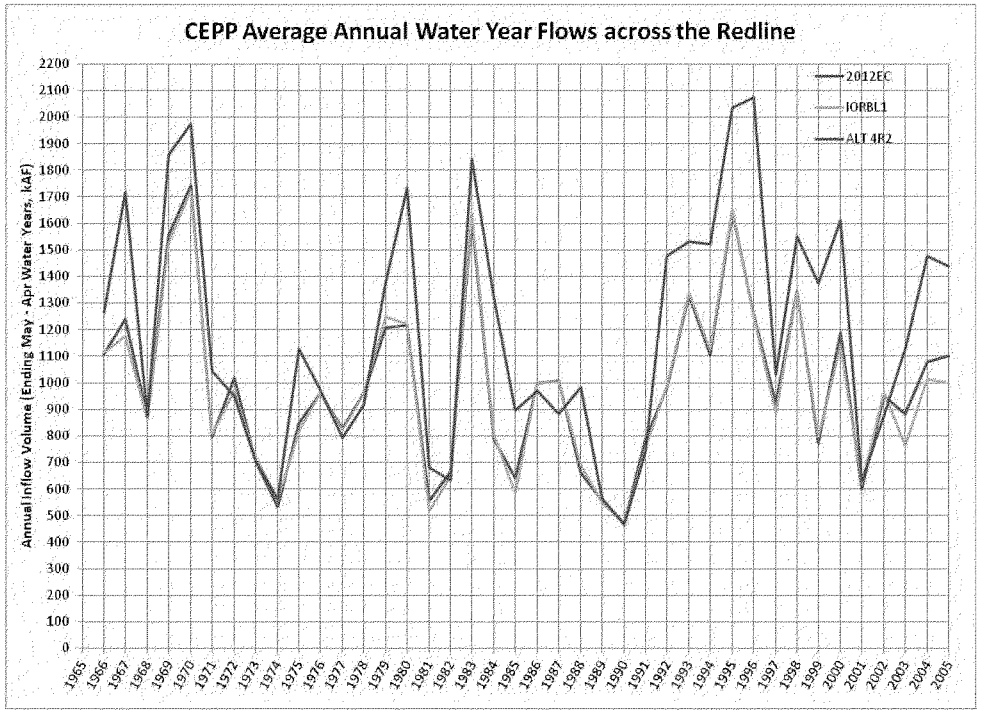

FIGURE A.8-35: ANNUAL WATER YEAR FLOWS ACROSS THE REDLINE FOR PROJECT ASSURANCES

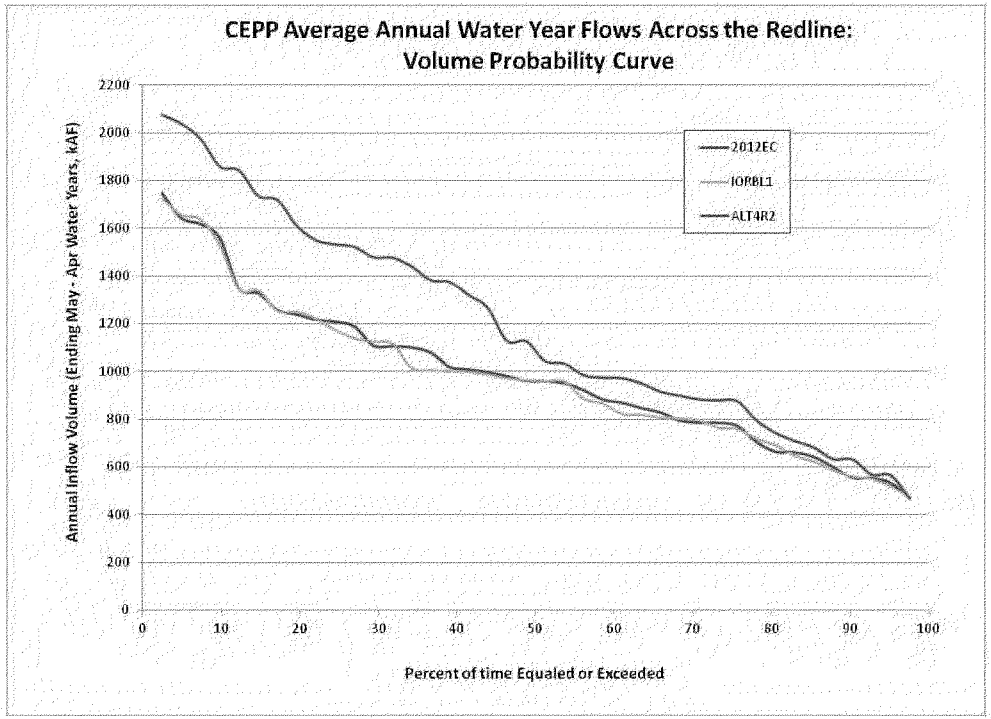

FIGURE A.8-36: VOLUME PROBABILITY CURVES OF ANNUAL WATER YEAR FLOWS ACROSS THE REDLINE FOR PROJECT ASSURANCES

568

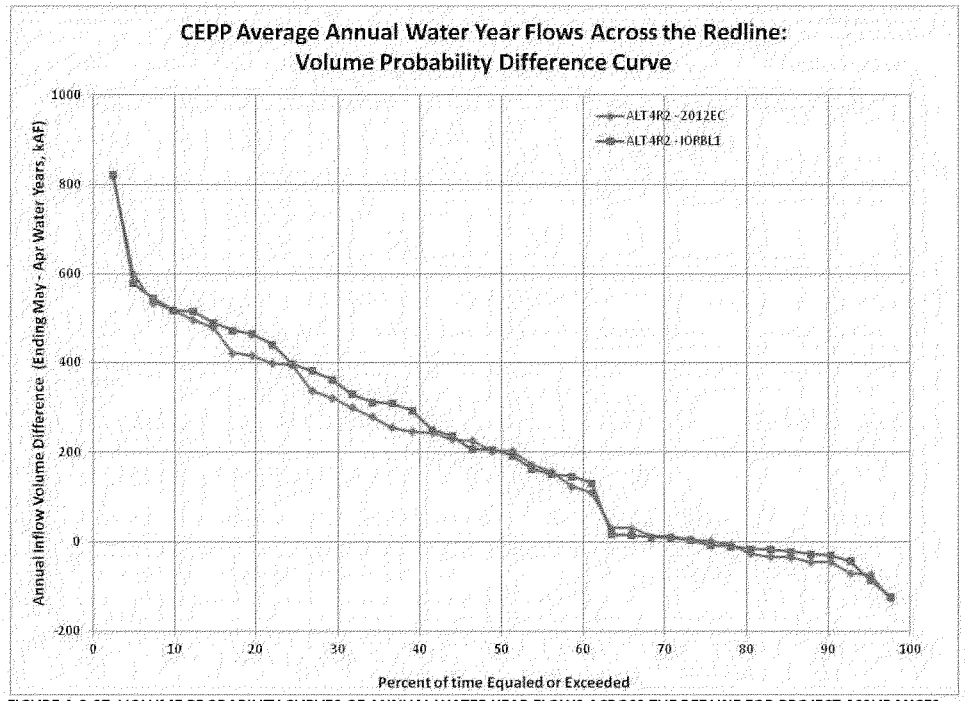

FIGURE A.8-37: VOLUME PROBABILITY CURVES OF ANNUAL WATER YEAR FLOWS ACROSS THE REDLINE FOR PROJECT ASSURANCES

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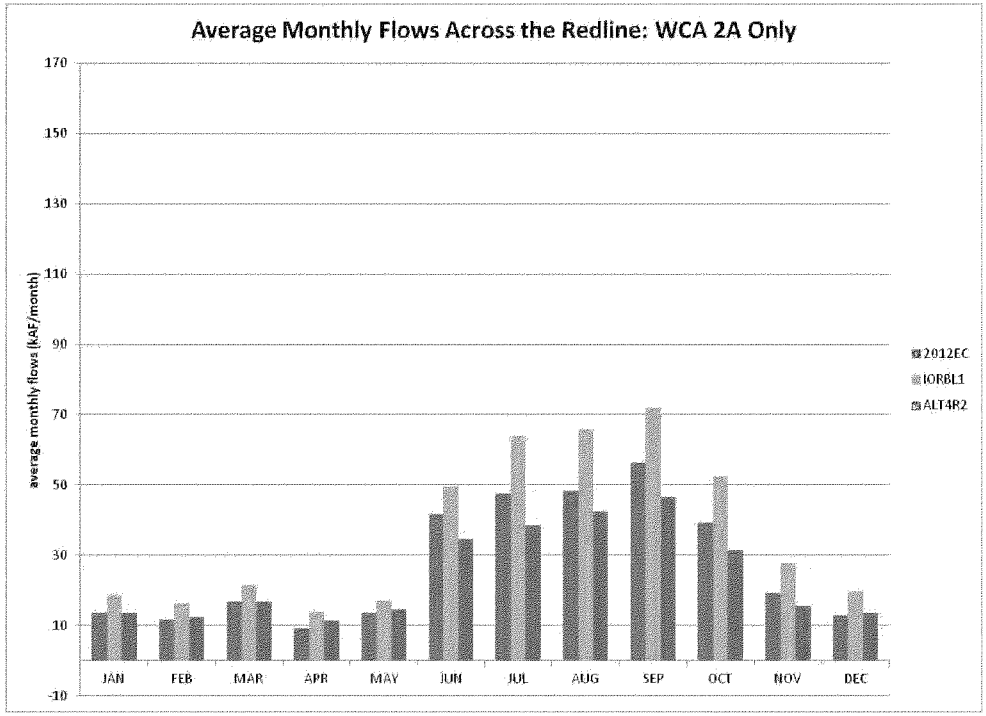

FIGURE A.8-38: INTRA-ANNUAL WATER YEAR FLOW VARIABILITY ACROSS THE REDLINE AT WCA-2A

670

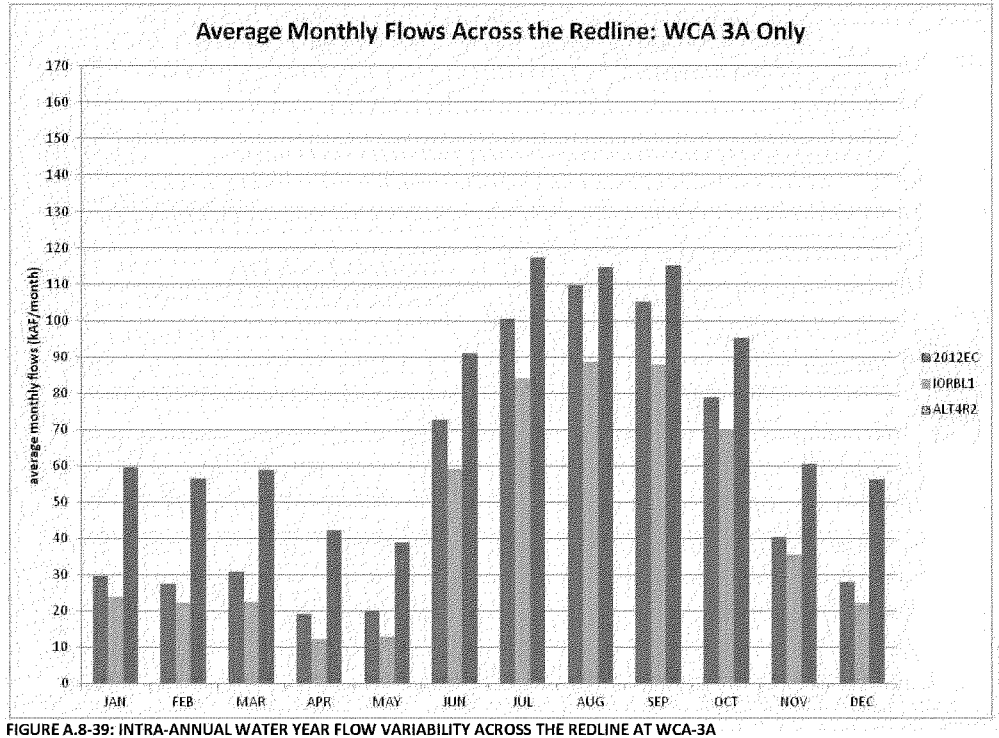

FIGURE A.8-39: INTRA-ANNUAL WATER YEAR FLOW VARIABILITY ACROSS THE REDLINE AT WCA-3A

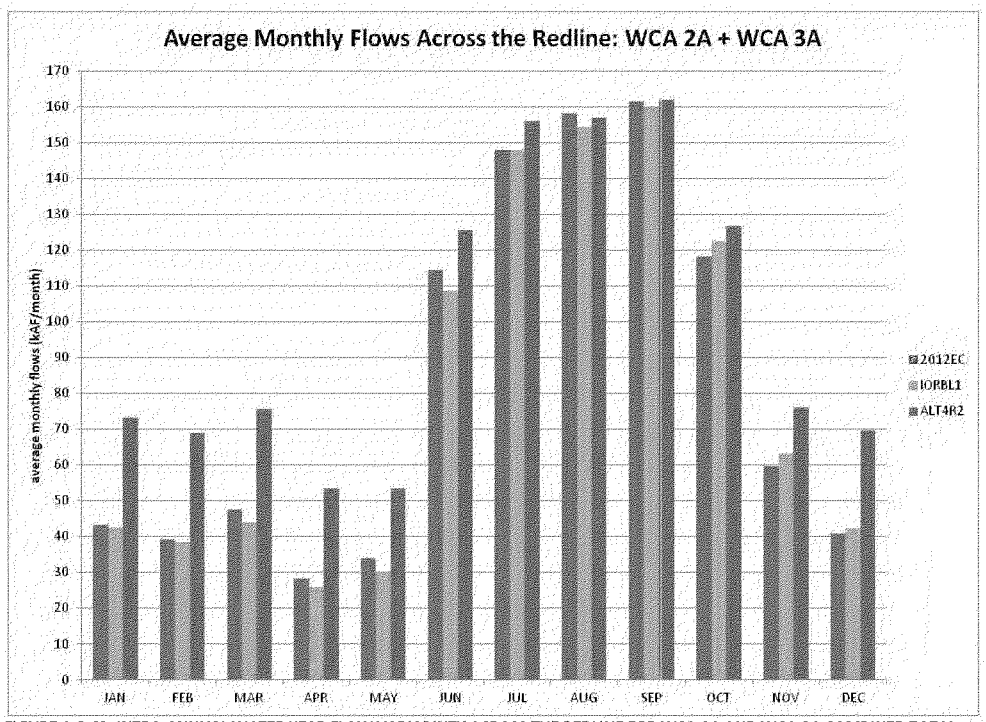

FIGURE A.8-40: INTRA-ANNUAL WATER YEAR FLOW VARIABILITY ACROSS THE REDLINE FOR WCA-2A AND WCA-3A COMBINED TOTAL

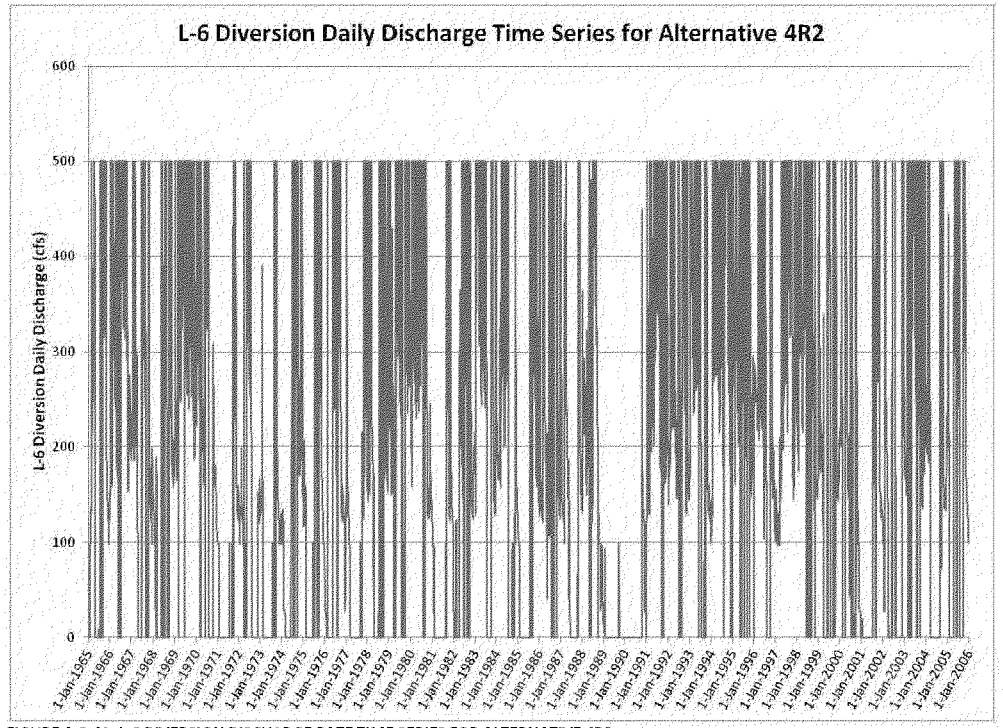

FIGURE A.8-41: L-6 DIVERSION DISCHARGE RATE TIME SERIES FOR ALTERNATIVE 4R2

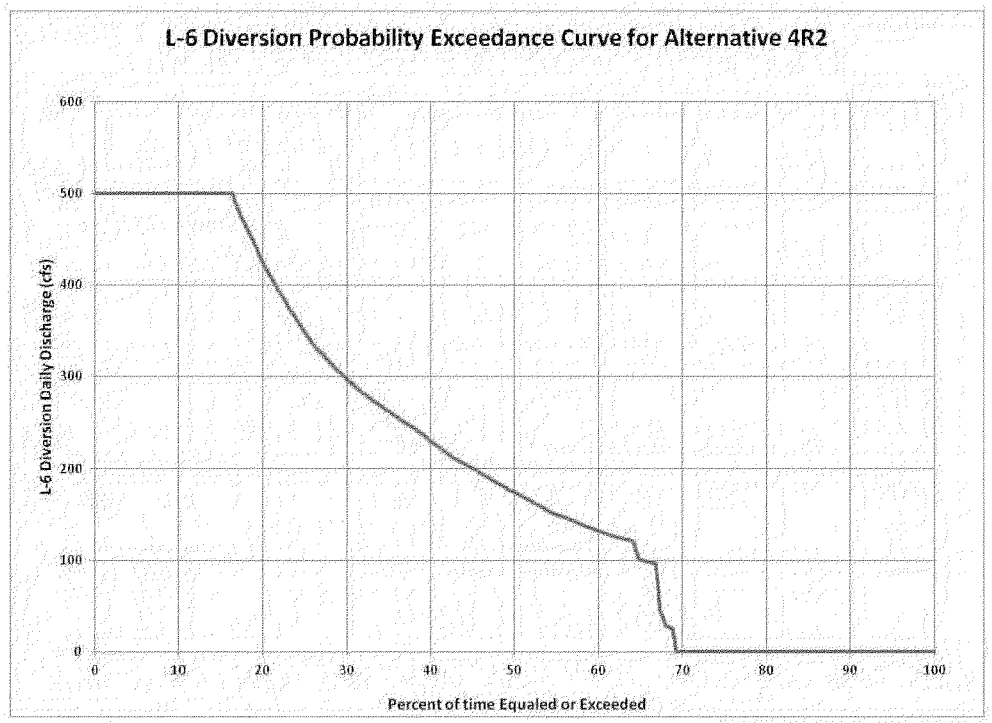

FIGURE A.8-42: L-6 DIVERSION DISCHARGE RATE PROBABILITY EXCEEDANCE FOR ALTERNATIVE 4R2

A.8.3.2.6 Quantification of Yellowline Seepage Flow Volumes

The ECB and FWO base conditions for CEPP do not include active seepage management along the L-30 Canal and L-31N Canal, which correspond to the portions of the LEC located adjacent to WCA-3B and the ENP NESRS, respectively. The ECB base condition includes active seepage management along portions of the C-111 Canal within LEC Service Area 3, east of ENP between structures S-331 and S-176, with ERTP operations of the existing S-332B, S-332C, and S-332D pump stations and the corresponding C-111 South Dade project South Detention Area (SDA) reservoirs located west of the canals. In addition to continued ERTP operations of the S-332B, S-332C, and S-332D pump stations, the FWO base condition additionally includes the following additional seepage management features: completion of the C-111 South Dade project North Detention Area reservoir, revised operations for the 8.5 Square Mile Area S-357 pump station and southern detention cell, and increased storage capacity for S-332B reservoir inflows; and completion of the CERP C-111 Spreader Canal Western PIR, including the Frog Pond Detention Area reservoir and operation of the corresponding S-199 and S-200 inflow pump stations located along the C-111 Canal between S-176 and S-177. The Recommended Plan Alternative 4R2 provides increased seepage management capability along the L-30 Canal and L-32N Canal through completion and operation of the 1000 cfs S-356 pump station (to replace the existing temporary 500 cfs S-356 pump station) and an approximately 4.2 mile long, 35 feet deep tapering seepage barrier cutoff wall along the L-31N Levee just south of Tamiami Trail and east of the ENP NESRS.

Table A.8-7 and Table A.8-8 provide a summary of the resultant seepage quantities along the L-30 Canal, L-31N Canal, and C-111 Canal. The seepage quantities are provided on an average annual basis for the 41-year RSM-GL period of simulation, using the canal sub-segments as shown on Figure A.8-43 (listed from north to south): L-30 North (L-30 north of the bridge in the tables); L-30 North of S-335 (L-30 between S-335 and the bridge in the tables); L-30 South of S-335 (same label in tables); L-31N North of G-211 (same label in tables); L-31N between G-211 and S-331 (L-31N from G-211 to S-331 in tables); L-31N South of S-331 (L-31N from S-331 to S-176 in tables); C-111 between S-176 and S-177 (C-111 from S-176 to S-177 in tables); and C-111 between S-177 and S-18C (C-111 from S-177 to S-18C in tables). RSM-GL modeling results are summarized in Table A.8-4 and Table A.8-5 for the following simulations: ECB, 2012EC, IORBL1, Alternative 4R (ALT4R), Alternative 4R2 (ALT4R2). Additional seepage quantification tables are available with the complete set of posted RSM-GL model output, to include portions of the LEC north of L-30.

TABLE A.8-7: AVERAGE ANNUAL LEVEE SEEPAGE FLOWS AT THE CEPP YELLOWLINE FOR ECB, FWO, ALTERNATIVE 4R, AND ALTERNATIVE 4R2

Annual Average
kac-ft

	Levee Seepage from Marsh Cell			
	ECB	FWO	ALT4R	ALT4R2
C-111 from S-176 to S-177	98	188	217	214
C-111 from S-177 to S-18C	29	43	49	47
L-30 between S-335 and the bridge	111	107	141	141
L-30 north of the bridge	218	214	203	201
L-30 south of S-335	92	82	98	100
L-31N from G-211 to S-331	29	29	28	28
L-31N from S-331 to S-176	209	236	329	322
L-31N north of G-211	149	164	211	251
L-31N changed to N of G-211 for 2966_3183 cell pr			38	

TABLE A.8-8: AVERAGE ANNUAL LEVEE SEEPAGE FLOWS AT THE CEPP YELLOWLINE FOR ECB, 2012EC, IORBL1, ALTERNATIVE 4R, AND ALTERNATIVE 4R2

Annual Average
kac-ft

	Levee Seepage from Marsh Cell				
	ECB	2012EC	IORBL1	ALT4R	ALT4R2
C-111 from S-176 to S-177	98	107	201	217	214
C-111 from S-177 to S-18C	29	30	44	49	47
L-30 between S-335 and the bridge	111	111	106	141	141
L-30 north of the bridge	218	215	211	203	201
L-30 south of S-335	92	92	84	98	100
L-31N from G-211 to S-331	29	29	30	28	28
L-31N from S-331 to S-176	209	207	227	329	322
L-31N north of G-211	149	171	160	211	251
L-31N changed to N of G-211 for 2966_3183 cell pr			23	38	

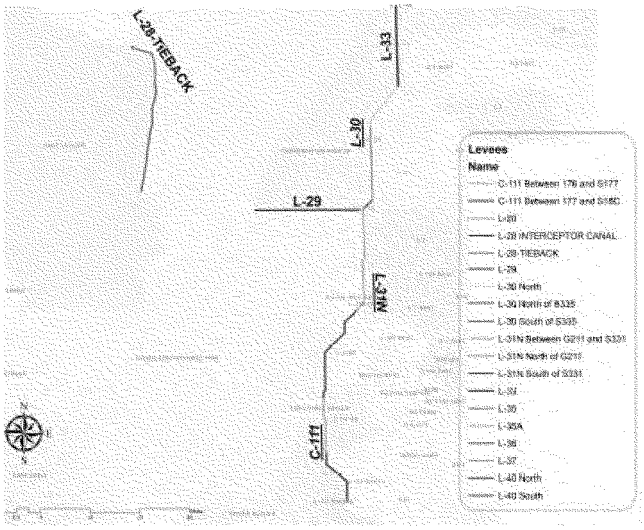

FIGURE A.8-43: RSM-GL LEVEE AND CANAL SEGMENT FOR SEEPAGE QUANTIFICATION

A.8.3.2.7 8.5 Square Mile Area Flood Mitigation Performance

The 8.5 Square Mile Area (8.5 SMA) is a primarily residential area adjacent to, but west of, the L-31N Canal. The 8.5 SMA, which is also known as the Las Palmas community, is bordered on both the west and north by NESRS (Figure A.8-44). The community has water management infrastructure consisting of a perimeter levee, a seepage collection canal, a pump station (S-357), and a southern detention cell meant to collectively provide flood mitigation as part of the MWD Project.

Stages within the 8.5 SMA, located along the eastern boundary of ENP, do not change significantly between the CEPP ECB and the FWO. The 8.5 SMA project components and operations are unchanged between the ECB and FWO modeling assumptions, with each baseline condition assuming operations of S-357 and S-331 as defined in the 2011 8.5 SMA Interim Operational Criteria; the S-357 pump station is limited to a 125 cfs average daily discharge rate, and S-331 flood mitigation operations for the 8.5 SMA are triggered based on the stage at the LPG-2 monitoring gauge (located within the protected area, along the western perimeter levee).

The CEPP alternatives modify the FWO operations of the S-357 pump station, in an effort to increase discharges from the 8.5 SMA detention cell to the C-111 South Dade North Detention Area and reduce the reliance on the S-331 pump station in L-31N to provide flood mitigation for the 8.5 SMA protected area. The protected portion of the 8.5 SMA is represented by only 3 model grid cells in the RSM-GL, and the resolution of the RSM-GL is extremely limiting for adequate representation of the 8.5 SMA project features. Prior to implementation of CEPP, further technical investigations and potentially additional hydrologic/hydraulic modeling with a higher resolution model will likely be needed for the 8.5 SMA operations. The current MWD 8.5 SMA configuration was identified in the USACE C&SF MWD 8.5 SMA General Reevaluation Report (2000 GRR), which provided a detailed quantification of potential affects to 8.5 SMA flood mitigation performance and potential affects to adjacent ENP wetlands supported by ModBranch hydrologic modeling.

RSM-GL final array modeling of Alternatives 1 through 4 indicated that stages within the 8.5 SMA were lowered by approximately 0.25 feet during wet conditions for the northern and southeastern areas of the 8.5 SMA, compared to the FWO. However, of concern with Alternatives 1 through 4, stages within the southwest portion of the 8.5 SMA were increased by approximately 0.3-0.6 feet, compared to the FWO, under all hydrologic conditions. These alternatives maintained increased utilization of the S-357 pump station to provide effective flood mitigation for the 8.5 SMA protected area but did not include lowering of the overflow weirs' elevations within the 8.5 SMA detention area (crest elevations for the S-360W and S-360E weirs were maintained at the elevations specified for the 2011 Interim Operations Plan for 8.5 SMA, corresponding to overflow depths of 4.0 and 3.5 feet, respectively); consistent with previous field observations during S-357 interim operations, the CEPP modeling demonstrated that increased operational depths within the 8.5 SMA detention area may potentially cause increased groundwater stages within the southwestern portion of the 8.5 SMA protected area. Stage duration curve graphics for Alternatives 1 through 4R2 are further described and included in the Hydrologic Modeling Annex A-2.

The 8.5 SMA detention cell weirs were lowered with Alternative 4R and Alternative 4R2 to allow overflow when depths exceeded 1.0 feet, which resulted in performance improvements within the southwestern portion of the 8.5 SMA protected area. RSM-GL modeling of the Recommended Plan Alternative 4R2 indicates that stages within the 8.5 SMA are lowered by approximately 0.25-0.50 feet during wet conditions for the three RSM-GL grid cells that represent the protected portion of the 8.5 SMA, compared to the FWO.

FIGURE A.8-44: LOCATION MAP FOR 8.5 SMA

A.8.3.2.8 Additional RSM-GL Post-Processing for Structures and Detention Areas

RSM-GL daily output for structure discharges and water stages at monitoring gauges are generated for the 1965-2005 period of simulation and tabulated using the USACE Hydrologic Engineering Center's Data Storage System (HEC-DSS). Due to the enormous volume of data included in the RSM-GL DSS files for the CEPP baselines and the CEPP alternatives, EN-W developed an additional suite of post-processed RSM-GL graphics to facilitate review of the preliminary Blue Line and Yellow Line screening modeling and the final array modeling by the CEPP water supply and flood control (WS/FC) technical sub-team. The primary assessment focus of the CEPP WS/FC sub-team was the South Dade Conveyance System (SDCS), including the effects of controlled/uncontrolled increased seepage from WCA-3B and eastern ENP with implementation of CEPP components and operations; the seepage flux dynamics along the Yellow Line are directly correlated to increased flood control risk (too much increased seepage and/or too little active seepage management) and reduced water availability for water supply (too little increased seepage and/or too much active seepage management).

Using the list of critical flow structures that was identified by EN-W for CEPP and included in the average annual critical flows reports, flow duration curve graphics were generated by EN-W for each of these critical structures to quantify the degree to which existing and/or proposed structure design capacities are sufficient for achievement of CEPP objectives, as well as the relative differences between the screening simulations and final alternatives. Stage duration curve graphics were also generated by EN-W for the 8.5 SMA Detention Area, C-111 North Detention Area, C-11 South Detention Area, and the Frog Pond Detention Area, to assess the relative differences in utilization of these storage areas for which standard model output graphics were not otherwise available. Several of the EN-W flow duration curves and stage duration curves were particularly utilized by the CEPP WS/FC sub-team during sub-team review of the final array modeling, and a selected sub-set of these graphics are provided in the Hydrologic Modeling Annex A-2. Aside from the unprocessed DSS output files, these flow duration curve and stage duration curve graphics are not otherwise available in the posted RSM-GL standard model output.

A.8.4 Identification of Additional Hydrologic Modeling for PED

Although the RSM-BN and RSM-GL hydrologic models are well suited to support the preliminary screening, alternative formulation, and evaluation of CEPP alternatives, it is expected that higher resolution hydrologic and hydraulic modeling tools will be required to further analyze localized and possibly regional-scale effects of specific components of the CEPP Recommended Plan, with the scope of these analyses further identified during the Pre-Construction Engineering and Design (PED) phase of the project. Based on components currently identified for the CEPP Recommended Plan, the following provides a minimum list of project components likely to require further hydrologic and hydraulic analyses and/or modeling during PED:

1. Identification of S-8 Pump station modifications (or potential replacement) required to redirect most S-8 outflows west to the L-4 Canal: An undefined length of the Miami Canal downstream of S-8 (1-2 miles is currently assumed) may be required to provide hydraulic conveyance under peak flood events, while maintaining S-8 tailwater conditions within the design criteria range of the S-8 pump.

2. Determination of the effects of the L-67 Extension Levee and Canal removal on the discharge capability of the S-12 spillways, including consideration of removal of all or portions of the old Tamiami Trail roadway located in close proximity to the S-12C and S-12D outlets.

3. Identification of potential conveyance improvements within the WCA-3B remnant agricultural ditches, east of the Blue Shanty levee (L-67D) to improve the ability to achieve north-to-south flows from eastern WCA-3B to the L-29 Canal, via the existing S-355A and S-355B gravity spillway structures. For example, by providing a hydrologic connection between the S-355B collector canal and the remnant agricultural ditches, the efficiency and quantity of conveyance from southern WCA-3B to the S-355B will be improved.

4. Determination of the required length and depth for the L-31N seepage cutoff wall to achieve the desired balance between seepage management, flood control, and water supply objectives, including potential consideration of monitoring data from similar existing seepage cutoff wall features and the potential need for additional design tests to support detailed design. Design capacity for the S-356 seepage management pump station may also be affected by design changes with the seepage wall.

5. Identification of structure operations within the South Dade Conveyance System during phased implementation of CEPP project components, including detailed operational planning studies that were not generally beyond the scope of CEPP formulation efforts.

6. Further technical investigations and potentially additional hydrologic/hydraulic modeling with a higher resolution model will likely be needed for the 8.5 SMA operations. The current MWD 8.5 SMA configuration was identified in the USACE C&SF MWD 8.5 SMA General Reevaluation Report (2000 GRR), which provided a detailed quantification of potential affects to 8.5 SMA flood mitigation performance and potential affects to adjacent ENP wetlands supported by ModBranch hydrologic modeling.

Additional data and analysis needs will also likely be identified during PED phase.

A.9 OPERATIONS AND MAINTENANCE

Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) begins after project construction and Operational Testing and Monitoring is complete and generally includes all operation activities and maintenance needed to keep the project features functioning as intended. OMRR&R for the CEPP project will occur for all new facilities constructed as a result of the project, and as an increase to the OMRR&R for State Facilities that CEPP will use to provide new water to the WCAs and ENP. There will be OMRR&R for CEPP features and for State facilities used by CEPP. Provided below are the tables for CEPP Project features and State facilities used by CEPP.

Activities included in the OMRR&R costs are:

- Pump and facility maintenance which are per manufacturer's recommendations and schedules.
- Repair and rehabilitation of pumps, drivers, and switchgear are assumed to be rehabilitated or replaced once during the 50-year life.
- Erosion control to make sure banks and areas around culverts and other structures are not compromised by weather, plant or animal forces.
- Mowing to maintain grass areas for a neat and clean appearance and also to make sure there are no other maintenance issues being hidden by high grass vegetation. Mowing also reduces the ability of woody plants to gain a foothold and lead to larger issues.
- All monitoring, required by permit, USFWS Incidental Take Statement, and/or needed to adaptively manage the Project.

- Invasive, exotic, native, and nuisance vegetation control. Vegetation control is done both to control underwater infestations and surface infestations. Invasive plants can prevent correct project function and can damage vital structural components if allowed to grow unchecked.
- Adaptive Management (AM) measures needed to ensure project benefits or avoid violating one or more project constraints.

A.9.1 CEPP project features.

Structure	OMRR&R Costs
A-2 FEB	$2,090,000
S-620 (CS-1) 500 cfs gated culvert, S-621 (CS-2) 2500 gated spillway, S-622 (CS-3) 500 cfs gated culvert	$330,000
Modified S-8 (2 gated culverts)	$230,000
S-630 (360 cfs PS)	$240,000
New S-333N - 1150 cfs	$160,000
New (S-356) PS at 1000 cfs	$600,000
500 cfs gated structures (S-631, S-632, and S-633)	$340,000
8.5 mile levee in WCA 3B	$50,000
S-355W-1230 cfs gated structure	$110,000
TOTAL Average Annual OMRR&R Costs New Facilities	**$4,150,000**

A.9.2 State facilities used by CEPP

The future OMRR&R costs of operating the system without CEPP features once CEPP is constructed and operational is based on new water flows through the state facilities as a portion of the overall water flows through the state facilities. Reference 6.4.2 of the main PIR for cost sharing information.

TABLE A-35. LIST OF STA 3/4 AND ASSOCIATED INFRASTRUCTURE [1]

Structure	Structure/Design Capacity	Description
G-370	2775 cfs Pump	Inflow Pump
G-370S	225 cfs Pump	Seepage Return Pump
G-371	2170 cfs Gated Spillway	North New River Canal Divide Structure (used for STA diversions and water supply)
G-372	3700 cfs Pump	Inflow Pump
G-372HL	250 cfs Gated Culvert	Culvert to convey untreated stormwater or STA-3/4 seepage to Holey Land WMA
G-372S	225 cfs Pump	Seepage Return Pump
G-373	2400 cfs Gated Spillway	Miami Canal Divide Structure (used for STA diversions and water supply)
G-374 A, B, C, D, E and F	362 cfs Gated Culvert	Cell 1A Inflow Structure
G-375 A, B, C, D, E and F	362 cfs Gated Culvert	Cell 1B Inflow Structure
G-376 A, B, C, D, E and F	362 cfs Gated Culvert	Cell 1B Outflow Structure
G-377 A, B, C, D, and E	396 cfs Gated Culvert	Cell 2A Inflow Structure
G-378 A, B, C, D, and E	396 cfs Gated Culvert	Cell 2B Inflow Structure

G-379 A, B, C, and D	396 cfs Gated Culvert	Cell 2B Outflow Structure
G-379E	396 cfs Gated Culvert	Lower SAV Cell Outflow Structure (PSTA)
G-380 A, B, C, D, E and F	282 cfs Gated Culvert	Cell 3A Inflow Structure
G-381 A, B, C, D, E and F	282 cfs Gated Culvert	Cell 3B Outflow Structure
G-382A	Various cfs Gated Culvert	Cell 1A/Cell 2A Transfer Structure
G-382B	Various cfs Gated Culvert	Cell 2A/Cell 3B Transfer Structure
G-383	1470 cfs Gated Culvert	Inflow Canal Divide Structure
G-384 A, B, C, D, E and F	282 cfs Gated Culvert	Cell 3B Inflow Structure
G-385	54 cfs Pump	Cell 1A/1B Transfer/Hydration Pump
G-386	29 cfs Pump	Cell 2A/2B Transfer/Hydration Pump
G-387	24 cfs Pump	Cell 3A/3B Transfer/Hydration Pump
G-388	160 cfs Pump	Outflow Pump (PSTA)
G-389A, B	105 cfs Ungated Culvert	Lower SAV Cell Inflow Structure (PSTA)
G-390A	105 cfs Gated Culvert	PSTA Cell Inflow Structure (PSTA)
G-390B	40 cfs Gated Culvert	PSTA Cell Inflow Structure (PSTA)
G404	600 cfs Pump	Pump to convey STA-3/4 (and STA-5/6) discharges and water supply to WCA-3A
G409	190 cfs Pump	Pump to convey water supply to the Big Cypress Seminole Indian Reservation (in conjunction with G-404)
S-150	1000 cfs Gated Culvert	Culvert to convey STA-3/4 discharges and water supply to WCA-3A
S-7	2490 cfs Pump	Pump to convey STA-3/4 discharges and water supply to WCA-2A
S-8	4160 cfs Pump	Pump to convey STA-3/4 (and STA-5/6) discharges and water supply to WCA-3A

(1) STA associated infrastructure will be identified prior to executing the PPA New Water

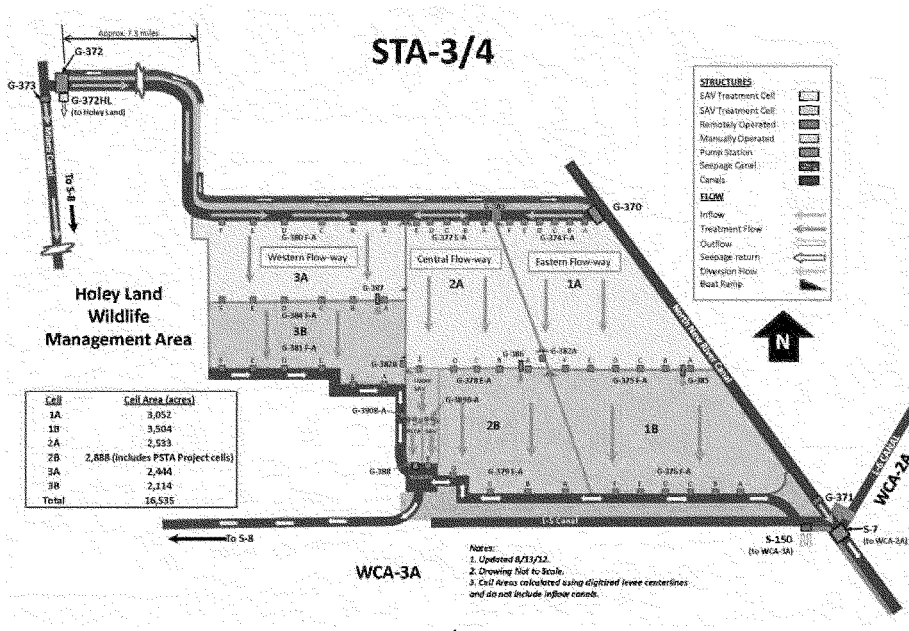

FIGURE A-9. STA 3/4 INFRASTRUCTURE

TABLE A-36. LIST OF STA 2 & ASSOCIATED INFRASTRUCTURE [1]

Structure	Structure/Design Capacity	Description
G-328	444 cfs Pump	Inflow Pump (co-located with culvert and 111 cfs pump for irrigation)
G-329A, B, C and D	197 cfs Gated Culvert	Cell 1 Inflow
G-330A, B, C , D and E	158 cfs Weir/Culvert	Cell 1 Outflow
G-331A, B, C , D, E, F and G	212 cfs Gated Culvert	Cell 2 Inflow
G-332	1485 cfs Gated Spillway	Cell 2 Outflow
G-333A, B, C , D and E	214 cfs Gated Culvert	Cell 3 Inflow
G-334	1071 cfs Gated Spillway	Cell 3 Outflow
G-335	3040 cfs Pump	Outflow Pump
G-336A, B, C , D, E, F and G	300 cfs Ungated Culvert	Culvert between L-6 Canal and WCA-2A
G-337	240 cfs Pump	Seepage Return Pump
G-337A	1020 cfs Gated Culvert	Inflow Canal Divide Structure
G-338	975 cfs Gated Spillway	Structure between Inflow Canal and WCA-1
G-339	2000 cfs Gated Spillway	Structure between Inflow Canal and L-6 Canal
G-341	600 cfs Gated Spillway	Ocean Canal Divide Structure

G-367 A, B, C , D, E, and F	110 cfs Gated Culvert	Cell 4 Inflow
G-368	1120 cfs Gated Culvert	Cell 4 Outflow
G-434	1120 cfs Pump	Inflow Pump
G-434S	300 cfs Pump	Seepage Return Pump
G-435	480 cfs Pump	Inflow Pump
G-436	1600 cfs Pump	Outflow Pump
G-338A, B, C , D and E	118 cfs Gated Culvert	Cell 5 Inflow
G-438F, G, H, I and J	106 cfs Gated Culvert	Cell 6 Inflow
G-440 A, B, C , D, E, and F	80 cfs Gated Culvert	Cell 7 Inflow
G-441	960 cfs Gated Culvert	Cell 8 Outflow
G-442	480 cfs Ungated Culvert	Cell 7 Outflow
G-443A and B	232 cfs Gated Culvert	Cell 4 Inflow
G-445	27 cfs Pump	Seepage Return Pump
S-6	2925 cfs Pump	Inflow Pump

(1) STA associated infrastructure will be identified prior to executing the PPA New Water

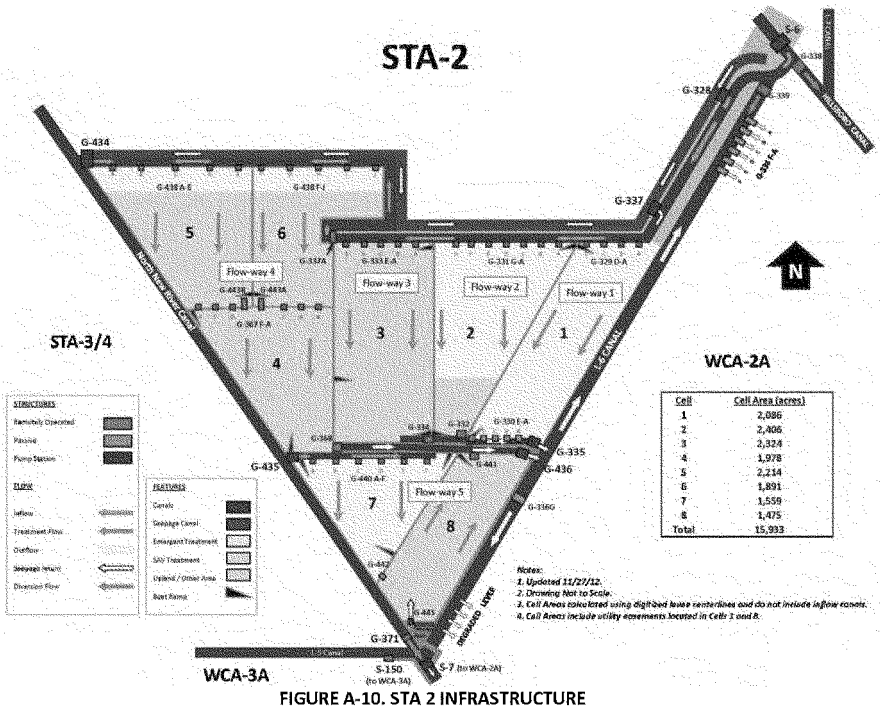

FIGURE A-10. STA 2 INFRASTRUCTURE

A.10 VALUE ENGINEERING

A joint Value Engineering (VE) Study and Cost Schedule & Risk Analysis Workshop for CEPP was conducted during the Analysis Phase 4-8 February, 2013. During the workshop various items were discussed and either screened for further consideration, retained as a possible Adaptive Management consideration or retained for Value Engineering recommendation for PED consideration. Those documented outcomes are described in the Value Engineering Study Report which is included as an Annex to Engineering Appendix and posted into the Value Engineering Library located on the USACE Value Engineering/Value Management Community of Practice Portal. A listing of the recommendations is provided below by project area. The Value Engineering Study satisfies the decision document VE requirements as stipulated in ER 11-1-321 Army Programs Value Engineering dated 01 January 2011. Appendix A, Annex B provides a copy of the Value Engineering Report.

A.10.1.1 North of Redline

- NR-1. Add outflow gravity structure on SE corner of A-2 - *Address recommendation in project design phase.*
- NR-2. Add in-line structure for North New River Canal - *Address recommendation in both current plan development and project design phase.*
- NR-3. Increase DS-8 gate capacity from 1,500 to 3,750 cfs to maintain existing drainage flowrate and water elevation - *Address recommendation in current plan development.*

A.10.1.2 South of Redline

- SR-1. Add AM strategy for G-336G (L-6 Diversion) - *Address recommendation in both current plan development and development of the adaptive management activities.*
- SR-2. Increase S-8 existing pump station horsepower and/or add supplemental exterior type pump unit(s) in lieu of constructing a new pump station - *Address recommendation in project design phase.*
- SR-3. Add new pump station (S-8) - *Address recommendation in project design phase.*
- SR-4. Integrate and optimize S-8 and G-404 system - *Address recommendation in both current plan development and project design phase.*
- SR-5. Re-visit USFWS/FWC Draft Ecological Guidelines for Water Management in WCA-2A – *Address recommendation in development of adaptive management activities.*

A.10.1.3 Blue/Green/Yellowline

- GB-1. Consider partial removal of the remaining length of the L-67 Extension Levee and/or system; also consider only partial removal of Old Tamiami Trail - *Address recommendation in development of adaptive management activities.*
- GB-2. Consider extending S-355B collector canal - *Address recommendation in both current plan development and development of the adaptive management activities*
- GB-3. Modify the ag canals in flowway - *Address recommendation in both current plan development and development of the adaptive management activities*

- GB-4. Use vegetation management to reduce vegetative resistance to water flow downstream of L-67A new structures S-345D & G - *Address recommendation in development of the adaptive management activities*
- GB-5. Retrofit DPM structure (S-152 800 cfs 10 - 60" HDPE barrels); Use DPM structure for interim period - *Address recommendation in both project design phase and development of the adaptive management activities*
- GB-6. Re-visit L-29 gated divide structure to determine actual flow need and gate flow size - *Address recommendation in both current plan development and development of the adaptive management activities*
- GB-7. Optimize operations at most northern structure into WCA 3B (consider for other control structures) - *Address recommendation in development of the adaptive management activities*
- Y-1. Determine new S-356 pump station capacity based on functional risk; do not design for both full contingency and unit redundancy - *Address recommendation in both current plan development and project design phase.*
- Y-2. For S-356, eliminate redundant pump but incorporate possible future expansion - *Address recommendation in project design phase.*
- Y-3. Defer construction of new S-356 pump station until adjacent seepage wall is constructed and system tested; further utilize existing S-356 temporary pump station - *Address recommendation in current plan development, project design phase and in development of the adaptive management activities.*
- Y-4. Phase implementation of seepage control features; use AM to determine path - *Address recommendation in development of the adaptive management activities*
- Y-5. Change the location L31N Seepage Management Pilot Project (SMPP) to the location which was the original location contained in the authorized decision document; use CEPP to increase the 902 Limit for L31N SMPP and install the L31N SMPP to remove project uncertainties. – *Not adopt. The L31N SMPP was the pilot component of the original CERP L-31N Improvements for Seepage Management. The CEPP PDT has decided to use the monitoring and results of a nearby constructed non-federal seepage project that was installed as described in main PIR sections 2.5.12 and section 6.10.2.1 to address project uncertainties for CEPP.*
- Y-6. Investigate alternative seepage barrier cutoff wall means (such as vinyl sheet pile) - *Address recommendation in project design phase.*

A.10.1.4 General

- GC-1. Create 'environmental friendly' conveyance channels where opportunity exits - *Address recommendation in both current plan development and project design phase.*
- GC-2. Coordinate vegetation management to achieve multiple objectives - *Address recommendation in development of adaptive management activities.*
- GC-3. Optimize pump station design - *Address recommendation in project design phase.*

A.10.1.5 Additional Value Engineering PED Considerations (Post VE Workshop)

After the VE workshop, cost and scope items were discussed and screened for further PED consideration. The robust description of cost assumption refinements are captured in Appendix B – Cost Engineering, Cost Assumptions documentation. A list of additional PED considerations from this effort is captured below:

- S-623 investigate construction in dry offset and offline from existing canal network and connecting both Miami Canal and STA 3 / 4 supply canal by 45 degree angle to this structure. This is to minimize interference with G-372 operations as partially restricting upstream conveyance is not preferred.
- S-628 investigate need for structure and it's function in PED. Possibly consider gravity outflow.
- L-624 investigate use of 7.5 miles of existing levee and it's capability to meet CEPP needs.
- S-621 investigate construction sequence and necessity of structure with S-622 and S-620 in coordination with STA 3 / 4 operations.
- S-8A New culverts investigate G-404 mods, S-8 mods, resizing spreader and a weir and all components tied to diverting flows south and east.
- S-622 investigate necessity for structure in PED.
- S-626 investigate tying in and utilizing the existing G-372 seepage pumps to reduce design capacity and move S-626 northward.
- C-624 investigate size and overland flow component to minimize having excess material
- C-624E investigate size and depth, remodel to minimize having excess material.
- C-626 investigate remodel and redesign cross section to minimize excess material.
- Tie A-2 FEB collection canal to the A-1 FEB to simplify canal improvements, reduce number of structures required for A-2 FEB outflow.

A.11 REFERENCES

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A.12 ENGINEERING PLATES

Plates
Annex C-2, Civil Plates L-4 Degrade, Cross Sections L-67A, L-67C, L-29, L-67D, Miami Canal Backfill/Islands
Annex D-1, Mechanical Plates M1 – M4

A.13 ENGINEERING APPENDIX SUPPORT DOCUMENTS

The following project plans were provided as similarly designed features as referenced in the main Engineering Appendix.

NOR - FEB Features
S-623 is referenced to S-65EX1
S-624, S-625 and S-628 are referenced to HHD (S-276 (C-4A) and S-277 (C-3))
S-627 is referenced to C-111 South Dade (S-327)
S-626 PS is referenced to S-357 design and Miller (S-486) layout (structural)

SOR Features
S-620 is referenced to HHD (S-276 (C-4A) and S-277 (C-3))
S-621 and S-622 are referenced to S-65EX1
S-630 PS is referenced to S-357 design and Miller (S-486) layout (structural)
S-8A

BGY Features
S-631, S-632 and S-633 (1 barrel each) are referenced to MWD and DECOMP (S-152)
S-333N and S-355W are referenced to S-65EX1
S-356 is referenced to Miller (S-486) and Merritt (S-488) (Plates for Merritt have been provided)
L-67D is referenced to (L-67A, L-67C and L-29 levees) and DECOMP (S-152)
Barrier Wall is referenced to L-31N SMPP and L-31N Rock Wall (plans already provided)

S-65EX1 Structural, Mechanical (PROVIDED)
12R0016_Plans1.pdf through 12R0016_Plans6.pdf

S-276(C-4A) (PROVIDED)
12R0025_Plans1.pdf – General, Civil (C-3, C-4, C-7, C-10), Structural
12R0025_Plans2.pdf – Mechanical, Electrical

S-277 (C-3) (PROVIDED)
12R0025_Plans3.pdf – General, Civil (C-3, C-4, C-7, C-10), Structural
12R0025_Plans4.pdf – Mechanical, Electrical

S-327 Data005.tif (PROVIDED)

S-357 and S-488 Structural, Mechanical
357a as-builts (357m101, 357m301, M302, 357m407) (PROVIDED)
357a as-builts (all remaining) (PROVIDED)
S-486 (in design)

S-488 Site, Structural and Mechanical (M1-M4) (PROVIDED)

DECOMP S-152, 12-R-0010 (PROVIDED)
L-67A and L-67C

L-31N SMPP
09R0028_Plans.pdf (PROVIDED)
L-31N seepage barrier 2 miles construction plans 10-2011.pdf (PROVIDED)

S-346
SFWMD Structure description sheet (PROVIDED)

ANNEX A-1: HYDRAULIC DESIGN

USACE Jacksonville District,
Water Resources Engineering Branch
February 2014

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A.1 INTRODUCTION

The CEPP recommended plan included numerous hydraulic features throughout the entire project extent. All features were identified and summarized in the Hydraulic Design sections of the EN Appendix. Supplemental material, including further detailed design analyses, is included in this Hydraulic Design Annex. The intent of this Annex is to provide a more thorough explanation of design criteria, assumptions, and modeling analysis. Further analysis will be conducted during PED phase in order to optimize all project features for performance and cost efficiency.

A.2 LOCATION MAPS

The CEPP project components north of the redline are located north of Holey Land and STA 3/4, and bounded on the east and west by the North New River Canal and Miami Canal, respectively. All north of redline features are located within Palm Beach County. L-6 Deliveries components south of the redline lie along the L-4 and L-5 Canals, which are on the border of Palm Beach County and Broward County. Components along the L-6 Canal are located in Palm Beach County.

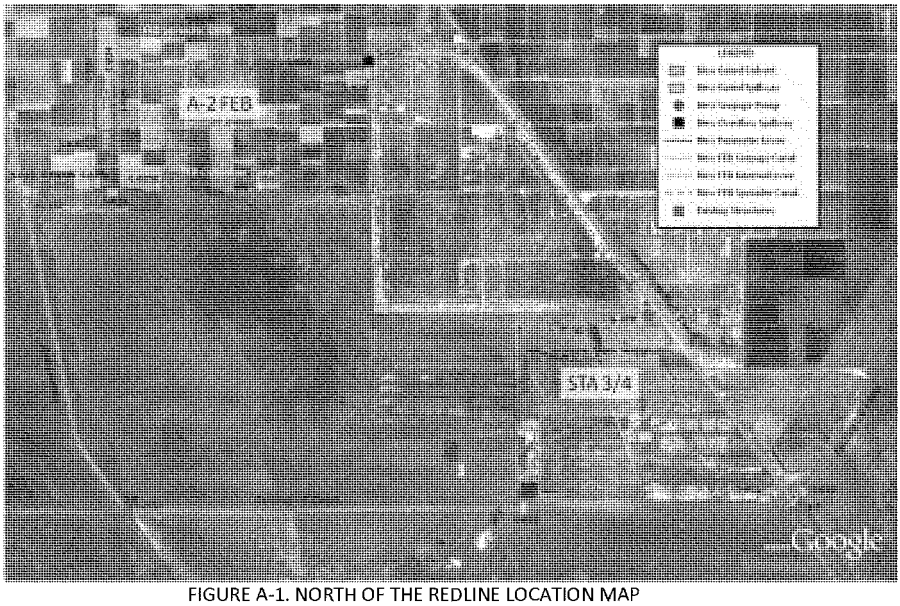

FIGURE A-1. NORTH OF THE REDLINE LOCATION MAP

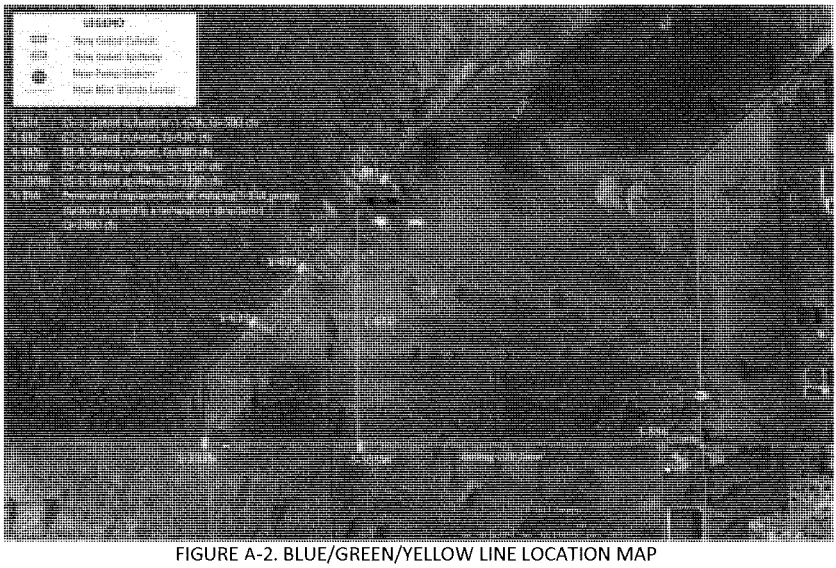

FIGURE A-2. BLUE/GREEN/YELLOW LINE LOCATION MAP

A.3. NORTH OF THE REDLINE ANALYSIS

A.3.1 MIAMI CANAL IMPROVEMENTS ANALYSIS

A.3.1.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.1.2 Objective

Using a steady flow HEC-RAS model, determine the existing conveyance capacity of the Miami Canal reach between Lake Okeechobee and the A-2 FEB proposed location, and identify the improvements needed for the canal to convey flows from the Lake. This analysis will also identify any low-lying reaches in the levees that may need improvements based on the outlined constraints. Cross section survey data, dated 2003, was used for design work. Flow through the model ran from S-354 south to G-372, a total length of 18.5 miles.

A.3.1.3 Assumptions/Constraints

Constraints and boundary conditions were determined based on the design criteria for the S-354 and G-372 structures.

- HW stage = 12.0 ft NGVD (10.6 ft NAVD); Design TW elev at S-354[1]
- TW stage = 10.0 ft NGVD (8.6 ft NAVD); Design HW elev at G-372[2]

- Design Flow Rate = 2,000 cfs from Lake Okeechobee
- Maintain a minimum 2 ft levee freeboard

Notes:
1. Prior Correspondence with SFWMD Operations Office; ECART project modeling
2. SFWMD, Operation Plan – STA 3/4, May 2004

	Average elevation, ft NGVD	Minimum elevation, ft NGVD
East (left) levee	20.67	15.64
West (right) levee	19.09	12.29

- Manning's n: n_{bank} = 0.05, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)
- Max velocity = 2.5 fps for limestone, based on GDM for NNR Canal (November 16, 1953)
- Steepest recommended canal side slopes = 1v:1h (typical slope excavated in South Florida due to limestone, as used in Modified Waters Deliveries to ENP)

A.3.1.4 Existing Conditions

1. The existing Miami Canal conditions were analyzed from S-354 south to G-372.
   - Design flow from S-354, Q = 2,000 cfs
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)

   Model Results – existing conditions:
   - Max WS elev = 13.03 ft NGVD (11.63 ft NAVD) *Violates max WS elev of 12.0 ft NGVD*
   - Minimum left levee freeboard = 2.61 ft
   - Minimum right levee freeboard = 1.87 ft *Violates minimum 2 ft freeboard*
   - Max channel velocity = 1.50 fps
2. The maximum conveyance through the Miami Canal with the given constraints is 1,550 cfs
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)

   Model Results at Q=1,550 cfs:
   - Max WS elev = 12.05 ft NGVD (10.65 ft NAVD)
   - Minimum left levee freeboard = 3.59 ft
   - Minimum right levee freeboard = 2.03 ft
   - Max channel velocity = 1.27 fps

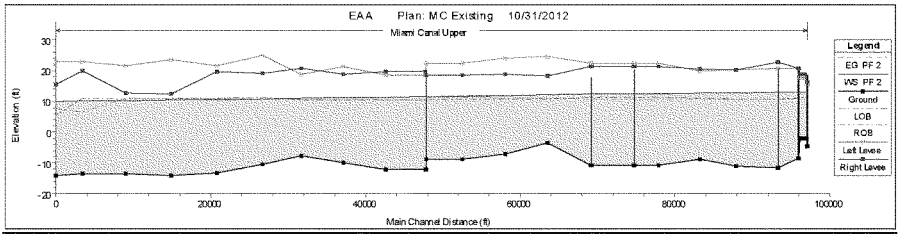

FIGURE A-3. MIAMI CANAL EXISTING CONDITIONS AT Q = 2,000 CFS (ELEVATIONS IN NGVD)

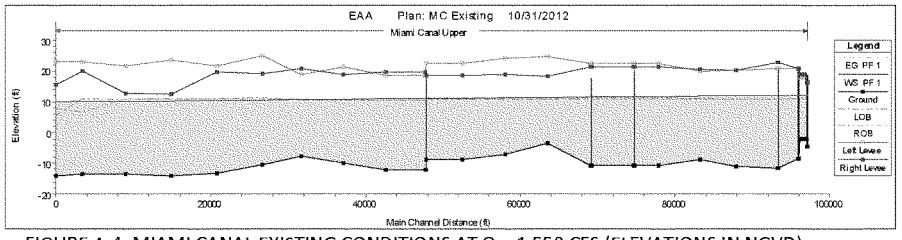

FIGURE A-4. MIAMI CANAL EXISTING CONDITIONS AT Q = 1,550 CFS (ELEVATIONS IN NGVD)

A.3.1.5 Canal Improvements

Template Design	
Template Depth:	20 ft
Bottom Width:	60 ft
Side Slope:	1
Manning's n value:	0.035
Bottom elevation:	-13.5 ft (NGVD)

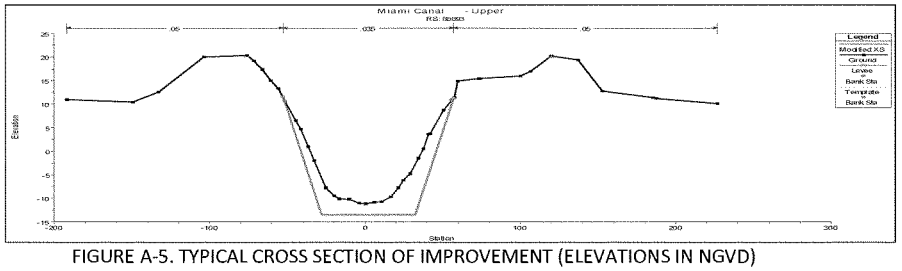

FIGURE A-5. TYPICAL CROSS SECTION OF IMPROVEMENT (ELEVATIONS IN NGVD)

Required excavation: 1,685,569 cy over a total reach length of 18.5 miles.

Model Results:

Max WS elev, ft NGVD	11.73
Max WS elev, ft NAVD	10.33
Minimum Left Levee Freeboard, ft	3.91
Minimum Right Levee Freeboard, ft	2.08
Max Channel Velocity, fps	1.7

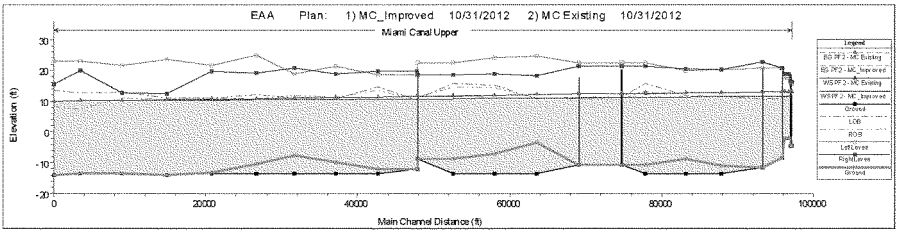

FIGURE A-6. FLOW PROFILE OF MIAMI CANAL WITH IMPROVEMENTS COMPARED TO EXISTING CONDITIONS (ELEVATIONS IN NGVD)

A.3.1.6 Conclusion

Modeling of the existing conditions of the Miami Canal indicated that the reach cannot convey the design flow of 2000 cfs with the assumed constraints. The existing conditions violate both the minimum freeboard criteria and the maximum upstream water surface elevation. Even with levee improvements at notable low spots, the maximum flow for the reach is 1550 cfs based on max upstream water surface elevation. The required improvements to convey the full design flow would require a bottom width expansion to 60 ft and a deepening to bottom elevation -13.5 ft NGVD (-14.9 ft NAVD). The total excavation required for those improvements is 1,685,569 cubic yards. The model results with the proposed improvements met all outlined assumptions and constraints. During modeling, the cross sections immediately upstream and downstream of the bridges were not included in improvements to avoid the need to improve/replace the bridges. The most narrow upstream/downstream bridge cross sections are located at RS 96898 and RS 96778; the cross section of RS 96898 is shown below to illustrate the existing bridge cross section to the proposed improved template.

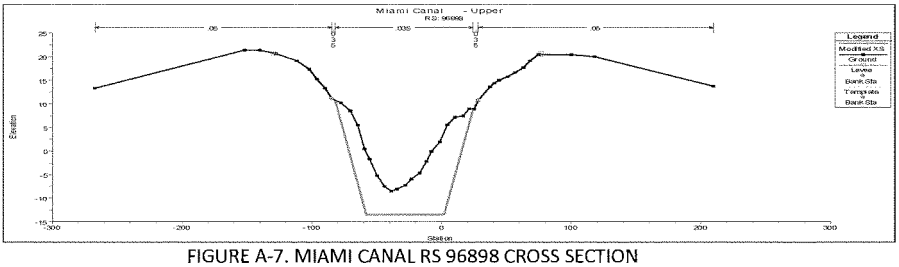

FIGURE A-7. MIAMI CANAL RS 96898 CROSS SECTION

A.3.2 NORTH NEW RIVER CANAL CONVEYANCE AND IMPROVEMENTS ANALYSIS

A.3.2.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.2.2 Objective

Using a steady flow HEC-RAS model, determine the existing conveyance capacity of the North New River (NNR) Canal reach between Lake Okeechobee and the A-1 FEB proposed location, and identify the improvements needed for the canal to convey flows from the Lake. Cross section survey data, dated 2003, was used for design work. Flow through the model ran from S-351 south to G-370, a total length of 22.5 miles.

A.3.2.3 Assumptions/Constraints

Constraints and boundary conditions were determined based on the design criteria for the S-351 and G-370 structures.

- HW stage = 12.0 ft NGVD (10.6 ft NAVD); Design TW elev at S-351[1]
- TW stage = 10.0 ft NGVD (8.6 ft NAVD); Design HW elev at G-370[2]
- Design Flow Rate = 2,000 cfs from Lake Okeechobee
- Maintain a minimum 2 ft levee freeboard

	Average elevation, ft NGVD	Minimum elevation, ft NGVD
East (left) levee	18.66	15.84
West (right) levee	18.56	16.34

- Manning's n: n_{bank} = 0.05, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)
- Max velocity = 2.5 fps for limestone, based on GDM for NNR Canal (November 16, 1953)
- Steepest recommended canal side slopes = 1v:1h (typical slope excavated in South Florida due to limestone, as used in Modified Waters Deliveries to ENP)

Notes:

3. Prior Correspondence with SFWMD Operations Office; ECART project modeling
4. SFWMD, Operation Plan – STA 3/4, May 2004

A.3.2.4 Existing Conditions

1. The existing NNR Canal conditions were analyzed from S-351 south to G-370.
   - Design flow from S-351, Q = 2,000 cfs
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)

   Model Results – existing conditions:
   - Max WS elev = 13.65 ft NGVD (12.25 ft NAVD) *Violates max WS elev of 12.0 ft NGVD*

- Minimum left levee freeboard = 3.75 ft
- Minimum right levee freeboard = 4.75 ft
- Max channel velocity = 2.24 fps

2. The maximum conveyance through the NNR Canal with the given constraints is 1,350 cfs
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)

   Model Results at Q=1,350 cfs:
   - Max WS elev = 11.99 ft NGVD (10.59 ft NAVD)
   - Minimum left levee freeboard = 4.78 ft
   - Minimum right levee freeboard = 5.78 ft
   - Max channel velocity = 1.56 fps

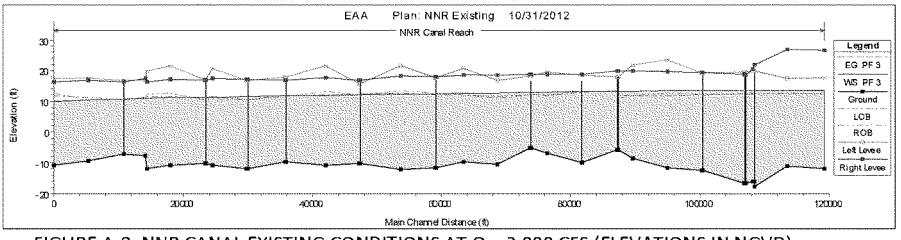

FIGURE A-8. NNR CANAL EXISTING CONDITIONS AT Q = 2,000 CFS (ELEVATIONS IN NGVD)

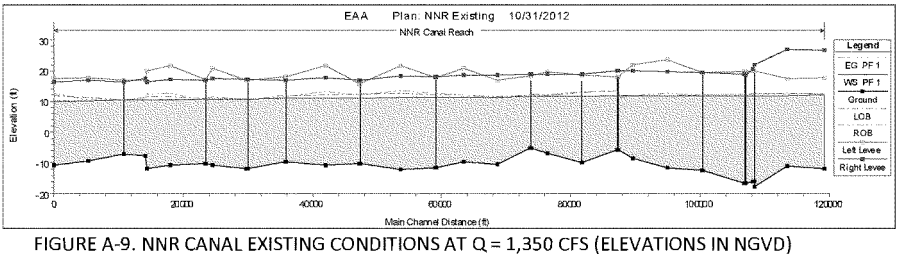

FIGURE A-9. NNR CANAL EXISTING CONDITIONS AT Q = 1,350 CFS (ELEVATIONS IN NGVD)

A.3.2.5 Canal Improvements

Template Design	
Template Depth:	30 ft
Bottom Width:	50 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-12.5 ft (NGVD)

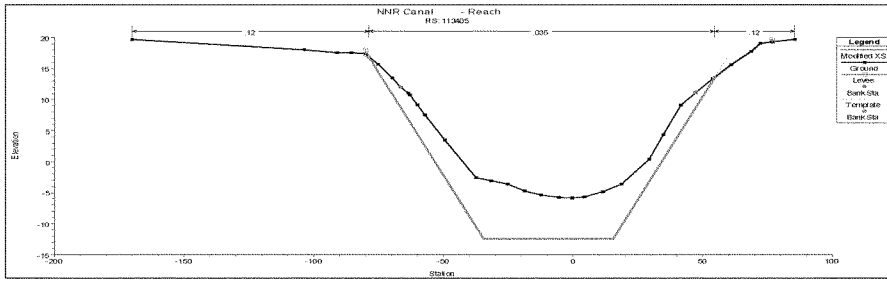

FIGURE A-10. TYPICAL CROSS SECTION OF IMPROVEMENT (ELEVATIONS IN NGVD)

Required excavation: 2,692,773 cubic yards over a total reach length of 22.5 miles.

Model Results:

Max WS elev, ft NGVD	11.97
Max WS elev, ft NAVD	10.57
Minimum Left Levee Freeboard, ft	5.04
Minimum Right Levee Freeboard, ft	6.04
Max Channel Velocity, fps	1.20

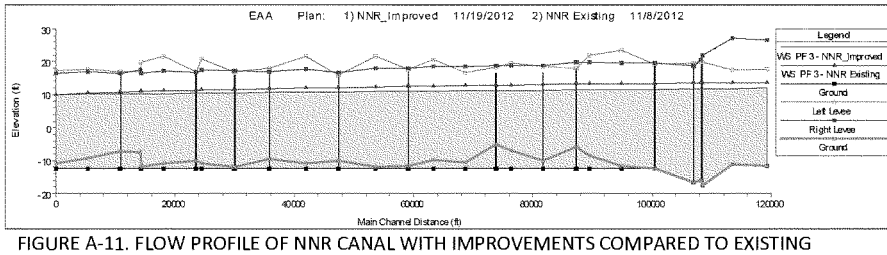

FIGURE A-11. FLOW PROFILE OF NNR CANAL WITH IMPROVEMENTS COMPARED TO EXISTING CONDITIONS (ELEVATIONS IN NGVD)

A.3.2.6 Conclusion

Modeling of the existing conditions of the NNR Canal indicated that the reach cannot convey the design flow of 2,000 cfs with the assumed constraints. The maximum flow for the reach is 1,350 cfs. The required improvements to convey the full design flow would require a bottom width expansion to 50 ft and a deepening to bottom elevation -12.5 ft NGVD (-13.9 ft NAVD). Improvements begin at RS 121023, leaving reaches in the canal where the bottom elevation is already lower than the proposed template as is. The total excavation required for those improvements is 2,692,773 cubic yards. The model results with the improvements met all outlined assumptions and constraints. Since improvements were made throughout the entire length of the NNR Canal to G-370, all bridges within the reach must be improved and/or replaced to accommodate the new channel template.

A.3.3 INFLOW CANAL ANALYSIS (CANAL C-624)

A.3.3.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.3.2 Objective

Using a steady-state HEC-RAS model, determine the necessary sizing of the canal providing inflow to the A-2 FEB. The canal will convey 1,550 cfs[1] from Lake Okeechobee via the Miami Canal, STA 3/4 Supply Canal, and S-624 gated control structure. The canal will be modeled as a stand-alone reach, not including geometry from the entire CEPP system; however, flows and water surface stages from upstream CEPP features will be used to establish constraints and design criteria.

A.3.3.3 Assumptions/Constraints

- Design HW stage = 14.25 ft NGVD
- Design TW stage = 13.0 ft NGVD
- Design flow rate = 1,550 cfs
- Design maximum velocity = 2.5 fps for limestone, based on GDM for NNR Canal (November 16, 1953)
- FEB perimeter levee height = 20.3 ft NGVD
- Interior levee height = 20.3 ft NGVD
- Canal length = 4.0 miles (21,120 ft)
- Manning's n: n_{bank} = 0.05, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)

A.3.3.4 Model Results

Template Design	
Template Depth	9.0 ft
Bottom Width	40 ft
Top Width	76 ft
Side Slopes (L/R)	1V:2H/1V:2H
Manning's n value	0.035
Invert elevation	0.0 ft NGVD
Bank elevation	9.0 ft NGVD
Levee elevation	20.3 ft NGVD

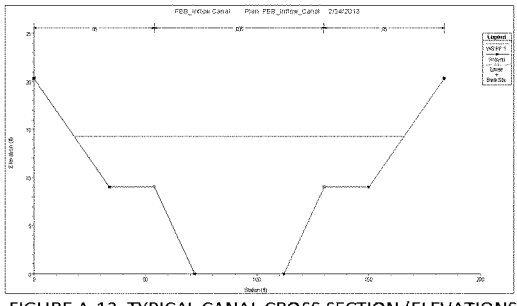

FIGURE A-12. TYPICAL CANAL CROSS SECTION (ELEVATIONS IN NGVD)

[1] Initial analysis of the Miami Canal and North New River Canal assumed 2,000 cfs discharge from Lake Okeechobee; however, the project team chose to utilize the existing capacity of the Miami Canal, therefore further design analysis used 1,500 cfs for a design flow.

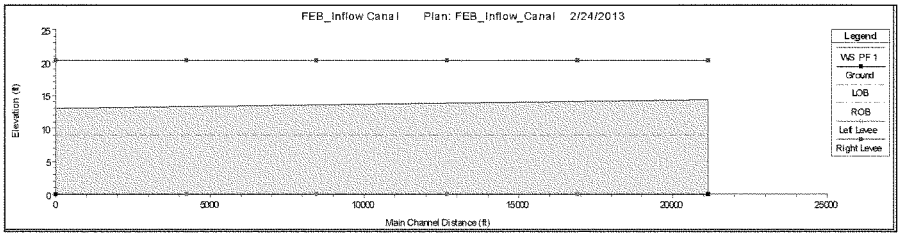

FIGURE A-13. CANAL PROFILE (ELEVATIONS IN NGVD)

River Sta	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
21120	0.00	14.27	14.31	0.000049	1.51	1217.21	147.64	0.08
16896.*	0.00	14.06	14.09	0.000052	1.55	1185.56	146.5	0.08
12672.*	0.00	13.83	13.86	0.000056	1.58	1151.84	144.96	0.08
8448	0.00	13.58	13.61	0.000061	1.63	1115.70	143.46	0.08
4224.*	0.00	13.30	13.34	0.000067	1.68	1076.65	141.82	0.09
0	0.00	13.0	13.04	0.000075	1.74	1034.00	140.0	0.09

TABLE A-1. HEC-RAS OUTPUT (* INDICATES INTERPOLATED CROSS SECTIONS)

A.3.3.5 Conclusion

A steady flow HEC-RAS analysis was conducted to determine the necessary canal template to convey the design flow rate. The resulting canal design required a template with a bottom width of 40 feet, canal depth of 9.0 feet, maximum water surface depth of 14.27 feet, and a total length of 4.0 miles. The S-624 (DS-5) gated structure is at the headwater of the inflow canal, conveying flows from the Miami Canal via the STA 3/4 Supply Canal. Due to the locations of the S-624 and S-625 (DS-7) structures along the FEB perimeter, the inflow canal will begin approximately 100 feet from the southern FEB perimeter. Since this analysis is used primarily to provide costs for alternatives, the cross sectional flow area is the key design component to determine total excavation volumes. Optimization of canal design will be conducted during the PED phase for performance and cost efficiency.

A.3.4 FEB SPREADER CANAL DESIGN (CANAL C-624E)

A.3.4.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.4.2 Objective

Using an unsteady flow HEC-RAS model, determine the necessary sizing of a spreader canal along the northern border of the A-2 FEB to distribute identified inflows from the Miami Canal. The discharge of the flow should be evenly distributed across the entire length of the reach.

A.3.4.3 Assumptions/Constraints

- Design HW = 13.0 ft NGVD
- Design TW = 12.0 ft NGVD
- Length = 4 miles (21,120 ft)
- Manning's n: n_{bank} = 0.05, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)

A.3.4.4 Model Results

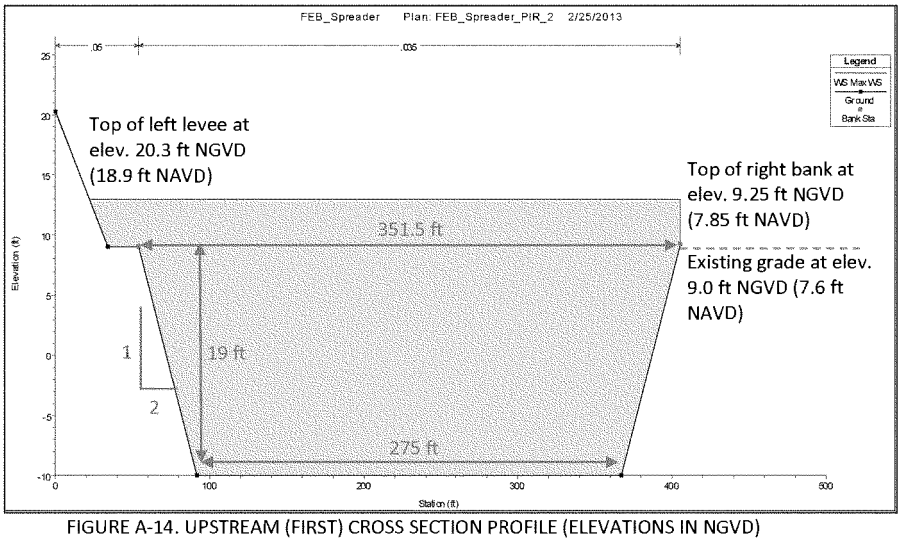

FIGURE A-14. UPSTREAM (FIRST) CROSS SECTION PROFILE (ELEVATIONS IN NGVD)

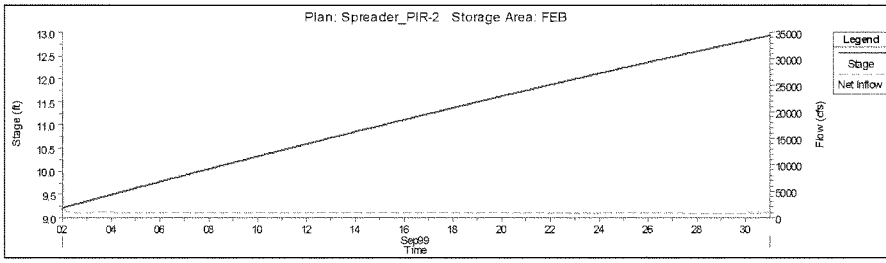

FIGURE A-15. FEB STAGE AND FLOW HYDROGRAPH (ELEVATIONS IN NGVD)

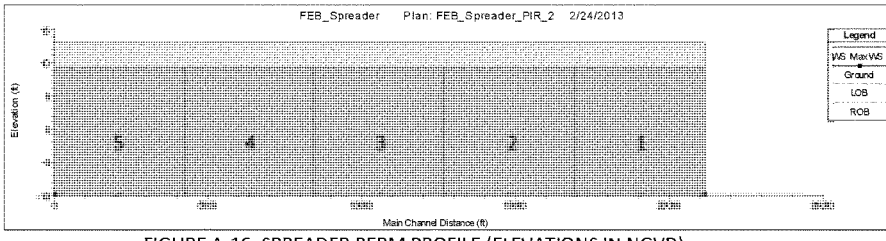

FIGURE A-16. SPREADER BERM PROFILE (ELEVATIONS IN NGVD)

Segment	Lateral Structure	Q Leaving Total (cfs)	% Total Flow
1	21119	259.06	20.68
2	16895	253.21	20.22
3	12671	249.2	19.89
4	8447	246.4	19.67
5	4223	244.81	19.54
Total		**1,252.58**	**100.00**

TABLE A-2. LATERAL STRUCTURE OUTFLOWS

A.3.4.5 Conclusion

The spreader canal was divided into five evenly spaced segments (lateral structures) of 4,224 ft in length, with a consistent top elevation at 9.25 ft NGVD; 0.25 ft above the existing ground elevation of 9.00 ft NGVD. A uniform canal template with a flow area of 5,951.75 sq ft was used throughout the length of the canal. The bottom of the canal was set at elevation -10.0 ft NGVD, with a bottom width of 275 ft. Side slopes for both the left and right banks were set to 1V:2H. The left (north) boundary will be along the FEB perimeter levee, while the right (south) bank will be a berm 0.25 ft above natural grade. This configuration produced a spreader system with evenly distributed out-of-bank flow and filled the FEB to a max stage of 12.94 ft NGVD within the 30 day simulation period (normal max pool depth at elevation 13.00 ft NGVD).

A.3.5 FEB DISCHARGE CANAL DESIGN/CANAL IMPROVEMENTS (C-625W CANAL)

A.3.5.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.5.2 Objective

Determine the necessary sizing of the canal providing discharge from the A-2 FEB to the headwater of the G-372 pump station. The canal will convey 1,550 cfs from the FEB through the S-625 (DS-7) gated control structure. The seepage canal adjacent to the north side of the STA 3/4 Supply Canal will be improved and used as the A-2 FEB discharge canal. The existing conditions of the seepage canal cannot accommodate the design discharge from A-2, so an expanded and deepened canal template will be required. The discharge canal will begin at S-625 and terminate upstream of the G-372, for a total length of approximately 1.5 miles. In addition to the improvements to the existing seepage canal, a short segment of a canal will have to be constructed to by-pass the G-372 seepage pump and tie in to the STA 3/4 Supply Canal. This segment is included in the total length of the reach in this analysis.

A.3.5.3 Assumptions/Constraints

- Design HW stage = 11.0 ft NGVD
- Design TW stage = 10.0 ft NGVD
- Design flow rate = 1,550 cfs
- Design maximum velocity = 2.5 fps for limestone, based on GDM for NNR Canal (November 16, 1953)
- Canal length = 1.5 miles
- Manning's n: n_{bank} = 0.05, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)

A.3.5.4 Model Results

Template Design	
Template Depth	21ft
Bottom Width	20 ft
Top Width	104 ft
Side Slopes (L/R)	1V:2H/1V:2H
Manning's n value	0.035
Invert elevation	-5.0 ft NGVD
Left bank elevation	16.0 ft NGVD
Right bank elev.	16.0 ft NGVD
Left levee elev.	23.0 ft NGVD
Right levee elev.	20.3 ft NGVD

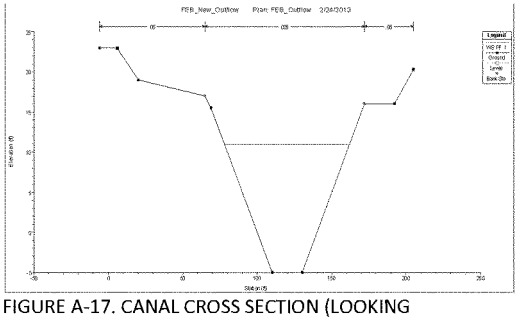

FIGURE A-17. CANAL CROSS SECTION (LOOKING DOWNSTREAM)

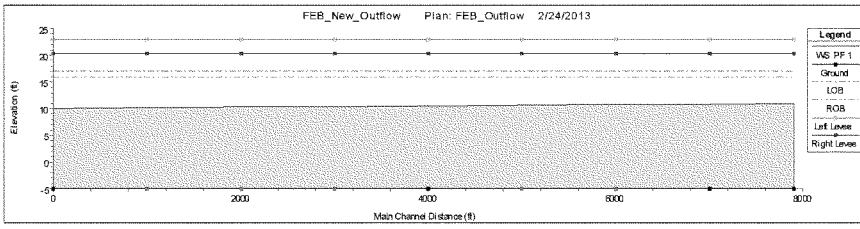

FIGURE A-18. DISCHARGE CANAL PROFILE

River Sta	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
7900	1550	-5.0	10.94	10.99	0.000103	1.87	826.89	83.76	0.11
7000	1550	-5.0	10.84	10.90	0.000106	1.89	818.92	83.38	0.11
6000*	1550	-5.0	10.73	10.79	0.000109	1.91	809.87	82.94	0.11
5000*	1550	-5.0	10.62	10.68	0.000113	1.94	800.58	82.49	0.11
4000	1550	-5.0	10.51	10.57	0.000116	1.96	791.03	82.03	0.11
3000*	1550	-5.0	10.39	10.45	0.000120	1.98	781.23	81.55	0.11
2000*	1550	-5.0	10.26	10.33	0.000125	2.01	771.13	81.05	0.11
1000*	1550	-5.0	10.13	10.20	0.000129	2.04	760.73	80.53	0.12
0	1550	-5.0	10.0	10.07	0.000134	2.07	750.00	80.00	0.12

TABLE A-3. HEC-RAS OUTPUT (* INDICATES INTERPOLATED CROSS SECTIONS)

A.3.5.5 Conclusion

The resulting canal design required a template with a bottom width of 20 feet, bottom elevation of -5.0 ft NGVD, canal depth of 21 feet, maximum water surface elevation of 10.94 ft NGVD, and a total length of 1.5 miles. Since this analysis is used primarily to provide costs for alternatives, the cross sectional flow area is the key design component to determine total excavation volumes.

A.3.6 FEB SEEPAGE COLLECTION CANAL ANALYSIS (C-626 CANAL)

A.3.6.1 Purpose

This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.6.2 Objective

Determine the sizing of the seepage canal necessary to accommodate the EN-GS provide seepage rate for the A-2 FEB.

A.3.6.3 Assumptions/Constraints

A seepage rate of 387 cu. ft/day/ft of levee at normal pool depth (4 ft deep) was used as provided by the Engineering Division, Soil Section (EN-GS), along with a seepage canal template and dimensions provided by the project Engineering Technical Lead (ETL). A factor of safety of 1.5 was applied to the seepage rate, giving an adjusted rate of 580.5 cu. ft/day/ft of levee. The total linear length of seepage canal around the FEB area is approximately 11 miles. The template and seepage rate were modeled in HEC-RAS to determine whether the given seepage canal geometry sufficiently conveyed the estimated seepage rate.

A.3.6.4 Conclusion

A steady flow HEC-RAS model was used to determine the necessary sizing of the seepage canal. The model determined the provided seepage canal template is sized appropriately to convey the adjusted seepage rate of 580.5 cu. ft/day/ft of levee. The maximum outflow resulted in 389.69 cfs. A seepage return pump with a total capacity of approximately 500 cfs would be required to return seepage flows back into the FEB. A proposed pump location is along the western perimeter of the FEB, north of the S-625 outlet structure and will discharge into the outflow canal. Since this analysis is used primarily to provide costs for alternatives, the cross sectional flow area is the key design component to determine total excavation volumes.

TABLE A-4. SEEPAGE COLLECTION CANAL DATA

Design seepage rate	580.5	cu. ft/day/ft of levee
	0.0067	cfs/ft of levee
Bottom Width	15.0	ft
Top Width	73.0	ft
Side Slope	1V:2H	
Average Cross sectional Flow area	507.47	sq ft
Natural grade	9.0	ft, NGVD
Bottom elevation	-5.5	ft, NGVD
Top of bank	9.0	ft, NGVD
Top of levee	18.0	ft, NGVD
Length of levee	58,000	Linear feet

	11.0	miles

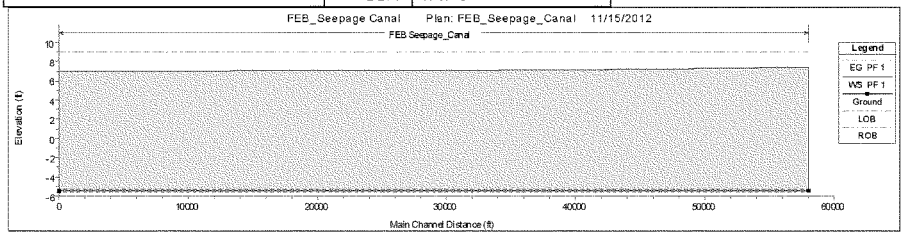

FIGURE A-19. SEEPAGE COLLECTION CANAL FLOW PROFILE

Max Water Surface Elev.	7.44	ft, NGVD
Max discharge	389.69	Cfs
Max velocity	0.74	fps

A.3.7 FEB EMERGENCY OVERFLOW SPILLWAY

A.3.7.1 Objective
This intermediate hydraulic design is used solely to provide parameters for the calculation of quantities for the purpose of costing alternatives. Final design will be performed in PED phase.

A.3.7. 2 Assumptions/Constraints

- Low hazard potential (HPC) classification; IDF = ½ PMP
- Normal pool depth = 4 ft (elev. 13.0 ft NGVD)
- Maximum pool depth = 6 ft (elev. 15.0 ft NGVD) – maintains low HPC and manages wind/wave impacts
- 50% PMP rainfall (72-hr storm) per ER-1110-8-2(FR)
- 100-yr 24hr storm per DCM-2
- 5-yr 72 hr storm per DCM-3
- Initial stage in FEB = 13.0 ft NGVD (max pool elevation)
- Downstream initial stage = 9.0 ft NGVD (natural grade)

A.3.7.3 Model Results and Analysis:

To determine the weir length, an unsteady HEC-RAS model was run comparing design criteria from ER 1110-8-2(FR) and DCMs 2 and 3. Based on DCM-1, the A-2 FEB was determined to have a low hazard potential classification (HPC). For Low HPC, DCM-2 requires the routing of the 100-yr 24-hr storm plus 60 mph wind applied to the peak surcharge stage. DCM-3 states that the Basis of Review ERP extends the basin permitted rate (storm implicit) to a 100-yr storm level to ensure that the WRDA 2000 Saving's Clause is not effectively violated. For the EAA, the ERP basin rule is 20 cfs/sq. mile (CSM) (approximately ¾" per day, or 440 cfs) for the 5-yr (assume 72-hr) storm event. Extending the discharge rate to the 100-yr 72-hr storm is above the DCM-2 requirement for low HPC impoundment/reservoir storm routing, which is the 100-yr 24-hr storm. In urban areas, the ERP rule is usually near the 20 CSM discharge rate, but it is typically combined with the 25-yr 72-hr storm event versus the 5-yr storm. Therefore, extending the ERP rule to the 100-yr 72-hr rate would provide better protection from a potential for impact than for urban areas.

Given those design criteria and guidance, the three different storm events (100-yr 24-hr; 100-yr 72-hr; and 50% 72-hr PMP) were routed with a max discharge rate of 440 cfs. The hydrographs shown in Figures A-20 to A-22 illustrate the storm rainfall and rainfall rates for each scenario. Each storm was run with a weir crest elevation of 13.00 ft NGVD and 13.50 ft NGVD; however, a final crest elevation of 13.50 ft NGVD was selected to provide an additional 6" above the normal spillway crest setting at Normal Flood Surface Level (NFSL) to prevent overtaxing of the seepage management system with more common frequent storm events since the spillway does not directly discharge into an adjacent major canal.

Table A-5 summarizes the HEC-RAS model results of each of the storm events. The use of the 100-yr 24-hr storm event at the DCM-3 recommended rate of 440 cfs resulted in a weir length of 265 feet. This allows a 3 foot freeboard on the USACE historically required 50% PMP surcharge pool peak stage on the Low HPC impoundment with the proposed minimal 9 foot embankment

(nearly so, 2.85 foot freeboard actually). This freeboard lowers risk of breach with extreme storm events.

TABLE A-5. OVERFLOW SPILLWAY MODEL RESULTS

Storm	Discharge Criteria	ERP Flow rate (cfs)	Crest Elev. (ft, NGVD)	Crest Length (ft)	Max Stage (ft, NGVD)	Max Head, weir (ft)	Max Depth (ft)	Max Flow (cfs)
100-yr 24-hr	3/4"/day	440	13	110	14.13	1.13	5.13	437.01
			13.5	265	14.14	0.64	5.14	443.42
100-yr 72-hr	3/4"/day	440	13	70	14.54	1.54	5.54	442.92
			13.5	125	14.56	1.06	5.56	447.8
			13.5	265	14.52	1.02	5.52	815.38
Previous 50%, 72-hr PMP			13.5	1,500	15.03	1.53	6.03	3,007.42
			13.5	265	15.15	1.65	6.15	1,845.57

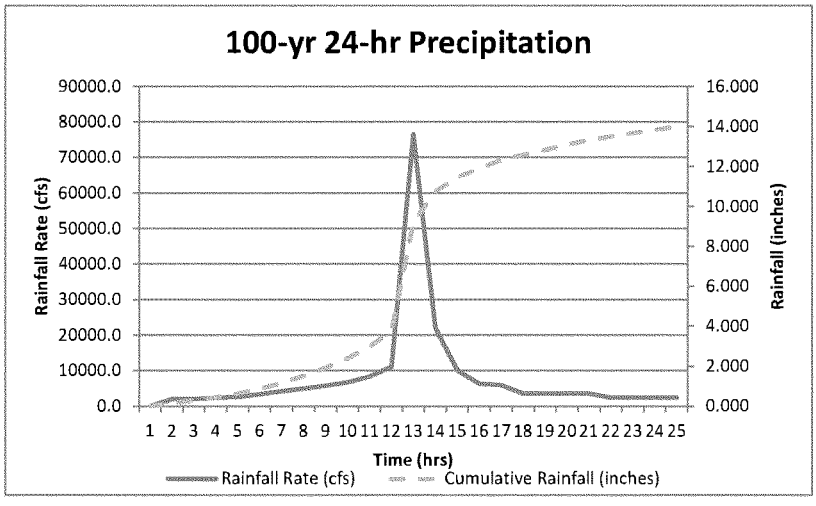

FIGURE A-20. 100-YR 24-HR STORM EVENT (Rainfall reference: SFWMD Technical Publication EMA #390, January 2001; Santa Barbara Urban Hydrograph Method (SBUH))

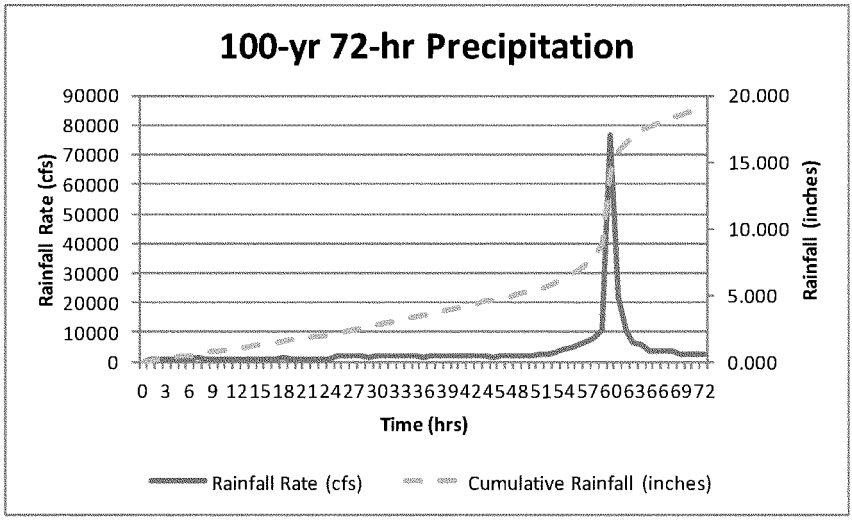

FIGURE A-21. 100-YR 72-HR STORM EVENT (Rainfall reference: SFWMD Technical Publication EMA #390, January 2001; Santa Barbara Urban Hydrograph Method (SBUH))

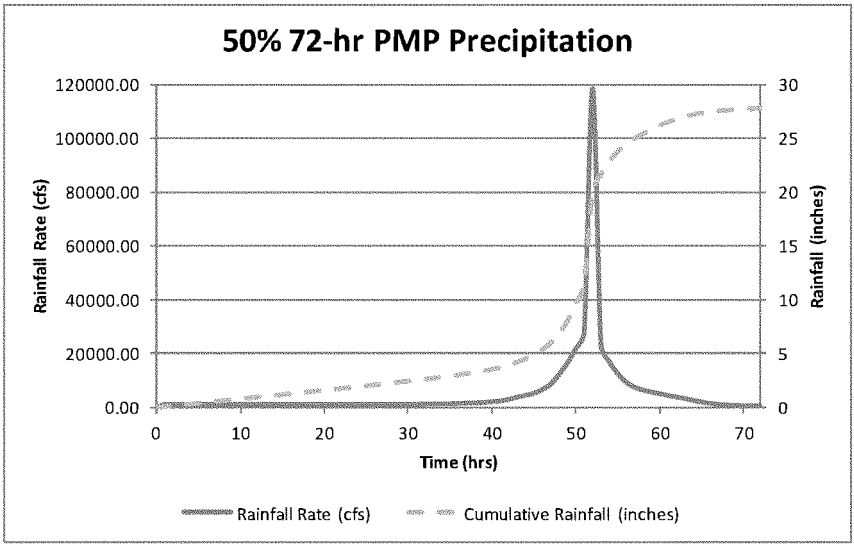

FIGURE A-22. 50% 72-HR PMP STORM EVENT (Rainfall reference: NOAA Hydrometeorological Report (HMR) 51, June 1978; Santa Barbara Urban Hydrograph Method (SBUH))

TABLE A-6.
S-627 Emergency Overflow Spillway
Hydraulic Design Data Sheet

Location A-2 FEB northeast corner; adjacent to the S-628 structure

Purpose The S-627 emergency overflow spillway will provide uncontrolled discharge from the A-2 FEB during extreme events into the adjacent seepage canal along the northern perimeter of the A-1 and A-2 FEBs.

Design Conditions	Discharge	1,845	cfs
	Headwater Elevation	15.15	feet, NGVD 29
	Tailwater Elevation	9.00	feet, NGVD 29
Maximum Expected Stages			
	Headwater Elevation	15.25	feet, NGVD 29
	Tailwater Elevation	10.00	feet, NGVD 29
Maximum Head Differential			
	Headwater Elevation	15.25	feet, NGVD 29
	Tailwater Elevation	9.00	feet, NGVD 29
Weir Design Data			
	Weir Type	Broad-crest	
	Crest Elevation	13.50	feet, NGVD 29
	Crest Length	265.00	feet
	Minimum Tieback Elevation	TBD	feet, NGVD 29
	Weir Control	Passive, none	
Canal Data	A-2 FEB		
	Side Slope Cotangent	3	
	Bottom Width	Pool	
	Bottom Elevation	9	feet, NGVD 29
	Combined Seepage/Spillway Conveyance		
	Side Slope Cotangent	2	
	Bottom Width	15	feet
	Bottom Elevation	-5.5	feet, NGVD 29
Apron/Riprap Requirements - to be verified with final geotechnical design			
	Apron Length	30	feet
	Minimum Riprap Size	TBD	feet

			A.3.8 S-623 Spillway								
			Miami Canal								
Structure Design Criteria											
1	Design Discharge =	3700	cfs					SPF Information			
2	Design Headwater Elev Hd =	10.25	ft NGVD	Hd =	6.750	feet		SPF Discharge =			cfs
3	Analize Headwater Elev He =	10.25	ft NGVD	He =	6.77	ft		SPF Headwater =			ft NGVD
4	Design Tailwater Elev =	10.00	ft NGVD	He/H'd =	1.003			SPF Tailwater =			ft NGVD
5	Crest Elevation =	3.50	ft NGVD	h or Hs =	6.5	ft					
6	Single Gate Crest Width =	35	ft	Hs/He =	0.960			Optimum Water Surface Elevations			
7	Number of gates =	4		Delta H or hd =	0.25	feet		High headwater =			ft NGVD
	Net Crest Width =	140	feet	Delta-H /He=	0.03694			High Tailwater =			ft NGVD
8	Intermediate Pier Width =	3.25	feet					Low Headwater =			ft NGVD
9	Upstr Canal Bottom Width =	100.00	feet					Low Tailwater =			ft NGVD
10	Upstr Bottom of channel Elev =	-13.5	ft NGVD					Max Headwater =			ft NGVD
11	Side Slope = 1 on	2.0	ft NGVD					Lowest tailwater =			ft NGVD
12	Natural Grade Upstream =	6	ft NGVD								
13	Natural Grade Downstream =	6	ft NGVD					Protection Elevations			
14	Highest Headwater el	12.00	ft NGVD					Wave Surge at SPF =			feet
15	Gate clearance above water	1.00	feet					Structure Protection Elev =			ft NGVD
	Upstream Approach Velocity =	1.06	fps					Upstream Riprip Elev =			ft NGVD
								Downstream Riprip Elev =			ft NGVD
Crest Length Reduction due to Contractions			Warning!! Check for wave runup.					BreastWall Elevation =			ft NGVD
	From Plate 7 EM 1110-2-1603		Computed Ka and Kp from charts					Clearance Elevation =			ft NGVD
16	Pier Type (1, 2, 3 or 4)	2	Kp=	0.013							
	Number of Gates =	4	Ka=	0.174							
	Number of Piers =	3									
	Width of Gates =	35	feet								
	Height of Gates	9.5	feet	Recommended height							
17	Height of Gates	14	feet	***Designer's choice***				Area (h*L) =	910	sqft	
	Gate Aspect Ratio (about 2.0) =	2.50	OK					Unit Q q =	26.429	cfs/ft	
	Top of Gate elev	13.00	ft NGVD	Clearance Elev				Upstr Depth	23.75	feet	
	L=L'-2(N *Kp+Ka)He	137.12	feet					Upstr Avg Area	3503.13	sq ft	
	Crest discharge/foot q=	26.985	cfs/ft								
	Apron Width =	149.75	feet	Net Crest Width + Pier width(s)				OR Levee Elevation			
COEFFICIENT OF DISCHARGE COMPUTATION											
18	Trial Upstr Apron Elev =	-2	ft NGVD								
	Computed Free Discharge Coefficients		High or Low Ogee Weir?								
	Approach Apron Height P=	5.50	feet	Ratio P/Hd =	0.815	Apron Elevation Ok					
	Approach velocity =	2.02	fps								
	Coefficient of Free Discharge Cf =	3.916	<<<<<	**From Plate 31 EM 1110-2-1603**							
19	Designer Discharge Coeff=	3.8500	***Designers Judgement***								
	Free Discharge Qf= C*L*He^1.5	9,293	cfs - HDC 111-4/1; Is Hs/Hc < 0.4?				**->NO!, Must Use Submerged Discharge Qs**				
DISCHARGE REDUCTION FOR SUBMERGENCE FORMULAS OUTPUT											
Low Ogee Crests Discharge Coeficient Reduction: Submerged Flow											
	From Plate 33 EM 1110-2-1603										
20	Trial Downstr Apron Elev =	-2.00	ft NGVD								
	Corps Reduction Factor Data d=	12.00	feet	(Hd+d)/He =	1.81	H/He =	0.04				
21	Corps % Reduction =	48.14%	**<<<<Look up on EM 1110-2-1603 Plate 3-5 or HDC 111-4**								
				Coefficient							
	Corps Reduced Coefficient =	0.5186	x Cf =	2.031							
	USGS Reduced Coefficient Cs/C=	0.4068	x Cf =	1.566							
	SCS Reduced Coefficient qs/q =	0.2670									
DISCHARGE REDUCED FOR SUBMERGENCE											
	REQUIRED Discharge =		3,700	cfs (From original input)							
	Corps Qs = C x (% Reduction) x L x He^1.5 =		4,820	cfs *Warning! Assumed Apron Elev, Recheck after downstream Apron design.							
				Be sure to check Apron design and Re-enter Dwnstr Elev if Reqd.							
	USDWC Qs =Cs*L*He^1.5		3,758	cfs							
	SCS Qs = (qs/qf)*Qf =		2,481	cfs							
	Average Discharge		3,694	cfs							
	SFWMD Qs =Qf*(1-(Hs/He)^1.5)^0.385 =		3,137	cfs							
										k	
	D'Aubusons Qs= k*A*(2g(Hw-Tw)+V^2)^0.5 =		3,209	cfs	k from M 1110-2-1605 pg 5-14					0.85	
	Delta H/He< 0.2 Ok to use D'Aubusons Q		3,021	cfs	If Del H >1.0 then k = 0.85; if Del H < 1.0 K= 0					0.8	

	Apron Design	Alternate Controlling	Ogee Design							
		1	2							
22	Design Discharge	3700	3700	cfs	Designers Choice; Choose higher computed discharge					
23	Headwater for Apron =	10.25	10.25	feet,ngvd						
24	Tailwater for Apron =	10	10	feet,ngvd	!!!Lowest tailwater with maximum discharge					
	Trial Apron Elevation =	-2	-2	feet,ngvd	Chosen at beginning of design process					
25	Design Apron Elevation =	-2	-8.5	feet,ngvd	*Designers choice to Change Check line10*					
	Congugate Depth "E" =	12.25	18.75	feet						
	$q/(E^{1.5})$ =	0.629	0.332							
	D_2/E =	0.5096	0.3801		Computed From Congugate Depth Curve					
	Computed D2 =	6.24	7.13	feet	(1)					
	Actual D2 (Tw El - Apron El) =	12	18.5	feet	(2)					
	Designers Choice D2 =	12	18.5	feet						
	Alternate Design 1 d/D2 =	192.24%		OK - Controlling D2 ratio > 85%						
	Alternate Design 2 d/D2 =		259.56%	Ok-Controlling D2 Ratio > 85%						
	D1/E =	0.0825	0.0415		Computed From Congugate Depth Curve					
	Computed D1 =	1.011	0.779	feet						
	Velocity at D1 Depth =	26.693	34.653	fps						
	Frude no. F1 =	4.678	6.920		Jump Classified as =	Steady jump				
	Design Apron Elevation =	-2	-8.5	feet						
	Designed Apron Width =	149.75	149.75	feet						
	Average Apron Velocity =	2.06	1.34	fps						
	Hydraulic Jump Length No Baffles =	35.81	43.11	feet	On Flat Floor No Baffles or Endsill EM1110-2-1603 (7-1)					
	Length of basin with Baffles =	14.32	19.85	feet	Lb=K*D1*F1^1.5 K=1.4 EM1110-2-1603					
	Apron Length with Baffles =	20.46	28.35	feet	Lb=K*D1*F1^1.5 K=2.0 EM1110-2-1603					
	Apron Length (2.5xD2) =	30.00	46.25	feet	Previous Recommendations					
	Apron Length (3xD2) =	36.00	55.50	feet	Previous Recommendations					
25	Designer Apron Length =	36.00	55.00	feet	*Designers choice*	Minimum Design OK				
	Baffle Block Design									
	Baffle Block Height =	2.00	1.01	feet	EM-1110-2-1603 Plate 7-4					
26	Designer Block Height D1 =	2.00	1.00	feet	*Designers choice*					
27	Design Width of Block (D1) =	2.00	2.00	feet	*Designers choice*				74.88	
	Top of Baffle Elevation =	0.00	-7.50	feet,ngvd						
	Distance from Toe of Ogee to Upstream Face of First Row of Blocks									
	Distance from Toe of Ogee =	18.11	12.00	feet	EM-1110-2-1603 Plate 7-4					
	Distance from Toe of Ogee =	9.36	10.69	feet	First Row of Blocks from OgeeWeir 1.5*D2					
28	Designer Distance to 1st row =	18.00	12.00	feet	*Designers choice*					
	Distance from Toe of Ogee to Upstream face of Second Row of Blocks									
	Distance from Ogee toe=	15.36	19.94	feet	Second Row of Blocks from OgeeWeir First Row + 0.5*D2					
29	Designer Distance to 2nd Row =	15.00	20.00	feet	*Designers choice*					
	End Sill Design			Edsill width =	1.00	feet				
	End Sill Height (D2/12) =	1.000	1.542							
	End Sill Height (D1/2) =	0.505	0.389			Slope =	13.889%			
	Recommended Height =	0.505	0.389							
30	Designer Sill Height =	0.50	1.00	feet	*Designers Choice*					
	End Sill Elevation	-1.5	-7.5	feet,ngvd						
	Additional Length ot basin	2.00	3.00	1 on 1 slope from apron floor to top of endsill						
	Total Apron Length from Ogee Toe =	38.00	58.00	feet						
	End Sill Froude No. =	0.11	0.06		ok					
	End Sill Velocity =	2.15	1.41	fps		Velocity < 9.0 fps, Design OK				
31	RipRap Velocity	5.00	5.00	fps	*Designers Recommendation*					

A.4. EAA FLOW EQUALIZATION BASIN EMBANKMENT HEIGHT EVALUATION

A.4.1 Introduction

The purpose of this study was to determine the minimum embankment height required for Everglades Agricultural Area (EAA) Flow Equalizing Basin (FEB) for a given set of design conditions.

Using a given design wind speed, pool depth, embankment slope, and embankment armor type, the wave run-up and over-wash rates at the embankment can be readily predicted. In the case of EAA FEB, this evaluation also includes the presence of vegetation. Vegetation has a dissipative effect on wave energy, which can significantly reduce wave heights and subsequent run-up and over-wash rates. Based on an allowable over-wash rate, the embankment height can then be determined.

The presence of permanent vegetation within the FEB basin allows for the use of the Vegetated Basin Evaluation Tool (VBET) (USACE, 2007). This tool combines wind speed, fetch, water depth, and vegetation type to predict the wave climate in the basin, Based upon the embankment type, slope of the embankment, and the allowable over-wash rate, the tool than determines the wave run-up on the interior embankment slopes and the resultant minimum embankment height.

A.4.2 Design Criteria

A.4.2.1 Wind Condition

The design wind condition is a key parameter in establishing embankment dimensions. For EAA FEB the design wind is 60mph. This wind speed was determined based on the recommended design wind speed for a Low Hazard Potential Classification (Low HPC) basin as outlined in Design Criteria Memorandum No. 2 (SFWMD, 2006).

A.4.2.2 Fetch

Fetch is defined as a distance over which the wind speed and direction are reasonably constant. Fetches fall into two categories, open-water fetches, where wave growth is limited only by the incident meteorological conditions, and restricted fetches, where wave growth is limited by a confined geometry such as that of a lake, river, bay, or reservoir. EAA FEB has a restricted fetch.

The restricted fetch methodology applies the concept of wave development in off-wind directions and considers the shape of the basin. The fetch is defined as the radial average over an arc of 24 degrees centered on the wind direction. For this study, the wind direction (for determination of the fetch-limited wind speed) is taken to be the direction corresponding to the maximum *averaged* (effective) fetch distance. This will provide the maximum design fetch for determining the maximum possible duration. Figure A-23 shows the FEB 24-degree arc, divided into 3-degree intervals. Averaging the radial lengths over each arc gives an effective fetch length of 34,990 feet (6.6 miles).

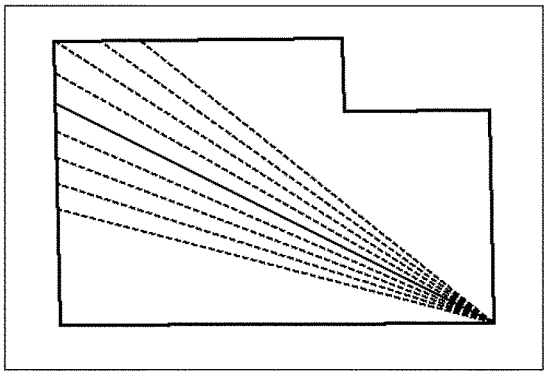

FIGURE A-23. EAA FEB FETCH DETERMINATION GRAPHIC

A.4.2.3 Water Depth

For this analysis, two water depth cases were evaluated, the 24 hour, 100 year storm maximum stage and the 50%, 72 hour PMP maximum stage. Assuming a maximum normal pool depth of 4.0 feet, the maximum water storage depths for these cases are 5.38 feet and 6.03 feet, respectively.

It should be noted that these are still water depths. Under sustained storm wind conditions, wind setup will force water levels higher at the downwind end of the basin, increasing the water depth at the toe of the embankment. For shallow basins wind setup has a significant role in determining embankment height.

Wind setup is calculated internally by the VBET model using Bretschneider's model (Ippen, 1966). Wind setup for the EAA FEB basin, under the given design conditions, is 2.3 feet for the 24 hour, 100 year storm stage case and 2.09 feet for the 50%, 72 hour PMP stage. These result in maximum total water depths at the downwind embankment of 7.68 feet and 8.09 feet, respectively.

A.4.2.4 Vegetation Type

It is assumed that vegetation, specifically cattails, will be a permanent feature of the EAA FEB basin. Therefore, embankment heights were evaluated for fully emergent vegetation. Within the VBET model, vegetation is represented by a Manning's n coefficient. Manning n values for emergent vegetation was specified as 0.35 (USACE, 1954).

A.4.2.5 Embankment Types and Slopes

In order to allow for flexibility in design, two types of embankment types were evaluated, smooth earth and riprap armored (on the interior slope). Two embankment slopes were also considered for each embankment type, 1V:3H and 1V:4H.

A.4.2.6 Allowable Over-wash Rate

Based on previous EAA documentation and on-site over-wash testing, the allowable over-wash rate was specified as 0.1 cfs/lf.

A.4.2.7 Wave Heights and Wave Periods

The VBET tool employs a look-up method to determine the wave climate within the basin. The VBET look-up database contains a series of STWAVE (Smith et al., 1999) numerical wave model runs covering a wide range of wind speed, fetch lengths, and vegetation types. Based on specified design criteria, the VBET model determines the wave height and wave period for those conditions.

A.4.3 Wave Run-up

Wave run-up can be described as the resulting forward translation of water mass that is converted from wave energy as waves encounter a sloped surface. Water rushes up the slope resulting in the vertical rise above the still water line known as run-up (Figure A-24).

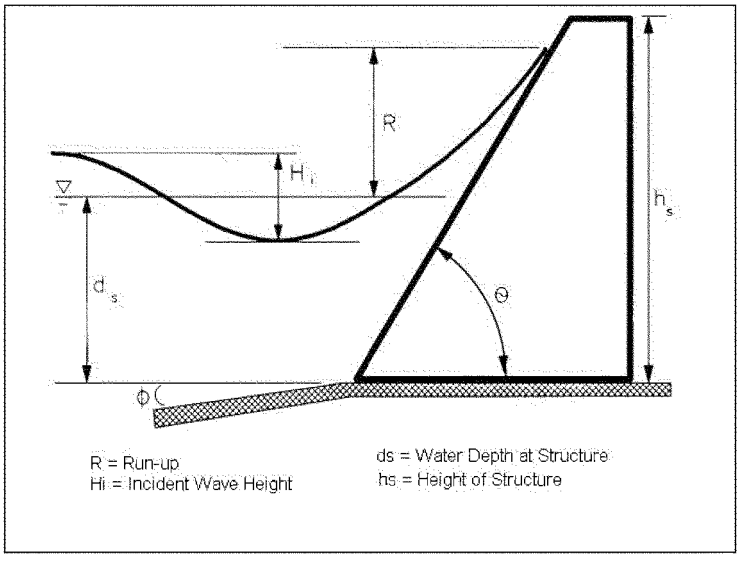

FIGURE A-24. WAVE RUN-UP DIAGRAM

A.4.3.1 Effective Depth

Although the generation of wind waves (and therefore wave run-up and over-wash) is influenced by the presence of wind setup, the relationship is highly complex and is not presently included in the methodology for determining wave height and period. Therefore, in order to include the total water

level increase due to wind conditions at the down-fetch face of the levee, wind setup is generally accounted for by adding the wind setup to the design water depth at the toe of the structure. The resulting "effective depth" then becomes the water depth used during calculation of wave run-up and subsequent over-wash. The effective depths for the given design cases are 7.68 feet for the 24 hour, 100 year storm stage case and 8.09 feet for the 50%, 72 hour PMP stage.

A.4.3.2 VBET Run-up Methodologies

VBET relies on two methodologies that allow for the estimation of wave run-up on smooth (earth) and rough (riprap) embankments.

Smooth Slope Wave Run-up (Earth)
Smooth slope run-up, as presented by Ahrens and Titus (1975), recommends the following general equation:

$$R = CH_i$$

where R is wave run-up, H_i is the incident wave height, and C is a coefficient characterized by the surf similarity parameter ξ.

Rough Slope Wave Run-up (Riprap)
The rough slope wave run-up formulation, as presented by Ahrens and McCartney (1975), was empirically derived from physical model studies conducted for specific structures and wave climates. According to this method, run-up is predicted as a nonlinear function of the surf parameter, ξ, and is defined as follows:

$$R = Hi\frac{a\xi}{1+b\xi}$$

where *a* and *b* are empirical coefficients associated with slope roughness (0.956 and 0.398, respectively).

A.4.4 Over-wash

Over-wash occurs when wave run-up and wind setup levels combine to produce a water level greater than the height of the levee. Over-wash is an important design element both in terms of predicting backside flooding and safeguarding structural integrity of the levee. Several methods exist for predicting the over-wash flow rate in a given situation. The VBET model employs an irregular wave over-wash method developed by Ahrens (1977). This method uses the following assumptions: run-up values caused by an irregular wave field will follow a Rayleigh probability distribution; significant deepwater wave height, H_s, causes significant run-up R_s, and parametersα, Q^*_o, and H_o remain constant for all members of the distribution.

Ahrens estimates the over-wash rate by summing the over-wash contributions from each individual member of the run-up distribution:

$$Q = \frac{1}{199}\sum_{i=1}^{199} Q_i$$

Where Q is the volume rate of over-wash caused by irregular waves (cfs/lf) and Q_i is the volume rate of over-wash caused by one run-up on the run-up distribution.

Ahrens accounts for the effect of irregular waves when the freeboard is less than the run-up of the significant wave, R_s. When the freeboard is greater than the significant wave run-up, R_s, larger run-ups in the distribution may still overtop the structure. For these relatively high freeboards, the run-up distribution is broken into 999 elements, instead of 199, to better resolve the effect of the higher run-ups. The over-wash equation for this larger distribution becomes:

$$Q = \frac{1}{999}\sum_{i=1}^{999} Q_i$$

For a given allowable over-wash rate (to be specified by the user), the above run-up and over-wash formulations are used to determine the embankment height at which the allowable over-wash rate will not be exceeded.

A.4.5 Results

The VBET model was run for all of the design cases. Wave height and wave period at the toe of the embankment, as well as the resulting wave run-up results are shown in Table A-7.

TABLE A-7. VBET WAVE AND RUN-UP RESULTS

Design Case	Wave Height (ft)	Wave Period (sec)	Embankment Type	Embankment Slope	Wave Run-up (ft)
24hour, 100year Storm	0.08	4.3	Earth	1:3	0.20
				1:4	0.22
			Riprap	1:3	0.16
				1:4	0.15
50%, 72 hour PMP	0.10	4.3	Earth	1:3	0.24
				1:4	0.28
			Riprap	1:3	0.19
				1:4	0.18

Based on predicted wave conditions, embankment characteristics, and maximum allowable over-wash rate, a recommended embankment height can be determined. Table A-8 provides the VBET determined embankment heights with corresponding freeboards for each of the design cases.

TABLE A-8. VBET EMBANKMENT HEIGHTS

Design Case	Embankment Type	Embankment Slope	Embankment Height (ft)	VBET Freeboard* (ft)
24hour, 100year Storm	Earth	1:3	7.7	2.3
		1:4	7.7	2.3
	Riprap	1:3	7.7	2.3
		1:4	7.7	2.3
50%, 72 hour PMP	Earth	1:3	8.1	2.1
		1:4	8.1	2.1
	Riprap	1:3	8.1	2.1
		1:4	8.1	2.1
* Freeboard is defined as the vertical distance between the maximum water storage level and the embankment crest				

A.4.6 Conclusions

As shown in Table A-6, the presence of emergent vegetation damps wave energy significantly resulting in minimal wave run-up. This minimal run-up, combined with low wave energy and an allowable over-wash rate of 0.1 cfs/lf, then results in relatively low and uniform freeboard requirements for each of the design cases. In each of these cases, the VBET determined freeboard requirement is governed by the extent of wind setup rather than the amount of wave run-up. This is typical of vegetated basins with significant wave damping.

According to USACE guidance (USACE, 1991) the minimum required freeboard for a Low HPC impoundment is 3 feet above the maximum storage level. In each of the study cases, the freeboard determined by VBET (to ensure an average over-wash rate of less than 0.1cfs/lf) is less than 3 feet. Therefore, the recommended freeboard is dictated by the minimum requirement for a Low HPC basin (3.0 feet) rather than the wind and wave conditions for the site. For all variations of the 24 hour, 100 year storm case, the recommended embankment height (as measured from crest to toe) is 8.38 feet (5.38 feet maximum storage depth + 3.0 feet of freeboard). For all variations of the 50%, 72 hour PMP, the recommended embankment height is 9.03 feet (6.03 feet maximum storage depth + 3.0 feet of freeboard).

A.4.7 References

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A.5 SOUTH OF THE REDLINE ANALYSIS

A.5.1 L-5 Conveyance and Improvements Analysis

A.5.1.1 Objective

Determine the existing conveyance capacity of the L-5 Canal and identify the improvements needed for the canal portions east and west of the plug to convey flows from the L-6 and STA 3/4. Using L-5 survey data from 2007, 155 cross sections were cut 500 ft apart for a total length of 14.6 miles. Flow through the model ran from east beginning at the North New River Canal (NNR) westward to the Miami Canal.

A.5.1.2 Assumptions/Constraints

USACE and SFWMD H&H team members met via conference call on 22 August 2012 to discuss the acceptable assumptions and constraints for modeling purposes. All criteria outlined below are results from the discussion.

- HW stage = 12.0 ft NGVD (10.6 ft NAVD) at S-7 and/or G-379B
- TW stage = 10.0 ft NGVD (8.6 ft NAVD) at S-8
- Design Flow 1: Q=500 cfs at NNR from L-6 conveyance
- Design Flow 2: Q=3,000 cfs after plug [3,000 cfs = 2,500 cfs (STA 3/4) + 500 cfs (L-6), or 3,000 cfs from STA 3/4 only]
- Maintain a minimum 2 ft levee freeboard; can overtop L-5 banks as consistent with current operations

	North (right) levee average elev., ft NGVD (NAVD)	South (left) levee average elev., ft NGVD (NAVD)
East L-5	18.57 (17.17)	15.47 (14.07)
West L-5	16.82 (15.42)	22.54 (21.14)

- Manning's n: n_{bank} = 0.1, n_{canal} = 0.035 (Source: C&SF Project General Studies and Reports, Part I, Supplement 18)
- Existing plug removed and replaced with a gated spillway (refer to section A.5.1.5)
- Max velocity = 2.5 fps for limestone, based on GDM for NNR Canal (November 16, 1953).

FIGURE A-25. L-5 CANAL LOCATION MAP

Refer to Appendix A for location map and Appendix B for S-7, S-8, and G-379B exceedance plots.

A.5.1.3 Existing Conditions

A.5.1.3.1 Eastern Remnant Canal:

1. The remnant canal existing conditions were analyzed from NNR to the plug.
   - Design flow from L-6 canal, Q = 500 cfs
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 11.5 ft NGVD (10.1 ft NAVD) – assumed a head loss of 0.5 ft for design purposes
   - Outlying high points in the channel bottom were brought to an average bottom elevation (RS=74198.19).

   Model Results:
   - Max WS elev = 12.30 ft NGVD (10.90 ft NAVD) *Violates max WS elev of 12.0 ft NGVD*
   - Minimum south (left) levee freeboard = 5.41 ft
   - Minimum north (right) levee freeboard = 2.02 ft
   - Max channel velocity = 1.22 fps

2. The maximum conveyance through the remnant canal with the given constraints is 350 cfs.
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD)
   - Boundary condition: TW = 11.5 ft NGVD (10.1 ft NAVD)
   - Outlying high points in the channel bottom were brought to an average bottom elevation (RS=74198.19).

   Model Results:
   - Max WS elev = 11.97 ft NGVD (10.57 ft NAVD)
   - Minimum south (left) levee freeboard = 5.82 ft
   - Minimum north (right) levee freeboard = 2.43 ft
   - Max channel velocity = 0.85 fps

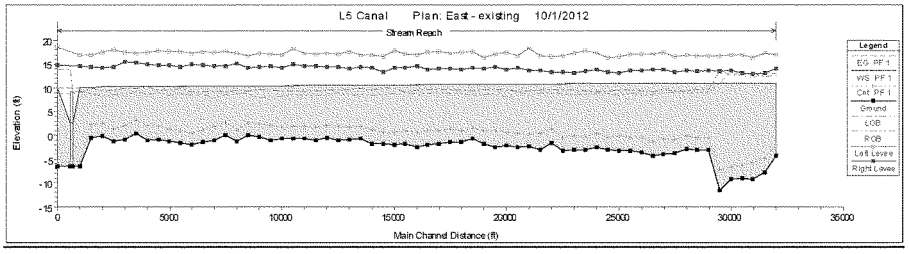

FIGURE A-26. REMNANT CANAL EXISTING CONDITIONS AT Q=500 CFS (ELEVATIONS IN NAVD)

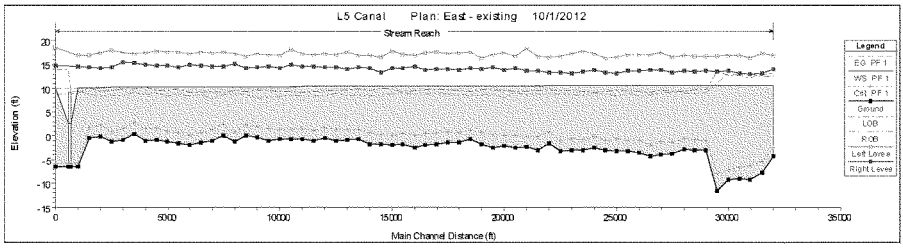

FIGURE A-27. REMNANT CANAL EXISTING CONDITIONS AT Q = 350 CFS (ELEVATIONS IN NAVD)

A.5.1.3.2 Western Canal:

1. The western canal existing conditions were analyzed from the plug to the Miami Canal.
   - Design flow from STA 3/4, Q = 3,000 cfs (assume no L-6 canal contribution)
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD) at G-379B (STA 3/4 outflow structure)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)
   - Outlying low points in the levees were brought to an average top elevation (RS = 45201.45 and RS = 43696.43).

   Model Results:

   - Max WS elev = 14.11 ft NGVD (12.71 NAVD) *Violates Max WS elev of 12.0 ft NGVD*
   - Minimum south (left) levee freeboard = 5.92 ft
   - Minimum north (right) levee freeboard = 2.09 ft
   - Max channel velocity = 2.55 fps

2. The maximum conveyance through the remnant canal with the given constraints is 1750 cfs.
   - Constraint: HW = 12.0 ft NGVD (10.6 ft NAVD) at G-379B (STA 3/4 outflow structure)
   - Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)
   - Outlying low points in the levees were brought to an average top elevation (RS= 45201.45 and RS = 43696.43).

   Model Results:

   - Max WS elev = 11.97 ft NGVD (10.57 ft NAVD)
   - Minimum south (left) levee freeboard = 8.06 ft
   - Minimum north (right) levee freeboard = 4.12 ft
   - Max channel velocity = 1.52 fps

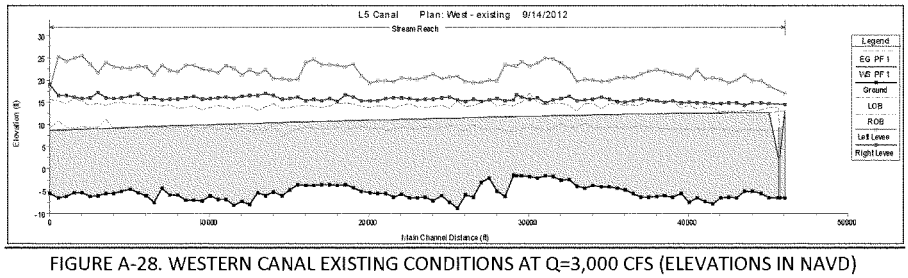

FIGURE A-28. WESTERN CANAL EXISTING CONDITIONS AT Q=3,000 CFS (ELEVATIONS IN NAVD)

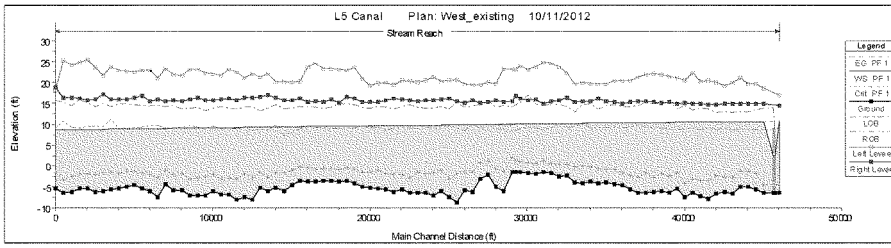

FIGURE A-29. WESTERN CANAL EXISTING CONDITIONS AT Q=1,750 CFS (ELEVATIONS IN NAVD)

A.5.1.3.3 Full L-5 Canal:

- Design flow from L-6 (500 cfs) and STA 3/4 (2500 cfs), Q = 3,000 cfs
- Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)
- Outlying low points in the levees were brought to an average top elevation (RS=74198.19).
- Outlying high points in the channel bottom were brought to an average bottom elevation (RS=45201.45 and RS = 43696.43).

Model Results:

- Max WS elev = 14.48 ft NGVD (13.08 ft NAVD) *Violates Max WS elev of 12.0 ft NGVD*
- Minimum south (left) levee freeboard = 3.31 ft
- Minimum north (right) levee freeboard = -0.08 ft (overtops), RS = *Violates minimum freeboard of 2.0 ft at RS = 76138.88*
- Max channel velocity = 2.55 fps

To support 500 cfs inflow from the L-6 canal via gravity conveyance structures, the conveyance in the western portion of the L-5 would need to be reduced to 1,100 cfs.

- Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)
- Outlying low points in the levees were brought to an average top elevation (RS=74198.19).
- Outlying high points in the channel bottom were brought to an average bottom elevation (RS=45201.45 and RS = 43696.43).

Model Results:

- Max WS elev = 12.01 ft NGVD (10.61 ft NAVD)
- Minimum south (left) levee freeboard = 5.78 ft
- Minimum north (right) levee freeboard = 2.39 ft
- Max channel velocity = 1.34 fps

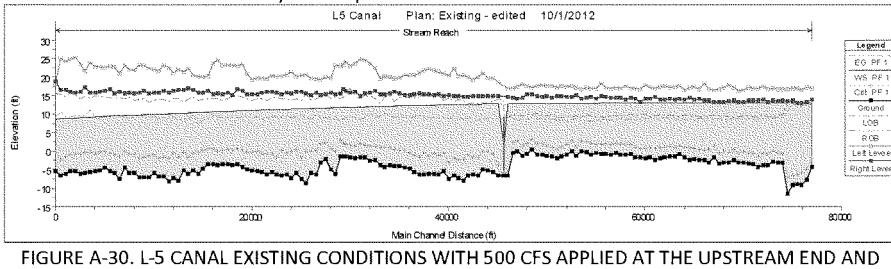

FIGURE A-30. L-5 CANAL EXISTING CONDITIONS WITH 500 CFS APPLIED AT THE UPSTREAM END AND 3,000 CFS APPLIED DOWNSTREAM OF THE PLUG REPLACEMENT (ELEVATIONS IN NAVD)

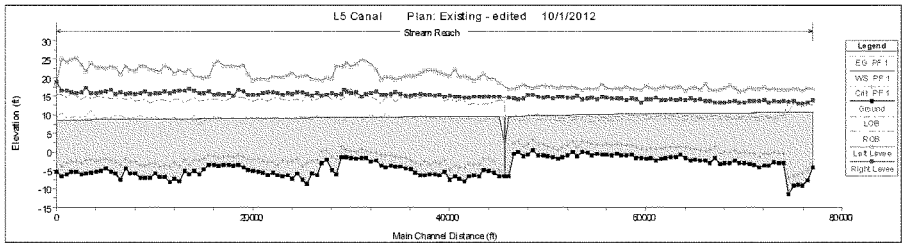

FIGURE A-31. L-5 CANAL EXISTING CONDITIONS WITH 500 CFS APPLIED AT THE UPSTREAM END AND 1,100 CFS APPLIED DOWNSTREAM OF THE PLUG REPLACEMENT (ELEVATIONS IN NAVD)

A.5.1.4 Canal Improvements

Four scenarios were considered to determine the improvements needed to the east and/or west portions of the L-5 canal to convey all proposed flows from the L-6 canal and STA 3/4; 1) full L-5 improvements and 2) western canal improvements only; 3) no L-6 conveyance; and 4) use of pump station rather than gravity structure.

Assumptions for all scenarios:

- HW stage = 12.0 ft NGVD (10.6 ft NAVD) at S-7 and/or G-379B
- TW stage = 10.0 ft NGVD (8.6 ft NAVD) at S-8
- Q=500 cfs, simulating inflows from L-6 canal
- Q=3,000 cfs, simulating: 1) 2,500 cfs inflows from STA 3/4 plus 500 cfs inflow from L-6 canal, or 2) 3,000 cfs inflow from STA 3/4 only.
- Manning's n: $n_{bank} = 0.1$, $n_{canal} = 0.035$
- Maintain a minimum 2 ft levee freeboard; can overtop banks
- Design maximum velocity = 2.5 fps for limestone, based on GDM for NNR Canal
- Outlying low points in the levees were brought to an average top elevation.
- Outlying high points in the channel bottom were brought to an average bottom elevation.

Scenario 1: Full L-5 Canal Improvements to convey flows from L-6 and STA 3/4

East Canal:

Template Design	
Template Depth:	20 ft
Bottom Width:	50 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-6.5 ft (NAVD)

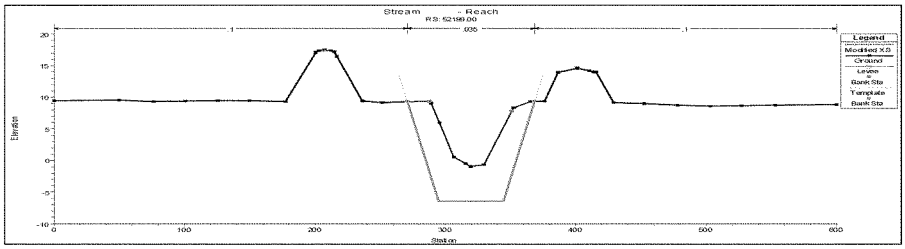

FIGURE A-32. TYPICAL CROSS SECTION OF SCENARIO 1 IMPROVEMENT; SOUTH LEVEE (LEFT), NORTH LEVEE (RIGHT) (ELEVATIONS IN NAVD)

West Canal:

Template Design	
Template Depth:	20.5 ft
Bottom Width:	100 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-7.0 ft (NAVD)

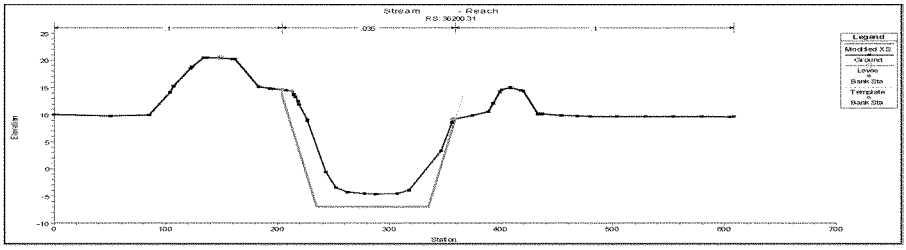

FIGURE A-33. TYPICAL CROSS SECTION OF SCENARIO 1IMPROVEMENT; SOUTH LEVEE (LEFT), NORTH LEVEE (RIGHT) (ELEVATIONS IN NAVD)

	Cut volume (cy)
Eastern Canal	732,117
Western Canal	1,242,366
TOTAL	**1,974,483**

***Note: Template depths are measured from canal bottom elevation to top of bank; not all cross sections actually measure 20 ft deep, but all have a bottom elevations of -6.5 ft NAVD and -7.0 ft NAVD, for the east and west portions respectively.**

Model Results for Scenario 1:

	West Canal	East Canal
Max WS elev (NGVD), ft	11.75	11.87
Max WS elev (NAVD), ft	10.35	10.47
Minimum Left Levee freeboard, ft	8.28	5.89
Minimum Right Levee Freeboard, ft	3.99	2.53
Max channel velocity, fps	1.56	0.39

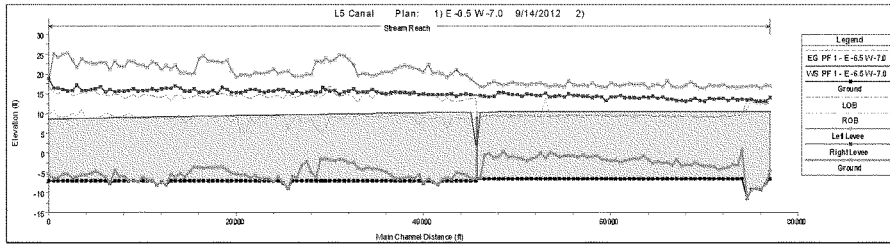

FIGURE A-34. FLOW PROFILE OF L-5 CANAL FOR SCENARIO 1 (ELEVATIONS IN NAVD)

Scenario 2: Improvements ta west canal only (still assumes 500 cfs inflow from L-6)

Template Design	
Template Depth:	24 ft
Bottom Width:	100 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-11.0 ft (NAVD)

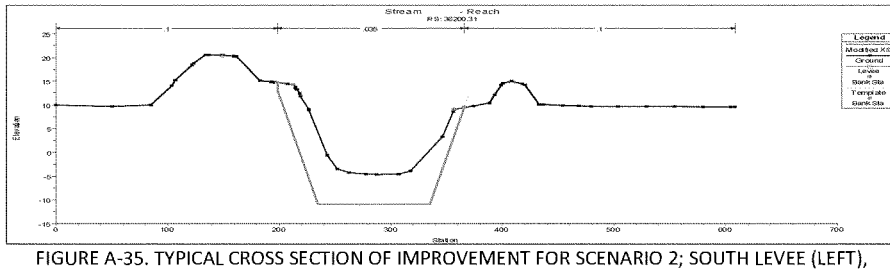

FIGURE A-35. TYPICAL CROSS SECTION OF IMPROVEMENT FOR SCENARIO 2; SOUTH LEVEE (LEFT), NORTH LEVEE (RIGHT) (ELEVATIONS IN NAVD)

	Cut volume (cy)
TOTAL	**2,298,112**

Model Results for Scenario 2:

	West Canal	East Canal
Max WS elev (NGVD), ft	10.88	12.01
Max WS elev (NAVD), ft	9.48	10.61
Minimum Left Levee freeboard, ft	9.15	5.78
Minimum Right Levee Freeboard, ft	4.83	2.39
Max channel velocity, fps	1.57	1.34

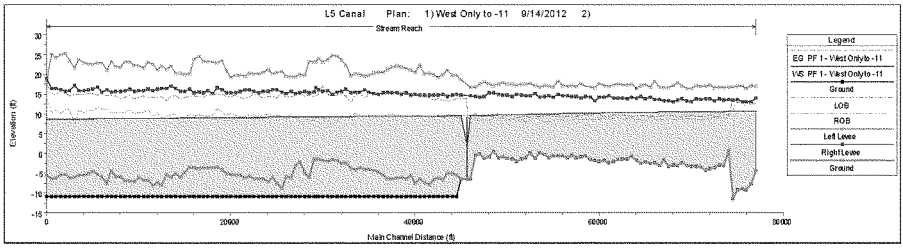

FIGURE A-36. FLOW PROFILE OF L-5 CANAL FOR SCENARIO 2 (ELEVATIONS IN NAVD)

Scenario 3: No inflow from L-6; Improvements to west canal to convey 3,000 cfs only from STA 3/4

Template Design	
Template Depth:	20.5 ft
Bottom Width:	100 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-7.0 ft (NAVD)

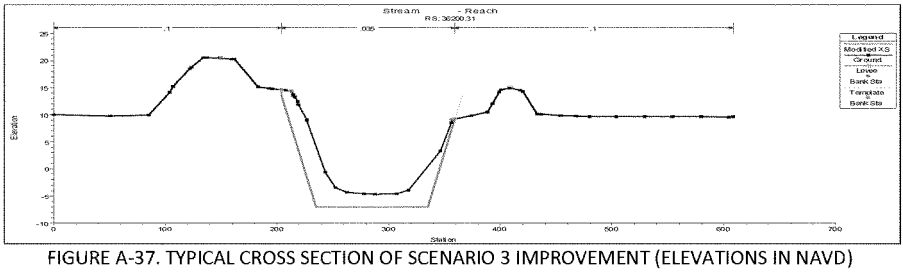

FIGURE A-37. TYPICAL CROSS SECTION OF SCENARIO 3 IMPROVEMENT (ELEVATIONS IN NAVD)

	Cut volume (cy)
TOTAL	**1,136,868**

Model Results for Scenario 3:
Boundary condition: TW = 10.0 ft NGVD (8.6 ft NAVD)

	West Canal
Max WS elev (NGVD), ft	11.59
Max WS elev (NAVD), ft	10.58
Minimum Left Levee freeboard, ft	8.05
Minimum Right Levee Freeboard, ft	3.85
.Max channel velocity, fps	1.97

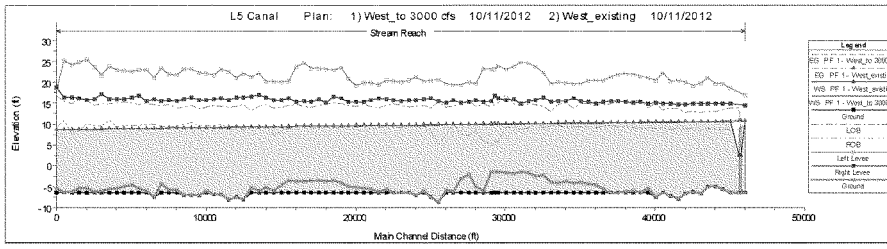

FIGURE A-38. FLOW PROFILE OF L-5 CANAL FOR SCENARIO 3 (ELEVATIONS IN NAVD)

Scenario 4: Pump station instead of gravity structure for plug replacement.
This scenario would require individual improvements of the eastern and western portions of the canal, independent of each other. The eastern portion is improved to convey 500 cfs with no back water effects from the western portion. The western portion improvements remain the same as those identified in Scenario 3.

East Canal:

Template Design	
Template Depth:	20 ft
Bottom Width:	50 ft
Side Slope:	1.5
Manning's n value:	0.035
Bottom elevation:	-1.0 ft (NAVD)

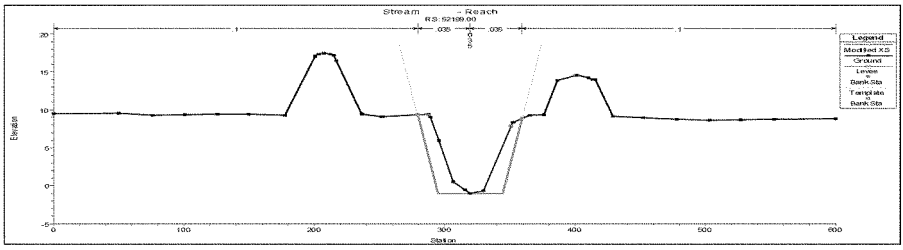

FIGURE A-39. TYPICAL CROSS SECTION OF SCENARIO 4 IMPROVEMENT (ELEVATIONS IN NAVD)

	Cut volume (cy)
Eastern Canal	233,710
Western Canal	1,136,868
TOTAL	**1,370,578**

Model Results for Scenario 4:
Boundary condition: TW = 11.5 ft NGVD (10.1 ft NAVD) – assumes 0.5 ft head loss from upstream constraint (12.0 ft NGVD)

	West Canal	East Canal
Max WS elev (NGVD), ft	11.59	11.87
Max WS elev (NAVD), ft	10.58	10.47
Minimum Left Levee freeboard, ft	8.05	5.92
Minimum Right Levee Freeboard, ft	3.85	2.53
Max channel velocity, fps	1.97	0.81

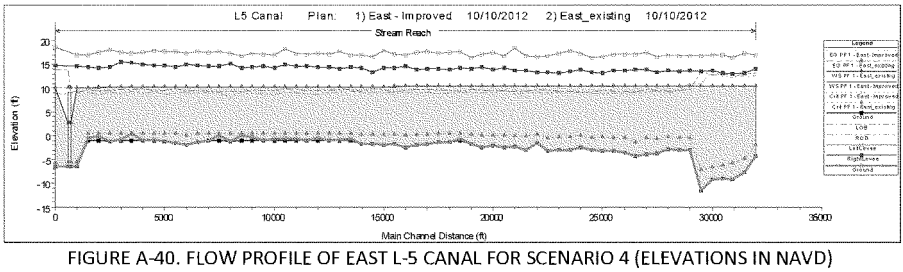

FIGURE A-40. FLOW PROFILE OF EAST L-5 CANAL FOR SCENARIO 4 (ELEVATIONS IN NAVD)

A.5.1.5 Plug Replacement

The plug separating the L-5 remnant and western canals will be fully removed and replaced with a gravity structure that will allow flow from the east (NNR, L-6 canal) to be controlled. The design aimed to minimize head loss across the structure. Preliminary designs evaluated the possibility of using box culverts; however, the resulting design capable of accommodating the proposed flows consisted of a large number and size of culverts. A gated spillway was chosen as a more suitable alternative for the plug replacement.

In order to determine HW and TW stages for the spillway, HEC-RAS analysis was conducted with L-5 Canal improvements in place and with no structure included. This scenario was run to capture the natural water surface elevations if no obstructions were present. Scenario 1 included the use of a gravity structure for the plug replacement, so the improvements resulting from that analysis were implemented for the modified geometry. The resulting water surface elevation at the cross section immediately downstream of the plug was 11.83 ft NGVD (10.43 ft NAVD). This elevation was used as the TW condition as well as a low head differential of 0.1 ft. The detailed spillway design calculations are discussed further in section A.5.2.

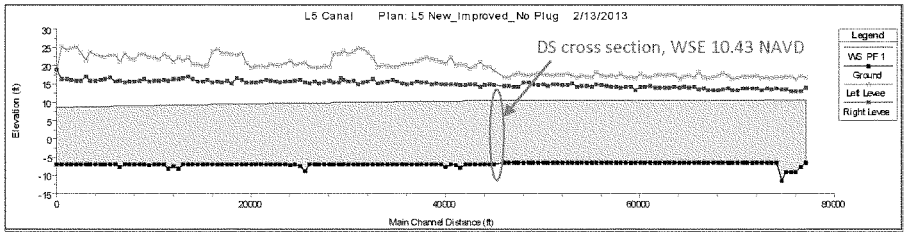

FIGURE A-41. FLOW PROFILE WITH SCENARIO 1 IMPROVEMENTS AND PLUG REMOVED (ELEVATIONS IN NAVD)

A.5.1.6 Conclusion

Modeling of the existing conditions of both the east and west portions of the L-5 canal indicated that neither portion can successfully convey the design flows given the assumed constraints. The maximum flow for the east and west are 350 cfs and 1,750 cfs, respectively. When modeled as a continuous reach assuming an inflow of 500 cfs from the L-6 canal, the western portion of L-5 can only convey 1,100 cfs (500 cfs from L-6 and 600 cfs from STA 3/4).

Scenario 1 included improvements to both the east and west portions of the L-5 canal to accommodate full L-6 and STA 3/4 conveyances, 500 cfs and 2,500 cfs (3,000 cfs total), respectively. The east portion of L-5 required an expansion to a bottom width of 50 ft and a deepening to bottom elevation of -5.1 ft NGVD (-6.5 ft NAVD). The west portion required an expansion to a bottom width of 100 ft and a deepening to bottom elevation -5.6 ft NGVD (-7.0 ft NAVD). The total excavation required for those improvements is 1,974,483 cubic yards. The model results from the improvements met all outlined assumptions and constraints.

Scenario 2 included improvements to only the west portion of the L-5 canal to accommodate full L-6 and STA 3/4 conveyances. Due to the lack of improvements east of the culverts, the 2,500 cfs lateral inflow from STA 3/4 west of the culverts into the L-5 canal creates a greater backwater effect than Scenario 1. The west portion of the canal must have a greater storage area to accommodate the increased flow in order to maintain a water surface elevation at or less than 12.0 ft NGVD on the most upstream (east) end of L-5. The improvements included a bottom width expansion to 100 ft and a deepening to -9.6 ft NGVD (-11 ft NAVD). The model results from the improvements met all outlined assumptions and constraints. The total excavation required for the improvement is 2,298,112 cubic yards, which exceeds the quantities for Scenario 1. Scenario 2 does not warrant further consideration.

Scenario 3 analyzed the west canal only, with no flow coming from the east (North New River Canal or L-6 canal). This scenario assumed the spillway gates were closed, or the existing plug remained. The flow analyzed was 3,000 cfs coming only from STA 3/4. The improvements included a bottom width expansion to 100 ft and a deepening to -5.6 ft NGVD (-7.0 ft NAVD). This improvement to the west differs from the improvements made in Scenario 1 in that it does not extend the entire length from Miami Canal to the culverts/plug. Improvements are made to cross sections beginning at the Miami Canal through RS 40193.85 (Figure A-38). The total excavation required for the improvement is 1,136,868 cubic yards. The model results from the improvements met all outlined assumptions and constraints.

Scenario 4 analyzed the canal with the assumption a pump station was constructed for the plug replacement in lieu of a gravity structure (spillway). This scenario improves both the east and west portions of the canal to convey their respective capacities of 500 cfs and 3,000 cfs. Each portion is improved independently of each other, since they are not hydraulically connected with a pump station in place. The eastern portion of the canal required an expansion to a bottom width of 50 ft and a deepening to bottom elevation of 0.4 ft NGVD (-1.0 ft NAVD). The west portion improvements were the same as those identified in Scenario 3. The total excavation required for those improvements is 1,370,578 cubic yards. The model results from the improvements met all outlined assumptions and constraints.

After all modeling was completed, it was determined that freeboard constraints were not the limiting constraint. The levee modifications to the north L-5 levee that were modeled were not further

considered for cost analysis. As such, it is not recommended to make improvements to the low lying areas on the north levee. Additionally, standard criteria for vegetation-free zone on canal banks is 15 ft minimum, from land side to water side levee toes. Multiple cross sections throughout all options violate this criteria. Further refinement of canal alignment and template configuration will be conducted during detailed design.

All four scenarios produce relatively large quantities of excavation to convey all flows from the L-6 canal and STA 3/4. Options to consider and further develop costs:

1. Make improvements to both reaches of the L-5 canal and utilize a gravity structure at the existing plug location (Scenario 1).
2. No L-6 flows (Scenario 3). This option limits flows to only those from STA 3/4, which would not require canal improvements, degrading of the existing plug, construction of a control structure, and would only require minimal levee improvements to select locations.
3. Make improvements to both reaches of the L-5 canal and utilize a pump station at the existing plug location (Scenario 4). This would require fewer improvements to the eastern portion of L-5 as compared to Option 1, and would decrease the amount of total excavation.

Features	Option 1	Option 2	Option 3
L-6 Conveyance	X		X
L-5 plug remains		X	
L-5 gravity structure	X		
L-5 Pump Station			X
West L-5 Improvements	X	X	X
East L-5 Improvements	X		X
Excavation Quantities	1.97M cy	1.14M cy	1.37M cy

TABLE A-9. L-5 CANAL SUMMARY OF OPTIONS

		A.5.2 S-621 Spillway STA 3/4 Outflow Canal								
Structure Design Criteria										
1	Design Discharge =	2500	cfs				SPF Information			
2	Design Headwater Elev Hd =	12.20	ft NGVD	Hd =	11.200	feet	SPF Discharge =			cfs
3	Analize Headwater Elev He =	12.20	ft NGVD	He =	11.22	ft	SPF Headwater =			ft NGVD
4	Design Tailwater Elev =	12.00	ft NGVD	He/H'd =	1.002		SPF Tailwater =			ft NGVD
5	Crest Elevation =	1.00	ft NGVD	h or Hs =	11	ft				
6	Single Gate Crest Width =	23	ft	Hs/He =	0.980		Optimum Water Surface Elevations			
7	Number of gates =	3		Delta H or hd =	0.2	feet	High headwater =			ft NGVD
	Net Crest Width =	69	feet	Delta-H /He=	0.01782		High Tailwater =			ft NGVD
8	Intermediate Pier Width =	3.25	feet				Low Headwater =			ft NGVD
9	Upstr Canal Bottom Width =	66.00	feet				Low Tailwater =			ft NGVD
10	Upstr Bottom of channel Elev =	-7.0	ft NGVD				Max Headwater =			ft NGVD
11	Side Slope = 1 on	2.0	ft NGVD				Lowest tailwater =			ft NGVD
12	Natural Grade Upstream =		ft NGVD							
13	Natural Grade Downstream =		ft NGVD				Protection Elevations			
14	Highest Headwater el	12.60	ft NGVD				Wave Surge at SPF =			feet
15	Gate clearance above water	1.00	feet				Structure Protection Elev =			ft NGVD
	Upstream Approach Velocity =	1.25	fps				Upstream Riprip Elev =			ft NGVD
							Downstream Riprip Elev =			ft NGVD
Crest Length Reduction due to Contractions			Warning!! Check for wave runup.				BreastWall Elevation =			ft NGVD
	From Plate 7 EM 1110-2-1603		Computed Ka and Kp from charts				Clearance Elevation =			ft NGVD
16	Pier Type (1, 2, 3 or 4)	2	Kp=	0.013						
	Number of Gates =	3	Ka=	0.174						
	Number of Piers =	2								
	Width of Gates =	23	feet							
	Height of Gates	12.6	feet	Recommended height						
17	Height of Gates	12.5	feet	***Designer's choice***			Area (h*L) =	759	sqft	
	Gate Aspect Ratio (about 2.0) =	1.84	OK				Unit Q q =	36.232	cfs/ft	
	Top of Gate elev	13.60	ft NGVD	Clearance Elev			Upstr Depth	19.2	feet	
	L=L'-2(N *Kp+Ka)He	64.51	feet				Upstr Avg Area	2004.48	sq ft	
	Crest discharge/foot q=	38.756	cfs/ft							
	Apron Width =	75.50	feet	Net Crest Width + Pier width(s)			OR Levee Elevation			
COEFFICIENT OF DISCHARGE COMPUTATION										
18	Trial Upstr Apron Elev =	-5	ft NGVD							
	Computed Free Discharge Coefficients		High or Low Ogee Weir?							
	Approach Apron Height P=	6.00	feet	Ratio P/Hd =	0.536		Apron Elevation Ok			
	Approach velocity =	1.93	fps							
	Coefficient of Free Discharge Cf =	3.879	<<<<<	**From Plate 31 EM 1110-2-1603**						
19	Designer Discharge Coeff=	3.7500	***Designers Judgement***							
	Free Discharge Qf= C*L*He^1.5	9,096	cfs - HDC 111-4/1; Is Hs/Hc < 0.4?				**->NO!, Must Use Submerged Discharge Qs**			
DISCHARGE REDUCTION FOR SUBMERGENCE FORMULAS OUTPUT										
Low Ogee Crests Discharge Coeficient Reduction: Submerged Flow										
	From Plate 33 EM 1110-2-1603									
20	Trial Downstr Apron Elev =	-5.00	ft NGVD							
	Corps Reduction Factor Data d=	17.00	feet	(Hd+d)/He =	1.53		H/He =	0.02		
21	Corps % Reduction =	71.96%	**<<<<Look up on EM 1110-2-1603 Plate 3-5 or HDC 111-4**							
				Coefficient						
	Corps Reduced Coefficient =	0.2804	x Cf =	1.088						
	USGS Reduced Coefficient Cs/C=	0.2796	x Cf =	1.048						
	SCS Reduced Coefficient qs/q =	0.1498								
DISCHARGE REDUCED FOR SUBMERGENCE										
	REQUIRED Discharge =	2,500	cfs (From original input)							
	Corps Qs = C x (% Reduction) x L x He^1.5 =	2,550	cfs *Warning! Assumed Apron Elev, Recheck after downstream Apron design.							
			Be sure to check Apron design and Re-enter Dwnstr Elev if Reqd.							
	USDWC Qs =Cs*L*He^1.5	2,533	cfs							
	SCS Qs = (qs/qf)*Qf =	1,362	cfs							
	Average Discharge	2,152	cfs							
	SFWMD Qs =Qf*(1-(Hs/He)^1.5)^0.385 =	2,369	cfs							
										k
	D'Aubusons Qs= k*A*(2g(Hw-Tw)+V^2)^0.5 =	2,451	cfs	k from M 1110-2-1605 pg 5-14						0.85
	Delta H/He< 0.2 Ok to use D'Aubusons Q	2,307	cfs	If Del H >1.0 then k = 0.85; if Del H < 1.0 K= 0						0.8

	Apron Design	Alternate Controlling	Ogee Design		
		1	2		
22	Design Discharge	2500	2500	cfs	Designers Choice; Choose higher computed discharge
23	Headwater for Apron =	12.2	12.20	feet,ngvd	
24	Tailwater for Apron =	12	12	feet,ngvd	!!!Lowest tailwater with maximum discharge
	Trial Apron Elevation =	-5	-5	feet,ngvd	Chosen at beginning of design process
25	Design Apron Elevation =	-5	-5	feet,ngvd	*Designers choice to Change Check line10*
	Congugate Depth "E" =	17.20	17.20	feet	
	$q/(E^{1.5})$ =	0.543	0.543		
	D_2/E =	0.4773	0.4773		Computed From Congugate Depth Curve
	Computed D2 =	8.21	8.21	feet	(1)
	Actual D2 (Tw El - Apron El) =	17	17	feet	(2)
	Designers Choice D2 =	17	17	feet	
	Alternate Design 1 d/D2 =	207.06%		OK - Controlling D2 ratio > 85%	
	Alternate Design 2 d/D2 =		207.06%	Ok-Controlling D2 Ratio > 85%	
	D1/E =	0.0711	0.0711		Computed From Congugate Depth Curve
	Computed D1 =	1.222	1.222	feet	
	Velocity at D1 Depth =	31.708	31.708	fps	
	Frude no. F1 =	5.054	5.054		Jump Classified as = Steady jump
	Design Apron Elevation =	-5	-5	feet	
	Designed Apron Width =	75.50	75.50	feet	
	Average Apron Velocity =	1.95	1.95	fps	
	Hydraulic Jump Length No Baffles =	49.42	49.42	feet	On Flat Floor No Baffles or Endsill EM1110-2-1603 (7-1)
	Length of basin with Baffles =	19.44	19.44	feet	Lb=K*D1*F1^1.5 K=1.4 EM1110-2-1603
	Apron Length with Baffles =	27.78	27.78	feet	Lb=K*D1*F1^1.5 K=2.0 EM1110-2-1603
	Apron Length (2.5xD2) =	42.50	42.50	feet	Previous Recommendations
	Apron Length (3xD2) =	51.00	51.00	feet	Previous Recommendations
25	Designer Apron Length =	51.00	25.00	feet	*Designers choice* Minimum Design OK
	Baffle Block Design				
	Baffle Block Height =	2.83	1.30	feet	EM-1110-2-1603 Plate 7-4
26	Designer Block Height D1 =	2.50	1.50	feet	*Designers choice*
27	Design Width of Block (D1) =	2.00	2.00	feet	*Designers choice* 37.75
	Top of Baffle Elevation =	-2.50	-3.50	feet,ngvd	
	Distance from Toe of Ogee to Upstream Face of First Row of Blocks				
	Distance from Toe of Ogee =	26.02	12.89	feet	EM-1110-2-1603 Plate 7-4
	Distance from Toe of Ogee =	12.31	12.31	feet	First Row of Blocks from OgeeWeir 1.5*D2
28	Designer Distance to 1st row =	25.00	25.00	feet	*Designers choice*
	Distance from Toe of Ogee to Upstream face of Second Row of Blocks				
	Distance from Ogee toe=	20.81	20.81	feet	Second Row of Blocks from OgeeWeir First Row + 0.5*D2
29	Designer Distance to 2nd Row =	20.00	20.00	feet	*Designers choice*
End Sill Design				Edsill width = 1.00	feet
	End Sill Height (D2/12) =	1.417	1.417		
	End Sill Height (D1/2) =	0.611	0.611		Slope = 10.784%
	Recommended Height =	0.611	0.611		
30	Designer Sill Height =	0.50	0.50	feet	*Designers Choice*
	End Sill Elevation	-4.5	-4.5	feet,ngvd	
	Additional Length ot basin	2.00	2.00	1 on 1 slope from apron floor to top of endsill	
	Total Apron Length from Ogee Toe =	53.00	27.00	feet	
	End Sill Froude No. =	0.09	0.09		ok
	End Sill Velocity =	2.01	2.01	fps	Velocity < 9.0 fps, Design OK
31	RipRap Velocity	5.00	5.00	fps	*Designers Recommendation*

		A.5.2 S-622 Spillway								
		L-5 Canal Plug Replacement								
Structure Design Criteria										
1	Design Discharge =	500	cfs					SPF Information		
2	Design Headwater Elev Hd =	11.93	ft NGVD	Hd =	6.930	feet		SPF Discharge =		cfs
3	Analize Headwater Elev He =	11.93	ft NGVD	He =	6.93	ft		SPF Headwater =		ft NGVD
4	Design Tailwater Elev =	11.83	ft NGVD	He/H'd =	1.000			SPF Tailwater =		ft NGVD
5	Crest Elevation =	5.00	ft NGVD	h or Hs =	6.83	ft				
6	Single Gate Crest Width =	15	ft	Hs/He =	0.985			Optimum Water Surface Elevations		
7	Number of gates =	3		Delta H or hd =	0.1	feet		High headwater =		ft NGVD
	Net Crest Width =	45	feet	Delta-H /He=	0.01443			High Tailwater =		ft NGVD
8	Intermediate Pier Width =	3.25	feet					Low Headwater =		ft NGVD
9	Upstr Canal Bottom Width =	75.00	feet					Low Tailwater =		ft NGVD
10	Upstr Bottom of channel Elev =	-5.1	ft NGVD					Max Headwater =		ft NGVD
11	Side Slope = 1 on	2.0	ft NGVD					Lowest tailwater =		ft NGVD
12	Natural Grade Upstream =	6	ft NGVD							
13	Natural Grade Downstream =	6	ft NGVD					Protection Elevations		
14	Highest Headwater el	12.00	ft NGVD					Wave Surge at SPF =		feet
15	Gate clearance above water	1.00	feet					Structure Protection Elev =		ft NGVD
	Upstream Approach Velocity =	0.27	fps					Upstream Riprip Elev =		ft NGVD
								Downstream Riprip Elev =		ft NGVD
Crest Length Reduction due to Contractions			Warning!! Check for wave runup.					BreastWall Elevation =		ft NGVD
	From Plate 7 EM 1110-2-1603		Computed Ka and Kp from charts					Clearance Elevation =		ft NGVD
16	Pier Type (1, 2, 3 or 4)	2	Kp=	0.013						
	Number of Gates =	3	Ka=	0.174						
	Number of Piers =	2								
	Width of Gates =	15	feet							
	Height of Gates	8	feet	Recommended height						
17	Height of Gates	10	feet	***Designer's choice***				Area (h*L) =	307.35	sqft
	Gate Aspect Ratio (about 2.0) =	1.50	OK					Unit Q q =	11.111	cfs/ft
	Top of Gate elev	13.00	ft NGVD	Clearance Elev				Upstr Depth	17.03	feet
	L=L'-2(N *Kp+Ka)He	42.22	feet					Upstr Avg Area	1857.29	sq ft
	Crest discharge/foot q=	11.842	cfs/ft							
	Apron Width =	51.50	feet	Net Crest Width + Pier width(s)				OR Levee Elevation		
COEFFICIENT OF DISCHARGE COMPUTATION										
18	Trial Upstr Apron Elev =	0	ft NGVD							
	Computed Free Discharge Coefficients		High or Low Ogee Weir?							
	Approach Apron Height P=	5.00	feet	Ratio P/Hd =	0.722	Apron Elevation Ok				
	Approach velocity =	0.81	fps							
	Coefficient of Free Discharge Cf =	3.903	<<<<<	**From Plate 31 EM 1110-2-1603**						
19	Designer Discharge Coeff=	3.7500	***Designers Judgement***							
	Free Discharge Qf= C*L*He^1.5	2,889	cfs - HDC 111-4/1; Is Hs/Hc < 0.4?					**->NO!, Must Use Submerged Discharge Qs**		
DISCHARGE REDUCTION FOR SUBMERGENCE FORMULAS OUTPUT										
Low Ogee Crests Discharge Coeficient Reduction: Submerged Flow										
	From Plate 33 EM 1110-2-1603									
20	Trial Downstr Apron Elev =	0.00	ft NGVD							
	Corps Reduction Factor Data d=	11.83	feet	(Hd+d)/He =	1.72	H/He =	0.01			
21	Corps % Reduction =	77.67%	**<<<<Look up on EM 1110-2-1603 Plate 3-5 or HDC 111-4**							
				Coefficient						
	Corps Reduced Coefficient =	0.2233	x Cf =	0.872						
	USGS Reduced Coefficient Cs/C=	0.2043	x Cf =	0.766						
	SCS Reduced Coefficient qs/q =	0.1094								
DISCHARGE REDUCED FOR SUBMERGENCE										
	REQUIRED Discharge =		500	cfs (From original input)						
	Corps Qs = C x (% Reduction) x L x He^1.5 =		645	cfs *Warning! Assumed Apron Elev, Recheck after downstream Apron design.						
				Be sure to check Apron design and Re-enter Dwnstr Elev if Reqd.						
	USDWC Qs =Cs*L*He^1.5		500	cfs						
	SCS Qs = (qs/qf)*Qf =		316	cfs						
	Average Discharge		517	cfs						
	SFWMD Qs =Qf*(1-(Hs/He)^1.5)^0.385 =		667	cfs						
										k
	D'Aubusons Qs= k*A*(2g(Hw-Tw)+V^2)^0.5 =		667	cfs	k from M 1110-2-1605 pg 5-14					0.85
	Delta H/He< 0.2 Ok to use D'Aubusons Q		627	cfs	If Del H >1.0 then k = 0.85; if Del H < 1.0 K= 0					0.8

	Apron Design	Alternate Controlling	Ogee Design		
		1	2		
22	Design Discharge	500	1000	cfs	Designers Choice; Choose higher computed discharge
23	Headwater for Apron =	11.93	11.93	feet,ngvd	
24	Tailwater for Apron =	11.93	11.83	feet,ngvd	!!!Lowest tailwater with maximum discharge
	Trial Apron Elevation =	0	0	feet,ngvd	Chosen at beginning of design process
25	Design Apron Elevation =	0	0	feet,ngvd	*Designers choice to Change Check line10*
	Congugate Depth "E" =	11.93	11.93	feet	
	$q/(E^{1.5})$ =	0.287	0.575		
	D_2/E =	0.3549	0.4894		Computed From Congugate Depth Curve
	Computed D2 =	4.23	5.84	feet	(1)
	Actual D2 (Tw El - Apron El) =	11.93	11.83	feet	(2)
	Designers Choice D2 =	11	11	feet	
	Alternate Design 1 d/D2 =	259.78%		OK - Controlling D2 ratio > 85%	
	Alternate Design 2 d/D2 =		202.61%	Ok-Controlling D2 Ratio > 85%	
	D1/E =	0.0355	0.0755		Computed From Congugate Depth Curve
	Computed D1 =	0.423	0.900	feet	
	Velocity at D1 Depth =	27.972	26.306	fps	
	Frude no. F1 =	7.576	4.886		Jump Classified as = Steady jump
	Design Apron Elevation =	0	0	feet	
	Designed Apron Width =	51.50	51.50	feet	
	Average Apron Velocity =	0.81	1.64	fps	
	Hydraulic Jump Length No Baffles =	25.66	34.03	feet	On Flat Floor No Baffles or Endsill EM1110-2-1603 (7-1)
	Length of basin with Baffles =	12.36	13.61	feet	Lb=K*D1*F1^1.5 K=1.4 EM1110-2-1603
	Apron Length with Baffles =	17.66	19.45	feet	Lb=K*D1*F1^1.5 K=2.0 EM1110-2-1603
	Apron Length (2.5xD2) =	27.50	27.50	feet	Previous Recommendations
	Apron Length (3xD2) =	33.00	33.00	feet	Previous Recommendations
25	Designer Apron Length =	33.00	33.00	feet	*Designers choice* Minimum Design OK
	Baffle Block Design				
	Baffle Block Height =	1.83	0.97	feet	EM-1110-2-1603 Plate 7-4
26	Designer Block Height D1 =	2.00	1.00	feet	*Designers choice*
27	Design Width of Block (D1) =	2.00	2.00	feet	*Designers choice* 25.75
	Top of Baffle Elevation =	2.00	1.00	feet,ngvd	
	Distance from Toe of Ogee to Upstream Face of First Row of Blocks				
	Distance from Toe of Ogee =	19.61	8.79	feet	EM-1110-2-1603 Plate 7-4
	Distance from Toe of Ogee =	6.35	8.76	feet	First Row of Blocks from OgeeWeir 1.5*D2
28	Designer Distance to 1st row =	20.00	9.00	feet	*Designers choice*
	Distance from Toe of Ogee to Upstream face of Second Row of Blocks				
	Distance from Ogee toe=	11.85	14.26	feet	Second Row of Blocks from OgeeWeir First Row + 0.5*D2
29	Designer Distance to 2nd Row =	12.00	14.50	feet	*Designers choice*
End Sill Design				Edsill width =	1.00 feet
	End Sill Height (D2/12) =	0.994	0.986		
	End Sill Height (D1/2) =	0.212	0.450		Slope = 13.636%
	Recommended Height =	0.212	0.450		
30	Designer Sill Height =	0.50	0.50	feet	*Designers Choice*
	End Sill Elevation	0.5	0.5	feet,ngvd	
	Additional Length ot basin	2.00	2.00	1 on 1 slope from apron floor to top of endsill	
	Total Apron Length from Ogee Toe =	35.00	35.00	feet	
	End Sill Froude No. =	0.04	0.09		ok
	End Sill Velocity =	0.85	1.71	fps	Velocity < 9.0 fps, Design OK
31	RipRap Velocity	5.00	5.00	fps	*Designers Recommendation*

A.6 BLUE/GREE/YELLOW LINES

		A.6.1 S-333N Spillway									
		L-67/L-29 Canal									
Structure Design Criteria											
1	Design Discharge =	1150	cfs					SPF Information			
2	Design Headwater Elev Hd =	7.50	ft NGVD	Hd =	10.600	feet		SPF Discharge =			cfs
3	Analize Headwater Elev He =	7.50	ft NGVD	He =	10.61	ft		SPF Headwater =			ft NGVD
4	Design Tailwater Elev =	7.00	ft NGVD	He/H'd =	1.001			SPF Tailwater =			ft NGVD
5	Crest Elevation =	-3.10	ft NGVD	h or Hs =	10.1	ft					
6	Single Gate Crest Width =	29	ft	Hs/He =	0.952			Optimum Water Surface Elevations			
7	Number of gates =	1		Delta H or hd =	0.5	feet		High headwater =			ft NGVD
	Net Crest Width =	29	feet	Delta-H /He=	0.04713			High Tailwater =			ft NGVD
8	Intermediate Pier Width =	3.25	feet					Low Headwater =			ft NGVD
9	Upstr Canal Bottom Width =	35.00	feet					Low Tailwater =			ft NGVD
10	Upstr Bottom of channel Elev =	-10.0	ft NGVD					Max Headwater =			ft NGVD
11	Side Slope = 1 on	3.0	ft NGVD					Lowest tailwater =			ft NGVD
12	Natural Grade Upstream =	15	ft NGVD								
13	Natural Grade Downstream =	15	ft NGVD					Protection Elevations			
14	Highest Headwater el	7.50	ft NGVD					Wave Surge at SPF =			feet
15	Gate clearance above water	1.00	feet					Structure Protection Elev =			ft NGVD
	Upstream Approach Velocity =	0.75	fps					Upstream Riprip Elev =			ft NGVD
								Downstream Riprip Elev =			ft NGVD
Crest Length Reduction due to Contractions			Warning!! Check for wave runup.					BreastWall Elevation =			ft NGVD
	From Plate 7 EM 1110-2-1603		Computed Ka and Kp from charts					Clearance Elevation =			ft NGVD
16	Pier Type (1, 2, 3 or 4)	2	Kp=	0.013							
	Number of Gates =	1	Ka=	0.174							
	Number of Piers =	0									
	Width of Gates =	29	feet								
	Height of Gates	11.6	feet	Recommended height							
17	Height of Gates	14.6	feet	***Designer's choice***				Area (h*L) =	292.9	sqft	
	Gate Aspect Ratio (about 2.0) =	1.99	OK					Unit Q q =	39.655	cfs/ft	
	Top of Gate elev	8.50	ft NGVD	Clearance Elev				Upstr Depth	17.5	feet	
	L=L'-2(N *Kp+Ka)He	25.31	feet					Upstr Avg Area	1531.25	sq ft	
	Crest discharge/foot q=	45.443	cfs/ft								
	Apron Width =	29.00	feet	Net Crest Width + Pier width(s)				OR Levee Elevation			
COEFFICIENT OF DISCHARGE COMPUTATION											
18	Trial Upstr Apron Elev =	-6	ft NGVD								
	Computed Free Discharge Coefficients		High or Low Ogee Weir?								
	Approach Apron Height P=	2.90	feet	Ratio P/Hd =	0.274	P is too low -Lower Approach Apron					
	Approach velocity =	2.94	fps								
	Coefficient of Free Discharge Cf =	3.843	<<<<<	**From Plate 31 EM 1110-2-1603**							
19	Designer Discharge Coeff=	3.7500	***Designers Judgement***								
	Free Discharge Qf= C*L*He^1.5	3,279	cfs - HDC 111-4/1; Is Hs/Hc < 0.4?					**->NO!, Must Use Submerged Discharge Qs**			
DISCHARGE REDUCTION FOR SUBMERGENCE FORMULAS OUTPUT											
Low Ogee Crests Discharge Coeficient Reduction: Submerged Flow											
	From Plate 33 EM 1110-2-1603										
20	Trial Downstr Apron Elev =	-6.00	ft NGVD								
	Corps Reduction Factor Data d=	13.00	feet	(Hd+d)/He =	1.27	H/He =	0.05				
21	Corps % Reduction =	47.71%	**<<<<Look up on EM 1110-2-1603 Plate 3-5 or HDC 111-4**								
				Coefficient							
	Corps Reduced Coefficient =	0.5229	x Cf =	2.010							
	USGS Reduced Coefficient Cs/C=	0.4458	x Cf =	1.672							
	SCS Reduced Coefficient qs/q =	0.3217									
DISCHARGE REDUCED FOR SUBMERGENCE											
	REQUIRED Discharge =		1,150	cfs (From original input)							
	Corps Qs = C x (% Reduction) x L x He^1.5 =		1,715	cfs *Warning! Assumed Apron Elev, Recheck after downstream Apron design.							
				Be sure to check Apron design and Re-enter Dwnstr Elev if Reqd.							
	USDWC Qs =Cs*L*He^1.5		[illegible]	cfs							
	SCS Qs = (qs/qf)*Qf =		1,055	cfs							
	Average Discharge		1,411	cfs							
	SFWMD Qs =Qf*(1-(Hs/He)^1.5)^0.385 =		1,191	cfs							
											k
	D'Aubusons Qs= k*A*(2g(Hw-Tw)+V^2)^0.5 =		1,425	cfs	k from M 1110-2-1605 pg 5-14						0.85
	Delta H/He< 0.2 Ok to use D'Aubusons Q		1,341	cfs	If Del H >1.0 then k = 0.85; if Del H < 1.0 K= 0						0.8

	Apron Design	Alternate Controlling	Ogee Design		
		1	2		
22	Design Discharge	1150	1650	cfs	Designers Choice; Choose higher computed discharge
23	Headwater for Apron =	7.5	7.50	feet,ngvd	
24	Tailwater for Apron =	7	7	feet,ngvd	!!!Lowest tailwater with maximum discharge
	Trial Apron Elevation =	-6	-6	feet,ngvd	Chosen at beginning of design process
25	Design Apron Elevation =	-6	-6	feet,ngvd	*Designers choice to Change Check line10*
	Congugate Depth "E" =	13.50	13.50	feet	
	$q/(E^{1.5})$ =	0.916	1.314		
	D_2/E =	0.5962	0.6839		Computed From Congugate Depth Curve
	Computed D2 =	8.05	9.23	feet	(1)
	Actual D2 (Tw El - Apron El) =	13	13	feet	(2)
	Designers Choice D2 =	13	13	feet	
	Alternate Design 1 d/D2 =	161.52%		OK - Controlling D2 ratio > 85%	
	Alternate Design 2 d/D2 =		140.81%	Ok-Controlling D2 Ratio > 85%	
	D1/E =	0.1239	0.1803		Computed From Congugate Depth Curve
	Computed D1 =	1.673	2.434	feet	
	Velocity at D1 Depth =	27.160	26.785	fps	
	Frude no. F1 =	3.700	3.025		Jump Classified as = Oscillating jump
	Design Apron Elevation =	-6	-6	feet	
	Designed Apron Width =	29.00	29.00	feet	
	Average Apron Velocity =	3.05	4.38	fps	
	Hydraulic Jump Length No Baffles =	41.68	44.83	feet	On Flat Floor No Baffles or Endsill EM1110-2-1603 (7-1)
	Length of basin with Baffles =	16.67	17.93	feet	Lb=K*D1*F1^1.5 K=1.4 EM1110-2-1603
	Apron Length with Baffles =	23.82	25.62	feet	Lb=K*D1*F1^1.5 K=2.0 EM1110-2-1603
	Apron Length (2.5xD2) =	32.50	32.50	feet	Previous Recommendations
	Apron Length (3xD2) =	39.00	39.00	feet	Previous Recommendations
25	Designer Apron Length =	39.00	39.00	feet	*Designers choice* Minimum Design OK
	Baffle Block Design				
	Baffle Block Height =	2.17	1.54	feet	EM-1110-2-1603 Plate 7-4
26	Designer Block Height D1 =	1.00	2.00	feet	*Designers choice*
27	Design Width of Block (D1) =	2.00	2.00	feet	*Designers choice* 14.50
	Top of Baffle Elevation =	-5.00	-4.00	feet,ngvd	
	Distance from Toe of Ogee to Upstream Face of First Row of Blocks				
	Distance from Toe of Ogee =	19.50	13.85	feet	EM-1110-2-1603 Plate 7-4
	Distance from Toe of Ogee =	12.07	13.85	feet	First Row of Blocks from OgeeWeir 1.5*D2
28	Designer Distance to 1st row =	19.50	14.00	feet	*Designers choice*
	Distance from Toe of Ogee to Upstream face of Second Row of Blocks				
	Distance from Ogee toe=	18.57	20.35	feet	Second Row of Blocks from OgeeWeir First Row + 0.5*D2
29	Designer Distance to 2nd Row =	19.00	20.50	feet	*Designers choice*
End Sill Design				Edsill width =	1.00 feet
	End Sill Height (D2/12) =	1.083	1.083		
	End Sill Height (D1/2) =	0.837	1.217		Slope = 6.154%
	Recommended Height =	0.837	1.083		
30	Designer Sill Height =	0.50	1.00	feet	*Designers Choice*
	End Sill Elevation	-5.5	-5	feet,ngvd	
	Additional Length ot basin	2.00	3.00	1 on 1 slope from apron floor to top of endsill	
	Total Apron Length from Ogee Toe =	41.00	42.00	feet	
	End Sill Froude No. =	0.16	0.24	ok	
	End Sill Velocity =	3.17	4.74	fps	Velocity < 9.0 fps, Design OK
31	RipRap Velocity	5.00	5.00	fps	*Designers Recommendation*

		A.6.2 S-355W Spillway									
		L-29 Canal									
Structure Design Criteria											
1	Design Discharge =	1230	cfs					SPF Information			
2	Design Headwater Elev Hd =	9.70	ft NGVD	Hd =	5.700	feet		SPF Discharge =			cfs
3	Analize Headwater Elev He =	9.70	ft NGVD	He =	5.71	ft		SPF Headwater =			ft NGVD
4	Design Tailwater Elev =	8.70	ft NGVD	He/H'd =	1.001			SPF Tailwater =			ft NGVD
5	Crest Elevation =	4.00	ft NGVD	h or Hs =	4.7	ft					
6	Single Gate Crest Width =	12	ft	Hs/He =	0.823			Optimum Water Surface Elevations			
7	Number of gates =	3		Delta H or hd =	1	feet		High headwater =			ft NGVD
	Net Crest Width =	36	feet	Delta-H /He=	0.17521			High Tailwater =			ft NGVD
8	Intermediate Pier Width =	3.25	feet					Low Headwater =			ft NGVD
9	Upstr Canal Bottom Width =	50.00	feet					Low Tailwater =			ft NGVD
10	Upstr Bottom of channel Elev =	-7.6	ft NGVD					Max Headwater =			ft NGVD
11	Side Slope = 1 on	3.0	ft NGVD					Lowest tailwater =			ft NGVD
12	Natural Grade Upstream =		ft NGVD								
13	Natural Grade Downstream =		ft NGVD					Protection Elevations			
14	Highest Headwater el	9.70	ft NGVD					Wave Surge at SPF =			feet
15	Gate clearance above water	1.00	feet					Structure Protection Elev =			ft NGVD
	Upstream Approach Velocity =	0.70	fps					Upstream Riprip Elev =			ft NGVD
								Downstream Riprip Elev =			ft NGVD
Crest Length Reduction due to Contractions			Warning!! Check for wave runup.					BreastWall Elevation =			ft NGVD
	From Plate 7 EM 1110-2-1603		Computed Ka and Kp from charts					Clearance Elevation =			ft NGVD
16	Pier Type (1, 2, 3 or 4)	2	Kp=	0.013							
	Number of Gates =	3	Ka=	0.174							
	Number of Piers =	2									
	Width of Gates =	12	feet								
	Height of Gates	6.7	feet	Recommended height							
17	Height of Gates	8	feet	***Designer's choice***				Area (h*L) =	169.2	sqft	
	Gate Aspect Ratio (about 2.0) =	1.50	OK					Unit Q q =	34.167	cfs/ft	
	Top of Gate elev	10.70	ft NGVD	Clearance Elev				Upstr Depth	17.3	feet	
	L=L'-2(N *Kp+Ka)He	33.71	feet					Upstr Avg Area	1762.87	sq ft	
	Crest discharge/foot q=	36.484	cfs/ft								
	Apron Width =	42.50	feet	Net Crest Width + Pier width(s)				OR Levee Elevation			
COEFFICIENT OF DISCHARGE COMPUTATION											
18	Trial Upstr Apron Elev =	-4	ft NGVD								
	Computed Free Discharge Coefficients		High or Low Ogee Weir?								
	Approach Apron Height P=	8.00	feet	Ratio P/Hd =	1.404	Apron Elevation Ok					
	Approach velocity =	2.11	fps								
	Coefficient of Free Discharge Cf =	3.953	<<<<<	**From Plate 31 EM 1110-2-1603**							
19	Designer Discharge Coeff=	3.7500	***Designers Judgement***								
	Free Discharge Qf= C*L*He^1.5	1,724	cfs - HDC 111-4/1; Is Hs/Hc < 0.4?					**->NO!, Must Use Submerged Discharge Qs**			
DISCHARGE REDUCTION FOR SUBMERGENCE FORMULAS OUTPUT											
Low Ogee Crests Discharge Coeficient Reduction: Submerged Flow											
	From Plate 33 EM 1110-2-1603										
20	Trial Downstr Apron Elev =	-4.00	ft NGVD								
	Corps Reduction Factor Data d=	12.70	feet	(Hd+d)/He =	2.40	H/He =	0.18				
21	Corps % Reduction =	9.55%	**<<<<Look up on EM 1110-2-1603 Plate 3-5 or HDC 111-4**								
				Coefficient							
	Corps Reduced Coefficient =	0.9045	x Cf =	3.575							
	USGS Reduced Coefficient Cs/C=	0.7531	x Cf =	2.824							
	SCS Reduced Coefficient qs/q =	0.8122									
DISCHARGE REDUCED FOR SUBMERGENCE											
	REQUIRED Discharge =		1,230	cfs (From original input)							
	Corps Qs = C x (% Reduction) x L x He^1.5 =		1,559	cfs *Warning! Assumed Apron Elev, Recheck after downstream Apron design.							
				Be sure to check Apron design and Re-enter Dwnstr Elev if Reqd.							
	USDWC Qs =Cs*L*He^1.5		1,488	cfs							
	SCS Qs = (qs/qf)*Qf =		1,400	cfs							
	Average Discharge		1,419	cfs							
	SFWMD Qs =Qf*(1-(Hs/He)^1.5)^0.385 =		1,018	cfs							
											k
	D'Aubusons Qs= k*A*(2g(Hw-Tw)+V^2)^0.5 =		1,159	cfs	k from M 1110-2-1605 pg 5-14						0.85
	Delta H/He< 0.2 Ok to use D'Aubusons Q		1,159	cfs	If Del H >1.0 then k = 0.85; if Del H < 1.0 K= 0						0.85

	Apron Design	Alternate Controlling	Ogee Design		
		1	2		
22	Design Discharge	1230	1500	cfs	Designers Choice; Choose higher computed discharge
23	Headwater for Apron =	9.7	9.70	feet,ngvd	
24	Tailwater for Apron =	8.7	8.7	feet,ngvd	!!!Lowest tailwater with maximum discharge
	Trial Apron Elevation =	-4	-4	feet,ngvd	Chosen at beginning of design process
25	Design Apron Elevation =	-4	-4	feet,ngvd	*Designers choice to Change Check line10*
	Congugate Depth "E" =	13.70	13.70	feet	
	$q/(E^{1.5})$ =	0.719	0.877		
	D_2/E =	0.5402	0.5861		Computed From Congugate Depth Curve
	Computed D2 =	7.40	8.03	feet	(1)
	Actual D2 (Tw El - Apron El) =	12.7	12.7	feet	(2)
	Designers Choice D2 =	12	12	feet	
	Alternate Design 1 d/D2 =	162.14%		OK - Controlling D2 ratio > 85%	
	Alternate Design 2 d/D2 =		158.16%	Ok-Controlling D2 Ratio > 85%	
	D1/E =	0.0937	0.1184		Computed From Congugate Depth Curve
	Computed D1 =	1.284	1.622	feet	
	Velocity at D1 Depth =	28.413	27.432	fps	
	Frude no. F1 =	4.419	3.796		Jump Classified as = Oscillating jump
	Design Apron Elevation =	-4	-4	feet	
	Designed Apron Width =	42.50	42.50	feet	
	Average Apron Velocity =	2.28	2.78	fps	
	Hydraulic Jump Length No Baffles =	41.74	41.98	feet	On Flat Floor No Baffles or Endsill EM1110-2-1603 (7-1)
	Length of basin with Baffles =	16.70	16.79	feet	Lb=K*D1*F1^1.5 K=1.4 EM1110-2-1603
	Apron Length with Baffles =	23.85	23.99	feet	Lb=K*D1*F1^1.5 K=2.0 EM1110-2-1603
	Apron Length (2.5xD2) =	30.00	30.00	feet	Previous Recommendations
	Apron Length (3xD2) =	36.00	36.00	feet	Previous Recommendations
25	Designer Apron Length =	36.00	36.00	feet	*Designers choice* Minimum Design OK
	Baffle Block Design				
	Baffle Block Height =	2.00	1.34	feet	EM-1110-2-1603 Plate 7-4
26	Designer Block Height D1 =	2.00	1.50	feet	*Designers choice*
27	Design Width of Block (D1) =	2.00	2.00	feet	*Designers choice* 21.25
	Top of Baffle Elevation =	-2.00	-2.50	feet,ngvd	
	Distance from Toe of Ogee to Upstream Face of First Row of Blocks				
	Distance from Toe of Ogee =	18.00	12.04	feet	EM-1110-2-1603 Plate 7-4
	Distance from Toe of Ogee =	11.10	12.04	feet	First Row of Blocks from OgeeWeir 1.5*D2
28	Designer Distance to 1st row =	18.00	12.00	feet	*Designers choice*
	Distance from Toe of Ogee to Upstream face of Second Row of Blocks				
	Distance from Ogee toe=	17.10	18.04	feet	Second Row of Blocks from OgeeWeir First Row + 0.5*D2
29	Designer Distance to 2nd Row =	17.00	18.00	feet	*Designers choice*
	End Sill Design			Edsill width =	1.00 feet
	End Sill Height (D2/12) =	1.058	1.058		
	End Sill Height (D1/2) =	0.642	0.811		Slope = 20.833%
	Recommended Height =	0.642	0.811		
30	Designer Sill Height =	0.50	1.00	feet	*Designers Choice*
	End Sill Elevation	-3.5	-3	feet,ngvd	
	Additional Length ot basin	2.00	3.00	1 on 1 slope from apron floor to top of endsill	
	Total Apron Length from Ogee Toe =	38.00	39.00	feet	
	End Sill Froude No. =	0.12	0.16		ok
	End Sill Velocity =	2.37	3.02	fps	Velocity < 9.0 fps, Design OK
31	RipRap Velocity	5.00	5.00	fps	*Designers Recommendation*

ANNEX A-2: HYDROLOGIC MODELING

USACE Jacksonville District,
Water Resources Engineering Branch
February 2014

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1. Hydrologic and Hydraulic Modeling Strategy Development

The primary application of models in the CEPP is for the assessment of regional-level hydrologic planning. More detailed models were also applied to address specific questions related to hydraulic and water quality constraints. The CEPP modeling tools were jointly selected by the USACE Jacksonville District (SAJ) and the South Florida Water Management District (SFWMD) in October-November 2011 based on their collective capability to provide adequate hydrologic information to conduct evaluations of the entire south Florida system for the needs of the CEPP. Due to the time required to complete prerequisite model documentation, documentation review, and compilation of this model validation review package, the expedited CEPP schedule did not afford the opportunity to submit the proposed modeling tools for USACE Engineering software validation evaluation prior to execution of the modeling strategy and application of the initial recommended modeling tool suite, which initiated in January 2012. However, prior to implementation of the CEPP modeling, the CEPP modeling strategy was vetted through USACE at the SAJ District, South Atlantic Division (SAD), and Headquarters (HQ) levels through the prior CEPP periodic in-progress reviews (IPR-1 in December 2010; IPR-2 in January 2012) and CEPP Decision Point 1 vertical coordination meeting (January 2012). Prior to completion of the hydrologic modeling of the CEPP final array of alternatives, all CEPP modeling tools were reviewed and approved for use through either the USACE Engineering software validation process or through the CEPP Agency Technical Review (ATR) process, as further documented in Section A.8.1.1 of the Engineering Appendix.

The CEPP modeling strategy centered around use of a decoupled link-node model Regional Simulation Model for Basins (RSM-BN) for the EAA, Stormwater Treatment Areas (STAs) and the northern estuaries, in combination with a detailed meshed Regional Simulation Model for the Glades and Lower East Coast Service Areas (RSM-GL) for the Water Conservation Areas (WCAs), Everglades National Park (ENP) and the Lower East Coast (refer to section A.8.1.2 of the Engineering Appendix for additional documentation of the RSM models). The CEPP modeling strategy provides an overview of the modeling tools, including maps of the model domains, applied throughout the plan formulation process and how the tools were applied in support of the CEPP planning process (refer to Reference 1 of this Hydrologic Modeling Annex). Preliminary screening assessments for Lake Okeechobee, the northern estuaries, and the impoundment storage within the Everglades Agricultural Area (EAA), collectively referred to as the "North of the Red Line components," utilized the Reservoir Sizing and Operations Screening (RESOPS) model, the Lake Okeechobee Operations Screening (LOOPS) model, and the C-43 Spreadsheet Model. Preliminary screening assessments for the Water Conservation Areas (WCAs) and Everglades National Park (ENP), collectively referred to as the "South of the Red Line components" (including the components at the EAA/WCA Red Line boundary, in addition to the Green/Blue/Yellow Line components) utilized the iModel tool and limited-scope sensitivity simulations using the RSM-GL. For the final array of alternatives, analysis of the North of Red Line components and the South of the Red Line components were conducted using the RSM-BN and the RSM-GL, respectively. The RSM-GL model was also used for performance evaluation within the Lower East Coast Service Areas, areas which were not encompassed within the domain of the iModel. The complete RSM-GL model calibration and verification report, which was completed in December 2011 as part of the Decomp PIR 1 project modeling effort, is posted with the Decomp project documentation report (Annex A-1, Appendix B-11): http://www.evergladesplan.org/pm/projects/docs_12_decomp_doc_report.aspx

The Dynamic Model for Stormwater Treatment Areas, Version 2 (DMSTA2) was utilized during preliminary screening and final array modeling to confirm compliance with required State of Florida water quality standards.

From initial formulation through selection of Recommended Plan (Alternative 4R2), the CEPP modeling strategy has not included the application of detailed flood event modeling (or hydrodynamic levee assessment). It is expected that higher resolution hydrologic and hydraulic modeling tools will be required to further analyze localized and possibly regional-scale effects of specific components of the CEPP recommended plan, with the scope of these analyses further identified during the Pre-Construction Engineering and Design (PED) phase of the project.

2. Preliminary Screening

2.1 Summary of Screening Tools and PIR Documentation

Execution of the modeling strategy and application of the initial recommended modeling tool suite initiated in January 2012. Preliminary screening assessments for Lake Okeechobee, the northern estuaries, and the impoundment storage within the EAA, collectively referred to as the "North of the Red Line components," utilized the RESOPS model, the LOOPS model, and the C-43 Spreadsheet Model. The CEPP plan formulation approach, screening methods, and results for the North of Red Line components, which ultimately identified the ~14,000 acre Flow Equalization Basin (FEB) on the EAA A-2 site for inclusion in the CEPP recommended plan, are summarized in Section 3 of the CEPP PIR. Formulation for the FEB component was completed between January and July of 2012. Preliminary screening assessments for the WCAs and ENP, collectively referred to as the "South of the Red Line components," utilized the iModel tool and limited-scope sensitivity simulations using the RSM-GL. The CEPP plan formulation approach, screening methods, and results for the South of Red Line components, which ultimately identified the remaining CEPP recommended plan components for the L-4/L-5 Levees, Miami Canal, L-67A/L-67C Levees, L-29 Levee, L-67 Extension Levee, and L-31N Canal within WCA-3 and ENP, are summarized in Section 3 of the CEPP PIR. Formulation for the Red, Green, Blue, and Yellow Line CEPP components were primarily completed between June and November of 2012. HESM/IMC Model Documentation Report (MDR) 1 (CEPP PIR Appendix A: Annex A-3) reviews the various model-supported feature screening efforts undertaken at various points in the planning process. Further documentation of the CEPP screening results and formulation approach is not included in the Engineering Appendix or the supporting Hydrologic Modeling Annex. The CEPP modeling strategy provides an overview of the modeling tools, including maps of the model domains, applied throughout the plan formulation process and how the tools were applied in support of the CEPP planning process (refer to Reference 1).

For the final array of alternatives, analysis of the North of Red Line components and the South of the Red Line components were conducted using the RSM-BN and the RSM-GL, respectively. This H&H Annex provides documentation of USACE SAJ performance analysis of the hydrologic modeling results for the CEPP final array of alternatives only, with specific emphasis on engineering design considerations that were actively tracked throughout the CEPP formulation, preliminary screening, and alternative development efforts. Specific discussion of the performance analysis for the recommended plan Alternative 4R2 has been summarized within the Engineering Appendix.

2.2 Decomp RMA-2 Screening of Miami Canal Plug Configurations

General overview information and summary conclusions from the Decomp RMA2 screening analysis, which were utilized by the CEPP plan formulation efforts, are documented in this Annex. Summary conclusions from the Decomp analysis were utilized to support CEPP preliminary screening of Miami Canal backfill and plug options. The Decomp RMA2 screening analysis was originally completed by the USACE SAJ Water Resources Engineering Branch between fall 2008 and summer 2009.

The Decomp project conducted a screening model evaluation of numerous Miami Canal plug configurations (plug length and spacing) to identify the optimal configuration(s) which most closely mimic the performance of a complete/full Miami Canal backfill within WCA 3A. The analysis considered both the use of existing fill onsite and importing additional fill to the project from offsite. Due to the limitations of the RMA-2 screening tool, plug configurations were also evaluated with the higher resolution model RSM-GL as part of the final array of alternatives.

Following the CEPP announcement in October 2011, the USACE SAJ and the SFWMD decided to integrate the previous Decomp planning effort into the CEPP. SAJ prepared a documentation Report to summarize the Decomp plan formulation and evaluation efforts, information obtained by the planning team, engineering work efforts, and lessons learned to date. The Decomp documentation report was used by the CEPP team and is available to staff and managers involved in the interagency state-federal Everglades restoration program as a resource to guide future planning efforts. The report documents the plan formulation and evaluation of seven alternatives (subset of final array), all plan formulation activities leading up to the development of the final array of alternatives, recommendations for an adaptive management strategy, and application of extensive hydrologic modeling (including RSM-GL application) conducted to support the formulation and evaluation efforts. The Decomp project documentation report can be reviewed at the following location:

http://www.evergladesplan.org/pm/projects/docs_12_decomp_doc_report.aspx

The Hydrology and Hydraulics Annex to the Engineering Appendix (Annex A-1) of the Decomp documentation report provides comprehensive documentation of the technical support provided by the SAJ Water Resources Engineering Branch: hydrologic data collection and analyses; development and application of numerical modeling tools to support PDT evaluations; preliminary hydraulic design efforts; and additional work-in-progress technical information for consideration by future CERP planning efforts. Annex A-1 of the Decomp PIR 1 project documentation report includes comprehensive documentation of the RMA-2 modeling development methodology and results, and this report should be referenced for additional information, if required.

Recognizing that the Decomp PIR 1 plan formulation process was not completed, the use of the information contained within this Decomp report for future CERP planning efforts included the caveat of recognizing the following key assumptions:

- Alternatives were limited to existing, available water for redistribution within the WCA-3A project area;
- Water quality of inflows to WCA 3A will meet state water quality standards;

- WCA-3A conveyance features to WCA-3B were assumed to be completed and operational (e.g., the Modified Water Deliveries to ENP structures in L-67 A);
- L-29 Canal maximum operating stage limit is 8.5 feet NGVD.

The RMA-2 and RSM-GL modeling efforts conducted for Decomp indicated that plugs along the Miami Canal may have the potential to work as effectively hydrologically as full backfill to reduce drainage and the disruption of sheetflow caused by the Miami Canal. RSM-GL final array modeling during Decomp also revealed that potential benefits from backfilling the Miami Canal south of Interstate 75 were limited under Decomp PIR 1 assumptions (particularly redistribution of existing inflows to WCA-3A only and limited MWD outlet modifications for WCA-3A), probably due to the limited conveyance out of WCA 3A resulting in continued ponded conditions in southern WCA 3A. The 2012 Decomp PIR 1 project documentation report recommended that proposed alterations to the Miami Canal south of Interstate 75 should be reevaluated if the ponding conditions within southern WCA 3A were altered or alleviated.

Although the CEPP recommended plan proposes significant increased conveyance between WCA-3A, WCA-3B, and ENP as compared to the Decomp assumptions and although the CEPP final array modeling indicates significant reduction to the frequency and magnitude of ponded conditions within southern WCA-3A, no meaningful plan formulation effort was given to modifications to the Miami Canal south of Interstate 75 because the CEPP plan formulation for the WCA-3A hydropattern restoration and Miami Canal components significantly leveraged the previous Decomp formulation efforts. Given consideration of CEPP schedule limitations and based on the results of the CEPP preliminary screening efforts (refer to Section 3.2.2 of the CEPP PIR report for detailed discussion of the formulation methodology), CEPP preliminary screening modeling conducted with the RSM-GL in July 2012 evaluated only one option for Miami Canal modifications south of Interstate 75 – inclusion of a 4000 foot long plug centered at S-340 and an 8000 foot long plug starting south of the C-11 Extension. The CEPP RSM-GL screening modeling additionally was conducted as a sensitivity analysis starting with the final array modeling from Decomp with WCA-3A inflows increased to account for the approximately 20 percent increase assumed for CEPP. Therefore, since the CEPP screening modeling assumptions incorporated the MWD project outlet modifications for WCA-3A, the screening modeling results did not demonstrate the expected significant reduction to the frequency and magnitude of ponded conditions within southern WCA-3A that would be realized if the CEPP components identified along the Green Line and Blue Line had been included for the CEPP screening. A different set of CEPP screening assumptions may have demonstrated increased benefits associated with the Miami Canal modifications south of I-75, but these analyses will instead be shifted for future consideration in future CEPP increments.

The plug proposed in the southern reach of the Miami Canal was intended to reduce the drainage effect of the Miami Canal, south of the existing S-340 structure. The Miami Canal south of S-340 and the L-67A Canal currently provides approximately 30 miles of unobstructed southerly canal flow towards the WCA-3A outlet structures along Tamiami Trail (S-333 and the S-12s), and the Miami Canal is aligned parallel to the northwest-to-southeast direction of flow within WCA 3A. In addition, initial screening modeling conducted during Decomp indicated that hydrologic performance improvements within Northeast WCA-3A were generally best achieved through backfill of the South Miami Canal Segment. Effects to recreational access were considered during CEPP formulation of the Miami Canal southern plugs, and the proposed plug location was south of the junction of the Miami Canal/C-11 Extension and north of the

Holiday Trail from Everglades Holiday Park. Recreational access from Everglades Holiday Park to the Miami Canal between S-340 and the proposed plug, to the Miami Canal south of the proposed plug, and to the L-67A Canal will be maintained. Based on review of aerial photographs, the plug length was proposed at 8000 feet, starting south of the C-11 Extension. The source of backfill material for the proposed plug was envisioned as the nearby spoil mounds along the Miami Canal and the then CEPP-proposed spoil mound degrade/gaps along the C-11 Extension (this component was subsequently excluded with the CEPP final array), with the proximity of the C-11 Extension spoil material serving as a factor in the plug location selection. Based on preliminary surveys of the Miami Canal spoil mound material under Decomp, a maximum of approximately 5.5 of the 9.7 miles (57%) of the Miami Canal between S-340 and the L-67A Canal could be backfilled with the on-site spoil material.

The Miami Canal plug configuration was ultimately screened out from the CEPP final array components because the RSM-GL screening modeling demonstrated only localized dry year benefits for the single evaluated plug configuration, which could not justify the additional incremental cost of approximately $13 million. However, consistent with the Decomp report conclusions, the final conclusions identified from the CEPP screening assessment should include consideration of the assumptions related to limited relief for the ponding conditions in southern WCA-3A and the limited spatial extent of plugs which were evaluated. Given recognition of this context, consideration of Miami Canal modifications south of Interstate 75 will likely warrant further detailed evaluation for future CERP/CEPP increments.

Beyond the insights afforded by hydrologic modeling, as further summarized in the Decomp report, questions remain regarding the ability of plugged canals to function ecologically as the pre-drainage ridge and slough landscape, especially in low flow conditions, and what the continuing effect of deep holes (spaces between plugs) in the canal have on Everglades flora and fauna, including providing pathways for invasive exotic species. These uncertainties would need further assessment for consideration of future plug options for canals within the Greater Everglades, although additional information may also be realized through CEPP adaptive management strategies.

Although the Miami Canal plugs were not included in the components for the CEPP final array (all final array alternatives included complete backfill of the Miami Canal to Interstate 75, starting from either approximately 1.5-2.0 miles south of S-8 (Alternative 1, 4R, and 4R2) or immediately downstream of S-8 (Alternatives 2 through 4)), information from the Decomp RMA-2 plug analysis was additionally utilized to establish the initial proposed spacing between Miami Canal mounds because the Miami Canal backfill to bedrock grade will leave remnant open water segments between the mounds that are expected to behave hydrologically similar to the plug options that were evaluated with RMA-2 for Decomp. As further documented in Table 3 and Table 4, overall plug performance (compared to the full backfill condition) is significantly diminished for plug spacing scenarios greater than approximately 4000-6000 feet, whereas no observed similar trend is observed for plug length. The initial proposed spacing between Miami Canal mounds was selected at 1 mile (5280 feet), given consideration of the insights from the Decomp RMA-2 modeling and overall CEPP project cost considerations (increased cost with reduced distance between mound features).

The Decomp modeling strategy recommended a limited modeling effort, utilizing a fine resolution hydraulic modeling tool, to allow evaluation of the potential near-field effects for

Miami Canal backfill options and yield enhanced understanding about the effectiveness and impacts of each type of canal backfilling option. The need to simulate three dimensional flow fields was not a critical element of the Miami Canal local feature modeling effort; two-dimensional flow fields with depth-averaged velocity parameters (including within open canal segments) were determined to provide sufficient analysis for the stated scope of this effort, noting the shallow depths representative of typical overland flow in the project area. RMA2 was recommended by the USACE within the Decomp modeling strategy as the most appropriate tool for this analysis. RMA2, developed by the Resource Management Associates (RMA), has been previously reviewed and classified by the HH&C CoP as a "CoP Preferred" hydraulic design and river hydraulics modeling tool.

RMA2 is a two dimensional depth averaged finite element hydrodynamic numerical model. It computes water surface elevations and horizontal velocity components for subcritical, free-surface flow in two dimensional flow fields. RMA2 computes a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flows. Friction is calculated with the Manning's or Chezy equation, and eddy viscosity coefficients are used to define turbulence characteristics; RMA2 includes the capability to vary roughness parameters as a function of flow depth. Both steady and unsteady state (dynamic) problems can be analyzed. RMA2 accepts a wide variety of boundary conditions including water surface elevations by node or line, discharge by node, element or line, tidal radiation boundary conditions by line and discharge as a function of elevation by line. The program has been applied to calculate water levels and flow distribution around islands; flow at bridges having one or more relief openings, in contracting and expanding reaches, into and out of off-channel hydropower plants, at river junctions, and into and out of pumping plant channels; circulation and transport in water bodies with wetlands; and general water levels and flow patterns in rivers, reservoirs, and estuaries. RMA2 operates under the hydrostatic assumption, meaning accelerations in the vertical direction are negligible. It is two dimensional in the horizontal plane. It is not intended to be used for near field problems where vortices, vibrations, or vertical accelerations are of primary interest. Vertically stratified flow effects are beyond the capabilities of RMA2. RMA2 is a free-surface calculation model for subcritical flow problems.

As presented to the Decomp PDT in July 2008, the following were the goals of the Decomp RMA2 modeling effort:

- Utilize available data to construct a fine-resolution hydraulic model to test Miami Canal backfill options, within a limited spatial scale, representative of the project area;
- Evaluate near-field hydraulic effects of various plug designs, lengths, spacing, locations, and depths (partial vs. complete fill) to gain additional information to assist project team evaluation of Miami Canal backfill options;
- Provide additional input to assist preliminary screening and determine optimal use of limited fill material available with the existing spoil mounds;
- Balance needs of the project schedule while maximizing the value-added from effective model simulation of backfill options.

The Decomp H&H sub-team advocated for use of the Miami Canal segment between S-8 and S-339 as reasonably representative of the Miami Canal hydrologic response and recommended a series of steady-state simulations for each evaluated Miami Canal backfill option. Topography for the RMA2 mesh was assigned from Decomp PIR 1 Miami Canal survey data, available Light

Detection and Ranging (LIDAR) data, and United States Geological Survey (USGS) High-Accuracy Elevation Data (HAED). The RMA2 model domain from S-8 to S-339, overlaid on an aerial photograph, is shown in Figure 1; the model domain is approximately 9.5 miles in length (along the Miami Canal) and approximately 4 miles in width (approximately 2 miles on each side of the Miami Canal). The model mesh elements are on the scale of 20 to 40 feet in length in the immediate vicinity of the Miami Canal and approximately 550 feet in length for elements within approximately 2 miles of the Miami Canal. The steady-state RMA2 model simulations utilized an upstream point-source inflow boundary condition at S-8 and a downstream head boundary condition along the southern model boundary (representative of S-339). The median flow rate for the S-8 pump station between 2000 and 2008 was used to define the upstream steady-state flow boundary condition of 950 cfs; arithmetic average historical stage predictions from the USGS Everglades Depth Estimation Network (EDEN) at four points along the southern model boundary, during all 2000-2008 conditions with S-8 historical flows approximating 950 cfs (a range of 900-1000 cfs was used), were used to establish the steady-state downstream head boundary condition of 10.66 feet NGVD at S-339 (approximate depth of 1 foot in the adjacent WCA-3A marsh). The S-339 structure along the Miami Canal was closed for all simulations, consistent with field operations of S-339 for this flow range. The RMA2 model was not needed to evaluate a wide range of hydrologic conditions or to assess the effects of groundwater or seepage, as the RSM-GL model would be relied on during the later Decomp alternative modeling to assess the performance of Decomp management measures (including Miami Canal plugs) for the 1965 through 2000 period of record based on the results of the RMA-2 screening analysis.

Due to the large potential number of Miami Canal plug length and spacing combinations and the challenges experienced by the Decomp PDT identifying only approximately three combinations for detailed RMA2 modeling (as originally scoped), the RMA2 modeling scope evolved into a robust modeling assessment of a wide range of Miami Canal plug length and spacing combinations. Since each Miami Canal plug length and spacing combination required the development of a distinct RMA2 model mesh, a sufficient number of the potential combinations were simulated to generate nomographs (refer to Figure 2 for a generalized example) able to illustrate performance trends of the simulated plug length and spacing combinations and allow interpolation of expected performance for non-simulated combinations. Table 1 illustrates the five Miami Canal plug lengths (500 feet to 10000 feet) and the eight Miami Canal plug spacing (1000 feet to 25000 feet) that were used to establish the RMA2 model test matrix; 18 total plug length and spacing combinations were simulated, in addition to the existing condition (no Miami Canal modifications), the existing condition with all Miami Canal spoil mounds removed (reasonable initial step toward sheetflow restoration), and the full backfill condition (complete Miami Canal backfill between S-8 and S-339, used to establish a target for sheetflow conditions). To represent Miami Canal plugs within the RMA2 model, the nodal elevations within the specified Miami Canal plug footprint were changed to match the adjacent marsh. For each plug scenario, a 1000 foot segment of the Miami Canal was left unmodified to provide a hydraulic get-away for the S-8 inflows to the model domain and all Miami Canal spoil mounds were assumed to be removed (reasonably expected consistent with Decomp sheetflow restoration objective).

The test matrix simulations were developed to answer the following question: for a given plug length, what is the optimal plug spacing to mimic the total backfill case? In order to maximize the utility of the RMA2 analysis for the Decomp alternative formulation process, the Decomp H&H sub-team developed and agreed on a set of post-processing and statistical analysis

performance metrics to facilitate evaluation of the RMA2 results; unlike the SFWMM and RSM Glades-LECSA model, a pre-established set of performance measures is not generated from RMA-2. The following performance measures were evaluated for each RMA2 test matrix simulation, compared to the total backfill case:

- Correlation Coefficient of absolute velocity magnitude
- Correlation Coefficient of along canal velocity
- Correlation Coefficient of across canal velocity
- Cosine Similarity (velocity vector)
- Flow across transect

The correlation coefficient, R, determines the strength of a relationship between two datasets. Cosine similarity is a measure of similarity between two vectors of n dimensions by finding the cosine of the angle between them. The selected flow transect was established approximately 2 miles upstream from S-339 and extended approximately 100 feet on both sides of the Miami Canal. All of the performance metrics for each plug length and spacing configuration were computed by comparison against the total backfill case.

The preliminary performance measure results are summarized in Table 2. Following review of the results by the Decomp H&H sub-team, the correlation coefficient of across canal velocity and the cosine similarity performance measures were dropped due to the lack of any trend or correlation to the plug configuration. The three remaining performance measures were ranked for each of the 18 plug configurations (1 = best compared to total backfill case; 18 = worst compared to total backfill case) and the scores for each performance measure were added together to produce a final combined score for each plug configuration; the complete results are displayed in Figures 3 through 5, and Tables 2 and 3. The summary for the top six plug configurations are displayed in Table 4.

The final RMA2 modeling results were presented to the Decomp PDT in July 2009. The RMA-2 conceptual plug design analysis results were then available to the Decomp plan formulation team to be integrated with the preliminary engineering costs for construction of the proposed Miami Canal management measures, PDT assessment of on-site fill availability (spoil mound material quantities, acceptability of spoil mound and associated vegetation/upland habitat removal, and material suitability for backfill), proposed construction methods for Miami Canal modifications, and the results from the SFWMM preliminary screening of Miami Canal management measures (refer to the Decomp PIR 1 project documentation report for additional documentation of the formulation process).

As shown in the last column of Table 3, each plug configuration was also able to be evaluated against the available volume of fill required. Based on preliminary USACE design calculations based on the Miami Canal survey data, approximately 2.66 million cubic yards (MCY) of potential backfill material is available in the existing Miami Canal spoil mounds. Approximately 4.52 MCY of material would be required to backfill the entire 27 miles of the Miami Canal within the Decomp PIR 1 project footprint (S-8 to S-151). Based on consideration of this material shortfall for a complete backfill, there is a recognized cost associated with importing the additional fill needed for any plug configuration that exceeds the 2.66 MCY estimated available on site; the final combined score (total ranking) for each plug configuration is plotted against the fill volume required to replicate each individual plug configuration along the entire 27 mile

Miami Canal project area length in Figure 6. Based on the RMA2 performance measure evaluation, the plug configuration with a 4000 foot plug length and 2000 foot spacing provided the closest match to the total backfill case, although this configuration, in the absence of further optimization (i.e. slightly shorter plug length or slightly increased plug spacing, not likely to significantly affect overall performance), would require the import of an estimated 0.35 MCY of material in excess of the spoil material available on site. If no additional fill material is generated from other components of Decomp PIR 1 (spreader canal construction, canal conveyance improvements, etc.) and fill availability is utilized as a selection criteria for the optimal plug configuration, the 1000 foot plug length and 3000 foot spacing would represent the preferred plug configuration.

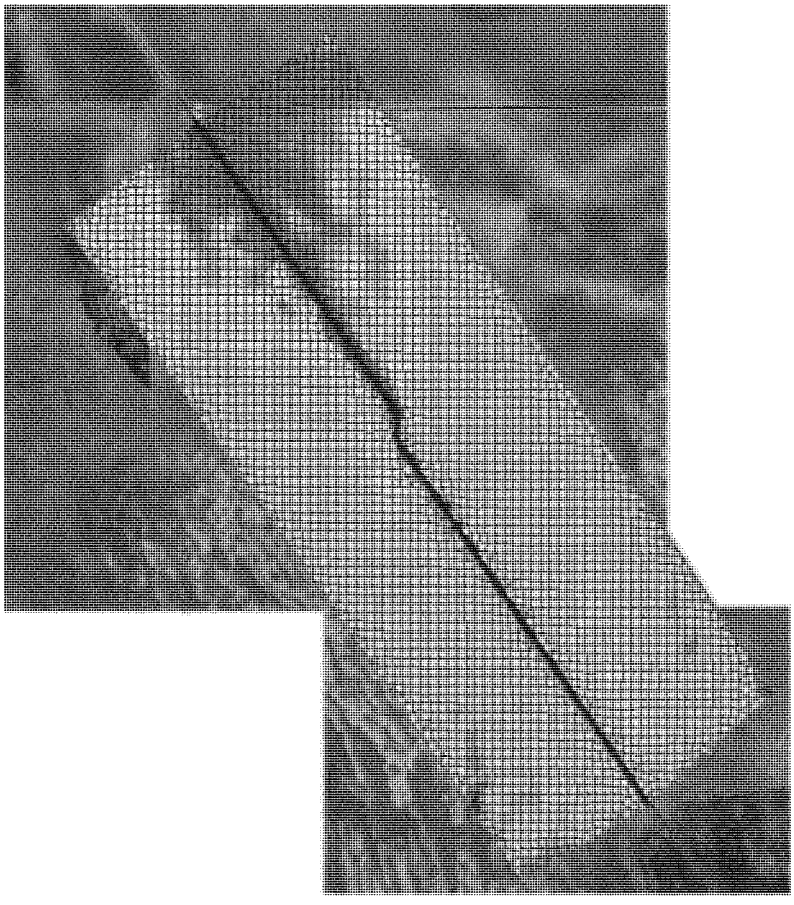

Figure 1: RMA2 Model Domain for Screening of Miami Canal Plug Configurotions

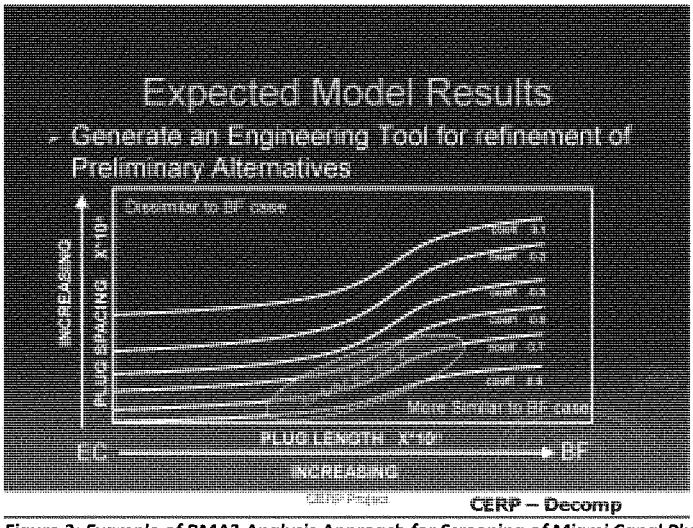

Figure 2: Example of RMA2 Analysis Approach for Screening of Miami Canal Plug Canfigurations

Table 1: RMA2 Model Test Matrix, Miami Canal Plug Length and Spacing Combinations Evaluated

Length (feet)	500	1000	2000	4000	10000
Spacing (feet)					
1000	X		X	X	
3000	X	X			
4000			X		
5000	X	X			X
10000		X	X	X	X
15000	X				
20000			X	X	
25000	X	X			

Table 2: Preliminary RMA2 Performance Measure Screening Results for Miami Canal Plug Configurations

Treatment # (plug Configuration)	Plug Length	Plug Spacing	R Velocity Magnitude	Cosine Similarity	R Velocity Along Canal	R Velocity Across Canal	Transect Flow (cfs)	Normalized Transect Flow (30 cfs for total backfill case)
1	500	1000	0.96	0.82	0.94	0.86	49	1.6
2	500	3000	0.86	0.81	0.84	0.82	70	2.3
3	500	6000	0.81	0.81	0.79	0.80	120	4.0
4	500	12000	0.65	0.82	0.63	0.79	171	5.7
5	500	24000	0.57	0.84	0.53	0.80	197	6.6
6	1000	3000	0.96	0.82	0.95	0.89	55	1.8
7	1000	5000	0.86	0.82	0.84	0.86	83	2.8
8	1000	12000	0.67	0.83	0.65	0.84	176	5.9
9	1000	23000	0.58	0.84	0.55	0.86	193	6.4
10	2000	1000	0.98	0.84	0.97	0.94	47	1.6
11	2000	4000	0.93	0.82	0.92	0.90	107	3.6

Treatment # (plug Configuration)	Plug Length	Plug Spacing	R Velocity Magnitude	Cosine Similarity	R Velocity Along Canal	R Velocity Across Canal	Transect Flow (cfs)	Normalized Transect Flow (30 cfs for total backfill case)
12	2000	10000	0.75	0.83	0.72	0.88	164	5.5
13	2000	23000	0.62	0.85	0.59	0.89	185	6.2
14	4000	2000	0.98	0.86	0.98	0.97	38	1.3
16	4000	10000	0.88	0.84	0.86	0.93	93	3.1
16	4000	18000	0.71	0.85	0.69	0.93	150	5.0
17	10000	5000	0.90	0.85	0.80	0.95	189	6.3
18	10000	10000	0.89	0.85	0.88	0.97	123	4.1

6900

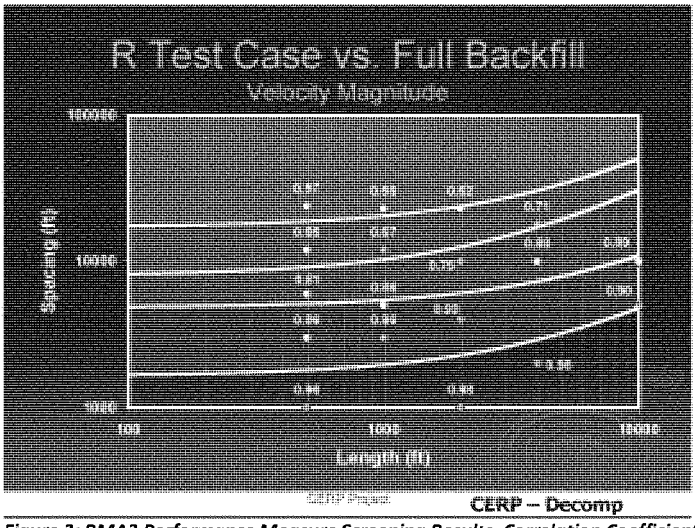

Figure 3: RMA2 Performance Measure Screening Results, Correlation Coefficient of absolute velocity magnitude

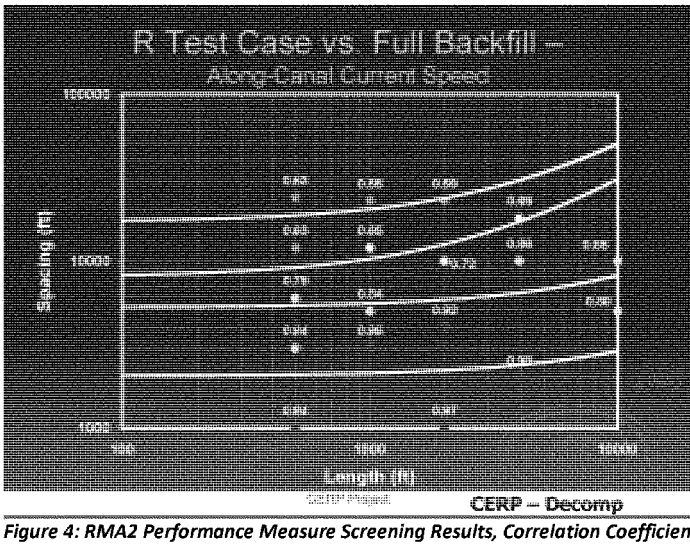

Figure 4: RMA2 Performance Measure Screening Results, Correlation Coefficient of along canal velocity

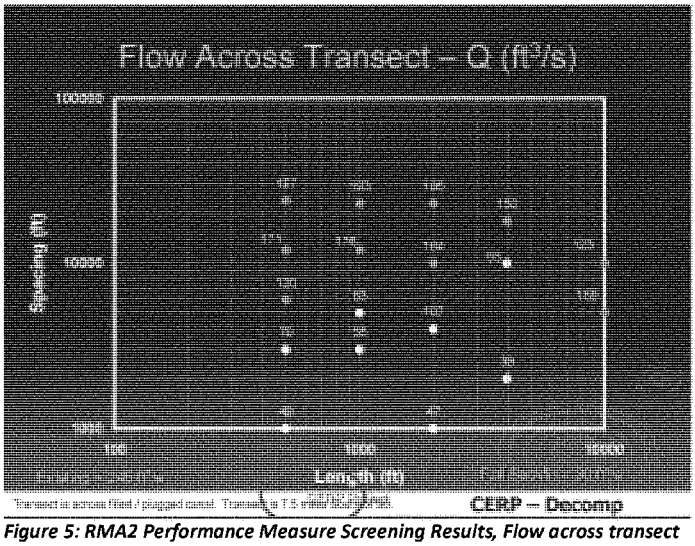

Figure 5: RMA2 Performance Measure Screening Results, Flow across transect

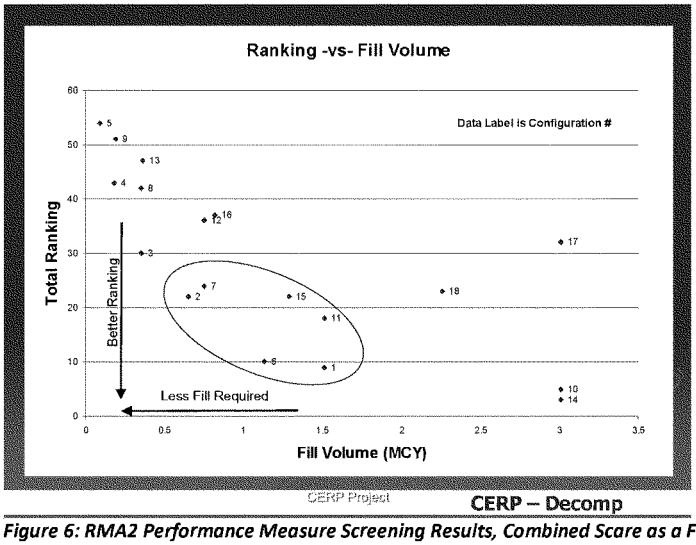

Figure 6: RMA2 Performance Measure Screening Results, Combined Scare as a Function of Plug Fill Requirements

Table 3: Final RMA2 Performance Measure Screening Results for Miami Canal Plug Configurations

Treatment # (plug Configuration)	Plug Length	Plug Spacing	R Velocity Magnitude Rank	R Velocity Along Canal Rank	Transect Flow Rank	Combined Score	Fill Required (MCY)
1	**500**	**1000**	3	4	2	9	1.51
2	**500**	**3000**	9	8	5	22	0.65
3	**500**	**6000**	10	11	9	30	0.35
4	**500**	**12000**	15	15	13	43	0.18
5	**500**	**24000**	18	18	18	54	0.09
6	**1000**	**3000**	3	3	4	10	1.13
7	**1000**	**5000**	10	8	6	24	0.75
8	**1000**	**12000**	14	14	14	42	.035
9	**1000**	**23000**	17	17	17	51	0.19
10	**2000**	**1000**	1	2	2	5	3.01
11	**2000**	**4000**	5	5	8	18	1.51

Treatment # (plug Configuration)	Plug Length	Plug Spacing	R Velocity Magnitude Rank	R Velocity Along Canal Rank	Transect Flow Rank	Combined Score	Fill Required (MCY)
12	**2000**	**10000**	12	12	12	36	0.75
13	**2000**	**23000**	16	16	15	47	0.36
14	**4000**	**2000**	1	1	1	3	3.01
15	**4000**	**10000**	8	7	7	22	1.29
16	**4000**	**18000**	13	13	11	37	0.82
17	**10000**	**5000**	6	10	16	32	3.01
18	**10000**	**10000**	7	6	10	23	2.26

Table 4: Final RMA2 Performance Measure Screening Results for the Top 6 Ranked Miami Canal Plug Configurations

Configuration #	Plug Length	Plug Spacing	Combined Score	Fill Volume Required (MCY)
14	4000	2000	3	3.01
10	2000	1000	5	3.01
1	500	1000	9	1.51
6	**1000**	**3000**	**10**	**1.13**
11	2000	4000	18	1.51
2	500	3000	22	0.65

*Available fill onsite = ~2.66 MCY

3. Evaluation of the Final Array of Alternatives

3.1 CEPP Baseline Condition Modeling

The study area for the CEPP encompasses Lake Okeechobee, the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), a portion of the EAA, the WCAs, ENP, the Southern Estuaries (Florida Bay and Biscayne Bay), and the Lower East Coast. Section 2.4 of the CEPP PIR main report provides a summary description of the existing and future without project conditions within the study area. Detailed documentation of existing and future without project conditions is further provided in Appendix C.1 to the CEPP PIR main report, including detailed documentation of hydrology, regional water management, flood control, and water supply performance for each base condition. Selected graphics are included to illustrate the performance of each baseline condition.

Hydrologic modeling simulations of the existing condition baseline (ECB) and the CEPP future without project condition (FWO) were developed with the RSM-BN and RSM-GL sub-regional modeling tools, to provide baseline conditions for plan formulation and the assessment of CEPP project benefits and the assessment of CEPP alternative performance for the level-of-service for flood protection and water supply (ECB). The ECB was developed to represent the system-wide infrastructure and operations that were in place at the time CEPP plan formulation was initiated, approximately January 2012. The FWO for CEPP assumes the construction and implementation of currently authorized C&SF and non-CERP projects, and other Federal, state or local projects constructed or approved under existing governmental authorities that occur in the CEPP study area; the CEPP FWO therefore included first generation CERP projects already authorized and under construction (Indian River Lagoon-South Project, Picayune Strand Restoration Project, Site 1 Impoundment Project), second generation CERP projects authorized by Congress in WRRDA 2014 (Biscayne Bay Coastal Wetlands Project, Broward County Water Preserve Areas Project, Caloosahatchee River (C-43) West Basin Storage Reservoir, C-111 Spreader Canal Western Project), and non-CERP projects currently in progress (SFWMD Restoration Strategies, C&SF C-51 West End Flood Control Project, the C-111 South Dade Project, the Kissimmee River Restoration Project, Modified Water Deliveries, and the DOI Tamiami Trail Modifications Next Steps Project. Documentation of RSM-BN and RSM-GL assumptions for the ECB and FWO baseline conditions are provided in Reference 2 of this Annex, respectively. HESM/IMC MDR 2 (CEPP PIR Appendix A: Annex A-3) reviews the model representations of existing conditions and the future without project conditions used throughout the CEPP plan formulation efforts.

The CEPP PIR report documentation and two complete sets of RSM-BN and RSM-GL hydrologic model performance measure output are posted on the Everglades Plan public web site for the CERP:
http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

The following complete performance measure data sets are provided to facilitate additional review of the hydrologic modeling output for the baselines and the recommended plan, Alternative 4R2:

- ECB, FWO, Alternative 4R, Alternative 4R2 (comparison used for NEPA evaluation in Section 5 of the main PIR report)

- ECB, 2012EC, IORBL1,Alternative 4R2 (comparison used for the Savings Clause and Project Assurances evaluation in Annex B of the PIR report)

Final CEPP hydrologic modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. CEPP modeling products in MMS can be accessed directly at the MMS project page through the Everglades Plan public web site:
http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

3.2 Final Array Modeling

CEPP plan formulation efforts identified the final array of four alternatives (Alternatives 1 through 4) in November 2012, and the corresponding RSM-BN and RSM-GL simulations of the alternatives was subsequently completed in December 2012. HESM/IMC MDR 3 (CEPP PIR Appendix A: Annex A-3) reviews these four proposed with-CEPP project model representations examined during this first round of CEPP plan formulation. As documented in Section 4.6 of the CEPP PIR main report, modifications to the final array were identified during January-February 2013 that resulted in the identification of Alternative 4M as the National Ecosystem Restoration (NER) Plan. The evaluation also identified the need to revise the operations for Alternative 4M, which was not evaluated with hydrologic modeling, to ensure the project savings clause constraints are met, to minimize localized adverse ecological effects, and to identify additional opportunities to provide for other water related needs.

Three additional modeling scenarios were conducted in the following months to identify project effects resulting from the identified operational changes: Alternative 4R (completed February 2013), Alternative 4R1 (May-June 2013), and Alternative 4R2 (June 2013). The first refinement, Alt 4R, focused on operation changes to avoid potential impacts to water supply levels of service in the Lake Okeechobee Service Area (LOSA) and Lower East Coast (LEC). Refinements included alleviating potential ecological impacts from lowered water depths in WCA 2B by retaining a small portion of the water in WCA 2B that Alternative 4M had diverted to WCA 3A. Increases in low flow events to the St. Lucie Estuary, minimized reductions in freshwater flows to Biscayne Bay, and improved water depths in eastern WCA 3B for purposes of improving environmental conditions were also considered. Building on the performance improvements achieved with the Alternative 4R operational changes, Alternatives 4R1 and 4R2 increased public water supply demand for Lower East Coast Service Area 2 (LECSA 2 - Broward County) and Lower East Coast Service Area 3 (LECSA 3 - Miami-Dade County) to determine whether there was a threshold for increased public water supply demand that would be capable of balancing increased water supply demands for LECSA 2 and LECSA 3 with maintaining the natural system performance of Alternative 4R. Alternative 4R1, which increased public water supply demand by 19 million gallons per day (MGD) for LECSA 2 and 53 MGD for LECSA 3, was not assessed in detail in the PIR report due to significant performance concerns identified with the observed reductions in discharges to Biscayne Bay and increased risk of saltwater intrusion at several wellfield locations. Based on information gained during the modeling of Alternative 4R1 and related RSM-GL sensitivity simulations, the subsequent Alternative 4R2 simulation limited the increase to public water supply demand by 12 MGD for LECSA 2 and 5 MGD for LECSA 3 and was determined to be successful with maintaining the ecological performance of Alternative 4R

without the negative effects to LEC groundwater and Biscayne Bay that Alt 4R1 realized. Alternative 4R2 was identified in the PIR main report as the recommended plan. HESM/IMC MDR 4 (CEPP PIR Appendix A: Annex A-3) reviews the model representation of the CEPP Recommended Plan and refinements to the NER plan during final plan formulation and project assurance planning.

Completion of the model documentation reports (MDRs) for the model assumptions and performance overviews of the CEPP preliminary screening modeling, CEPP base condition modeling, and Alternatives 1 through 4R2 was deferred to following completion of the CEPP final array and Project Assurances/Savings Clause modeling, and the MDRs were therefore not available to be included with the Draft PIR. The CEPP MDRs were completed concurrent with the Draft PIR public review process, and the Final CEPP MDRs are included as Annex A-3 of Appendix A (Engineering). Prior to the availability of the complete MDRs, RSM-BN and RSM-GL model assumption tables for Alternative 4R and Alternative 4R2 were provided in Reference 2 of this Annex; to maintain consistency within the Final PIR, these tables remain included in Reference 2 of the Final PIR. The following four MDR reports, which sequentially track the CEPP plan formulation and evaluation efforts, are included in Annex A-3 of Appendix A:

- MDR 1: CEPP Model Supported Screening Efforts
- MDR 2: CEPP Baseline Runs
- MDR 3: CEPP Final Array of Alternatives (Alternatives 1 through 4)
- MDR 4: CEPP Tentatively Selected Plan (including NER refinement modeling)

The study area for the CEPP encompasses Lake Okeechobee, the Northern Estuaries (St. Lucie River and Indian River Lagoon and the Caloosahatchee River and Estuary), a portion of the EAA, the WCAs, ENP, the Southern Estuaries (Florida Bay and Biscayne Bay), and the Lower East Coast. Section 4 and Section 5 of the CEPP PIR main report provides a performance evaluation for the final array of alternatives. Detailed documentation of the effects of the alternatives 1 through 4 on regional hydrology and water supply and flood control, compared to the future without project base condition, are provided in Section 5.1.8, Section 5.1.15.2 and Appendix C.2.1 of the CEPP PIR main report. Detailed documentation of the effects of the operational refinements of the National Ecosystem Restoration (NER) plan (Alternative 4R and Alternative 4R2) on regional hydrology and water supply and flood control, compared to the future without project base condition, are provided in Sections 5.2.8, Section 5.2.15.2, and Appendix C.2.2 of the CEPP PIR main report. Selected graphics are included to illustrate the performance of each alternative.

An enormous amount of output is generated from each RSM-BN and RSM-GL simulation and the accompanying post-processed performance measures. Reference maps to assist with user navigation of RSM-GL indicator regions, performance measure zones, transects, reference gages, and viewing window spatial locations are included in Reference 3 of this Annex. The monitoring gage map, levee map, and transect map are additionally included in this Annex as Figures 7 through 9.

For the CEPP, standard RSM-BN and RSM-GL performance measure output are grouped into the following directory structure, to assist with user navigation: duration curves; Florida Bay salinity (directory name: FlaBay_Salinity); flow magnitude (data files summarize daily cosine similarity statistics for surface water flow vectors); Lake Okeechobee; Northern Estuaries; percent period-

of-record inundation for ridge and slough landscape (PPOR inundation); slough vegetation; soil oxidation; continuity metric for transects (transectflow_continuity); distribution metric for transects (transectflow_distribution); and timing metric for transects (transectflow_timing). For the CEPP, standard RSM-BN and RSM-GL performance indicators output are grouped into the following directory structure, to assist with user navigation: critical flow (data file summarizes average annual structure flows); 1983-1993 stage duration curves for selected indicator cells within the Lower East Coast (duration_8393); water restriction frequency for Lower East Coast Service Areas (freq_water_restrictions); hydrographs and stage duration curves for selected recreational camp locations (hyd_dur_camps); hydrographs and stage duration curves for C&SF canals (hyd_dur_canals); hydrographs and stage duration curves for selected monitoring gages within the Greater Everglades and Lower East Coast (hyd_dur_gages); hydrographs and stage duration curves for Lake Okeechobee (Lake Okeechobee); Lake Okeechobee Service Area water supply performance, including Seminole Tribe reservations (LOSA_Water_Supply); Northern Estuaries; Lower East Coast levee seepage (seepage_reports); average annual wet and dry season transect flows (transect_flows); and Everglades water level spatial and temporal variability viewing windows (viewing_windows). The performance indicators directory also includes sub-directories for each baseline condition and alternative, which include annual average and period-of-simulation average graphics for groundwater vector maps, hydroperiod maps, ponding depth maps, stage maps, surface water vector maps, water budget maps (period-of-simulation average only), and average April water stage level maps for the Lower East Coast (average year 1978, dry years 1989 and 2001, and wet year 1995).

The CEPP final array modeling output includes two performance measure sets that include: (1) concurrent performance measure display of the CEPP FWO outputs and Alternative 1 through 4, including combined outputs for both the RSM-BN and RSM-GL models; and (2) concurrent performance measure display of the CEPP FWO outputs, Alternative 4R, and Alternative 4R2, including combined outputs for both the RSM-BN and RSM-GL models.

The CEPP PIR report documentation and two complete sets of RSM-BN and RSM-GL hydrologic model performance measure output are posted on the Everglades Plan public web site for the CERP:
http://www.evergladesplan.org/pm/projects/proj_51_cepp.aspx

The following complete performance measure data sets are provided to facilitate additional review of the hydrologic modeling output for the baselines and the recommended plan, Alternative 4R2:

- ECB, FWO, Alternative 4R, Alternative 4R2 (comparison used for NEPA evaluation in Section 5 of the main PIR report)
- ECB, 2012EC, IORBL1, Alternative 4R2 (comparison used for the Savings Clause and Project Assurances evaluation in Annex B of the PIR report)

Final CEPP hydrologic modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. CEPP modeling products in MMS can be accessed directly at the MMS project page through the Everglades Plan public web site:

http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

For additional reference, the following selected RSM-BN and RSM-GL model output is provided within this Hydrologic Modeling Annex. Reference 4 of this Hydrologic Modeling Annex includes the RSM-BN water budget map output for the CEPP baselines (ECB, 2012EC, FWO, and IORBL1) and Alt4R2, including structure crosswalk information for the water budget maps. Reference 5 of this Hydrologic Modeling Annex includes the RSM-GL water budget map output for the CEPP baselines (ECB, 2012EC, FWO, and IORBL1) and Alt4R2. Reference 6 of this Hydrologic Modeling Annex includes the RSM-GL stage output maps, RSM-GL hydroperiod output maps, stage difference maps for Alt4R2 compared to each baseline, and hydroperiod difference maps for Alt4R2 compared to each baseline.

Sections 3.2.1 through 3.2.4 of this H&H Annex provide documentation of USACE SAJ performance analysis of the hydrologic modeling results for the CEPP final array of alternatives with specific emphasis on engineering design considerations that were actively tracked throughout the CEPP formulation, preliminary screening, and alternative development efforts. Following the CEPP PDT evaluations of Alternatives 1 through 4, Alternative 4 was the alternative selected for further optimization and which ultimately became the recommended plan, Alternative 4R2. Since the modeling for Alternative 4R and Alternative 4R2 was conducted subsequent to the modeling for Alternatives 1 through 4, most figures within the Annex are duplicated for: (1) Alternatives 1 through 4; and (2) Alternatives 4R and 4R2 only (Alternative 4 may also be shown, as an additional reference point). Within the Engineering Appendix, summary information is typically provided only for the recommended plan, Alternative 4R2.

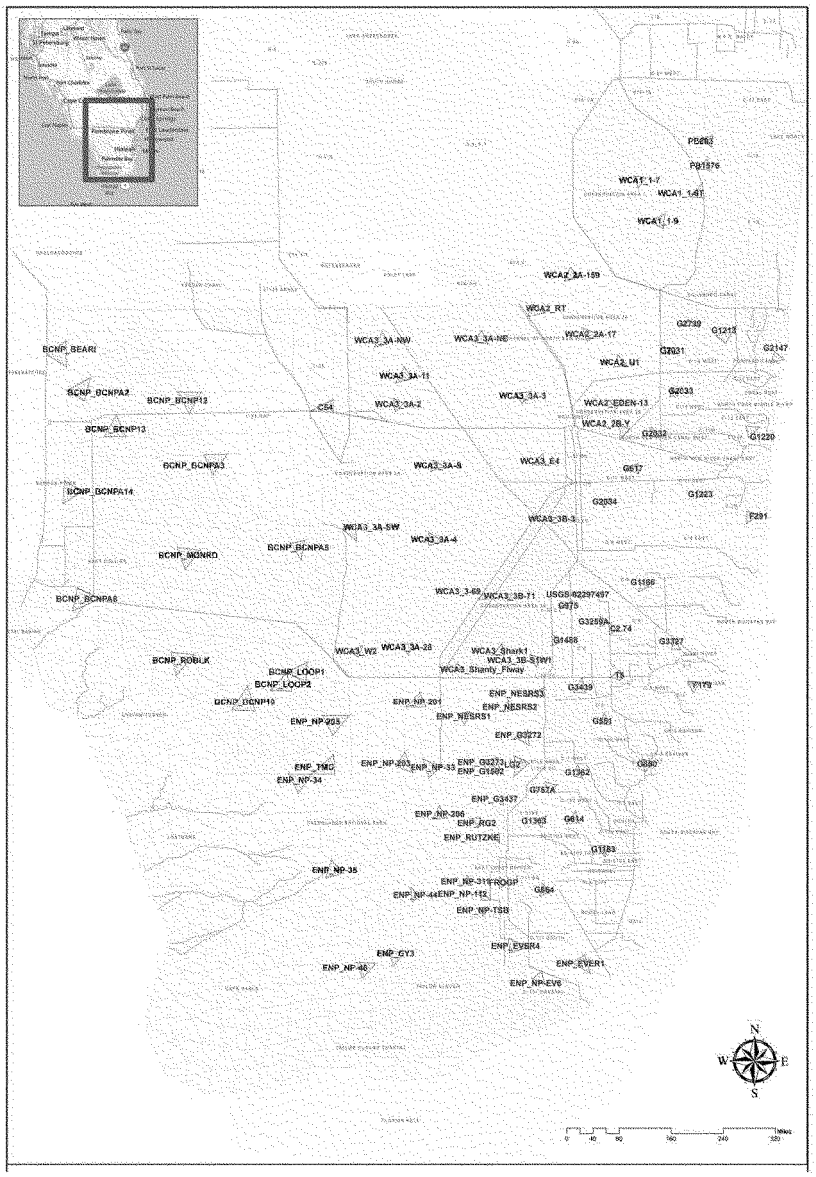

Figure 7: Map of RSM-GL monitoring gage locations

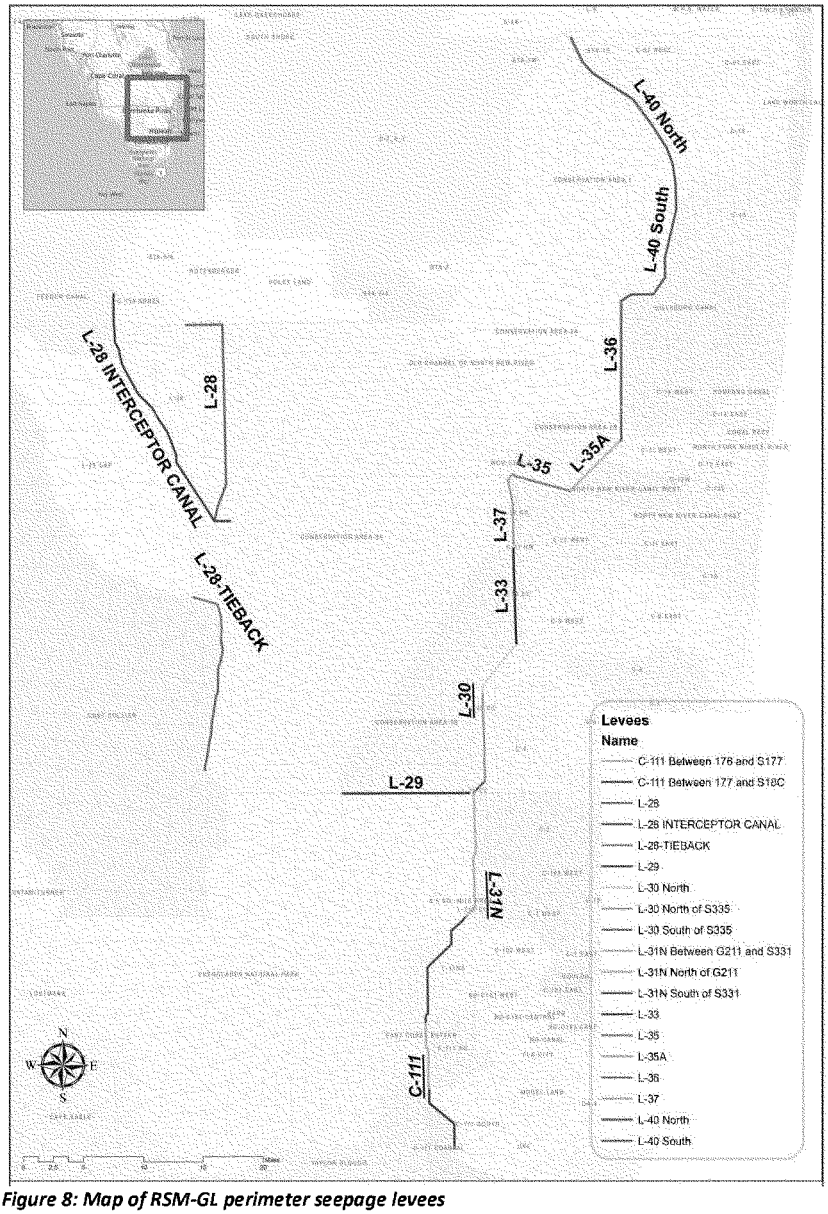

Figure 8: Map of RSM-GL perimeter seepage levees

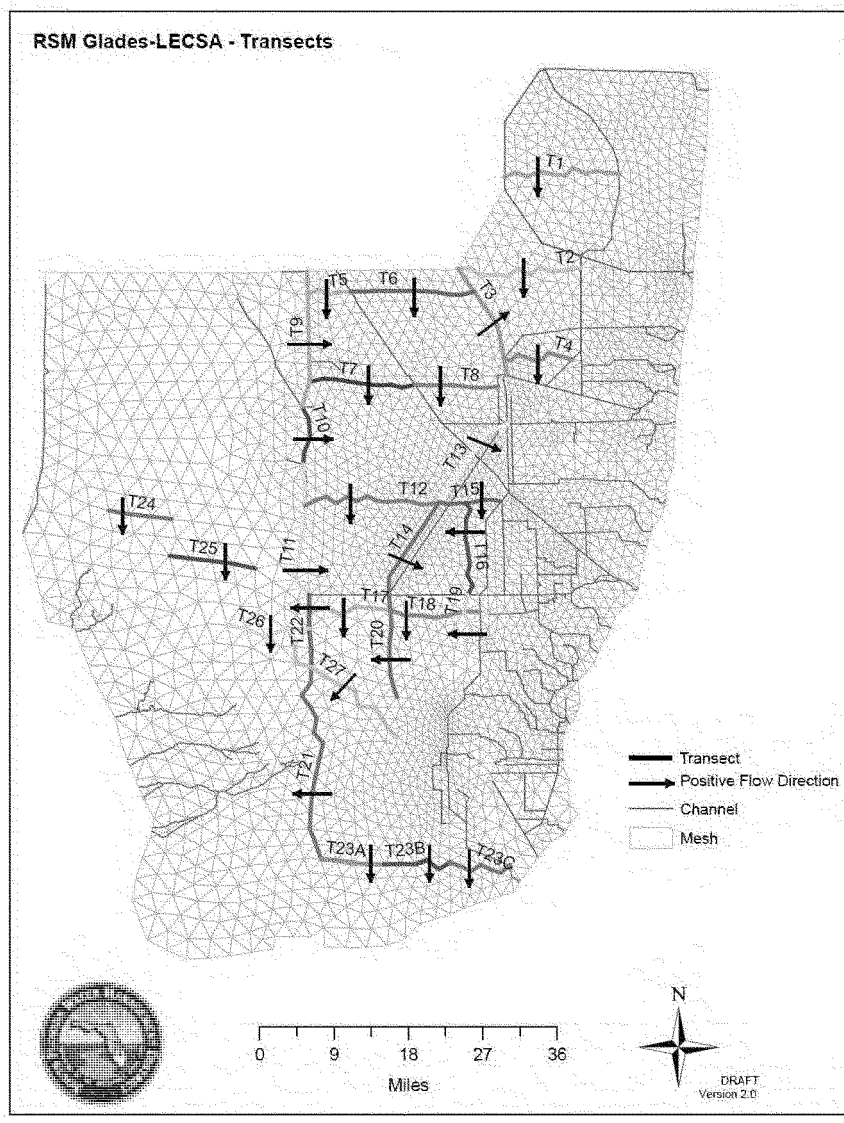

Figure 9: Map of RSM-GL surface water and groundwater reporting transects

3.2.1. WCA-3A High Water Performance Evaluation Methodology and Results

The USACE Final Everglades Restoration Transition Plan (ERTP) EIS and Record of Decision (ROD signed on 19 October 2012) identified the 1960 WCA-3A 3A 9.5 to 10.5 feet, NGVD Regulation Schedule as an interim measure water management criterion for WCA-3A Zone A. This change to Zone A, compared to the previous Interim Operational Plan (IOP) for WCA-3A regulation, was necessary to mitigate for the observed effects, including discharge limitations of the S-12 spillways. The preliminary EN-W analysis of WCA-3A high water levels, which was integrated into the ERTP EIS, also recommended further consideration of additional opportunities to reduce the duration and frequency of Water Conservation Area 3A high water events (ERTP Final EIS, Appendix A-5).

The ERTP analysis of WCA-3A high water events indicated that, based on current system conditions as simulated in the water budget spreadsheet, the IOP infrastructure and operational configuration of WCA-3A would result in a predicted increase in the Standard Project Flood (SPF) stage for WCA-3A of between 1.3 and 1.4 feet compared to the WCA-3A design assumptions (1960 General Design Memorandum (GDM), C&SF Project for Flood Control and Other Purposes, Part I, Supplement 33). Predicted SPF stages are increased from 12.40 to 13.76 feet NGVD and from 13.90 to 15.20 feet NGVD for the S-12 headwater stage and the WCA-3A three-gage average stage, respectively. The ERTP analysis also illustrated, through the use of current USGS rating curves for the S-12 spillways, that the peak SPF stage is increased over the original design due to a reduction in outlet capacity from WCA-3A through the S-12s. This significant change to the original design assumptions, with the additional diminished extent of emergent vegetation within WCA-3A, led the USACE to identify WCA-3A high water stages as a potential cause for concern. Due to the simplistic nature (i.e., volumetric and not hydraulic routing) of the ERTP (Phase 1) analysis, the level of flood protection afforded by WCA-3A was not completely addressed during the initial assessment under ERTP; additional analyses, as identified for inclusion under a subsequent detailed study phase (termed Phase 2 in the ERTP Final EIS), are required to investigate and specify the level of protection afforded by the WCA-3A water management regime and levee configuration.

The preliminary ERTP analysis was limited to a simplified hydrology and hydraulics assessment, while the ERTP-recommended Phase 2 analysis was envisioned to include a more robust hydrology and hydraulics assessment and additional engineering analysis of the structural and geotechnical design aspects for WCA-3A. The recommended Phase 2, which concurrent with CEPP development has remained in the initial scoping and funding phase, is projected to include development of hydrologic/hydraulic models; SPF hydraulic routings for each of the WCAs, to address system changes that have occurred since the original C&SF design; detailed evaluation and risk assessment by hydrology and hydraulic, geotechnical, and structural design engineering disciplines; and quantification of flood protection levels. Upon completion of the SPF routing, additional engineering analysis, incorporating current USACE guidelines for risk analysis requirements will be performed to analyze levee stability and safety issues. This assessment is expected to identify proposed water management operating criteria and potential infrastructure modifications to address identified concerns. Due to the high level of effort and projected time required, USACE recognized that the results from the Phase 2 WCA-3A flood routing hydraulic analysis would not be available for CEPP consideration. Results from Phase 2 will be incorporated into future phases of ERTP, potential future CEPP implementation, or other future regional operational planning efforts, as appropriate.

Although the preliminary ERTP analysis did not provide a quantifiable risk assessment, the hydrologic insights gained from the analysis made it prudent for the USACE to recommend the lowering Zone A of the WCA-3A Regulation Schedule as an interim risk reduction measure, based upon the following considerations:

(1) USGS rating curves and historical discharge data demonstrate limitations in the outlet capacity of the S-12 structures, as compared to the original structure design capacities;
(2) Design storm analysis and SPF event flood routings have not been incorporated into the assessment of WCA-3A Regulation Schedule changes implemented under the Experimental Program, ISOP, and IOP. These analyses are planned for inclusion under the Phase 2 analysis;
(3) The Phase 1 (ERTP) analysis predicted an increase to the WCA-3A high water stages for the SPF design event of 1.3-1.4 feet, compared to the original WCA-3A design assumptions. There is also a recognition that the L-29 Levee/ Tamiami Trail crest elevations (design grade 14.0 feet NGVD) were originally established in conjunction with 1960 WCA-3A regulation Schedule;
(4) Compared to the original WCA-3A design assumptions, the diminished extent of emergent vegetation within WCA-3A may increase the potential effects of wind and wave set-up against the levees;
(5) Zone A lowering is a prudent risk reduction measure that could be implemented expediently with ERTP, which appears to be effective at reducing the peak stage of smaller, more frequent events than the SPF (maximum historical stages correspond to ~50% of SPF).
(6) The lowered Zone A would re-establish consistency with the 1960 regulation schedule, utilized for the original WCA-3A design.
(7) The lowered Zone A will be better able to meet the depths recommended within the FWS Multi-Species Transition Strategy (MSTS) (at critical time periods), providing direct benefits to snail kites, apple snails, wood storks and other wading birds, and tree islands.

Zone A is the top zone of the WCA-3A Regulation Schedule and, when water levels are within Zone A, releases from WCA-3A are to be made up to maximum practicable levels given operational constraints. The ERTP lowering of Zone A represents a return to pre-Experimental Program stage levels for Zone A. The previous IOP Regulation Schedule for WCA-3A included a seasonally varying stage of between 10.7S to 10 feet NGVD in Zone A, while the ERTP schedule has a seasonally varying stage of between 10.5 to 9.5 feet NGVD in Zone A. Flow will overtop the structure gates of the S-12s when the gates are closed, if the S-12 headwater stage exceeds 11.0 feet NGVD; with the gates fully open, the gate clearance elevation is 13.4 feet NGVD. For additional reference, the crest elevation of U.S. Highway 41 (Tamiami Trail) in the reach between S-12A and S-12D is approximately 14.8-14.95 feet NGVD, with slightly lower crest elevations (14.3 feet NGVD) along this portion of the L-29 Levee (Section 2) located further east at S-333.

The information on which the USACE relied on to require the ERTP WCA-3A Zone A as an interim risk reduction measure for WCA-3A high water levels has not changed prior to CEPP formulation, and no new information is currently available compared to the July 2010 assessment included as Appendix A-5 of the ERTP Final EIS. Throughout CEPP formulation, the SAJ Water Resources

Engineering Branch (EN-W) advocated that CEPP formulation efforts attempt to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP Future Without Project (FWO) condition, which includes ERTP, given recognition of the WCA-3A high water concerns identified with ERTP; prior to CEPP formulation, the January 2012 CEPP Risk Register explicitly recognized that the ERTP constraint precluded raising of the top of the WCA-3A Regulation Schedule, while simultaneously recognizing that substantial benefits were still expected and that goals to further lower stages in WCA-3A were consistent with the constraint. EN-W also indicated that it would continue to rely on the WCA-3A three-gage average stages for assessment of WCA-3A high water frequency, durations, and peak stages, consistent with the original WCA-3A design assumptions and the ERTP assessment; increased weight would not be considered for a single gage, such as 3A-28 (Site 65). It was further noted that if CEPP can provide operational assurances of additional WCA-3A outlet capacity under high water conditions, including adequate consideration of potential WCA-3B seepage management and/or ecological operational limitations, the EN-W may be able to further consider proportional relaxation of the WCA-3A FWO high water duration and frequency targets.

Preliminary CEPP formulation efforts for the Green and Blue Line components, which relied on the iModel, were not able to demonstrate achievement of the FWO frequency of time within Zone A of the ERTP WCA-3A Regulation Schedule, based on the system-wide optimization of ecological targets and consideration of the additional ~220,000 acre-feet (220 kAF) of inflows to WCA-3A available from the Flow Equalization Basin (FEB) and associated water quality treatment (refer to section 3.2.3 of the CEPP PIR main report and Appendix E.1 for additional discussion). Significant increases in WCA-3A regulatory discharge capacity were also not identified through the preliminary iModel screening.

The requirements to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP Future Without Project (FWO) condition were actively integrated into the formulation efforts to identify the CEPP final array of alternatives, and the assessment of the final array demonstrated levels of performance consistent with this requirement. The EN-W assessment relied on additional post-processing of the RSM-GL model results, as subsequently discussed.

3.2.1.1. WCA-3A High Water Performance Criteria

To establish the WCA-3A high water performance criteria to assist with CEPP formulation and to provide technical recommendations to the CEPP formulation efforts, EN-W developed comparisons between the ERTP Recommended Plan modeling (Alternative 9E1 in the ERTP Final EIS), which was simulated with the SFWMM, and the RSM-GL base conditions representations that were developed for CEPP starting in May 2012. Based on the results of these comparisons, EN-W recommended in July 2012 that CEPP formulation efforts should identify alternative configurations which maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP FWO condition. No significant changes to WCA-3A stage duration curves were observed for subsequent incremental iterations of the SFWMM ECB and FWO base conditions that were generated in August 2012 and December 2012, and, therefore the original EN-W WCA-3A high water performance criteria were retained throughout CEPP formulation efforts.

Following USACE vertical team endorsement of the CEPP modeling strategy in January 2012 (Decision Point 1), it was known that SFWMM modeling simulations would not be conducted for CEPP. Different from ERTP, initial assessments for CEPP formulation screening and alternative evaluations for WCA-3A were based on RSM-GL results, including a 1965-2005 period of simulation (the ERTP SFWMM modeling period of simulation was 1965-2000). The CEPP FWO Baseline modeling assumed ERTP operations, in addition to the following additional assumptions potentially affecting WCA-3A: operation of the SFWMD A-1 FEB to achieve water quality compliance (note: this feature was not modeled for the draft FWO baseline simulations in May 2012 and August 2012, pending additional details from the then-concurrent SFWMD Restoration Strategies modeling efforts and water quality compliance coordination); operation of Compartments B and C (STA-2 and STA-5, respectively); operation of Broward Water Preserve Areas (BCWPA) CERP project; and completion of the Tamiami Trail 1-mile bridge (G-3273 constraint remains in place, and L-29 constraint remains at 7.5 feet NGVD). Since ERTP was modeled with the SFWMM (1965-2000 period of simulation), the ERTP simulation results are not directly comparable to the CEPP modeling.

To provide a meaningful comparison between ERTP SFWMM modeling and the CEPP baselines, the SFWMM and RSM-GL comparisons were limited to the 1965-2000 time period. Stage hydrographs for the WCA-3A three-gage average stage (average of the 3A-3, 3A-4, and 3A-28 monitoring gages; refer to the Figure 7 map) are displayed in Figure 10 for the ERTP SFWMM Recommended Plan (Alternative 9E1), and the final CEPP RSM-GL ECB and FWO baseline simulations; Figure 10 includes a sample time period for 1993-2005, which includes representative extreme wet and dry conditions within the ERTP SFWMM and CEPP RSM-GL simulation periods, with the seasonally-varying ERTP WCA-3A Regulation Schedule Zone A line shown for reference. Compared to the ERTP SFWMM modeling, the CEPP RSM-GL FWO baseline indicates an approximately 0.25 foot lowering in the upper 10 percent of the stage duration curve for the WCA-3A three-gage average stage, as shown in Figure 11 (full stage duration curve) and Figure 12 (upper 25 percent of the stage duration curve). In order to consider potential differences during specific years, the EN-W assessment also considered the annual duration of exceedance of the ERTP WCA-3A Zone A stage levels for the comparison time period (Figure 13). The annual durations were also displayed and assessed as a frequency curve (Figure 14). Given consideration of the across-model comparison, the differences in assumptions between the ERTP SFWMM modeling and the CEPP RSM-GL FWO modeling, and the ERTP engineering-based recommendations to lower the frequency, duration, and peak stage of WCA-3A high water levels, the RSM-GL FWO simulation was recommended by EN-W to serve as an upper bound for WCA-3A high water levels for CEPP formulation. Figures 11 through 14 additionally show the lowered WCA-3A water levels with ERTP through comparison of the CEPP ECB (IOP operations) and the CEPP FWO, as well as the insignificant effects on peak WCA-3A stages and Zone A exceedance with the RSM-GL FWO update for inclusion of the A-1 FEB operations (comparing the May 2012 RSM-GL FWO version to the final December 2012RSM-GL FWO simulation).

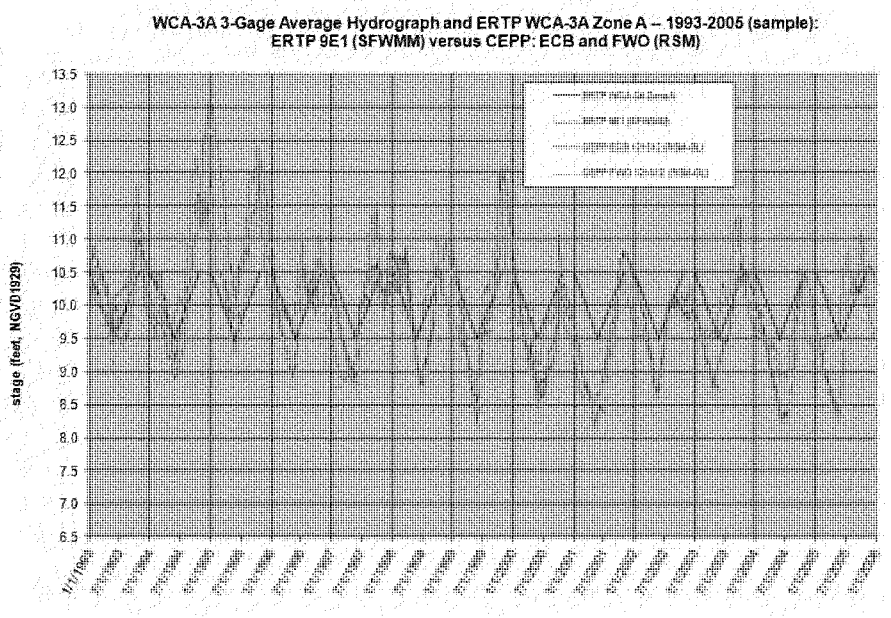

Figure 10: WCA-3A 3-gage average hydrographs for ERTP SFWMM modeling and CEPP RSM-GL baselines

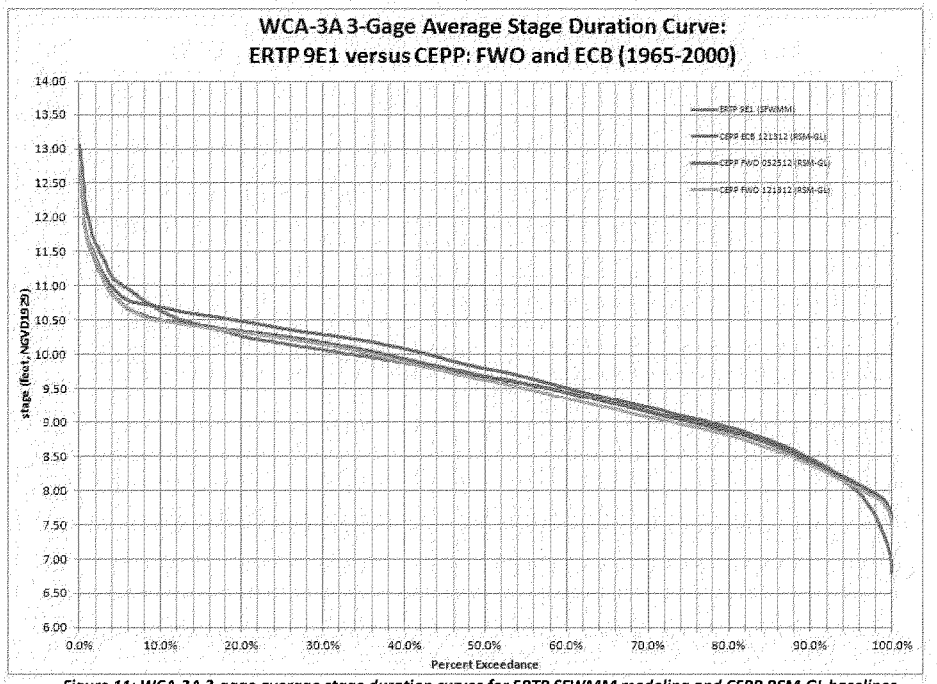

Figure 11: WCA-3A 3-gage average stage duration curves for ERTP SFWMM modeling and CEPP RSM-GL baselines

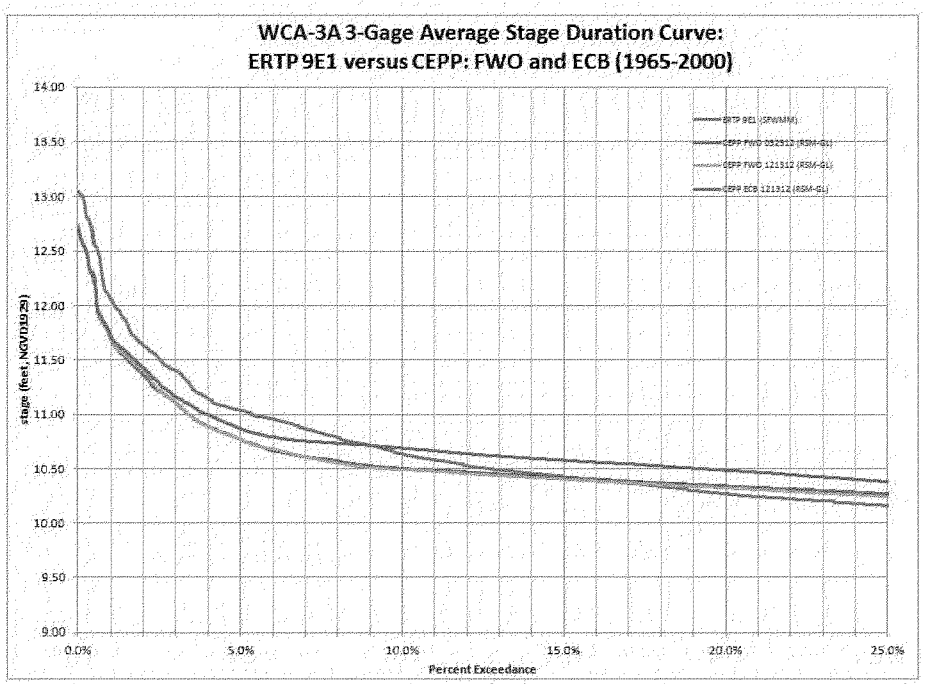

Figure 12: WCA-3A 3-goge average stage duration curves for ERTP SFWMM modeling and CEPP RSM-GL baselines (Upper 25%)

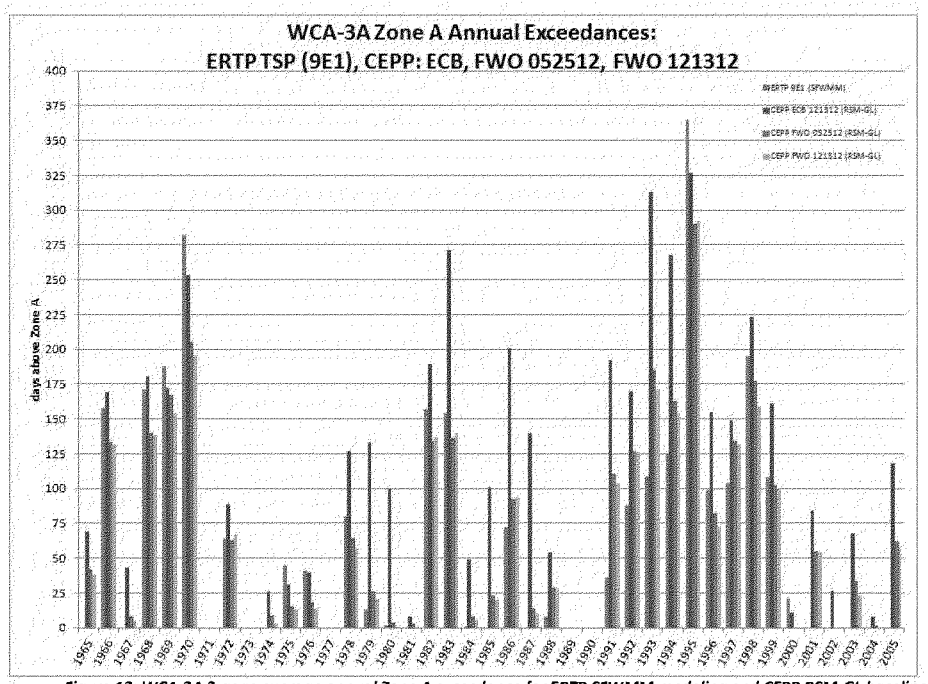

Figure 13: WCA-3A 3-gage average onnual Zone A exceedance for ERTP SFWMM modeling and CEPP RSM-GL baselines

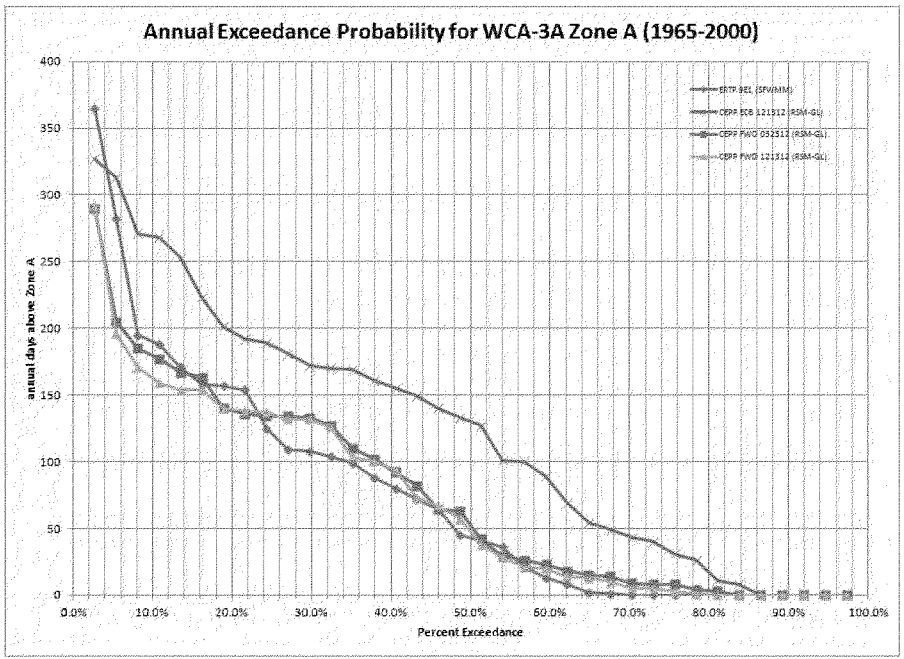

Figure 14: WCA-3A 3-gage averoge duration curve for annual Zone A exceedance far ERTP SFWMM modeling and CEPP RSM-GL baseline

3.2.1.2. WCA-3A High Water Performance Evaluation

The requirements to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP FWO condition were actively integrated into the formulation efforts to identify the CEPP final array of alternatives, and the CEPP modeling team considered these requirements as a constraint during the modeling of the final array of alternatives.

Applying the EN-W recommendation to utilize the CEPP FWO as the upper bounds for WCA-3A high water performance, the performance of the CEPP final array of alternatives for WCA-3A high water conditions was initially assessed in January 2013 for Alternatives 1 through 4 and updated in June-July 2013 for Alternatives 4R and 4R2. The CEPP FWO and the CEPP final array of alternatives were each simulated with the RSM-GL, with the complete 1965-2005 period of simulation. Example stage hydrographs for the WCA-3A three-gage average stage are displayed in Figure 15 (Alternatives 1 through 4) and Figure 16 (Alternatives 4, 4R, and 4R2) for the CEPP FWO and the CEPP final array of alternatives for a sample time period for 1993-2005, with the seasonally-varying ERTP WCA-3A Regulation Schedule Zone A line shown for reference. Compared to the CEPP FWO (final December 2012 release), the CEPP alternatives are lowered by approximately 0.1-0.3 feet in the upper 10 percent of the stage duration curve for the WCA-3A three-gage average stage, as shown in Figures 17-18 (full stage duration curve) and Figures 19-20 (upper 25 percent of the stage duration curve). In order to consider potential differences during specific years, the EN-W assessment also considered the annual duration of exceedance of the ERTP WCA-3A Zone A stage levels for the complete period of simulation (Figures 21-22). The annual durations were also displayed and assessed as a frequency curve (Figure 23-24). The total number of days above Zone A is summarized as follows for the CEPP FWO and CEPP alternatives (with percent of total period of simulation, 14975 days, in parentheses): CEPP FWO – 2718 days (18.15%); Alternative 1 – 3206 days (21.41%); Alternative 2 – 3034 days (20.26%); Alternative 3 – 3285 days (21.94%); Alternative 4 – 3227 days (21.55%); Alternative 4R – 3307 days (22.08%); and Alternative 4R2 – 3323 days (22.19%).

The EN-W performance assessment for the final array of alternatives further reviewed the WCA-3A stage hydrographs for individual years in which the number of days above Zone A increased by more than 20 percent between the CEPP FWO and any of the CEPP alternatives, as shown highlighted in Table 5 and Table 6. Annual hydrographs are also provided for each of the twelve years which triggered this further detailed assessment (Figures 25 through 38): 1969, 1980, 1983-1985, 1993-1996, 1999, 2003, and 2005.

Annual stage hydrograph statistical distribution plots were developed to assist with the general characterization of differences in intra-annual stage variability, to facilitate comparisons between the CEPP ECB baseline condition, the CEPP FWO baseline condition, and the CEPP final array of alternatives (refer to Figures 39 through 46). For the 41-year period of simulation, the graphics illustrate the maximum and minimum stage, 90th and 10th percentile stages, 75th and 25th percentile stages, median stage, and mean stage at a daily time step. The graphics also include the ERTP WCA-3A Regulation Schedule Zone A reference line, the FWS MSTS recommended seasonal range for January 1 and May 1-31, and the average ground surface elevation (GSE) for the WCA-3A 3-gage average at 8.34 feet NGVD (3A-3 GSE 9.08 feet NGVD; 3A-4 GSE 8.49 feet NGVD; 3A-28 GSE 7.44 feet NGVD). Compared to the CEPP FWO, the following general trends are noted for the CEPP alternatives (which all perform similarly for

WCA-3A stages): increased stages through the dry season, particularly January through May (most evident for the 75th and 90th percentiles); increased stages at the end of the dry season in May (most evident for 10th through 90th percentiles); increased stages at the beginning of the wet season in June-July (evident under all conditions); increased stages through the wet season and start of the dry season during average to dry years (evident for minimum to median stages); reduced stages at the end of the wet season in September-October during wet years (90th percentile and maximum stage); and reduced stages at the beginning of the dry season in November and December during wet years (90th percentile and maximum stages). These graphics illustrate that the increased durations within Zone A with the CEPP alternatives, as compared to the CEPP FWO, are the combined result of higher stages at the end of the dry season (along the Zone A recession) and higher antecedent stages at the beginning of the wet season (June 1) with the resulting effects of early wet season rainfall events. Peak stages and durations of Zone A exceedance at the end of the wet season, when WCA-3A design limitations are most critical due to the maximum stages, do not increase and, in many instances, are significantly reduced compared to the FWO condition. This conclusion is consistent with detailed review of the annual hydrographs presented in Figure 25 through 38. To facilitate direct comparisons between Alternative 4 and the operational refinements to the NER Plan Alternative 4M (Alternatives 4R and 4R2), WCA-3A 3-gage average statistical distribution plots were specifically generated for the mean daily stage hydrograph (Figure 47), 25th percentile daily stage hydrograph (Figure 48), 75th percentile daily stage hydrograph (Figure 49), maximum daily stage hydrograph (Figure 50), and minimum daily stage hydrograph (Figure 51) for the complete RSM-GL simulation period-of-record (POR) 1965-2005. Figure 52 provides a mean daily stage difference hydrograph, which compares the intra-annual variability of the recommended plan (Alternative 4R2) with the ECB, FWO, Alternative 4, and Alternative 4R. Comparison hydrographs for Alternative 4 and the operational refinements to the NER Plan are also displayed for selected wet (1995, 1995, 1999) and dry (1989, 2001) years in Figures 53 through 57.

The detailed EN-W assessment of the frequency, duration, and peak stages of high water levels within WCA-3A concluded: (1) WCA-3A peak stages are lowered (these stages are most critical for WCA-3A design limitations); (2) the frequency and durations of Zone A exceedance are increased; (3) the increased frequency and durations occur during periods of the year when WCA-3A water levels are below peak critical levels; (4) CEPP infrastructure modifications (increased WCA-3A outlet capacity) and operations demonstrate that increased WCA-3A stages at the end of the dry season and start of the wet season can be effectively managed to avoid exacerbating high water conditions at the end of the wet season when Zone A levels off at 10.5 feet NGVD; and (5) CEPP infrastructure and operations utilized to achieve these performance levels need to be codified in the CEPP Project Operating Manual (POM). The requirements to maintain the frequency, duration, and peak stages of high water levels within WCA-3A consistent with the CEPP FWO were, therefore, successfully achieved based on EN-W assessment of the overall performance of the CEPP final array, including the recommended plan.

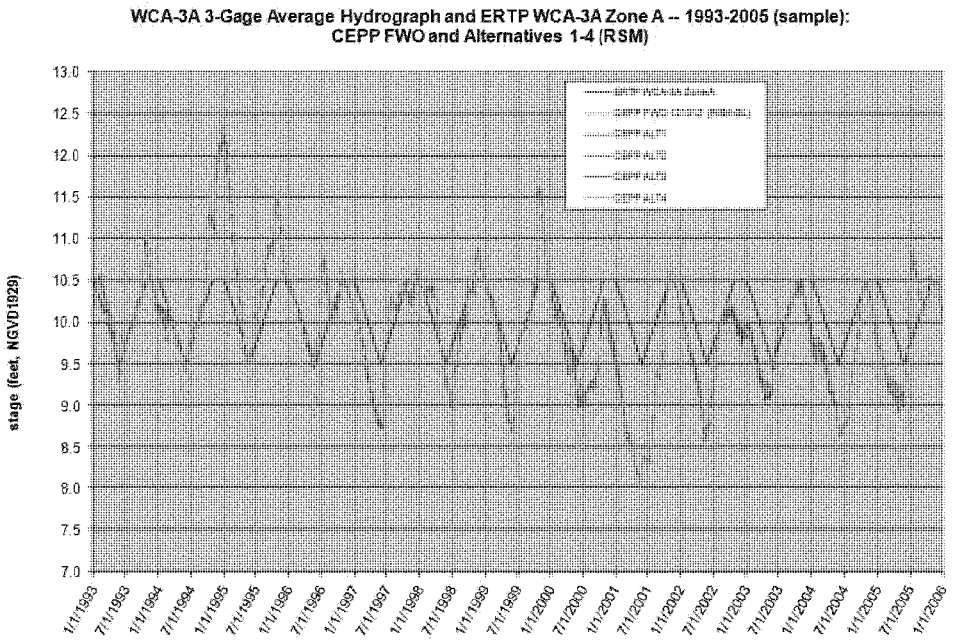

Figure 15: WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternotives 1 through 4

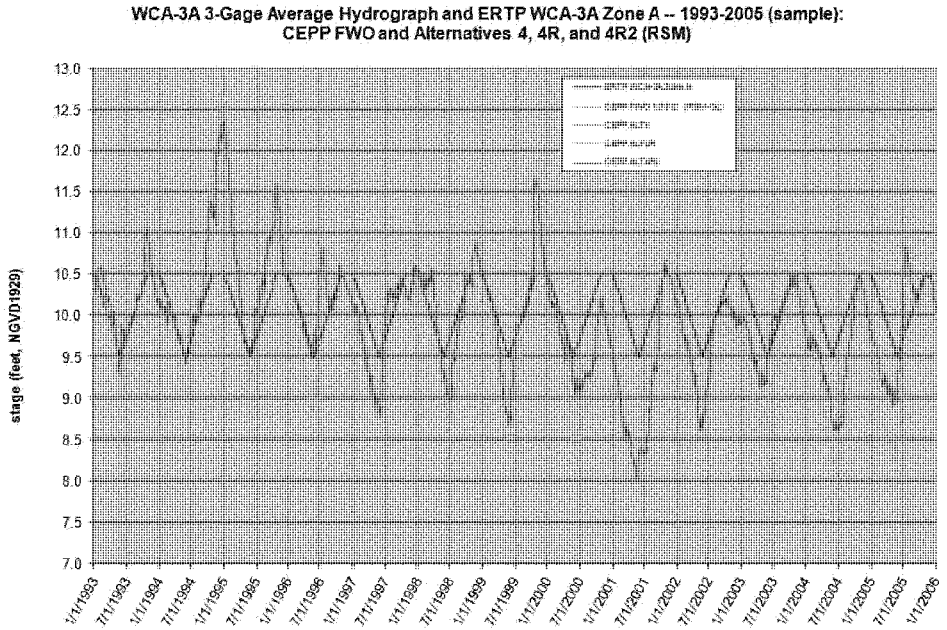

Figure 16: WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

6986

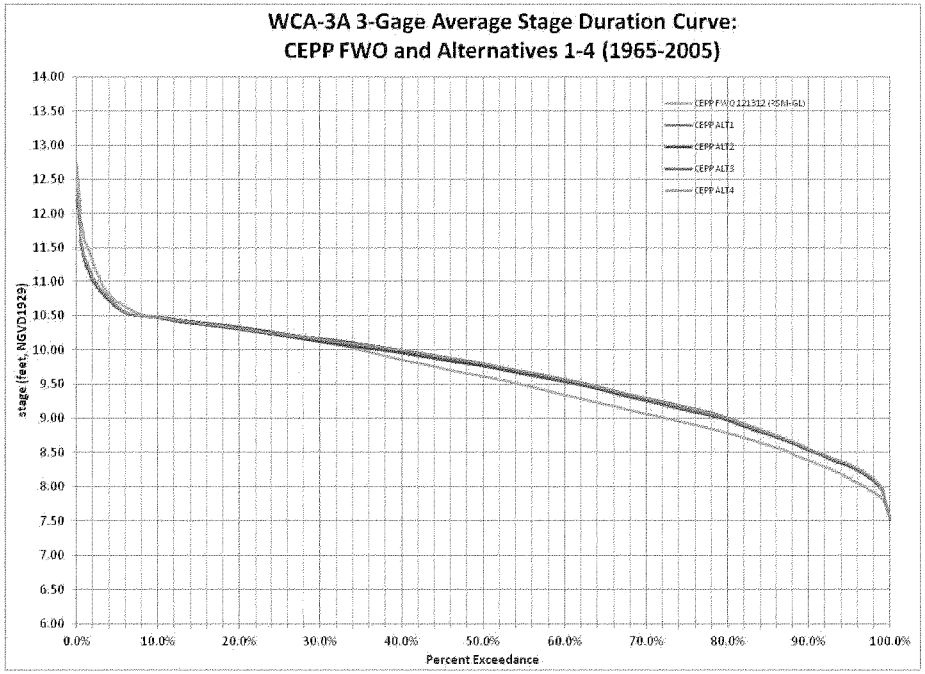

Figure 17: WCA-3A 3-gage average stage duration curve for CEPP FWO and CEPP Alternatives 1 through 4

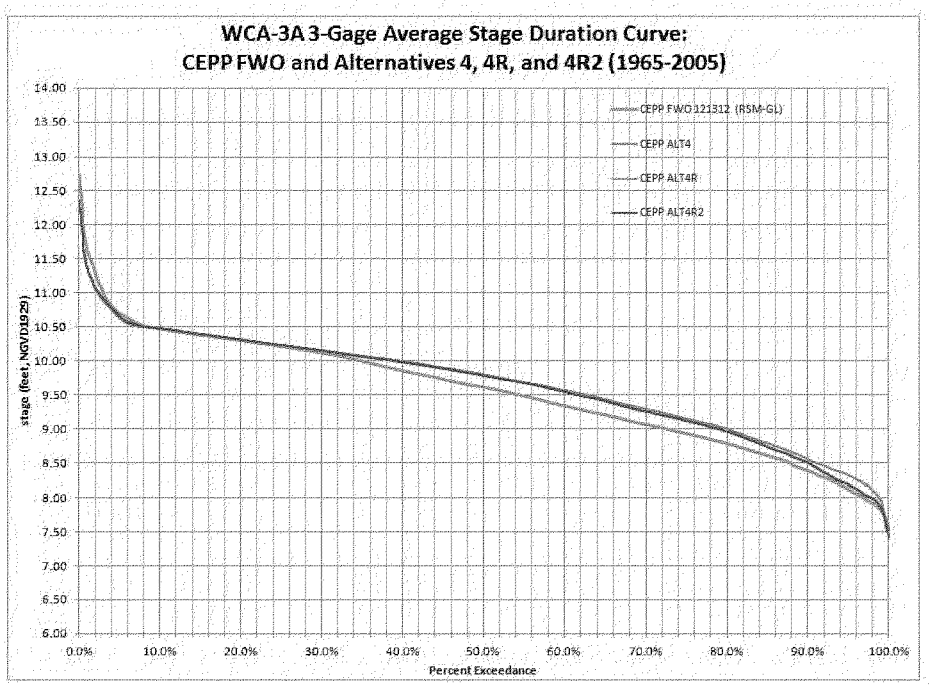

Figure 18: WCA-3A 3-gage average stage duration curve for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

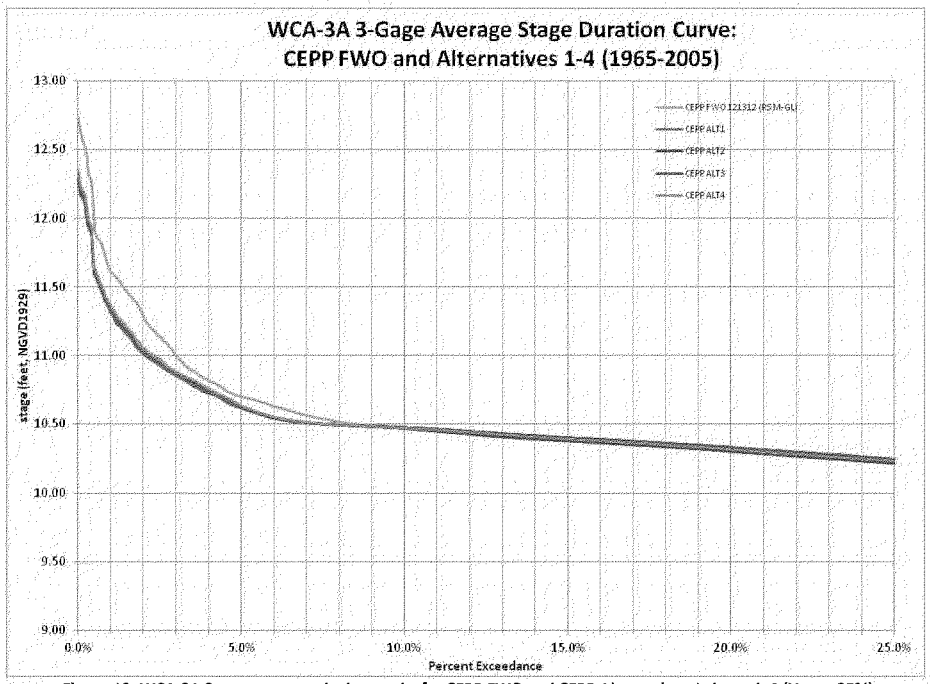

Figure 19: WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4 (Upper 25%)

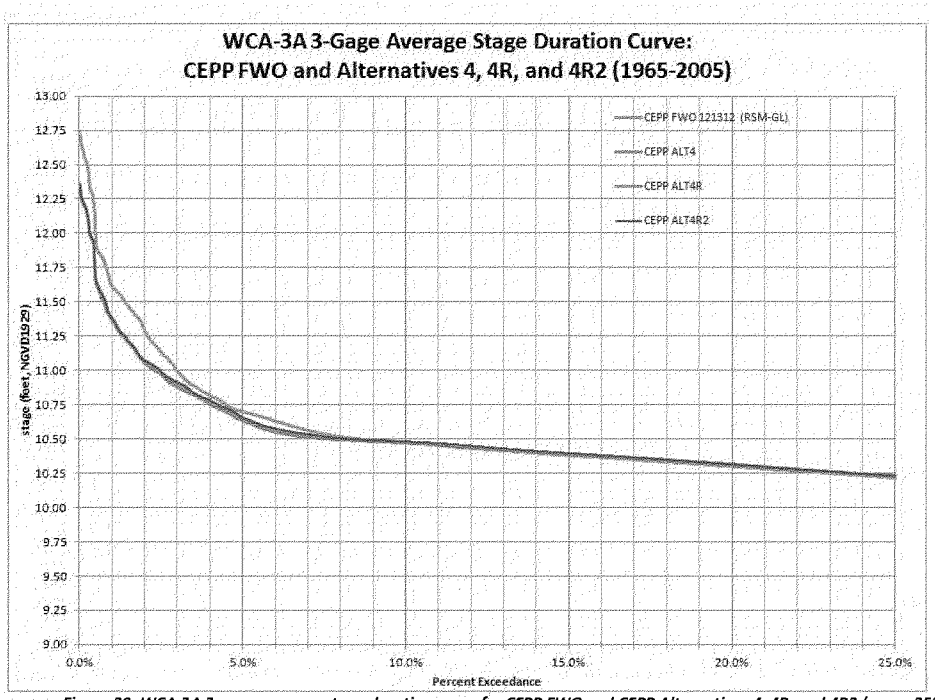

Figure 20: WCA-3A 3-goge overage stage duration curve for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2 (upper 25%)

690

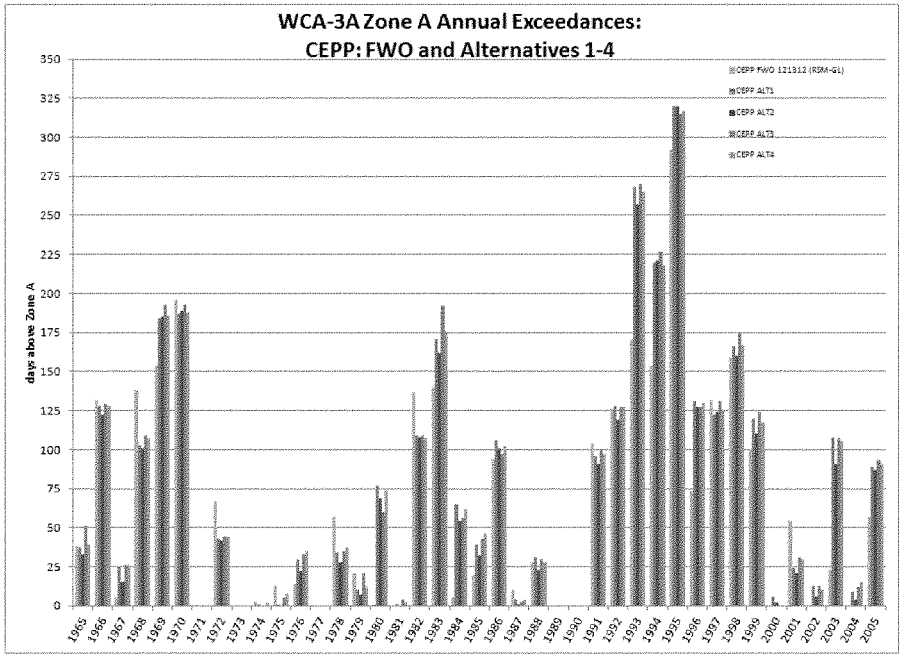

Figure 21: WCA-3A 3-gage average annual Zone A exceedance for CEPP FWO and CEPP Alternatives 1 through 4

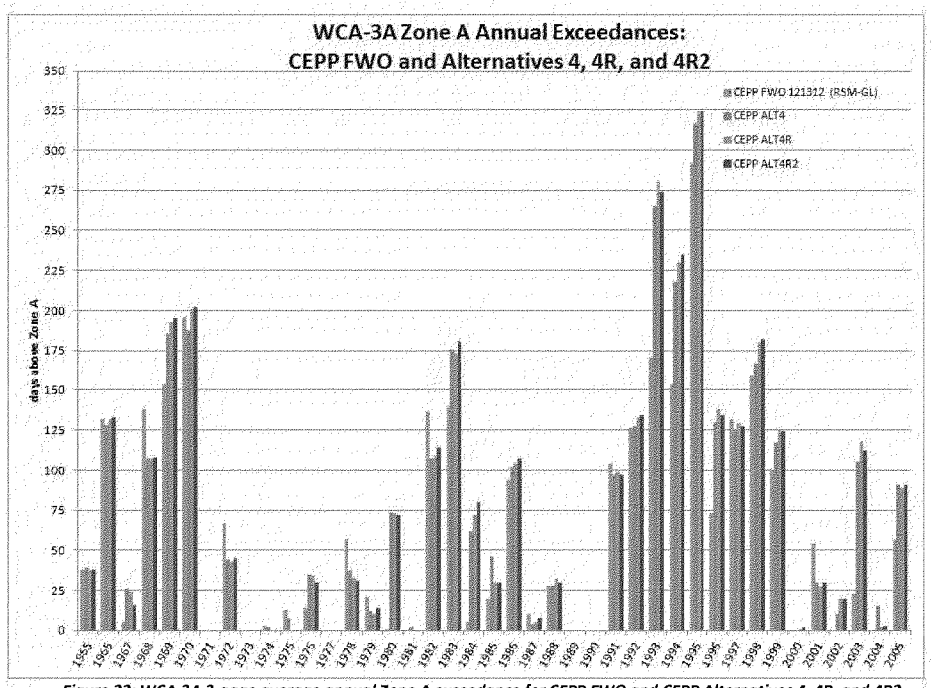

Figure 22: WCA-3A 3-gage average annual Zone A exceedance for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

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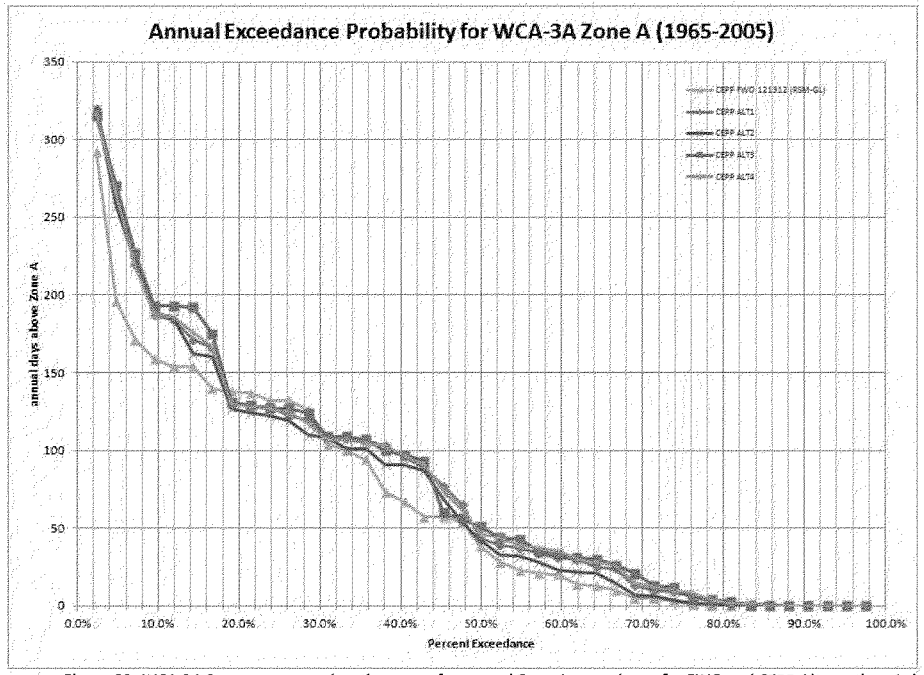


Figure 23: WCA-3A 3-gage average duration curve for annual Zone A exceedance for FWO and CEPP Alternatives 1 through 4

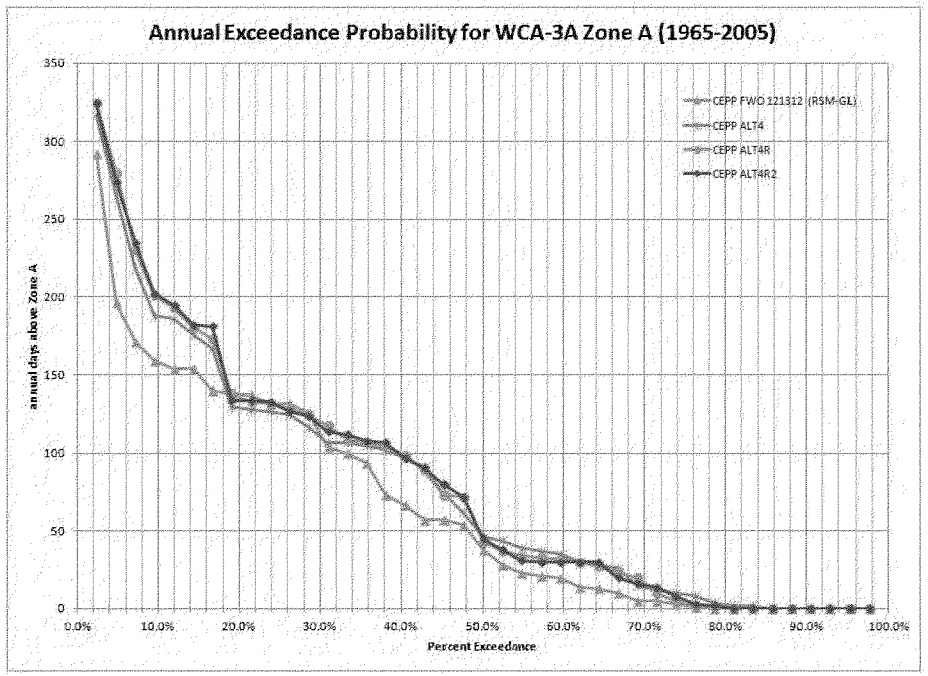


Figure 24: WCA-3A 3-gage average duration curve for annual Zone A exceedance for FWO and CEPP Alternatives 4, 4R, and 4R2

Table 5: Annual Zone A exceedance days (WCA-3A 3-gage average) for FWO and CEPP Alternatives 1 through 4

	Summary Table: WCA-3A Zone A Annual Exceedance Duration				
Year	**CEPP FWO 121312**	**CEPP ALT1**	**CEPP ALT2**	**CEPP ALT3**	**CEPP ALT4**
1965	38	37	33	51	39
1966	132	126	122	129	126
1967	5	25	15	26	26
1968	138	103	101	109	107
1969	154	184	185	193	186
1970	196	187	189	193	188
1971	0	0	0	0	0
1972	67	43	42	44	44
1973	0	0	0	0	0
1974	3	1	0	0	2
1975	13	1	0	5	8
1976	14	30	22	33	35
1977	0	0	0	0	0
1978	57	34	28	35	37
1979	21	10	7	21	12
1980	1	77	69	60	74
1981	0	1	0	4	2
1982	137	109	108	109	107
1983	140	171	162	192	176
1984	5	55	54	56	52
1985	20	39	32	43	46
1986	94	106	101	97	102
1987	10	4	1	3	4
1988	28	31	23	30	28
1989	0	0	0	0	0
1990	0	0	0	0	0
1991	104	96	91	100	97
1992	126	128	119	127	127
1993	171	268	257	276	265
1994	154	220	221	227	218
1995	292	320	320	315	317
1996	73	131	127	127	130
1997	132	122	124	131	125
1998	159	166	160	175	167
1999	100	120	116	124	117
2000	0	6	2	0	0
2001	54	24	21	31	30
2002	0	13	6	13	10
2003	23	108	91	107	105
2004	0	9	4	12	15
2005	57	89	87	93	91
	Summary Table: WCA-3A Zone A Annual Exceedance Duration				
	CEPP FWO 121312	**CEPP ALT1**	**CEPP ALT2**	**CEPP ALT3**	**CEPP ALT4**
total (1965-2005 POR, 14975 days)	2718	3206	3034	3285	3227
total (percent of POR)	**18.15**	**21.41**	**20.26**	**21.94**	**21.55**
percent increase vs FWO	--	17.95	11.63	20.86	18.73

Table 6: Annual Zone A exceedance days (WCA-3A 3-gage average) for FWO and CEPP Alternatives 4, 4R, and 4R2

	Summary Table: WCA-3A Zone A Annual Exceedance Duration (days)			
Year	**CEPP FWO 121312**	**CEPP ALT4**	**CEPP ALT4R**	**CEPP ALT4R2**
1965	38	39	37	38
1966	132	128	132	133
1967	5	26	24	16
1968	138	107	107	108
1969	154	186	193	195
1970	196	188	201	202
1971	0	0	0	0
1972	67	44	43	45
1973	0	0	0	0
1974	3	2	0	0
1975	13	8	0	0
1976	14	35	34	30
1977	0	0	0	0
1978	57	37	33	31
1979	21	12	10	14
1980	1	74	73	72
1981	0	2	0	0
1982	137	107	109	114
1983	140	176	173	181
1984	5	62	72	80
1985	20	46	30	30
1986	94	102	104	107
1987	10	4	5	8
1988	28	28	32	30
1989	0	0	0	0
1990	0	0	0	0
1991	104	97	99	97
1992	126	127	133	134
1993	171	265	280	274
1994	154	218	230	235
1995	292	317	324	324
1996	73	130	138	134
1997	132	125	129	127
1998	159	167	180	182
1999	100	117	125	124
2000	0	0	1	2
2001	54	30	27	30
2002	0	10	20	20
2003	23	105	118	112
2004	0	15	2	3
2005	57	91	89	91
	Summary Table: WCA-3A Zone A Annual Exceedance Duration			
	CEPP FWO 121312	**CEPP ALT4**	**CEPP ALT4R**	**CEPP ALT4R2**
total (1965-2005 POR; 14975 days)	2718	3227	3307	3323
total (percent of POR)	**18.15**	**21.55**	**22.08**	**22.19**
percent increase vs FWO	--	18.73	21.67	22.26

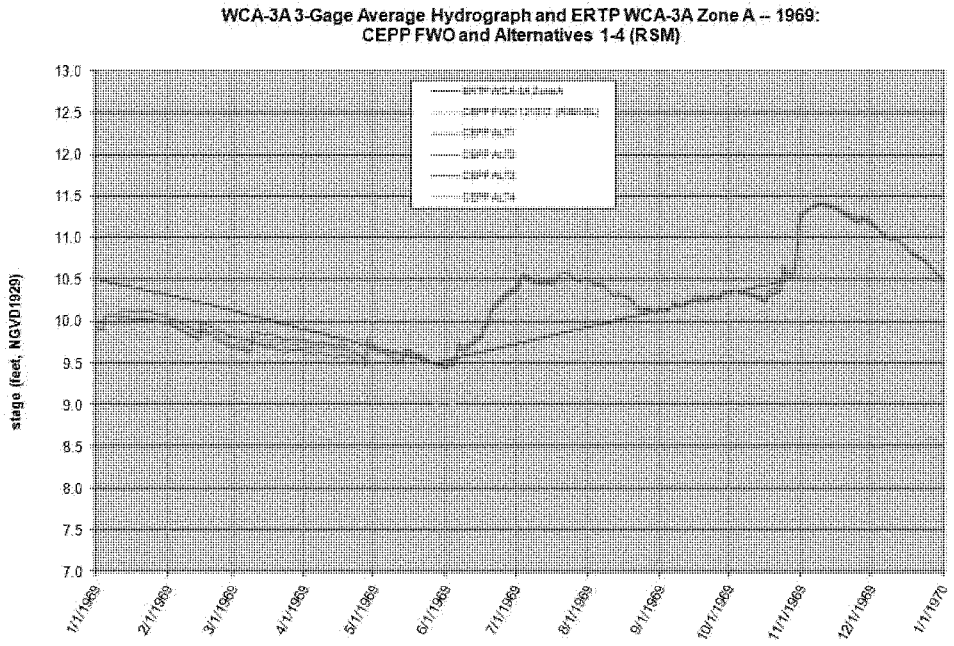


Figure 25: 1969 WCA-3A 3-goge average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

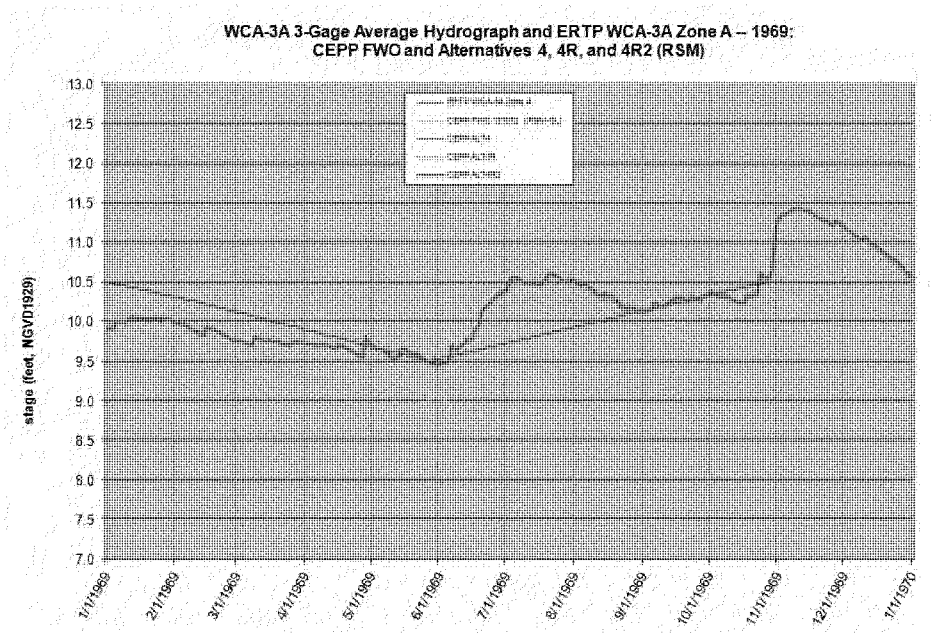


Figure 26: 1969 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

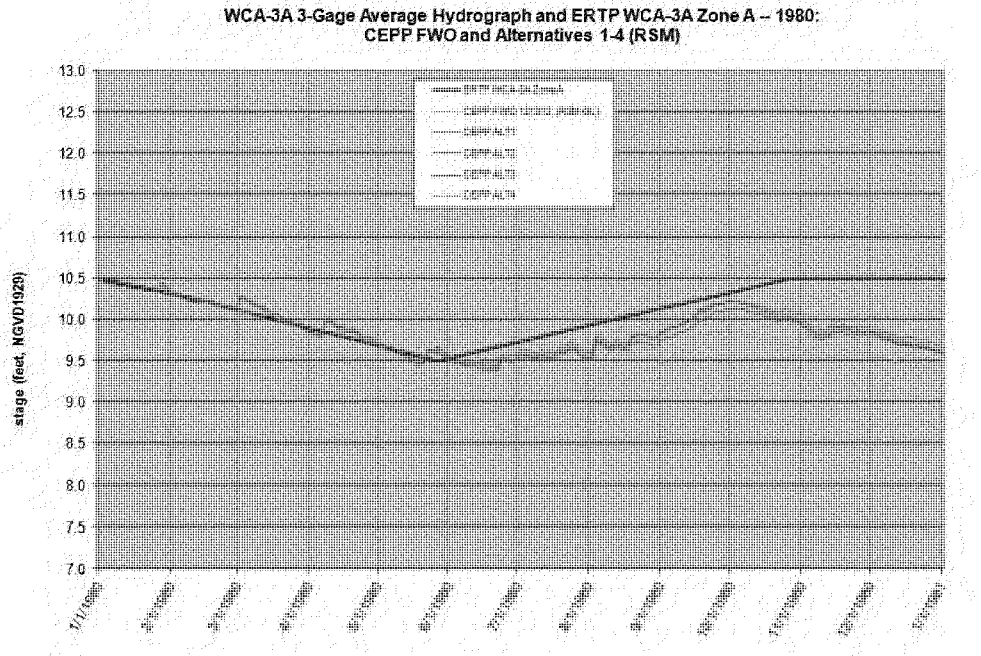


Figure 27: 1980 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

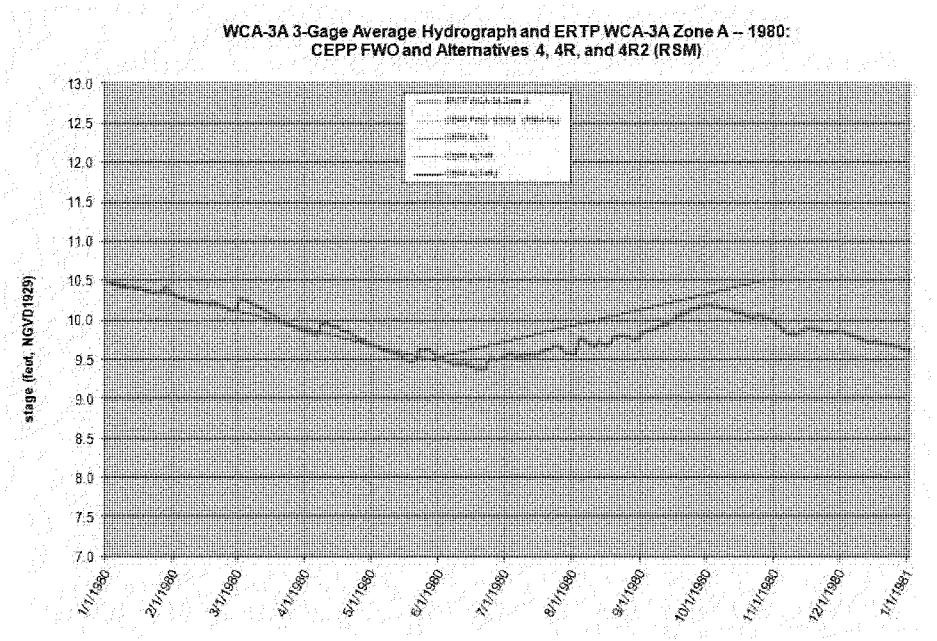


Figure 28: 1980 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

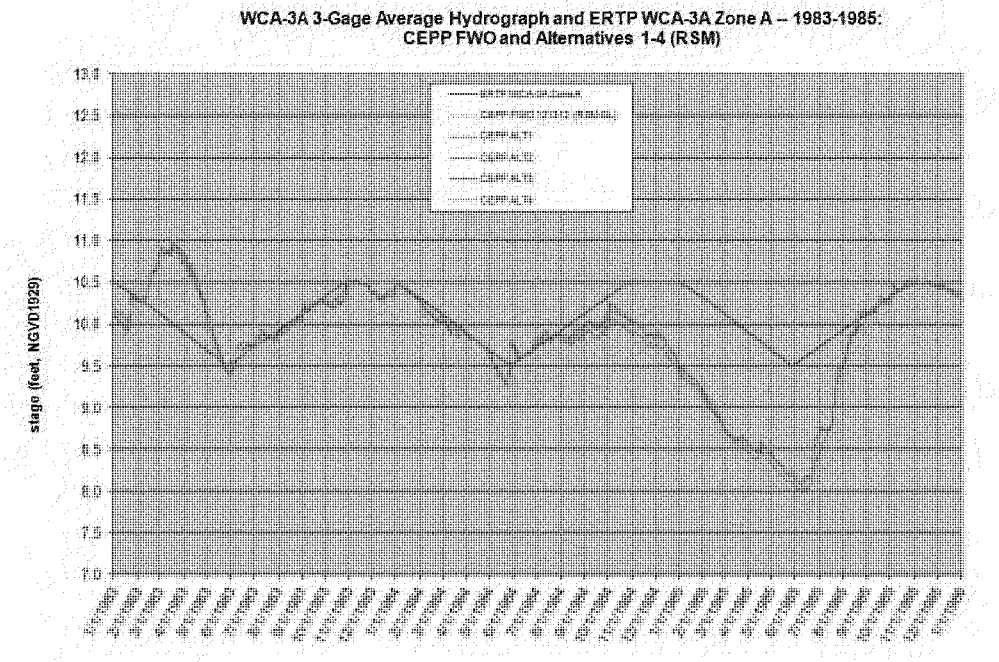


Figure 29: 1983-1985 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

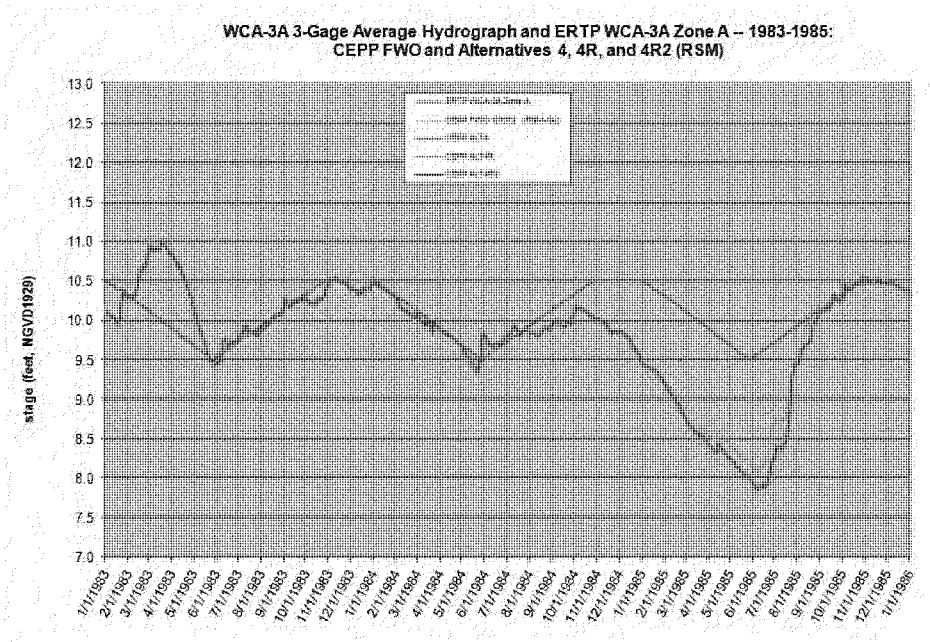


Figure 30: 1983-1985 WCA-3A 3-goge average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

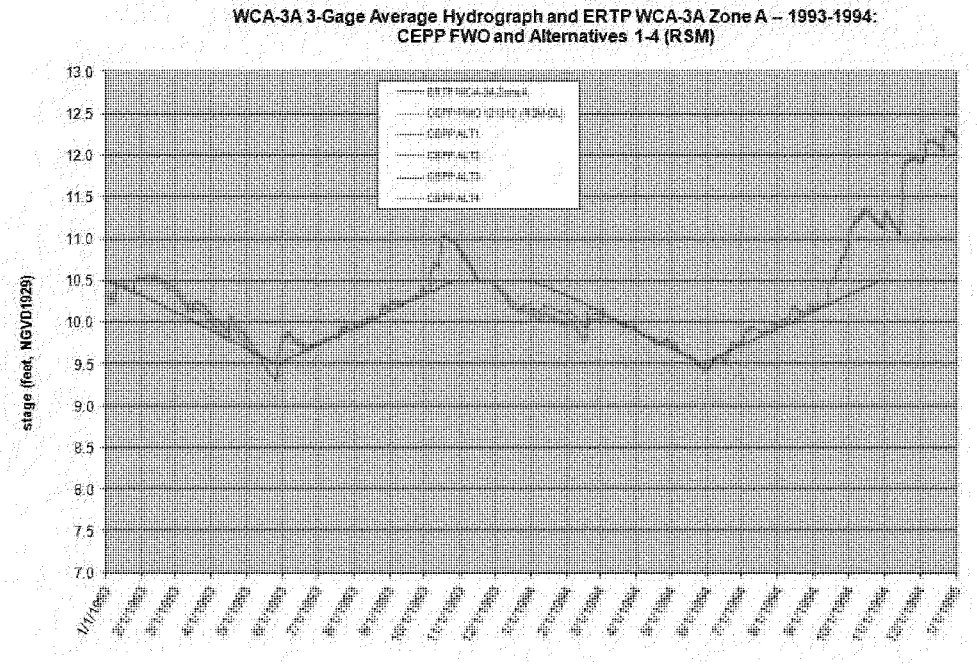


Figure 31: 1993-1994 WCA-3A 3-goge average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

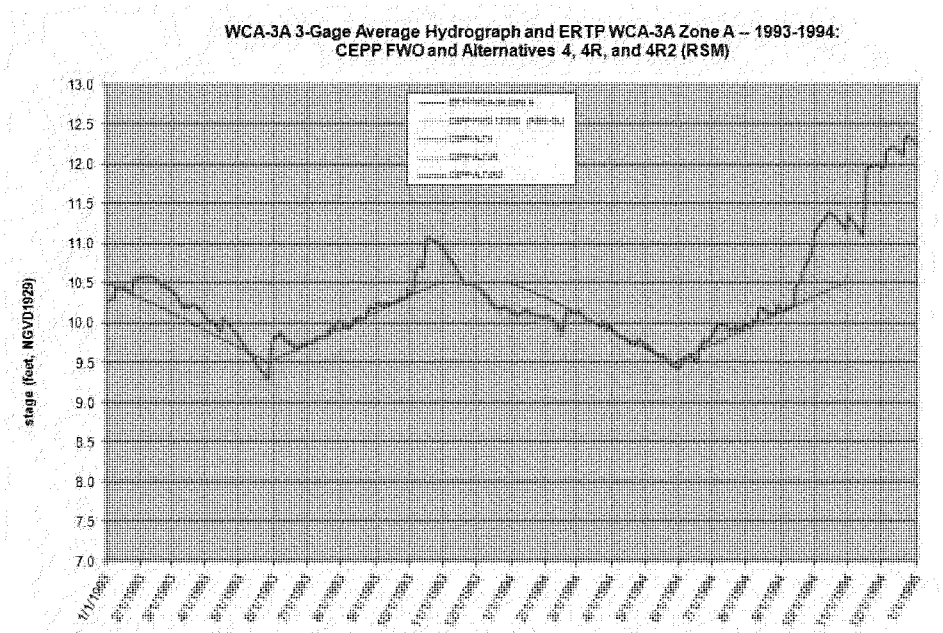


Figure 32: 1993-1994 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

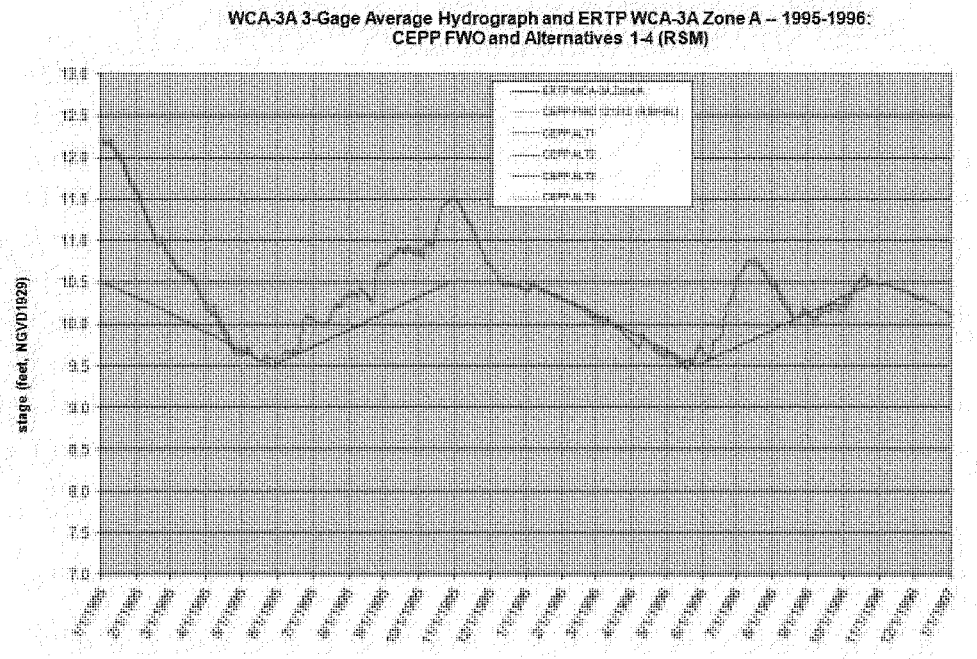


Figure 33: 1995-1996 WCA-3A 3-gage overage hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

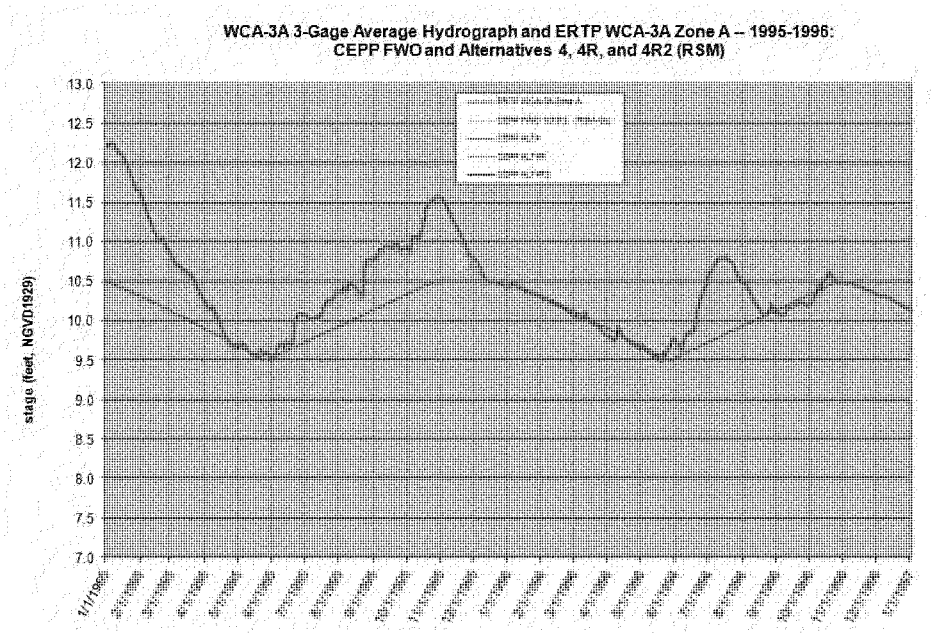


Figure 34: 1995-1996 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

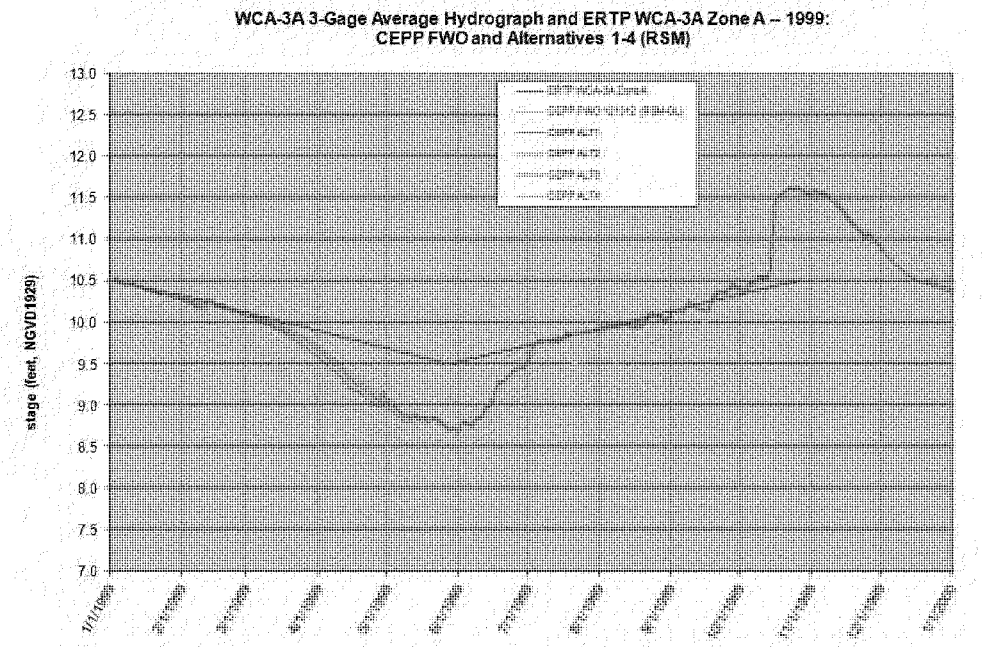


Figure 35: 1999 WCA-3A 3-gage average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

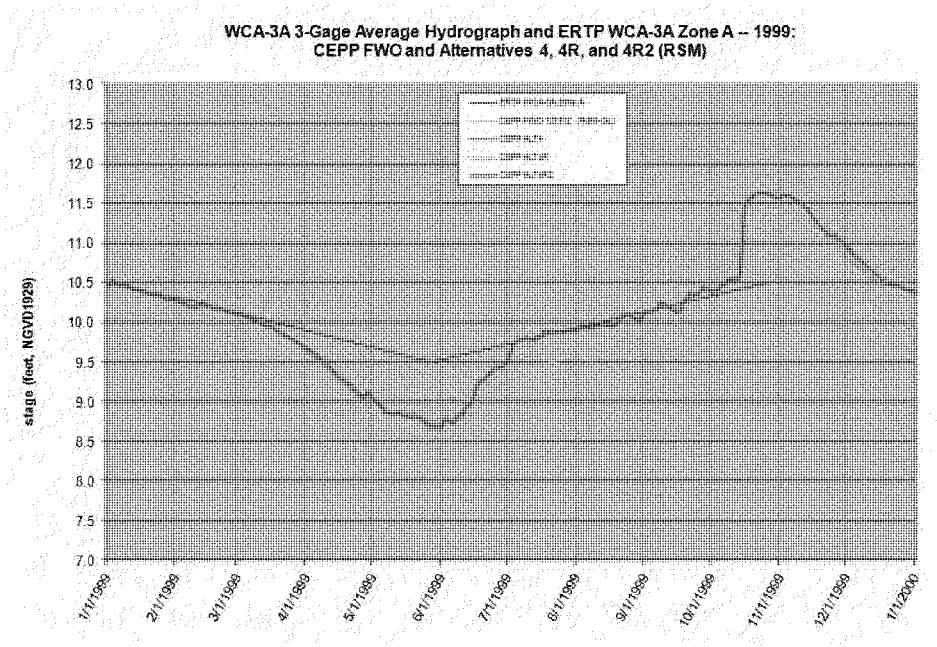


Figure 36: 1999 WCA-3A 3-gage averoge hydrographs for CEPP FWO and CEPP Alternatives 4,4R, and 4R2

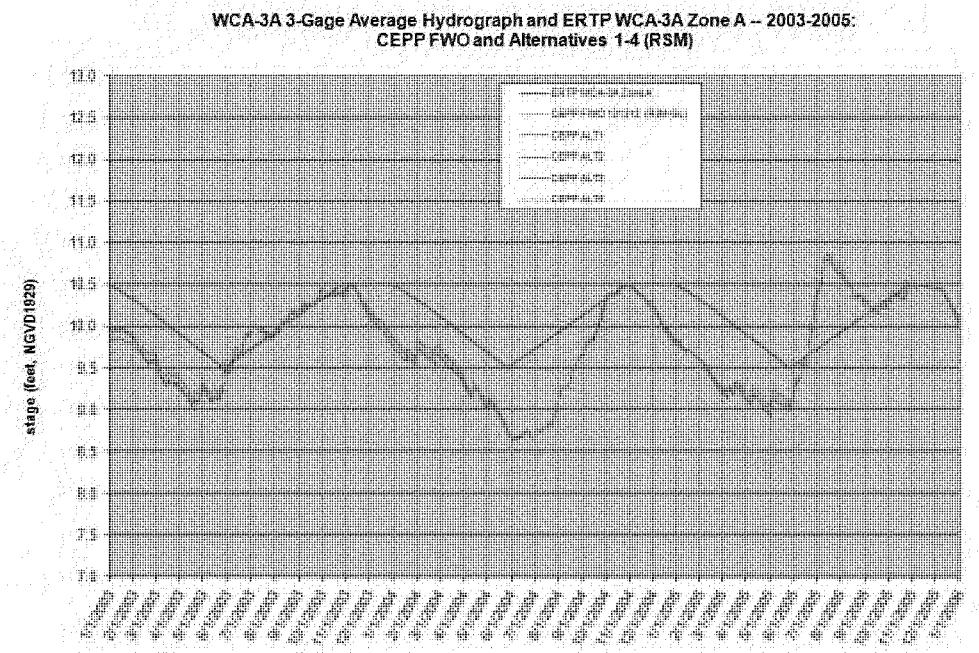


Figure 37: 2003-2005 WCA-3A 3-goge average hydrographs for CEPP FWO and CEPP Alternatives 1 through 4

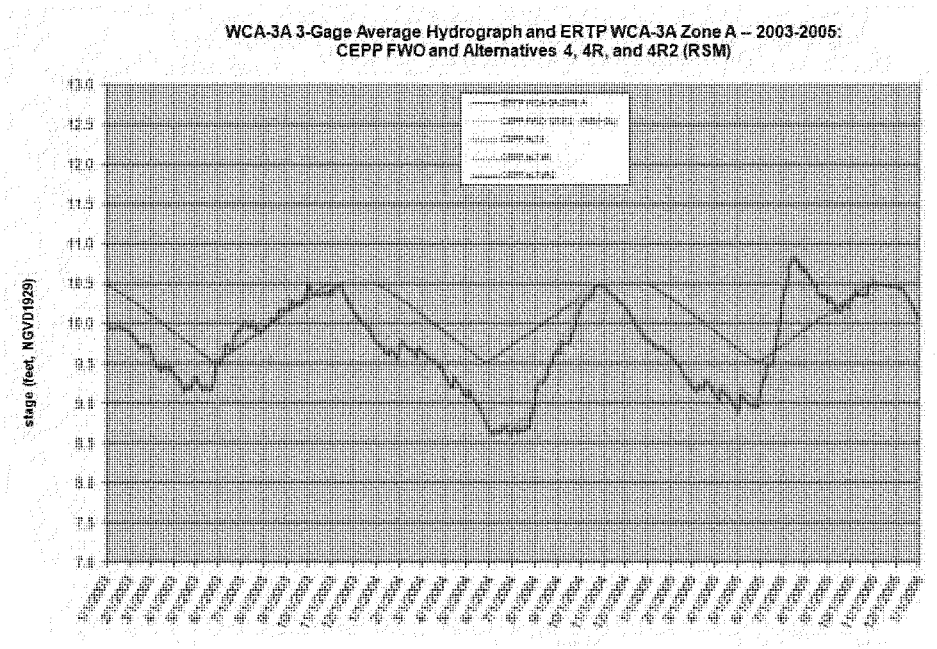


Figure 38: 2003-2005 WCA-3A 3-goge average hydrographs for CEPP FWO and CEPP Alternatives 4, 4R, and 4R2

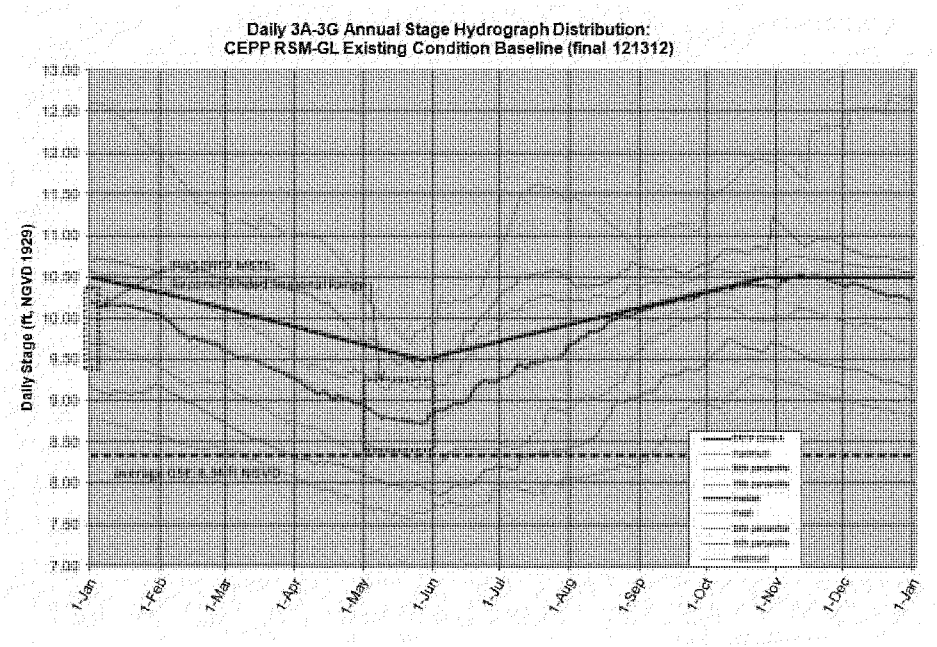


Figure 39: WCA-3A 3-gage averoge annual averoge stage hydrographs for CEPP ECB

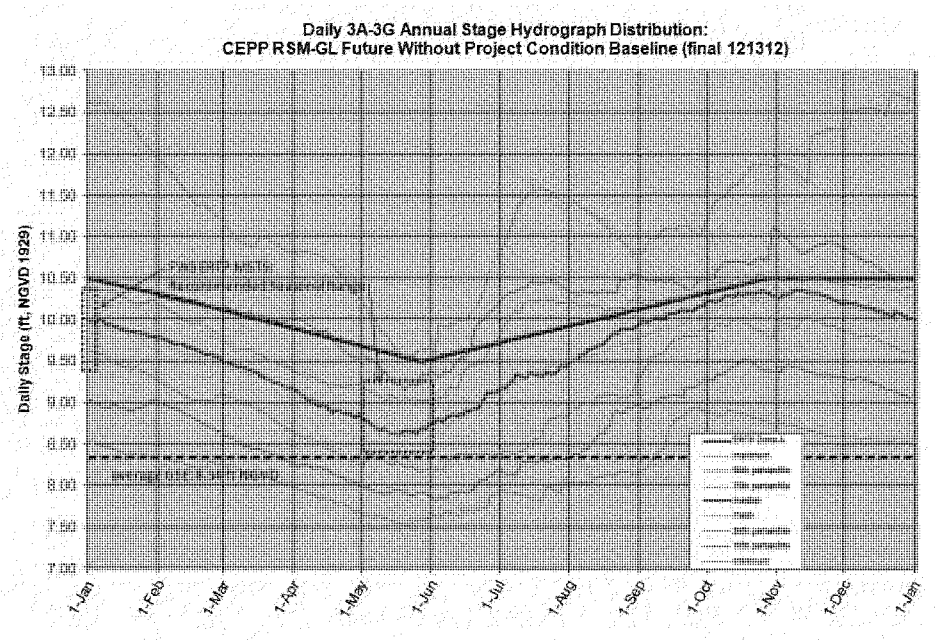


Figure 40: WCA-3A 3-gage average annual overage stage hydrographs for CEPP FWO

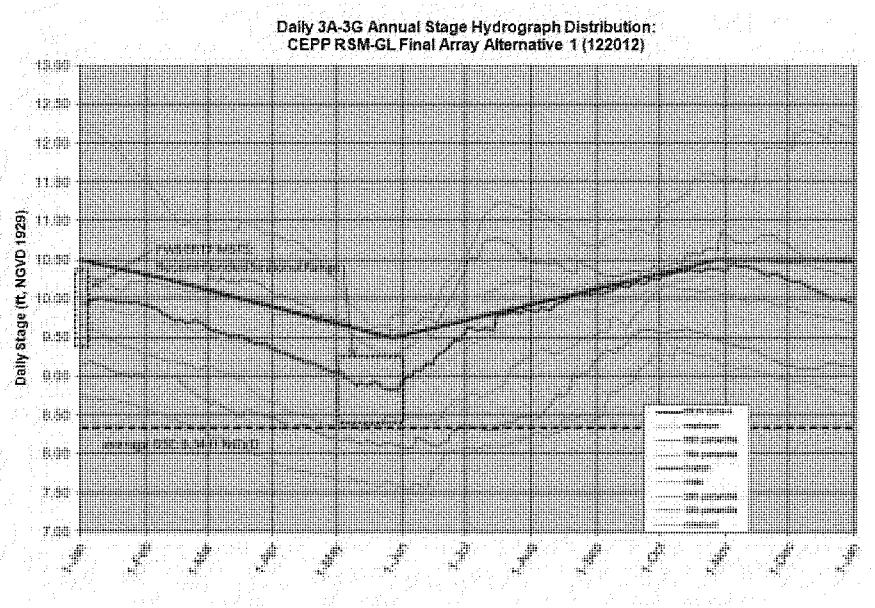


Figure 41: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 1

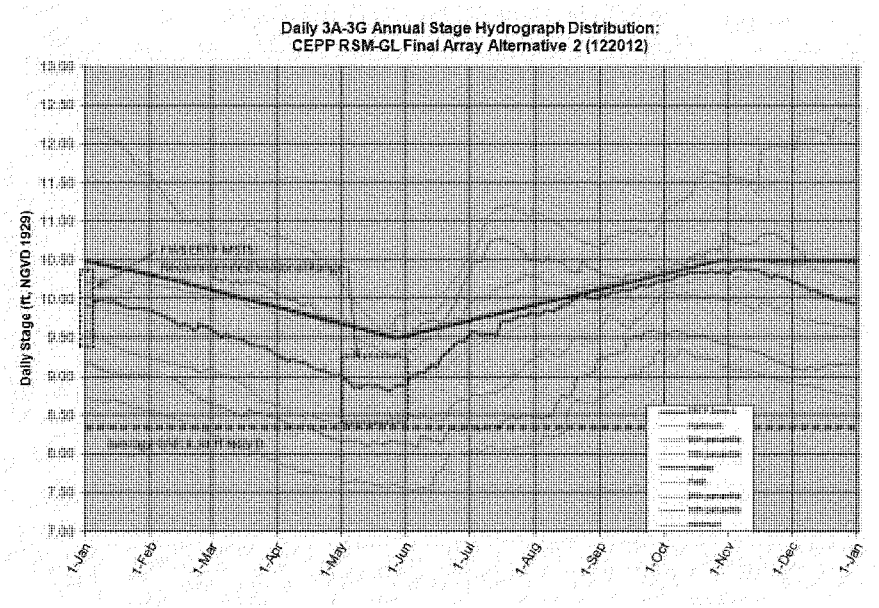


Figure 42: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 2

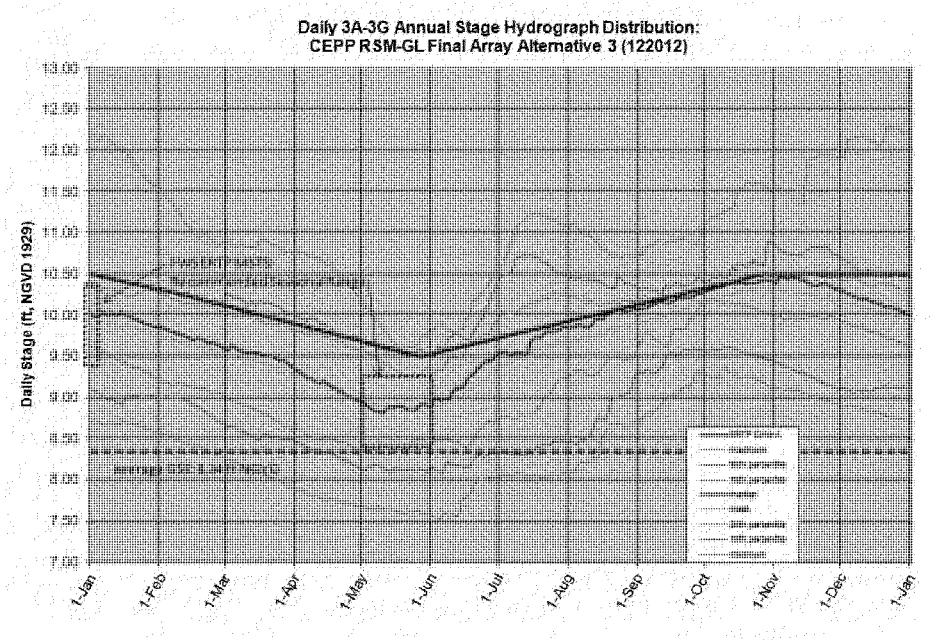


Figure 43: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 3

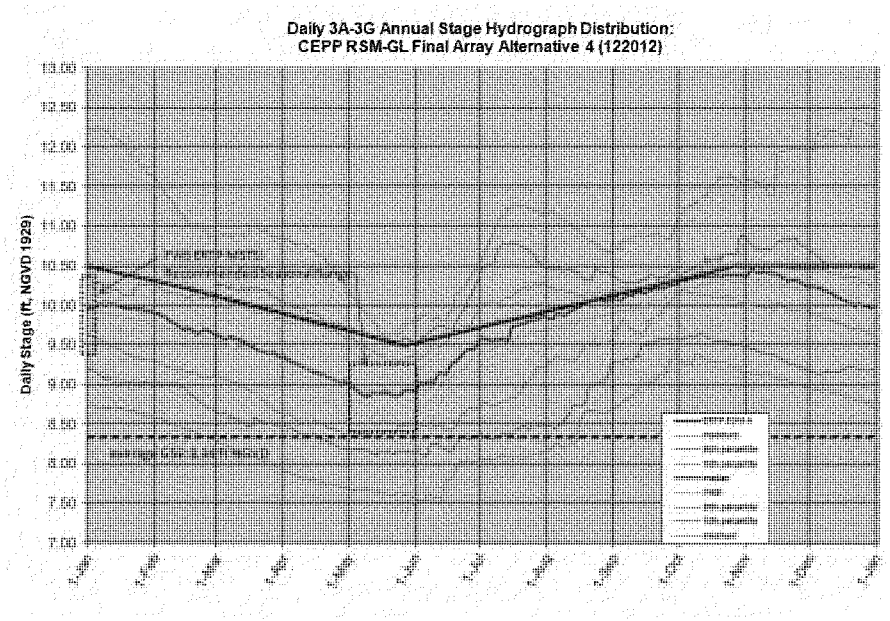


Figure 44: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 4

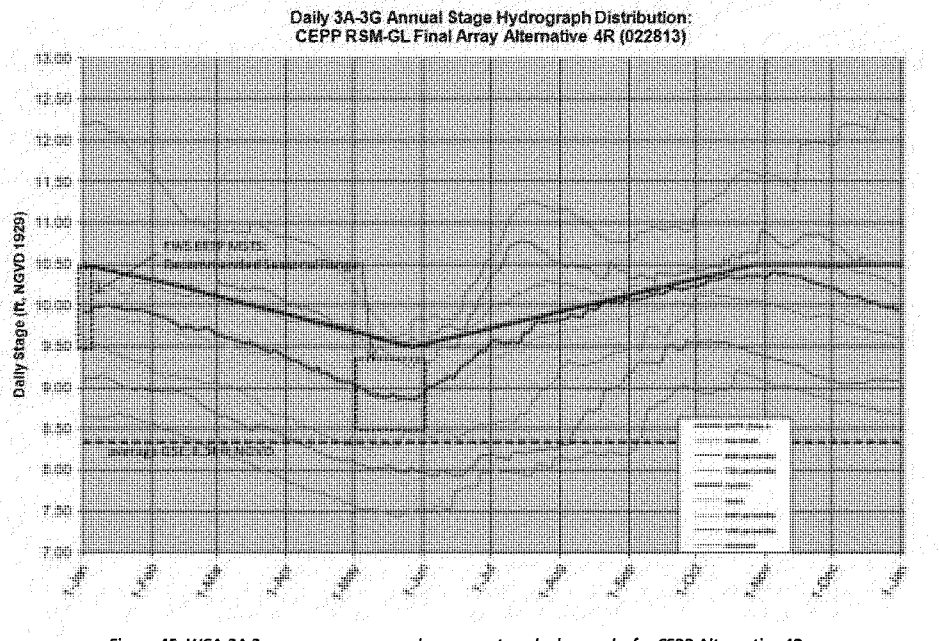


Figure 45: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 4R

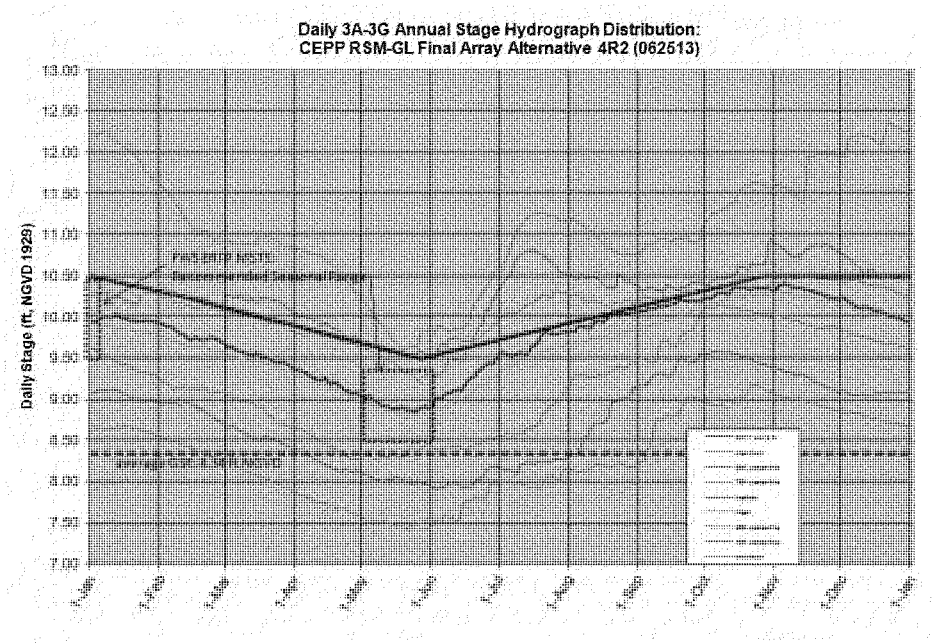


Figure 46: WCA-3A 3-gage average annual average stage hydrographs for CEPP Alternative 4R2

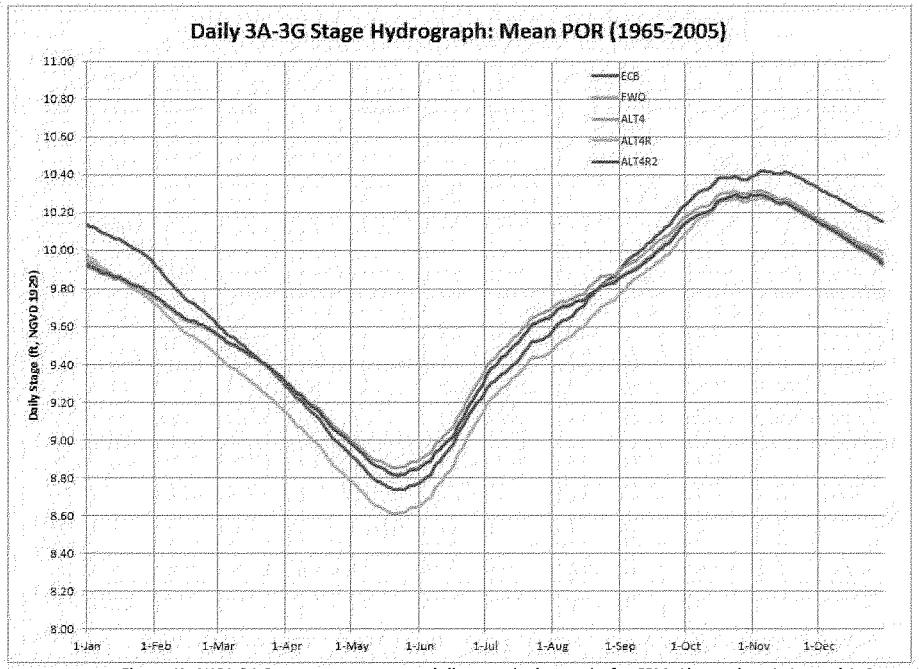


Figure 47: WCA-3A 3-gage average mean daily stoge hydrographs for CEPP Alternatives 4, 4R, and 4R2

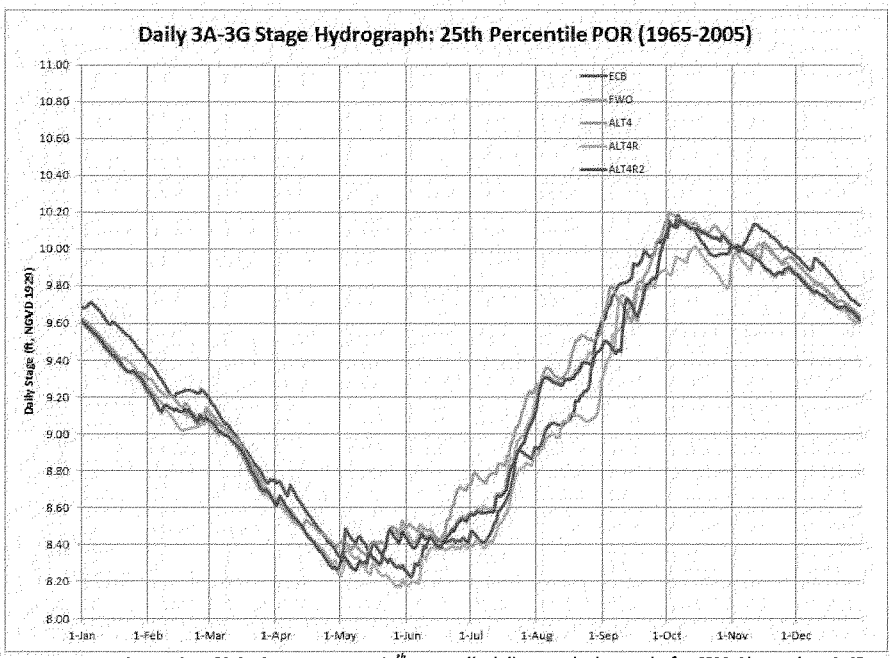


Figure 48: WCA-3A 3-gage average 25th percentile daily stage hydrographs for CEPP Alternatives 4, 4R, and 4R2

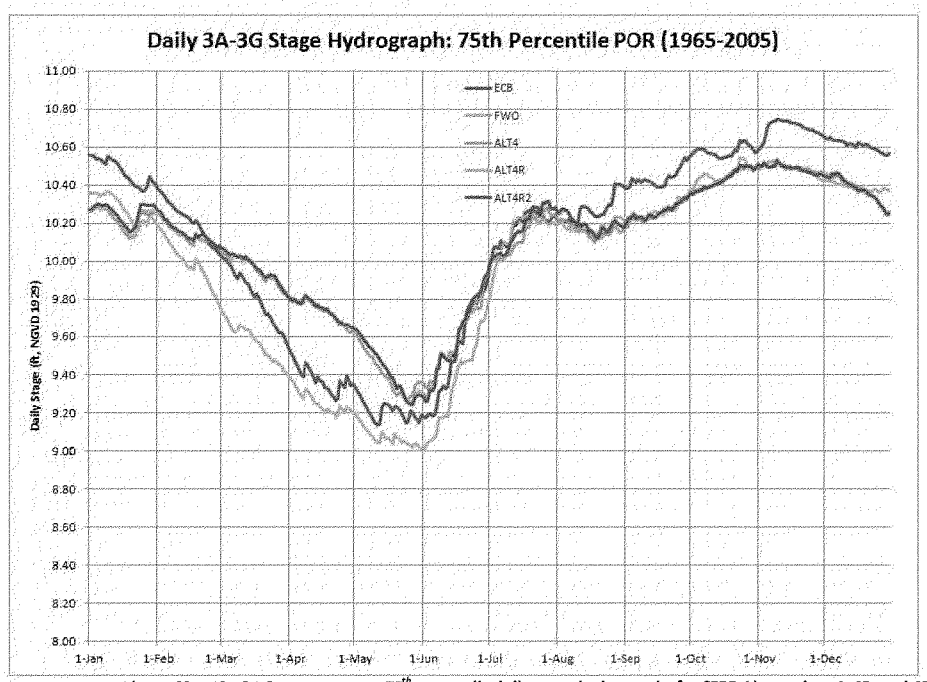


Figure 49: WCA-3A 3-gage average 75th percentile doily stage hydrographs for CEPP Alternatives 4, 4R, and 4R2

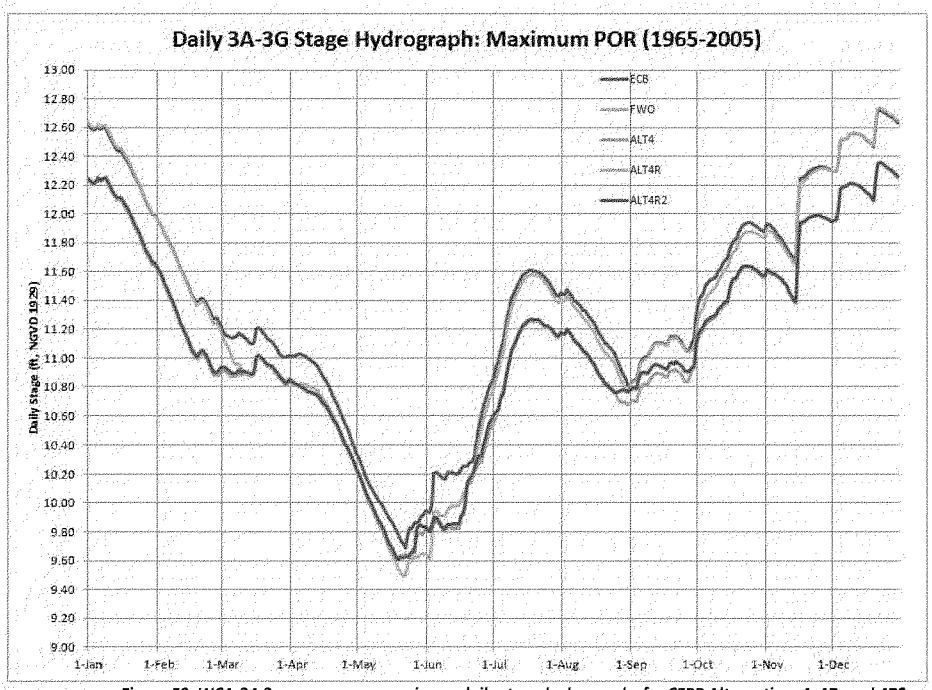


Figure 50: WCA-3A 3-gage average maximum daily stage hydrographs for CEPP Alternatives 4, 4R, and 4R2

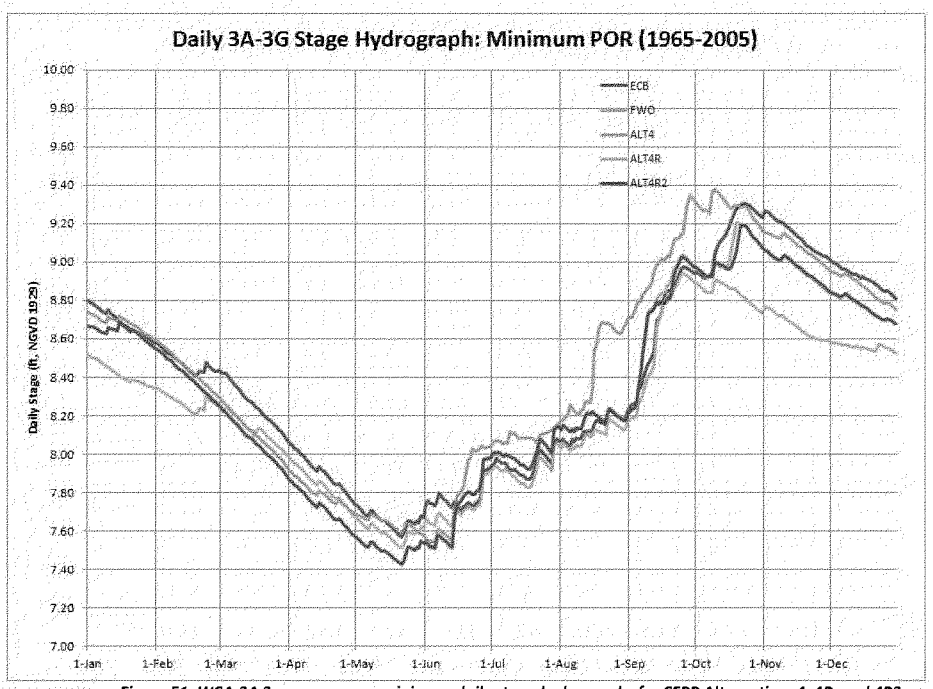


Figure 51: WCA-3A 3-gage average minimum daily stage hydrographs for CEPP Alternatives 4, 4R, and 4R2

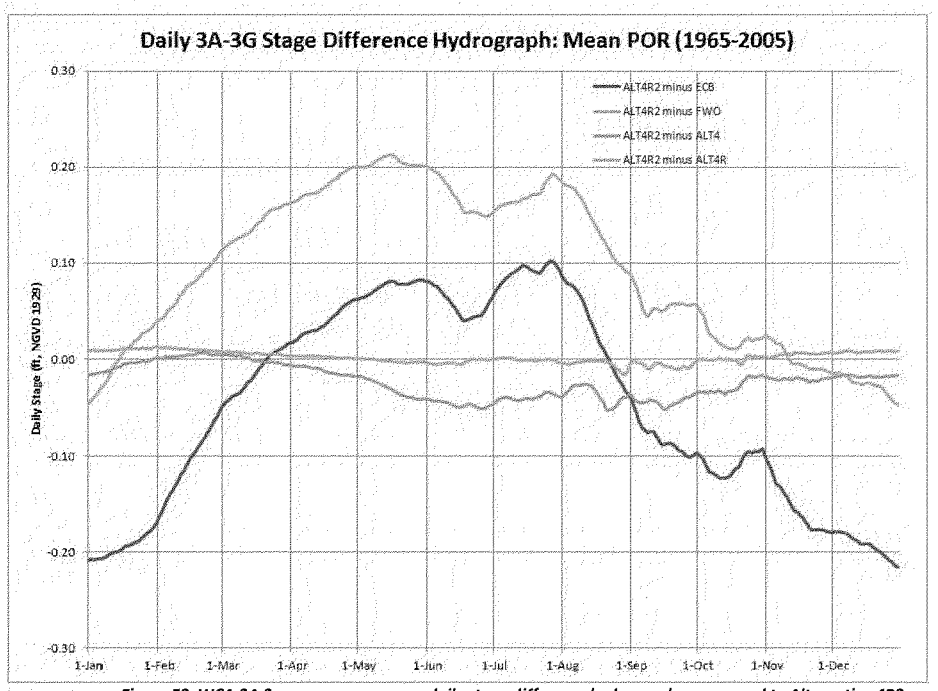


Figure 52: WCA-3A 3-gage average mean daily stage difference hydrographs, compared to Alternative 4R2

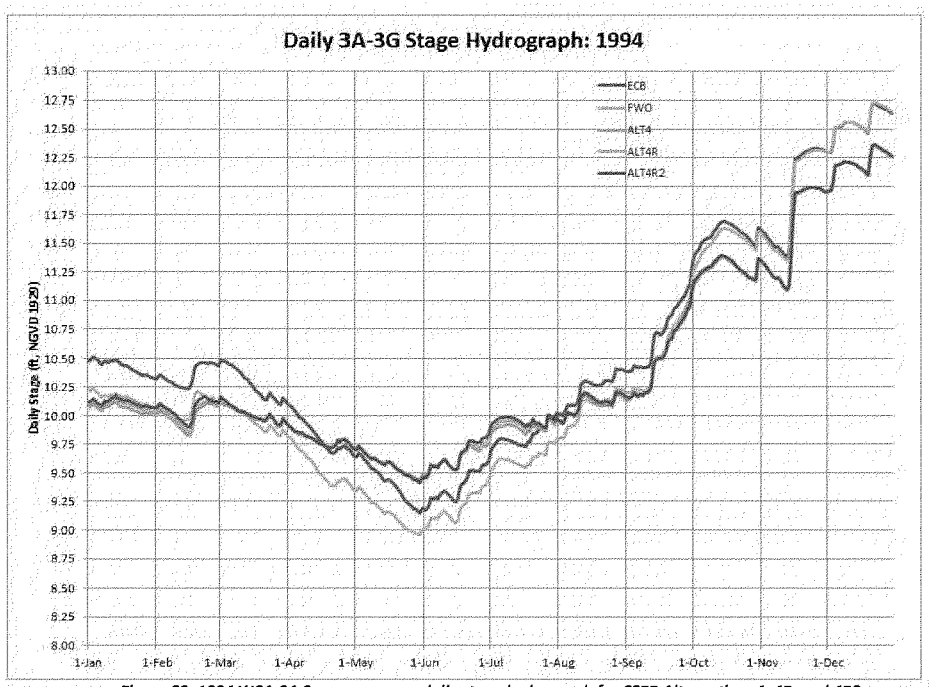


Figure 53: 1994 WCA-3A 3-gage overage daily stage hydrograph for CEPP Alternatives 4, 4R, and 4R2

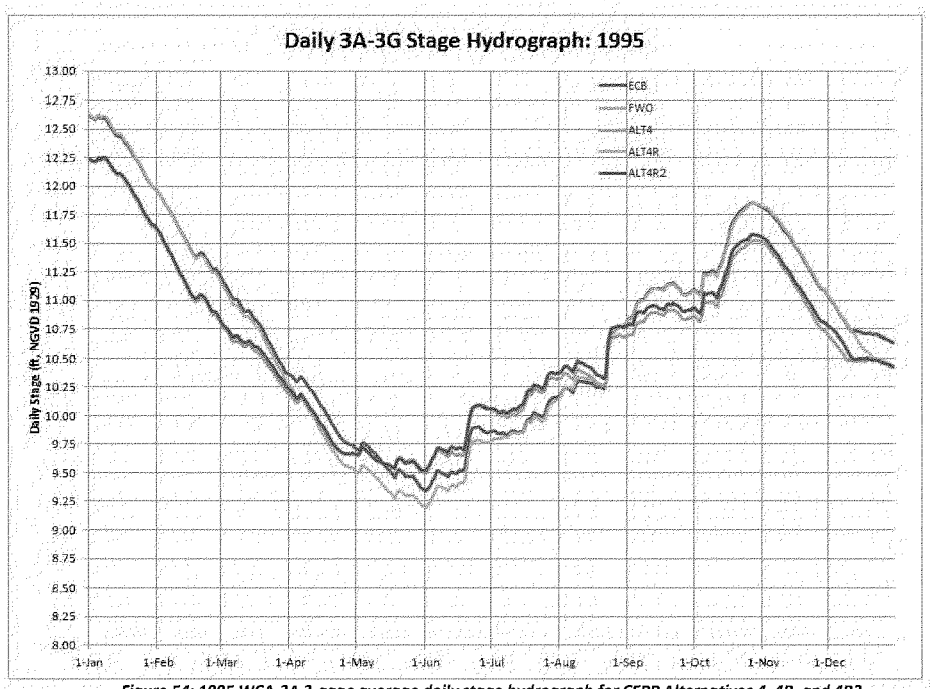


Figure 54: 1995 WCA-3A 3-gage average doily stage hydrograph for CEPP Alternatives 4, 4R, and 4R2

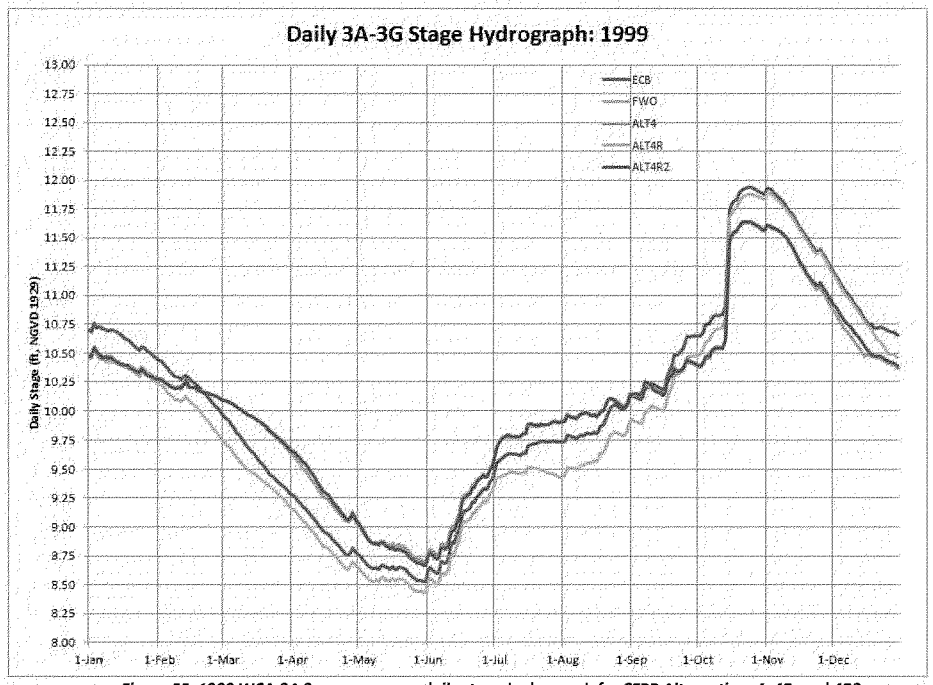


Figure 55: 1999 WCA-3A 3-gage average daily stage hydrograph far CEPP Alternatives 4, 4R, and 4R2

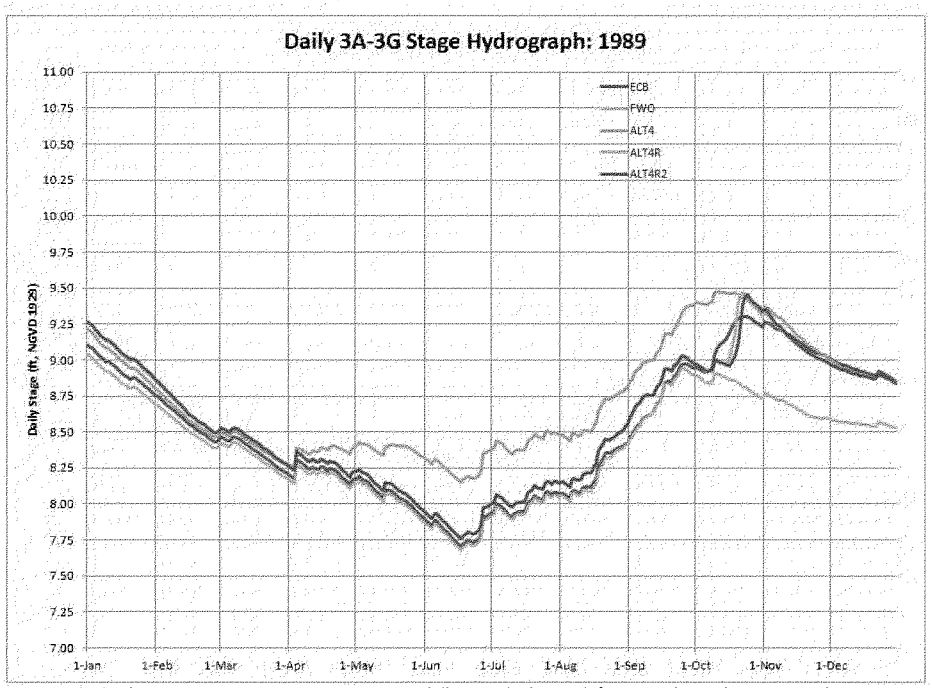


Figure 56: 1989 WCA-3A 3-gage average daily stage hydrograph for CEPP Alternatives 4, 4R, and 4R2

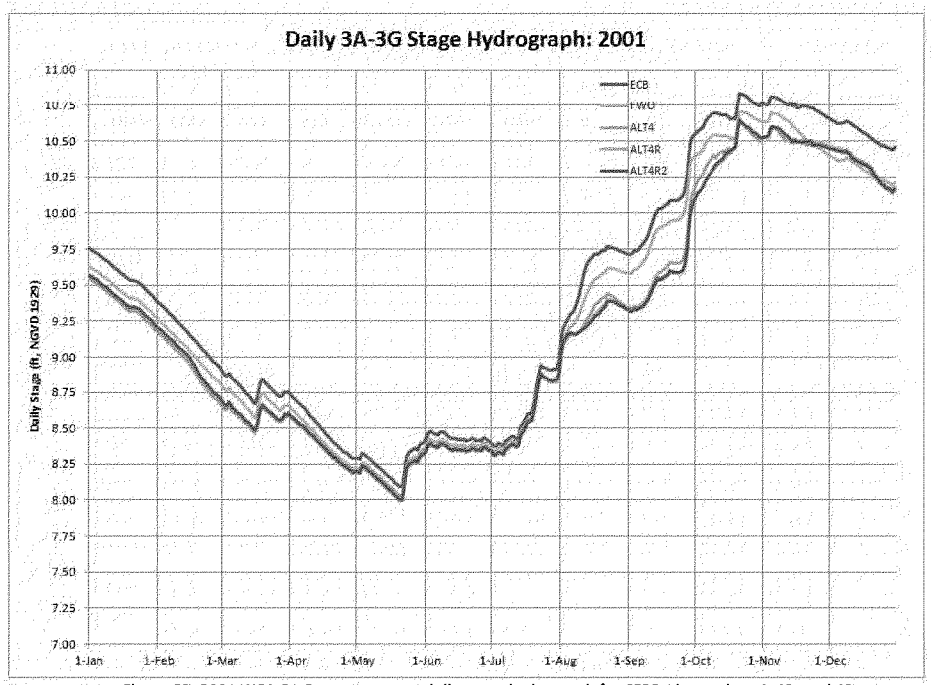


Figure 57: 2001 WCA-3A 3-gage average daily stage hydrograph for CEPP Alternatives 4, 4R, and 4R

3.2.2. WCA-3B Design Considerations

Subsequent to completion of the L-67A Levee in 1962 (the adjacent L-67C Levee was completed in 1966), WCA-3B water levels have been highly managed. The S-151 gated culvert (1105 cfs design capacity) currently provides the only structural connection between WCA-3A and WCA-3B. The SPF stage for WCA-3B, based on Site 71 (refer to the Figure 7 map), was initially established in the 1960 GDM for WCA-3 (C&SF Part 1, Supplement 33) at 8.50 feet NGVD based on an assumed 5-day, 16.5-inch rainfall event; detailed SPF flood routing information for WCA-3B is not provided in the GDM. Starting in 1985, the C&SF Experimental Program for Water Deliveries to ENP established S-151 operational criteria that discontinued S-151 regulatory releases from WCA-3A if stages at Site 71 exceed 8.5 feet NGVD. The Site 71 constraint at 8.5 feet NGVD was also used for the 1994-1995 L-67 gap tests, which were conducted as design tests for the MWD to ENP Project. The IOP and ERTP WCA-3A Regulation Schedules specify operation of S-151 for water supply only during Column 1 operations (no WCA-3A regulatory releases to the South Dade Conveyance System (SDCS)) and S-151 regulatory inflows to WCA-3B during Column 2 operations (WCA-3A regulatory releases to the SDCS), contingent on the Site 71 stage being below 8.5 feet NGVD.

The USACE has not conducted a comprehensive review of the previously-established SPF stages for WCA-3B, pending consideration of modified inflow infrastructure for WCA-3B. SFWMM modeling conducted for the 1993 MWD to ENP Feature Design Memorandum (FDM), based on the 1992 MWD GDM default operational plan, identified a revised SPF stage of 11.6 feet NGVD at Site 71 for the MWD Project condition; however, despite subsequent multiple interagency efforts, a final configuration for WCA-3B inflow structures and an associated MWD operational plan, has not been identified prior to the conclusion of CEPP formulation efforts.

Concurrent with CEPP alternative formulation and modeling efforts, EN-W conducted a review of WCA-3B high water levels compared to the WCA-3B design criteria and independent of any previous SPF stage considerations. WCA-3B is currently bounded by the L-29 Levee (Section 3) to the south, the L-67A Levee and the L-67C Levee to the west, and the L-30 Levee to the east; the design grades for these WCA-3B perimeter levees range between 13.0 feet NGVD for the L-29 Levee (note: typical sections range from 13.5-17.5 feet NGVD, due to subsequent stockpiling of spoil material from L-29 Canal improvements, and all L-29 Section 3 Levee sections meet or exceed the design grade) to 20.0 feet NGVD for the L-30 Levee (the design grades for the L-67A and L-67C Levees are 17.5 and 12.5 feet NGVD, respectively), such that the L-29 Levee design grade represents the limiting factor for peak WCA-3B stages for CEPP. Stage duration curves for the CEPP ECB, the CEPP FWO, and the CEPP final array alternatives (including the operational modifications of the recommended plan) are provided in Figures 58 through 65 for the two RSM-GL monitoring gage locations within WCA-3B at Site 71 and Shark-1 (also alternatively referred to as SRS-1) that are produced with the model standard output information; corresponding RSM-GL model GSE elevations for these gages are 6.64 and 6.61 feet NGVD, respectively. Annual stage hydrograph statistical distribution plots for Site 71, which is currently utilized for WCA-3B operational management, are provided in Figures 66-68 to facilitate comparisons of intra-annual stage variability between the CEPP ECB baseline condition, the CEPP FWO baseline condition, and the recommended plan (Alternative 4R2). For the 41-year period of simulation, the graphics illustrate the maximum and minimum stage, 90th and 10th percentile stages, 75th and 25th percentile stages, median stage, and mean stage at a daily time step. For the CEPP alternatives, peak stages within WCA-3B (outside of the Blue Shanty Flow-

way in Alternatives 4, 4R, and 4R2) ranged between 9.22-9.62 feet NGVD at Site 71 and between 9.22-9.65 feet NGVD at Shark-1. WCA-3B peak stages for the CEPP alternatives are approximately 0.15-0.60 feet greater than the CEPP ECB and CEPP FWO baselines; however, the WCA-3B peak stages for the CEPP alternatives remain approximately 3.4-3.8 feet below the L-29 Section 3 design grade of 13.0 feet NGVD. The SPF rainfall for WCA-3B is approximately 1.5 feet (17.5 inches; based on the C&SF definition of 125% of the localized 3-day, 100-year maximum rainfall event of 14 inches (SFWMD Technical Publication EMA #390, January 2001)). Based on EN-W assessment of these maximum simulated WCA-3B peak water depths of slightly more than 3.0 feet for the final array of alternatives, maximum wind and wave run-up potentials would not be expected to exceed 1-2 feet. For this preliminary EN-W assessment (further analysis will be conducted during PED), a presumed worst-case scenario was defined with peak CEPP stages exacerbated by the additional SPF rainfall and maximum wind and wave run-up depths. Under the assumptions for this worst-case scenario, the L-29 Section 3 Levee would not be expected to be overtopped with the simulated stages for Alternatives 1, 4, 4R, or 4R2; potential overtopping under this worst-case scenario would only occur for the relatively higher WCA-3B stages simulated with Alternative 2 and Alternative 3, at the two lowest elevation points along the L-29 Section 3 Levee. Although Alternative 2 and Alternative 3 were not identified as the recommended plan, it is noted that potential WCA-3B depths in the range of those contemplated with Alternative 2 and Alternative 3 would most likely require additional analyses during PED and/or minor improvements to the L-29 Levee Section 3.

For the CEPP recommended plan (Alternative 4R2), however, peak stages within WCA-3B (outside of the Blue Shanty Flow-way in Alternative 4R2) were 9.25 and 9.24 feet NGVD at Site 71 and Shark-1, respectively, or approximately 0.20 feet greater than the CEPP ECB and CEPP FWO baselines (9.05-9.06 feet NGVD); however, the WCA-3B peak stages for the CEPP recommended plan remains approximately 3.75 feet below the L-29 Section 3 design grade of 13.0 feet NGVD. The SPF rainfall for WCA-3B is approximately 1.5 feet. Based on EN-W assessment of these WCA-3B peak water depths less than 3 feet (2.61-2.63 feet peak depth for Alternative 4R2 stages), maximum wind and wave run-up potentials would not be expected to exceed 1-2 feet. For this preliminary EN-W assessment (further analysis will be conducted during PED), a presumed worst-case scenario was defined for the CEPP recommended plan, with peak Alternative 4R2 stages exacerbated by the additional SPF rainfall and maximum wind and wave run-up depths. Under this assumed worst-case scenario (9.25 feet NGVD stage + 1.5 feet SPF rainfall + 2.0 feet run-up potential), the L-29 Section 3 Levee would not be overtopped at the two lowest elevation points (with approximately 0.25 feet of remaining freeboard, compared to the minimum L29 Section 3 Levee elevation of 13.0 feet NGVD). Given no predicted L-29 Section 3 Levee overtopping for this conservative assumed combination of events and recognition that CEPP inflows to WCA-3B (both within the Blue Shanty flow-way and eastern WCA-3B) will utilize controllable structures that may be closed in anticipation of extreme rainfall events, the EN-W preliminary assessment of the WCA-3B design criteria concluded that the proposed CEPP water levels of Alternative 4R2 would not adversely affect the flood control capability of the unmodified eastern segment of the L-29 Levee (or other perimeter levees, which have higher design elevations) bordering WCA-3B. The USACE currently anticipates revisiting the WCA-3B SPF stage during PED, pending final authorization of the CEPP and the establishment of operating criteria for WCA-3B water management structures for a System Operating Manual revision for CEPP implementation.

Maximum stages within the WCA-3B Blue Shanty flow-way and maximum head differential across the L-67D Levee are utilized for the hydraulic, geotechnical, and civil design of the L-67D Levee for the CEPP recommended plan (Alternative 4R2). Stage duration curves within the interior of the Blue Shanty flow-way, external to the flow-way at the Shark 1 gage in WCA-3B, and within the L-29 Canal (Alternatives 4, 4R, and 4R2 are the only alternatives which include this flow-way component), both west of the CEPP-proposed S-355W L-29 divide structure (within the flow-way, following CEPP removal of this section of the L-29 Levee) and east of the S-355W structure, are shown in Figure 69 (Alternative 4), Figure 70 (Alternative 4R), and Figures 71-72 (Alternative 4R2). The head differential across the L-67D Levee for Alternatives 4 and 4R are shown in Figures 73 through 74 and Figure 76 in both time series format and frequency curve format. The head differential across the L-67D Levee for the CEPP recommended plan (Alternative 4R2) is shown in Figures 75 through 77 in both time series format and frequency curve format; the maximum head differential across the CEPP-proposed L-67D Levee is approximately 1.50 feet during the 1965-2005 RSM-GL period of simulation.

For additional reference, the L-29 Canal stage duration curves for the CEPP ECB, CEPP FWO, and CEPP alternatives 1 through 4R2 are shown in Figure 78 through 81 (stages correspond to the western reach of the L-29 Canal for Alternatives 4, 4R, and 4R2, west of the S-355W structure); peak stages are indicated on Figure 79 and Figure 81. Peak L-29 Canal stages for CEPP will need to be considered for future implementation of the DOI TTNS roadway modifications, including the potential need to further raise the eastern portion of the Tamiami Trail roadway, east of the CEPP-proposed S-355W L-29 divide structure. Peak simulated L-29 Canal stages for Alternative 4R2 are 9.59 feet NGVD west of the divide structure and 9.50 feet NGVD east of the divide structure (refer to Figures 71 and 72).

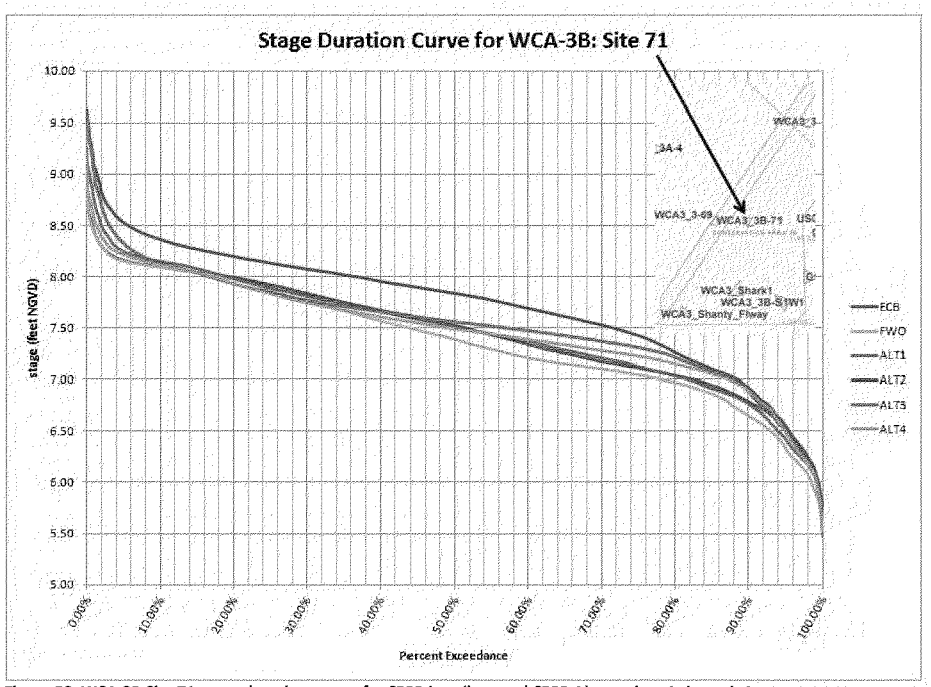


Figure 58: WCA-3B Site 71 stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4

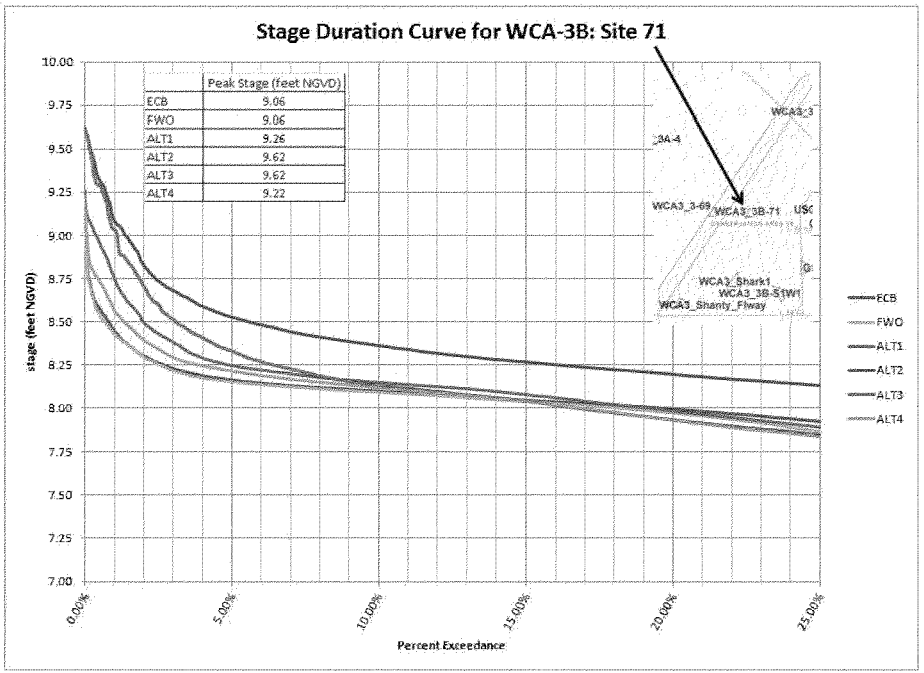


Figure S9: WCA-3B Site 71 stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4 (Upper 25%)

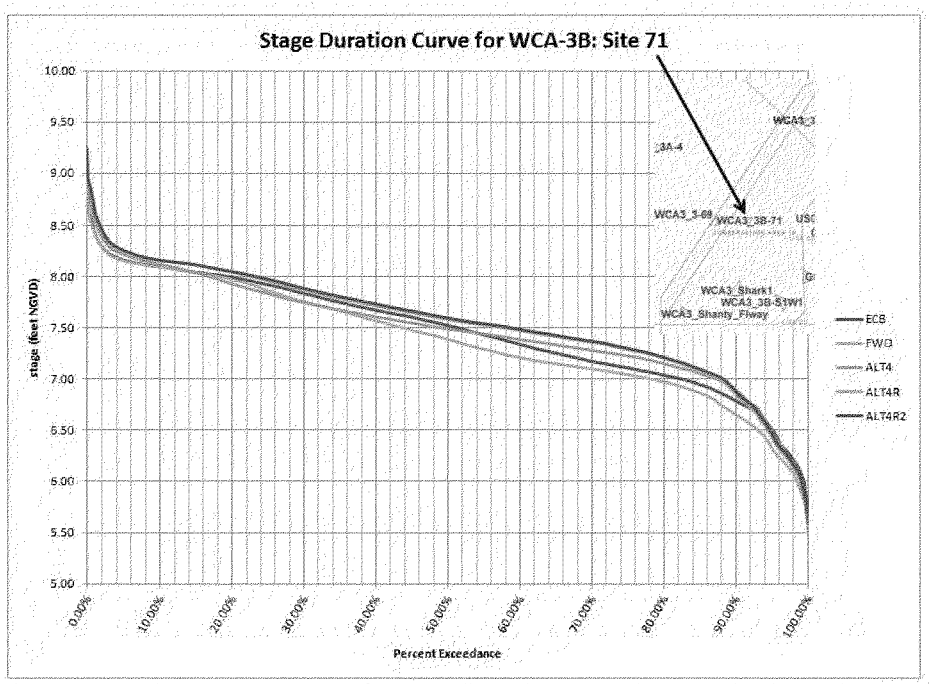


Figure 60: WCA-3B Site 71 stoge durotion curves for CEPP baselines and CEPP Alternatives 4,4R, and 4R2

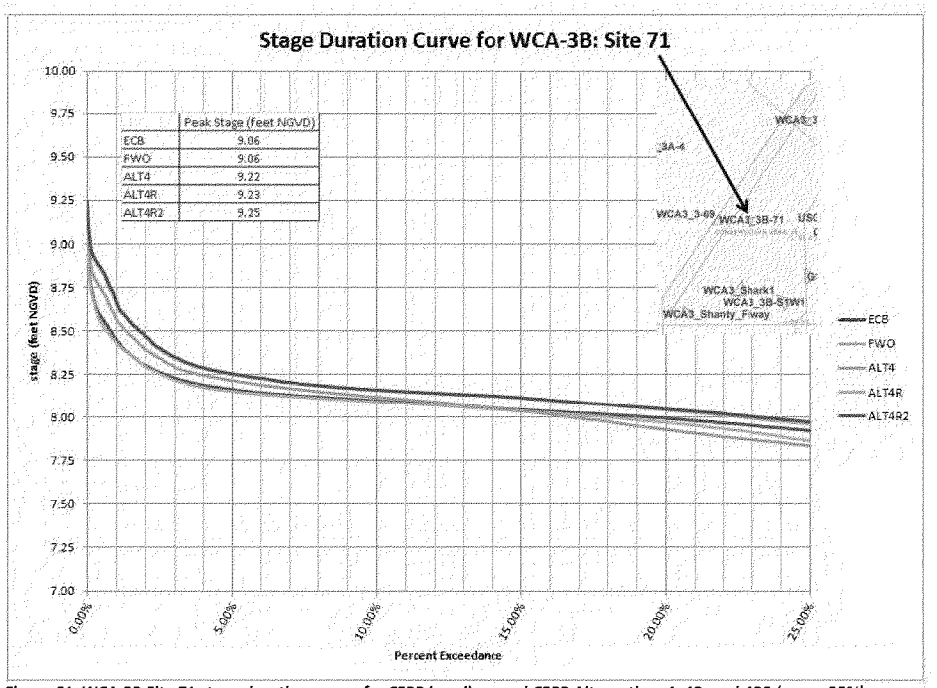


Figure 61: WCA-3B Site 71 stage duration curves for CEPP baselines and CEPP Alternatives 4, 4R, and 4R2 (upper 25%)

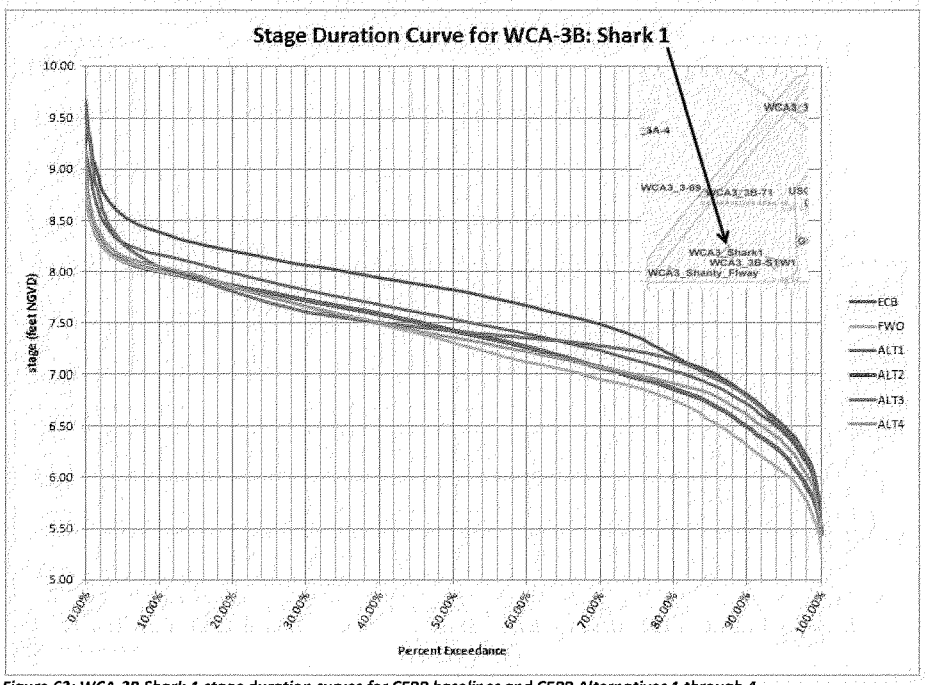


Figure 62: WCA-3B Shark-1 stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4

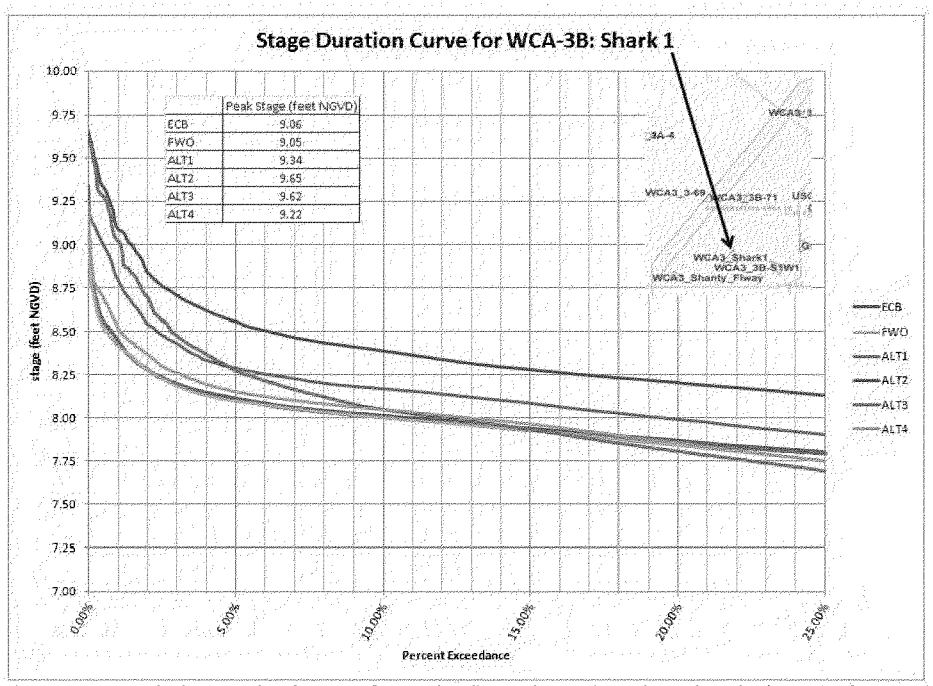


Figure 63: WCA-3B Shark-1 stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4 (Upper 25%)

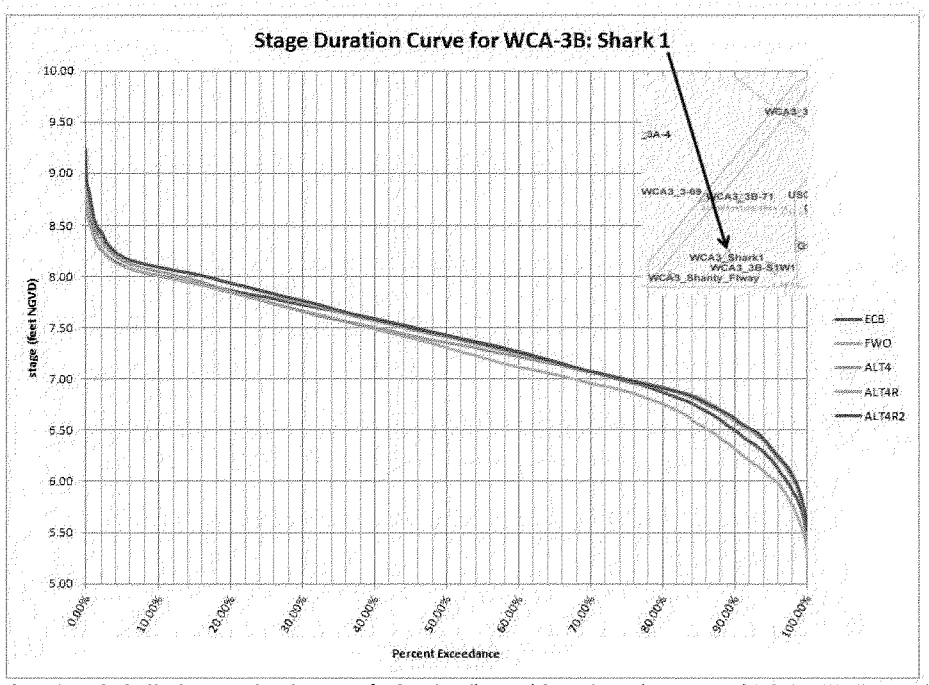


Figure 64: WCA-3B Shork-1 stage duration curves for CEPP baselines and CEPP Alternatives 4, 4R, and 4R2

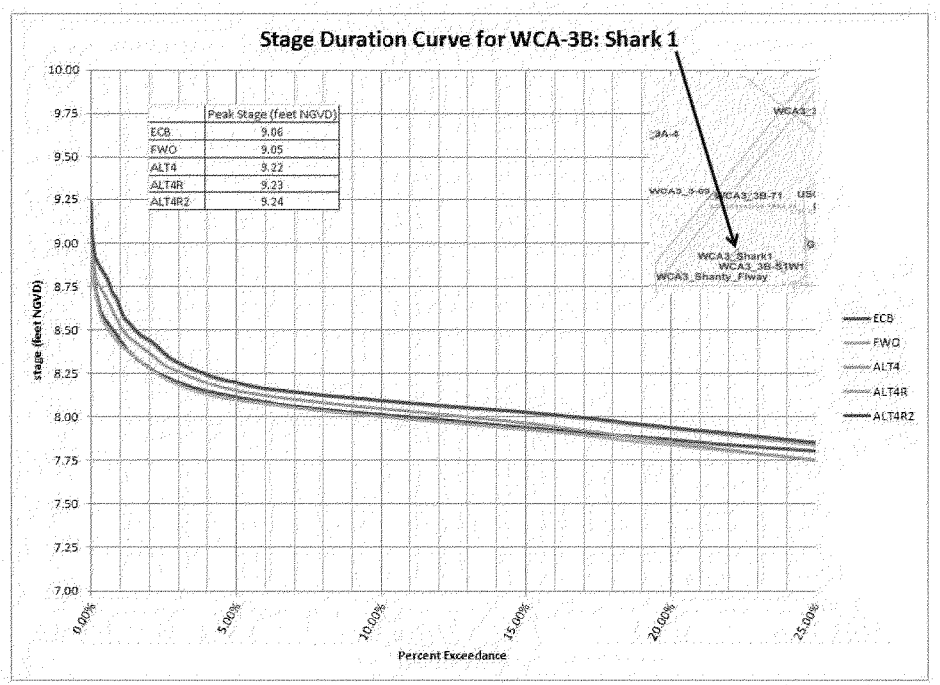


Figure 65: WCA-3B Shork-1 stage duration curves for CEPP baselines and CEPP Alternatives 4, 4R, and 4R2 (upper 25%)

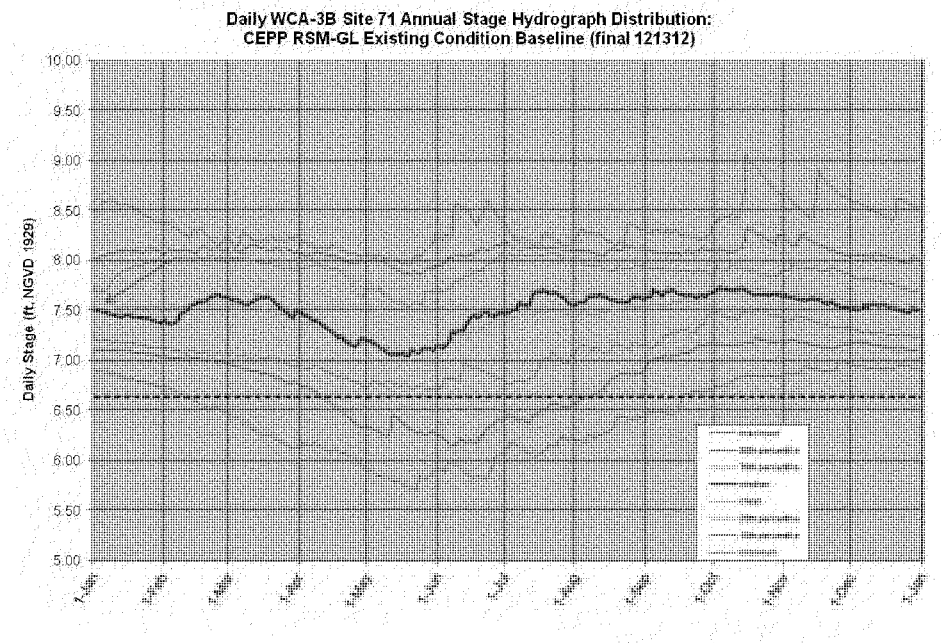


Figure 66: WCA-3B Site 71 annual average stage hydrographs for CEPP ECB Baseline

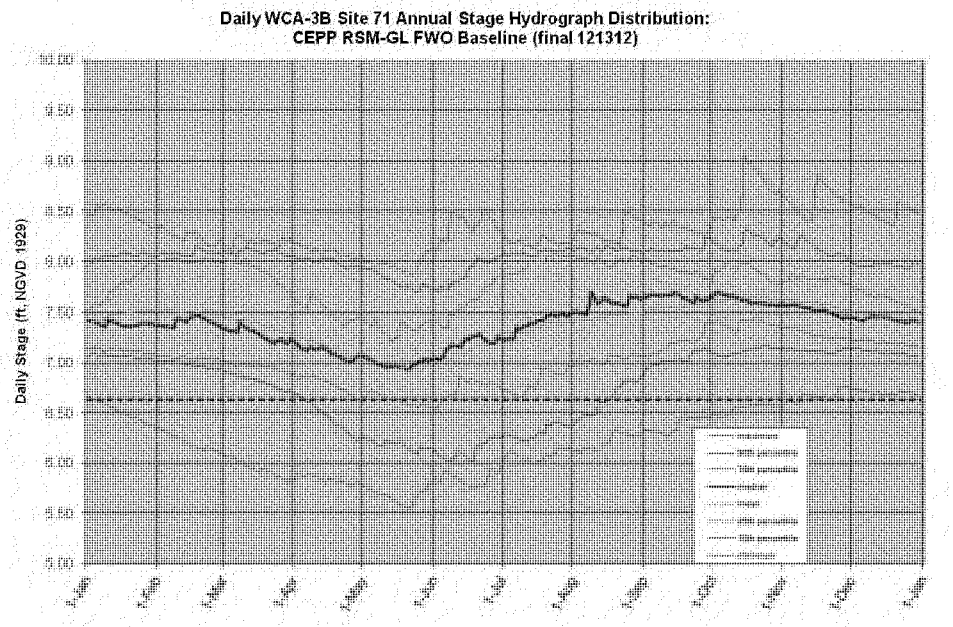


Figure 67: WCA-3B Site 71 annual average stage hydrographs for CEPP FWO Baseline

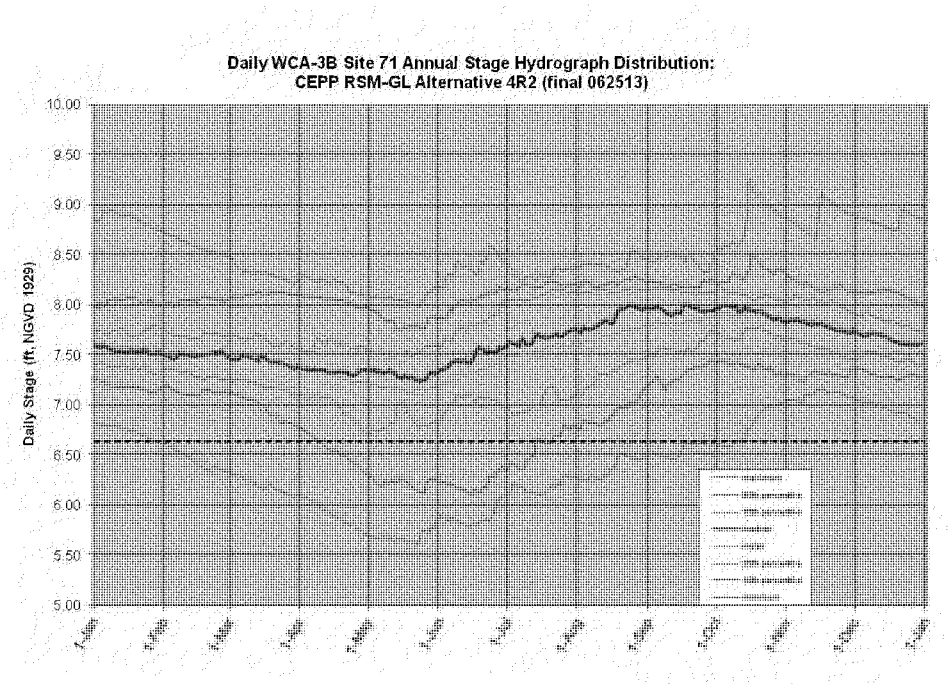


Figure 68: WCA-3B Site 71 annual average stage hydrographs for CEPP Alternative 4R2

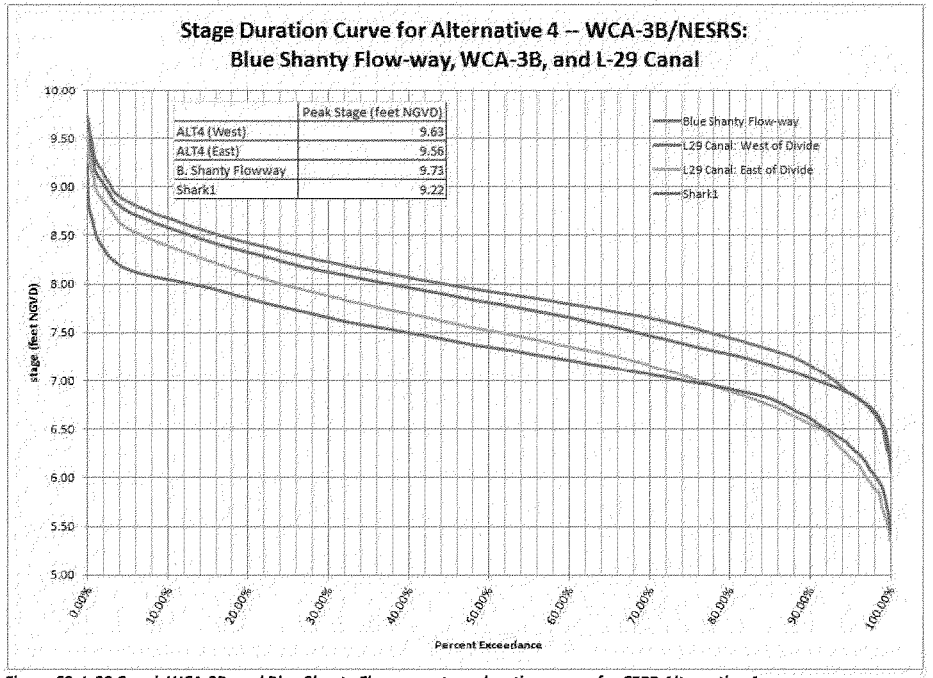


Figure 69: L-29 Canal, WCA-3B, ond Blue Shanty Flow-way stoge duration curves far CEPP Alternative 4

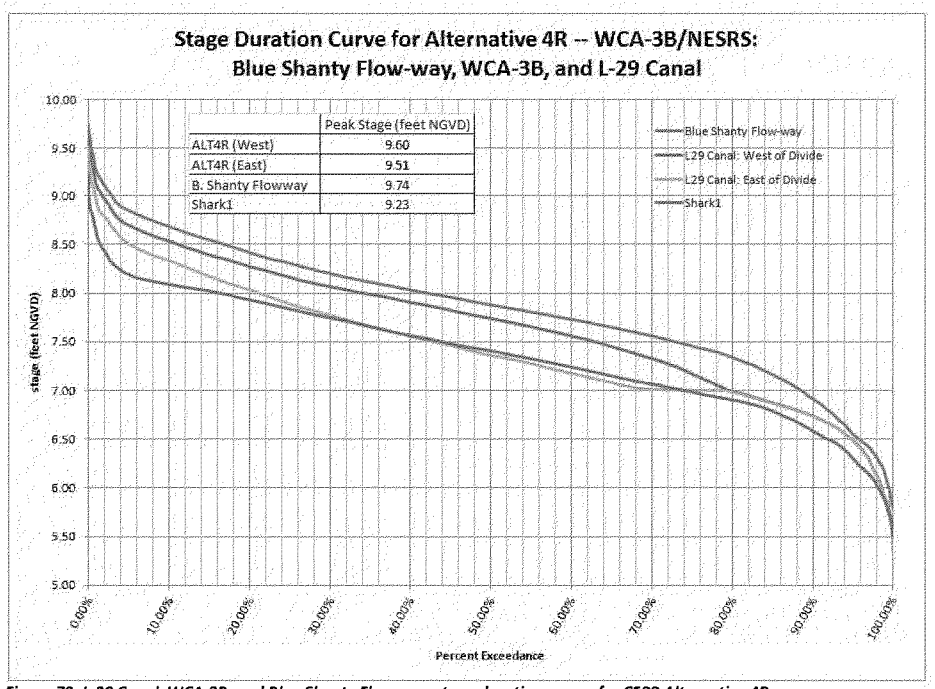


Figure 70: L-29 Canal, WCA-3B, and Blue Shanty Flow-way stage duration curves for CEPP Alternative 4R

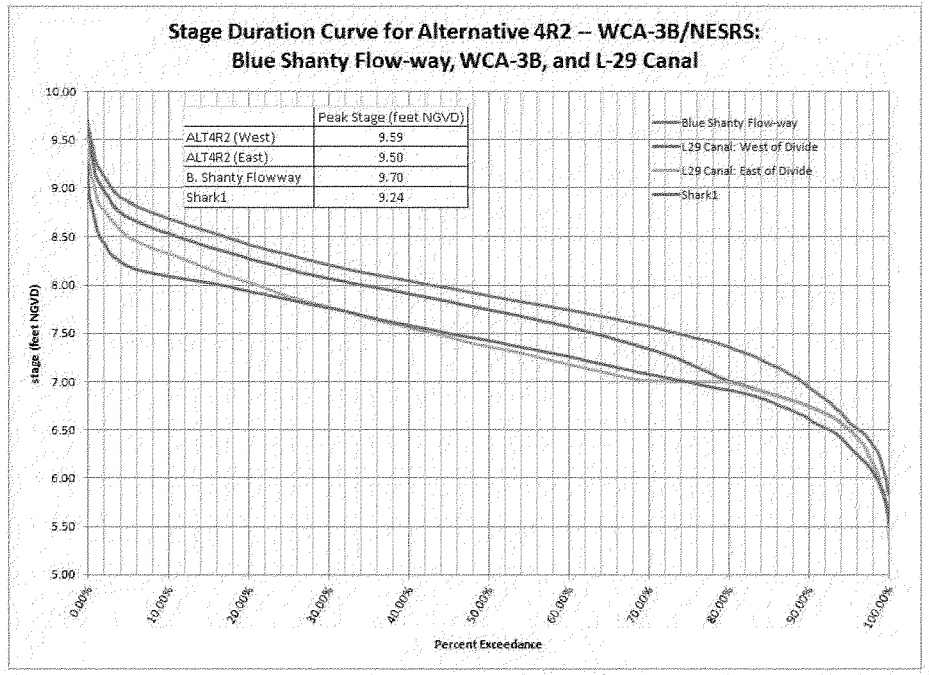


Figure 71: L-29 Canal, WCA-3B, and Blue Shanty Flow-way stoge duration curves for CEPP Alternative 4R2

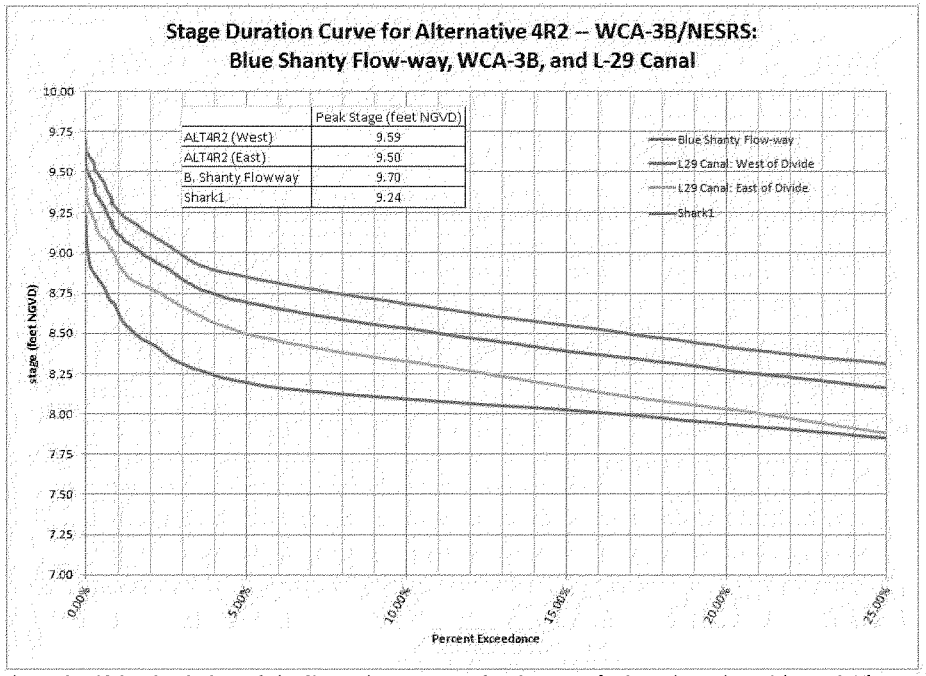


Figure 72: L-29 Canal, WCA-3B, and Blue Shanty Flow-way stoge duration curves for CEPP Alternative 4R2 (Upper 25%)

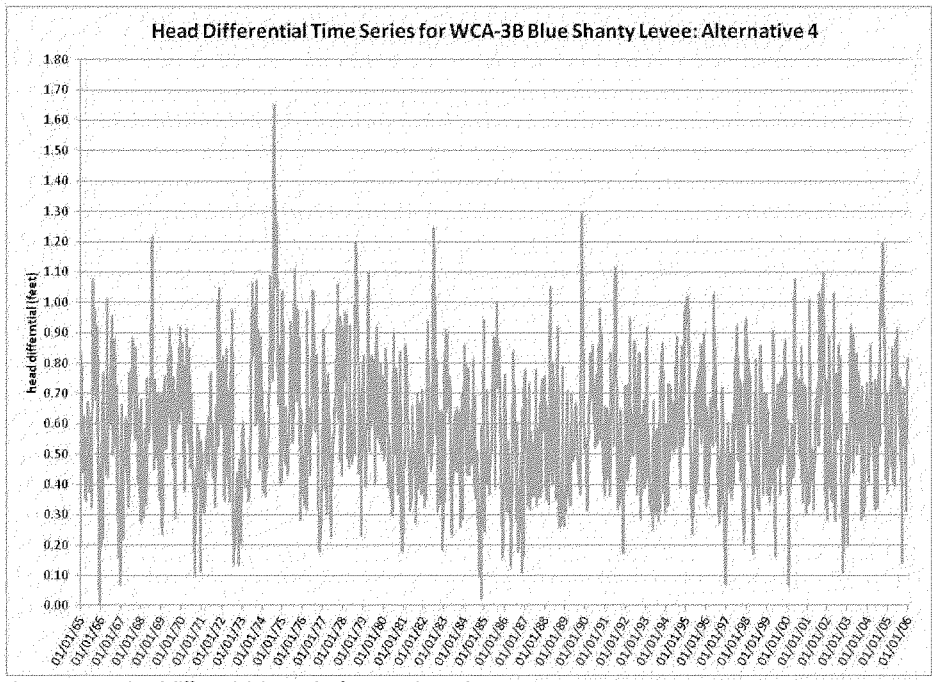


Figure 73: L-67D head differential time series for CEPP Alternative 4

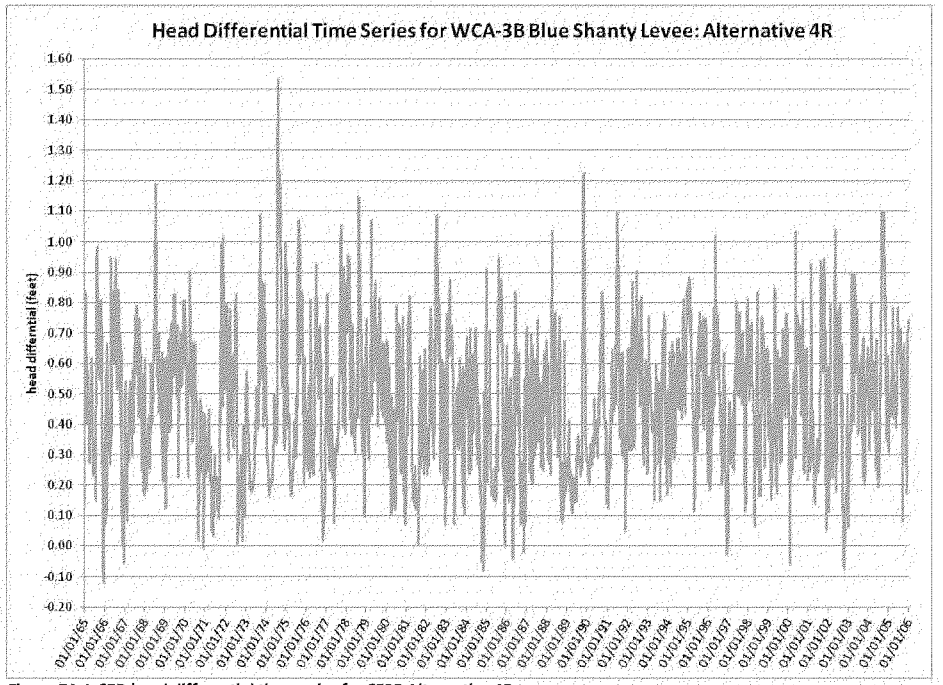


Figure 74: L-67D head differential time series for CEPP Alternative 4R

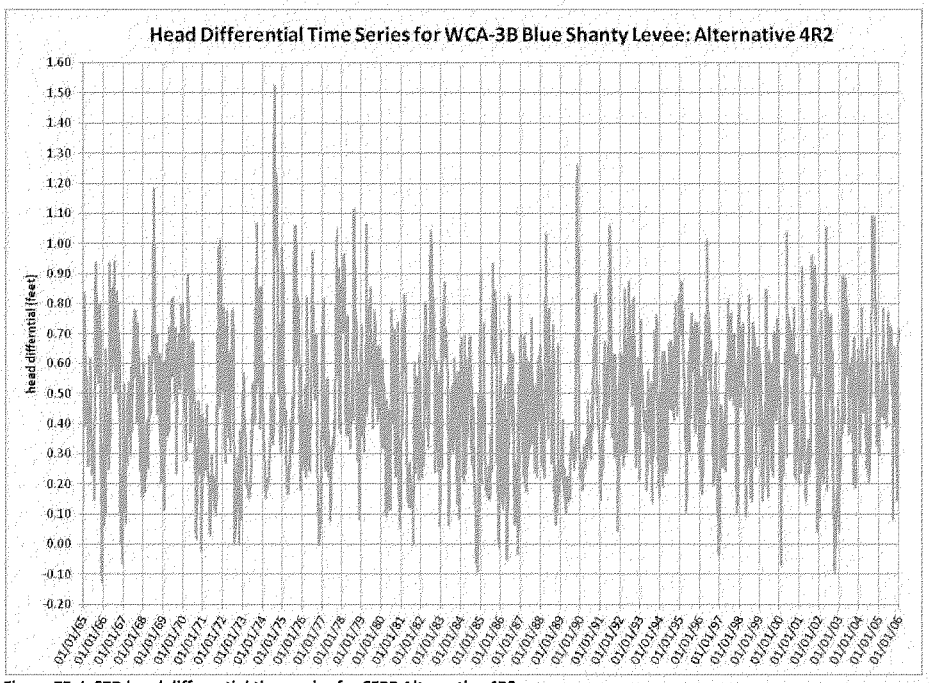


Figure 75: L-67D head differential time series for CEPP Alternative 4R2

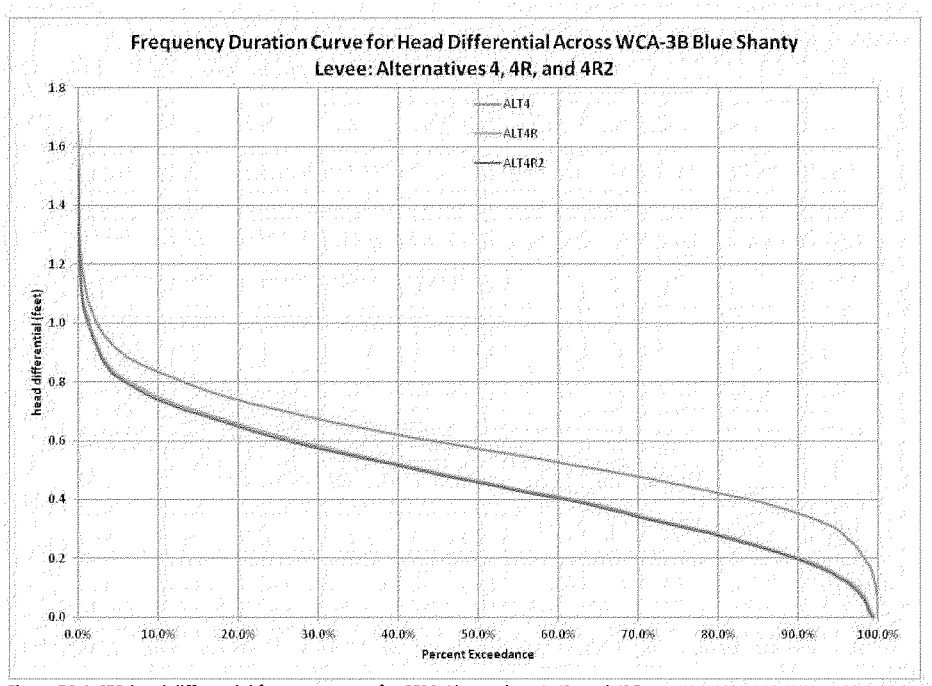


Figure 76: L-67D head differential frequency curve for CEPP Alternatives 4, 4R, and 4R2

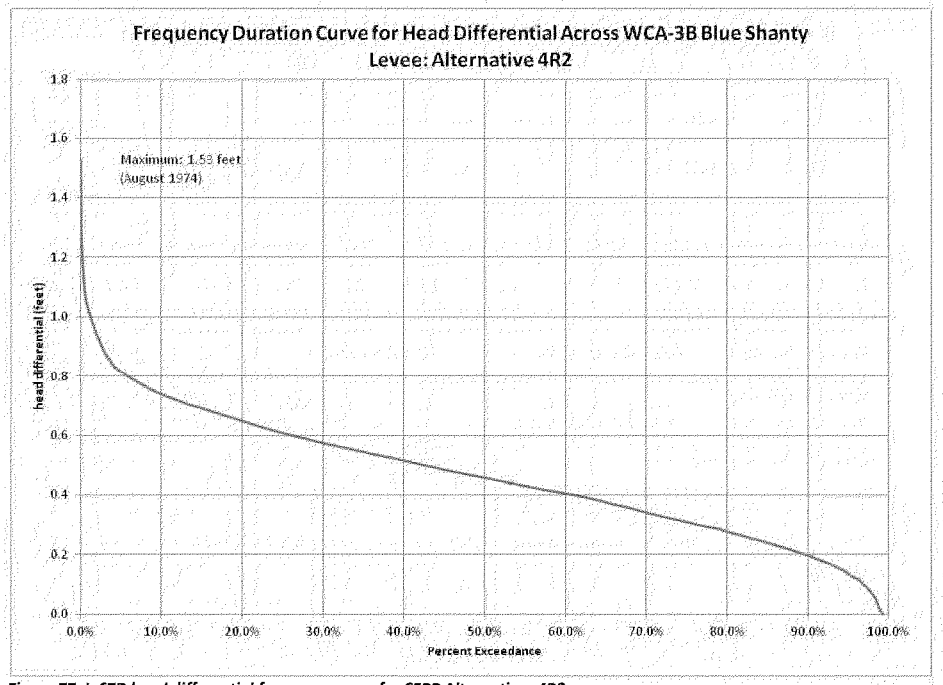


Figure 77: L-67D head differential frequency curve for CEPP Alternatives 4R2

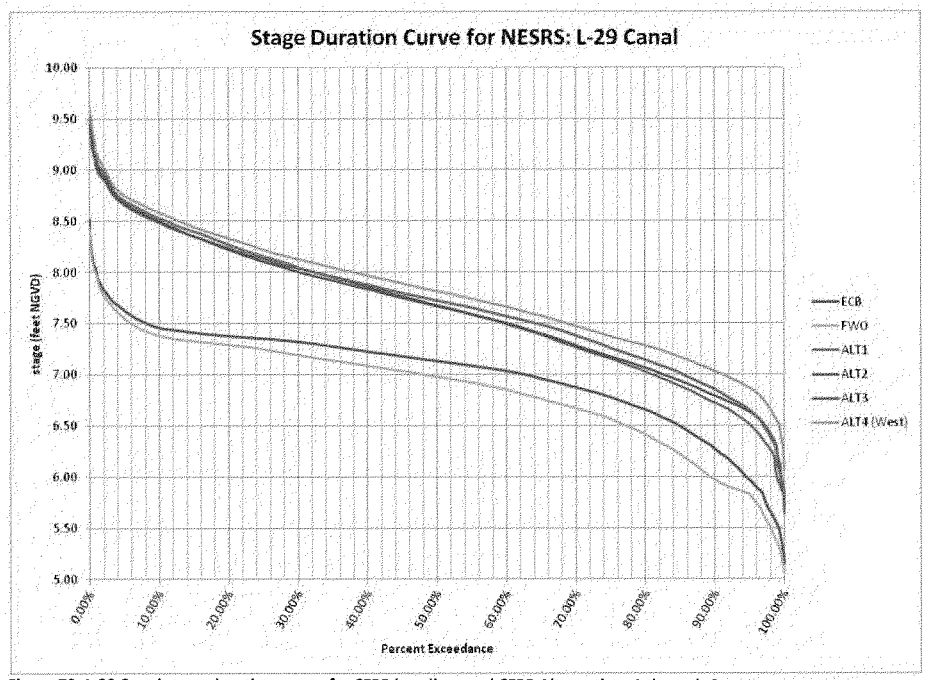


Figure 78: L-29 Canal stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4

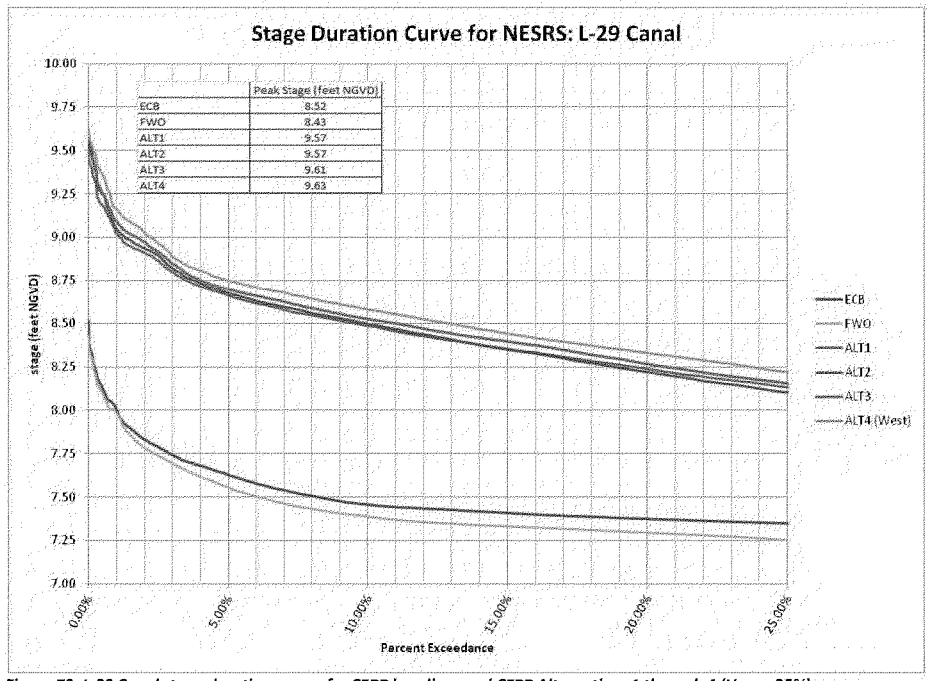


Figure 79: L-29 Canal stage duration curves for CEPP baselines and CEPP Alternatives 1 through 4 (Upper 25%)

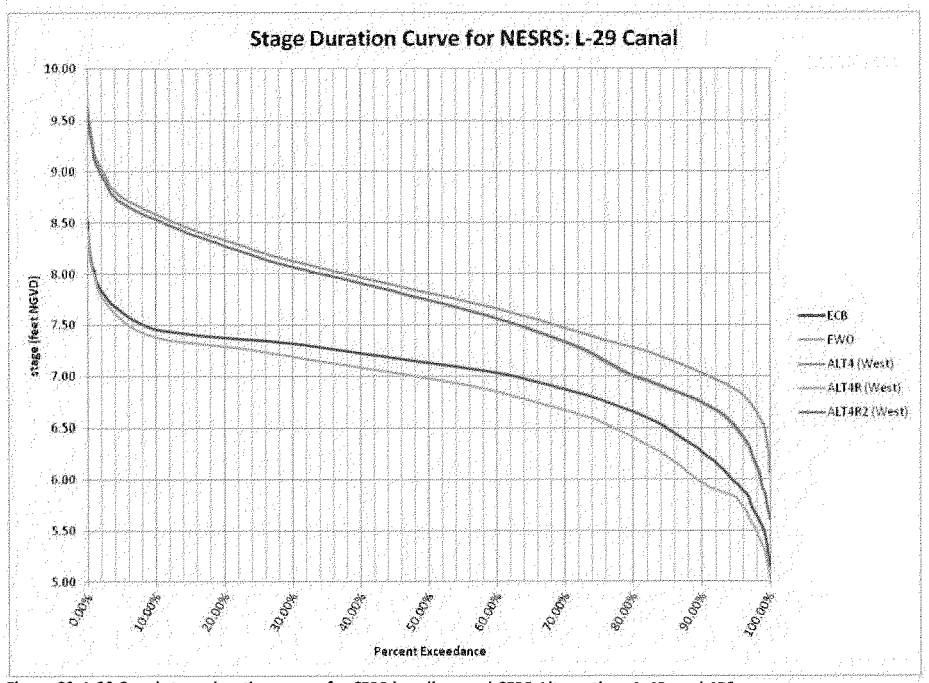


Figure 80: L-29 Canal stage duration curves for CEPP baselines and CEPP Alternatives 4, 4R, and 4R2

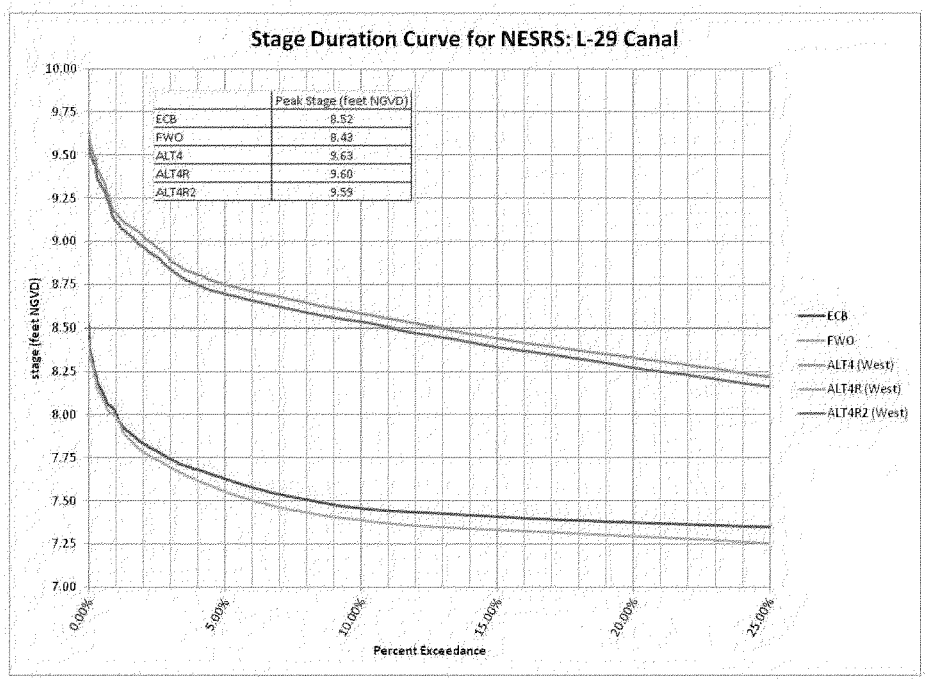


Figure 81: L-29 Canal stage duratian curves for CEPP baselines and CEPP Alternatives 4, 4R, and 4R2 (upper 25%)

3.2.3. Lake Okeechobee Herbert Hoover Dike Design Considerations

Herbert Hoover Dike (HHD) design considerations, with particular consideration of the effects of operational flexibility within the 2008 Lake Okeechobee Regulation Schedule, are addressed in Section A.8.3.2.3 of the Engineering Appendix. Information is presented in the Engineering Appendix (Appendix A) of the PIR for CEPP alternatives 1 through 4R2.

3.2.4. 8.5 Square Mile Area Flood Mitigation Performance

The 8.5 Square Mile Area (8.5 SMA) is a primarily residential area adjacent to, but west of, the L-31N Canal. The 8.5 SMA, which is also known as the Las Palmas community, is bordered on both the west and north by NESRS (Figure 82). The community has water management infrastructure consisting of a perimeter levee, a seepage collection canal, a pump station (S-357), and a southern detention cell meant to collectively provide flood mitigation as part of the MWD Project.

Stages within the 8.5 SMA, located along the eastern boundary of ENP, do not change significantly between the CEPP ECB and the FWO. The 8.5 SMA project components and operations are unchanged between the ECB and FWO modeling assumptions, with each baseline condition assuming operations of S-357 and S-331 as defined in the 2011 8.5 SMA Interim Operational Criteria; the S-357 pump station is limited to a 125 cfs average daily discharge rate, and S-331 flood mitigation operations for the 8.5 SMA are triggered based on the stage at the LPG-2 monitoring gage (located within the protected area, along the western perimeter levee).

The CEPP alternatives modify the FWO operations of the S-357 pump station, in an effort to increase discharges from the 8.5 SMA detention cell to the C-111 South Dade North Detention Area and reduce the reliance on the S-331 pump station in L-31N to provide flood mitigation for the 8.5 SMA protected area. The protected portion of the 8.5 SMA is represented by 3 model grid cells in the RSM-GL (Figure 83), and the resolution of the RSM-GL is extremely limiting for adequate representation of the 8.5 SMA project features. Prior to implementation of CEPP, further technical investigations and potentially additional hydrologic/hydraulic modeling with a higher resolution model will likely be needed for the 8.5 SMA operations. The current MWD 8.5 SMA configuration was identified in the USACE C&SF MWD 8.5 SMA General Reevaluation Report (2000 GRR), which provided a detailed quantification of potential affects to 8.5 SMA flood mitigation performance and potential affects to adjacent ENP wetlands supported by ModBranch hydrologic modeling.

RSM-GL final array modeling of Alternatives 1 through 4 indicated that stages within the 8.5 SMA were lowered by approximately 0.25 feet during wet conditions for RSM-GL grid cells 2965 (Figure 84) and 2962 (Figure 85), compared to the FWO; within the resolution of the RSM-GL model, these grid cells represent northern and southeastern 8.5 SMA, respectively. However, of concern with Alternatives 1 through 4, stages within the southwest portion of the 8.5 SMA, represented by RSM-GL grid cell 2749, were increased by approximately 0.3-0.6 feet, compared to the FWO, under all hydrologic conditions (Figure 86). These alternatives maintained increased utilization of the S-357 pump station to provide effective flood mitigation for the 8.5 SMA protected area but did not include lowering of the overflow weirs' elevations within the 8.5 SMA detention area (crest elevations for the S-360W and S-360E weirs were maintained at the elevations specified for the 2011 Interim Operations Plan for 8.5 SMA, corresponding to

overflow depths of 4.0 and 3.5 feet, respectively); consistent with previous field observations during S-357 interim operations, the CEPP modeling demonstrated that increased operational depths within the 8.5 SMA detention area may potentially cause increased groundwater stages within the southwestern portion of the 8.5 SMA protected area.

The 8.5 SMA detention cell weirs were lowered with Alternative 4R and Alternative 4R2 to allow overflow when depths exceeded 1.0 feet, which resulted in performance improvements within the southwestern portion of the 8.5 SMA protected area, RSM-GL grid cell 2749. RSM-GL modeling of Alternative 4R and Alternative 4R2 indicates that stages within the 8.5 SMA are lowered by approximately 0.25-0.50 feet during wet conditions for the three RSM-GL grid cells that represent the protected portion of the 8.5 SMA, compared to the FWO (Figures 84 through 86).

During the PED phase of CEPP, further technical investigations and potentially additional hydrologic/hydraulic modeling with a higher resolution model will likely be needed for the 8.5 SMA operations.

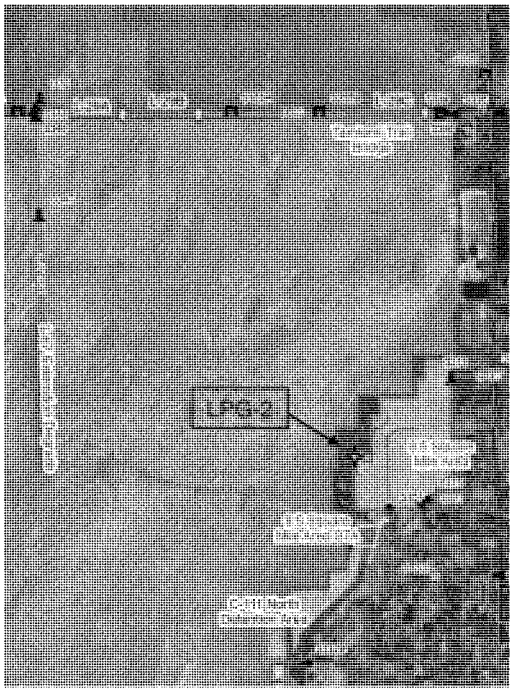


Figure 82: Location map for 8.5 SMA

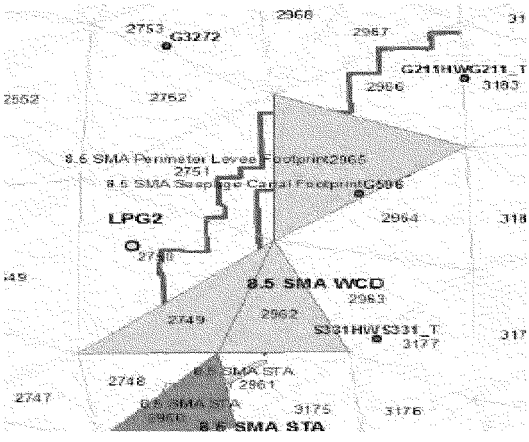


Figure 83: RSM-GL grid cell representation of the 8.5 SMA

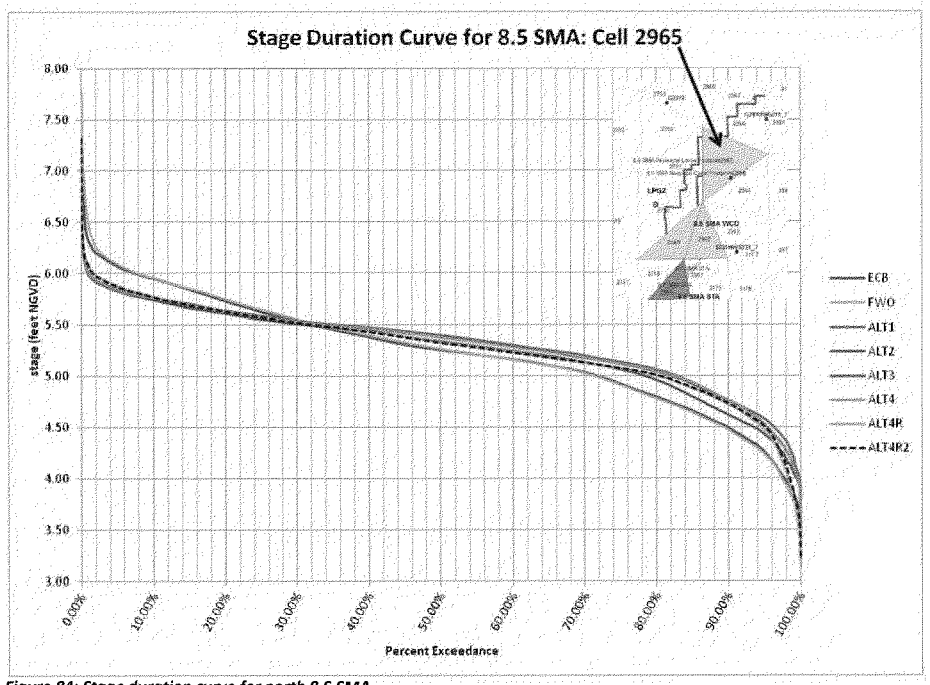


Figure 84: Stage duration curve for north 8.5 SMA

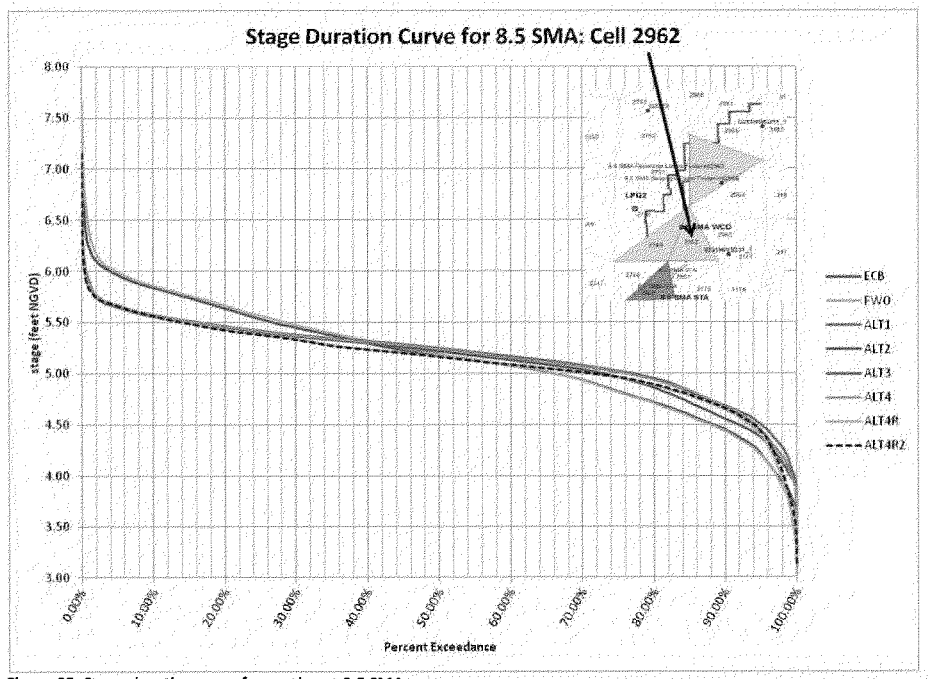


Figure 85: Stoge duration curve for southeast 8.5 SMA

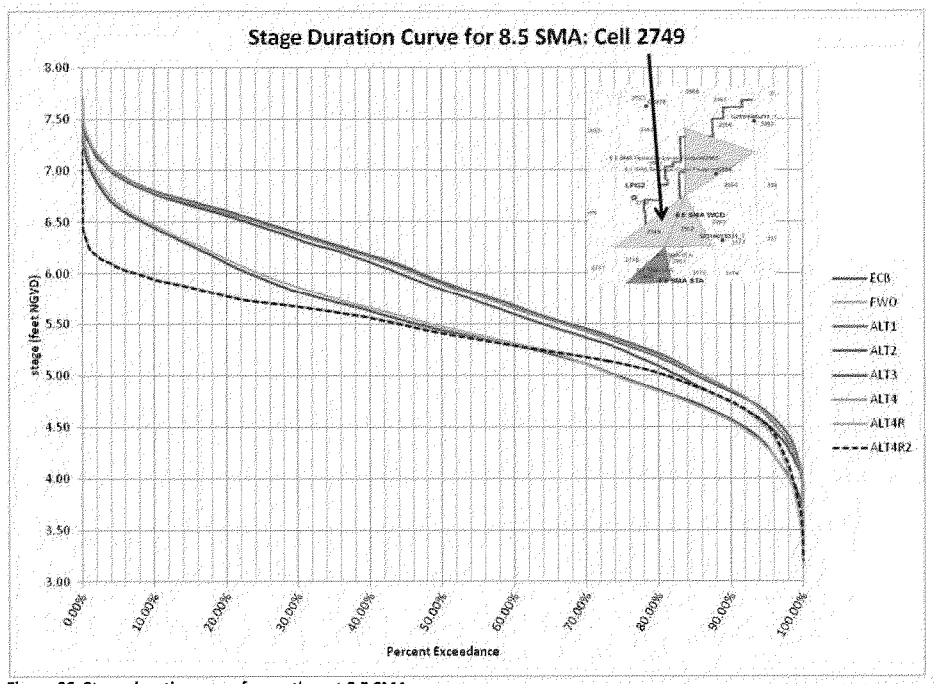


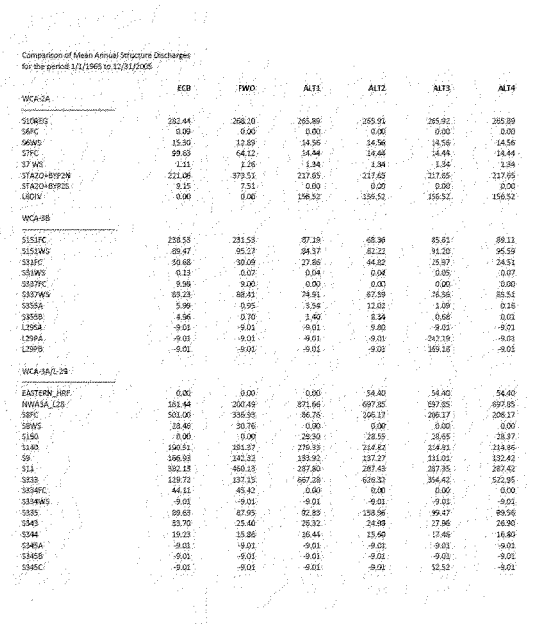
Figure 86: Stage duration curve for southwest 8.5 SMA

3.2.5. Additional RSM-GL Post-Processing for Structures and Detention Areas

RSM-GL daily output for structure discharges and water stages at monitoring gages are generated for the 1965-2005 period of simulation and tabulated using the USACE Hydrologic Engineering Center's Data Storage System (HEC-DSS). Due to the enormous volume of data included in the RSM-GL DSS files for the CEPP baselines and the CEPP alternatives, EN-W developed an additional suite of post-processed RSM-GL graphics to facilitate review of the preliminary Blue Line and Yellow Line screening modeling and the final array modeling by the CEPP water supply and flood control (WS/FC) technical sub-team. The primary assessment focus of the CEPP WS/FC sub-team was the South Dade Conveyance System (SDCS), including the effects of controlled/uncontrolled increased seepage from WCA-3B and eastern ENP with implementation of CEPP components and operations; the seepage flux dynamics along the Yellow Line are directly correlated to increased flood control risk (too much increased seepage and/or too little active seepage management) and reduced water availability for water supply (too little increased seepage and/or too much active seepage management).

Using the list of critical flow structures that was identified by EN-W for CEPP and included in the average annual critical flows reports (units are kAF), flow duration curve graphics were generated by EN-W for each of these critical structures to quantify the degree to which existing and/or proposed structure design capacities are sufficient for achievement of CEPP objectives, as well as the relative differences between the screening simulations and final alternatives. For reference, the critical flows reports generated for the final array of alternatives are provided in Table 7 (ECB, FWO, Alternatives 1 through 4) and Table 8 (ECB, FWO, Alternative 4R, Alternative 4R2). Stage duration curve graphics were also generated by EN-W for the 8.5 SMA Detention Area, C-111 North Detention Area, C-11 South Detention Area, and the Frog Pond Detention Area, to assess the relative differences in utilization of these storage areas for which standard model output graphics were not otherwise available. Several of the EN-W flow duration curves and stage duration curves were particularly utilized by the CEPP WS/FC sub-team during sub-team review of the final array modeling, and a selected sub-set of these graphics are provided in Figures 87 through 130. For each structure or detention area, two graphics are provided: the first graphic for each figure (part A) displays the ECB, FWO, and Alternatives 1 through 4R; the second graphic for each figure (part B) displays the ECB, 2012EC, IORBL1, Alternative 4R, and Alternative 4R2 (the 2012 Existing Condition Baseline [2012EC] and the Initial Operating Regime Baseline [IORBL1] simulations were specifically developed for the CEPP Savings Clause and Project Assurances assessments, and these simulations are discussed in more detail in Annex B of the CEPP PIR main report). The structures are generally sequenced from north to south and west to east, beginning with S-151. Aside from the unprocessed DSS output files, these flow duration curve and stage duration curve graphics are not otherwise available in the posted RSM-GL standard model output. On these graphics, absence of a legend entry for one or more base conditions or alternatives indicates that the particular structure was not included for the absent simulation. Graphic colors are automatically assigned by the post-processing script in sequential order, and graphics corresponding to structures or detention areas that are not included in all CEPP simulations will display with a different color scheme.

Table 7: RSM-GL critical flaws report for CEPP baselines and Alternative 1 through 4



Comparison of Mean Annual Structure Discharges
for the period 1/1/1965 to 12/31/2005

	ECB	FWO	ALT1	ALT2	ALT3	ALT4
WCA-2A						
S10EEG	282.44	268.10	265.89	265.91	265.92	265.89
S6FC	0.09	0.00	0.00	0.00	0.00	0.00
S6WS	15.39	12.89	14.56	14.56	14.56	14.56
S7FC	59.63	64.12	14.44	14.44	14.44	14.44
S7 WS	1.11	1.26	1.34	1.34	1.34	1.34
S7AZO+BYP2N	221.05	373.51	217.65	217.62	217.65	217.65
S7AZO+BYP2S	9.15	7.51	0.00	0.00	0.00	0.00
L6DIV	0.00	0.00	156.52	156.52	156.52	156.52
WCA-3B						
S151FC	238.53	231.53	87.19	68.36	85.61	89.11
S151WS	89.47	95.27	94.37	82.22	91.20	95.59
S31FC	50.68	30.09	27.86	44.82	25.97	24.51
S31WS	0.13	0.07	0.04	0.04	0.05	0.07
S337FC	9.56	9.00	0.00	0.00	0.00	0.00
S337WS	89.23	88.41	74.91	87.59	76.56	85.51
S355A	5.99	0.95	3.56	12.02	1.09	0.16
S355B	4.96	0.70	1.40	8.34	0.68	0.01
L29SA	-9.01	-9.01	-9.01	9.80	-9.01	-9.01
L29PA	-9.01	-9.01	-9.01	-9.01	242.19	-9.01
L29PB	-9.01	-9.01	-9.01	-9.01	169.16	-9.01
WCA-3A/L-29						
EASTERN_HRF	0.00	0.00	0.00	54.40	54.40	54.40
NWA3A_L28	181.44	200.49	871.66	697.35	697.85	697.65
S8FC	501.06	336.93	86.76	206.17	206.17	206.17
S8WS	33.46	30.76	0.00	0.00	0.00	0.00
S150	0.00	0.00	29.30	28.59	28.65	28.37
S140	190.51	181.37	276.33	214.82	214.81	214.86
S9	166.93	142.83	133.92	137.27	131.01	132.42
S11	332.13	468.13	287.80	287.43	287.35	287.42
S333	129.72	137.13	667.28	626.33	364.42	522.95
S334FC	44.11	45.42	0.00	0.00	0.00	0.00
S334WS	-9.01	-9.01	-9.01	-9.01	-9.01	-9.01
S335	99.69	87.95	82.85	158.96	99.47	89.56
S343	33.70	25.40	26.32	24.99	27.96	26.90
S344	19.23	15.86	16.44	15.60	17.46	16.80
S345A	-9.01	-9.01	-9.01	-9.01	-9.01	-9.01
S345B	-9.01	-9.01	-9.01	-9.01	-9.01	-9.01
S345C	-9.01	-9.01	-9.01	-9.01	52.52	-9.01

3345D	-9.01	-9.01	-9.01	129.77	106.16	82.11
3345E	-9.01	-9.01	126.85	59.90	51.12	-9.01
3345G	-9.01	-9.01	-9.01	-9.01	-9.01	94.93
3345F	-9.01	-9.01	-9.01	75.64	79.39	83.39
3356	0.00	0.00	63.64	83.92	29.88	28.58
312A	37.33	29.76	15.25	14.54	16.76	15.87
312B	86.56	92.16	46.57	44.90	51.06	48.26
312C	172.91	242.85	150.81	149.99	157.56	152.74
312D	384.87	320.39	204.73	194.48	211.93	206.29
	685.67	685.16	417.56	397.85	437.31	423.16
ENP & Detention Areas						
L31PA	-9.01	-9.01	98.42	-9.01	-9.01	-9.01
L31PB	-9.01	-9.01	159.20	17.79	-9.01	-9.01
3332B	59.37	65.57	61.69	47.19	48.38	61.20
3332BN	42.66	51.73	48.16	37.36	38.37	47.91
3332C	75.12	87.77	74.12	55.45	57.18	74.19
3332D	97.57	107.09	101.76	105.62	107.83	100.35
South Bade						
G211PC	110.17	110.78	2.90	0.66	0.68	6.83
G211WS	60.48	62.41	57.51	60.24	58.58	58.09
3336	5.95	5.71	4.04	4.21	5.73	6.55
3336	58.89	57.13	51.17	53.19	29.02	32.97
3357	1.66	3.17	47.20	45.18	48.22	47.31
3331PC	164.10	164.94	87.39	80.43	80.38	88.29
3331WS	61.41	62.58	53.02	57.85	54.70	54.35
3194	20.98	25.82	15.89	15.63	16.86	18.53
3196	8.99	13.72	6.59	6.09	6.08	7.14
3176	50.25	42.96	41.28	43.04	43.06	42.03
3177	124.33	69.78	73.25	71.96	72.80	71.31
318C	182.90	144.98	144.35	143.52	145.08	144.56
3197	16.49	6.66	7.91	7.85	8.12	8.25
CERP Impoundments						
3504	-9.01	19.44	18.78	18.89	18.56	18.76
3509_P	-9.01	0.14	0.06	0.07	0.15	0.05
3510	-9.01	0.04	0.04	0.04	0.04	0.04
3525A_P	-9.01	5.39	5.46	5.47	5.48	5.46
3536A_C	-9.01	12.90	12.93	12.94	12.94	12.93
3199	-9.01	32.50	30.60	33.00	33.60	28.20
3200	-9.01	89.90	91.80	89.29	89.53	96.02

Run date: December 18, 2012
NOTE: Values of -9.01 indicate structure not found!!

Table 8: RSM-GL critical flows report for CEPP baselines, Alternative 4R, and Alternative 4R2

Comparison of Mean Annual Structure Discharges (kacft/yr)
For the period 1/1/1965 to 12/31/2005

	ECB	FWO	ALT4R	ALT4R2
WCA-2A				
S18REG	282.4	282.2	265.7	266.0
S8FC	0.1	0.0	0.0	0.0
S6WS	1.1	1.3	1.3	1.3
S7FC	59.6	64.1	14.5	55.6
S7WS	15.3	12.9	14.6	12.3
STA2D+BYP2N	221.1	373.5	229.8	235.8
STA2D+BYP2S	9.2	7.5	0.0	0.0
L9DIV	0.0	0.0	144.7	147.9
WCA-3B				
S151FC	238.5	231.5	89.9	89.8
S151WS	89.5	95.3	82.1	76.7
S31FC	30.7	30.1	32.2	33.4
S31WS	0.1	0.1	0.1	0.1
S337FC	10.0	9.0	0.0	0.0
S337WS	83.2	88.4	74.4	70.1
S355A	6.0	1.0	1.9	2.1
S355B	5.0	0.7	0.8	0.9
L29SA	-9.01	-9.01	-9.01	-9.01
L29PA	-9.01	-9.01	-9.01	-9.01
L29PB	-9.01	-9.01	-9.01	-9.01
L29_DIVIDE	-9.01	-9.01	38.0	37.8
WCA-3A/1-29				
EASTERN_HRF	0.0	0.0	0.0	0.0
NWA3A_L29	161.4	200.5	757.0	757.0
S8FC	501.0	336.9	161.3	120.1
S8WS	28.5	30.8	0.0	0.0
S150	0.0	0.0	57.4	57.7
S140	190.5	191.4	197.3	199.0
S9	166.9	142.3	134.7	145.3
S11	302.1	460.1	289.3	323.1
S333	129.7	137.2	456.1	457.0
S334FC	44.1	45.4	0.0	0.0
S334WS	-9.01	-9.01	-9.01	-9.01
S335	89.6	88.0	82.5	85.3
S343	33.7	25.4	27.3	27.4
S344	19.3	19.3	17.1	17.1
S345A	-9.01	-9.01	-9.01	-9.01
S345B	-9.01	-9.01	-9.01	-9.01

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S343C	-9.01	-9.01	-9.01	-9.01
S343D	-9.01	-9.01	132.6	132.9
S343E	-9.01	-9.01	-9.01	-9.01
S343G	-9.01	-9.01	112.9	113.3
S343F	-9.01	-9.01	130.7	131.4
S356	0.0	0.0	67.4	68.9
S12A	37.3	29.8	13.9	14.0
S12B	98.6	91.2	48.3	48.7
S12C	172.9	242.9	135.5	138.1
S11D	334.9	320.4	182.4	185.3
	693.7	685.2	375.5	381.1
ENP & Detention Areas				
L31FA	-9.01	-9.01	-9.01	-9.01
L31FB	-9.01	-9.01	-9.01	-9.01
S332B	59.4	65.6	65.7	63.1
S332BN	42.7	51.8	86.4	63.6
S332C	75.1	87.8	114.2	108.0
S332D	97.6	107.1	127.5	124.4
South Dade				
G211FC	110.2	110.8	64.0	57.2
G211WS	60.5	62.4	50.5	52.3
S336	3.9	3.7	4.6	4.3
S335	58.9	57.1	58.0	72.9
S357	2.7	3.3	59.5	58.9
S331FC	164.1	164.9	134.0	130.9
S331WS	61.4	61.6	49.8	51.4
S194	21.0	23.8	20.8	26.8
S196	9.0	13.7	8.8	13.6
S176	50.3	43.0	35.4	35.1
S177	124.3	99.2	80.3	79.6
S18C	182.8	143.8	157.8	155.6
S187	16.5	6.7	9.4	8.2
CERP Impoundments				
S304	-9.01	18.4	18.5	17.9
S309_P	-9.01	0.1	0.2	0.2
S310	-9.01	0.0	0.0	0.1
S525A_P	-9.01	5.4	5.3	5.3
S526A_C	-9.01	12.9	12.9	12.8
S199	-9.01	32.5	33.9	32.2
S200	-9.01	89.9	102.6	102.6

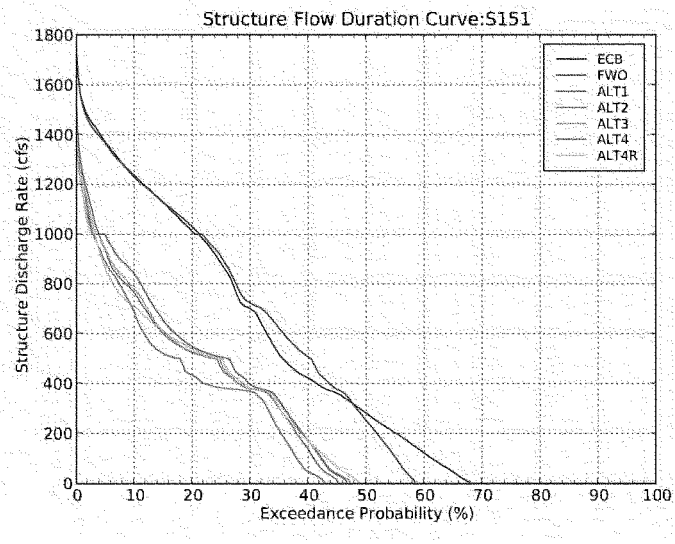

Figure 87A: Flow duration curve for WCA-3A outflow structure S-151

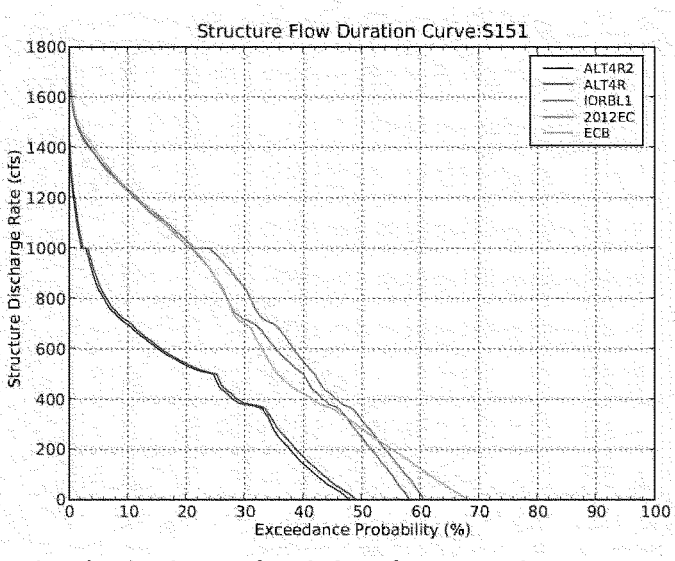

Figure 87B: Flow duration curve for WCA-3A outflow structure S-151

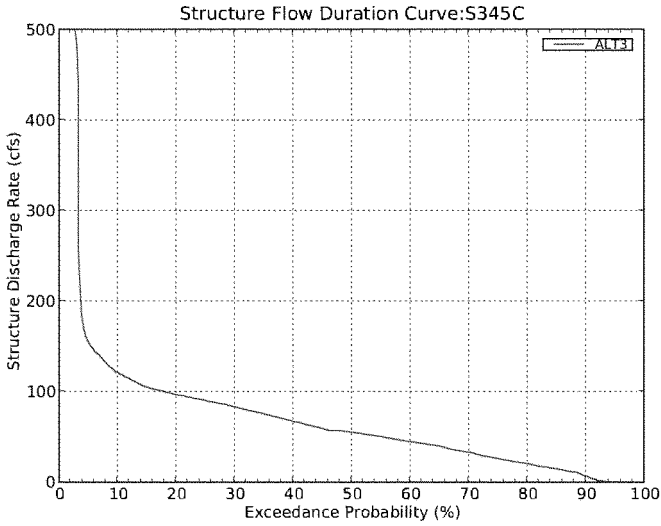

Figure 88A: Flow duration curve for WCA-3A outflow structure S-345C

Note: Structure S345C is not included in the simulations displayed in the part B graphics.

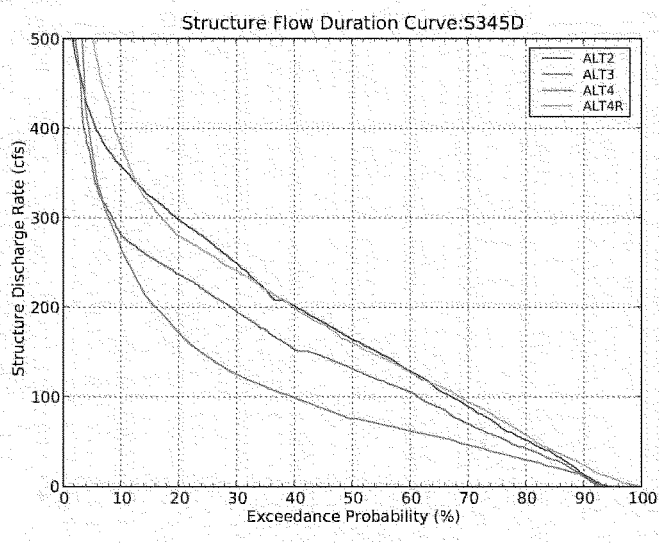

Figure 89A: Flow duration curve for WCA-3A outflow structure S-345D

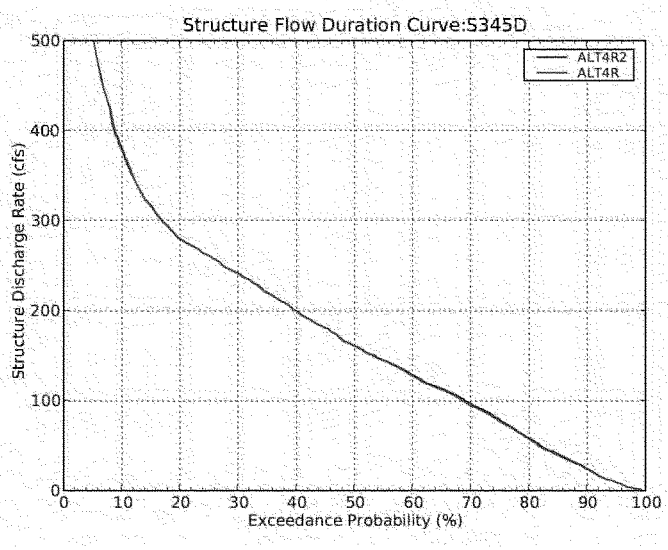

Figure 89B: Flow duration curve for WCA-3A outflow structure S-345D

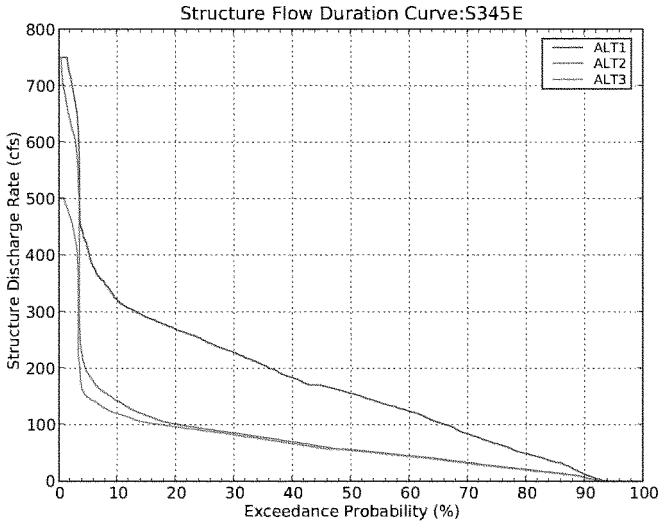

Figure 90A: Flow duration curve for WCA-3A outflow structure S-345E

Note: Structure S345E is not included in the simulations displayed in the part B graphics.

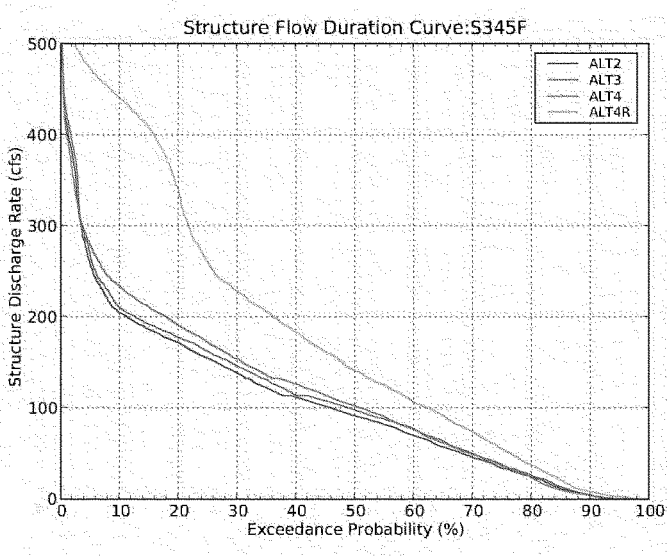

Figure 91A: Flow duration curve for WCA-3A outflow structure S-345F

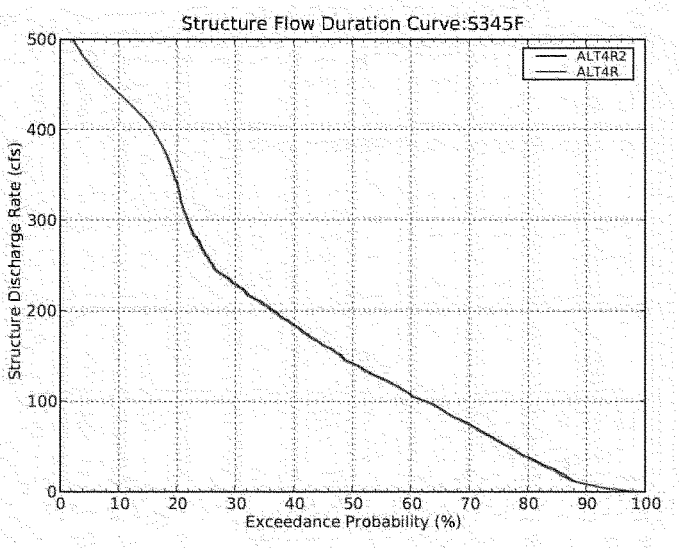

Figure 91B: Flow duration curve for WCA-3A outflow structure S-345F

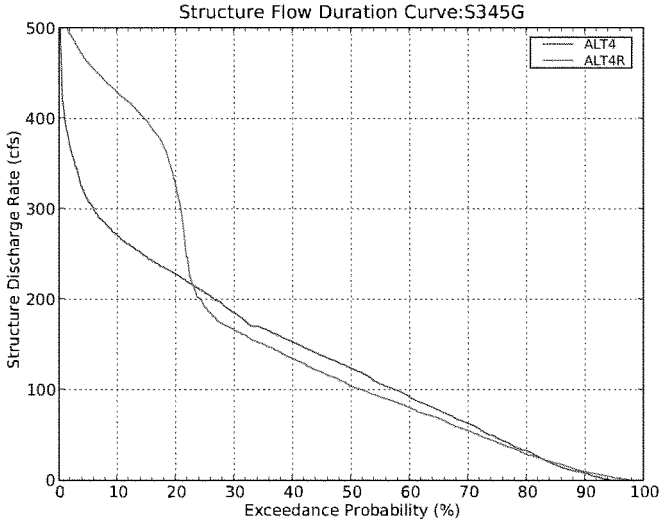

Figure 92A: Flow duration curve for WCA-3A outflow structure S-345G

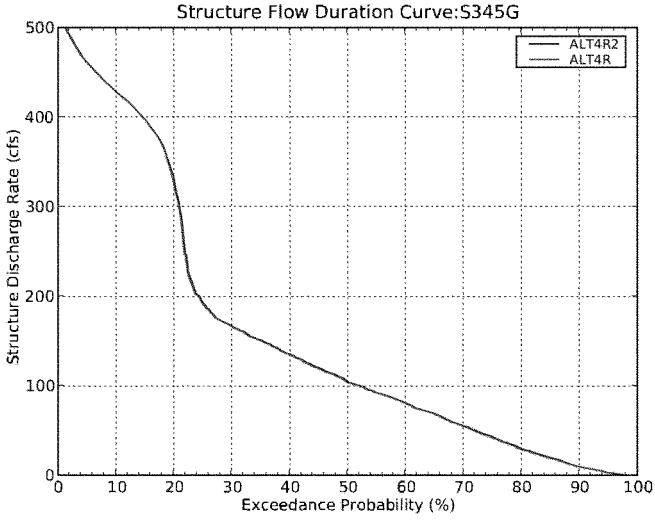

Figure 92B: Flow duration curve for WCA-3A outflow structure S-345G

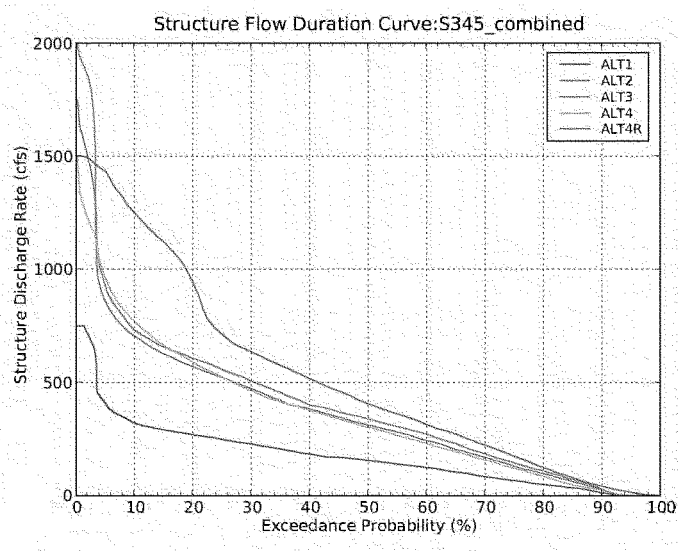

Figure 93A: Combined flow duration curve for WCA-3A outflow structures: S-345C, S-345D, S-345E, S-345F, and S-345G (CEPP proposed new WCA-3B inflow structures)

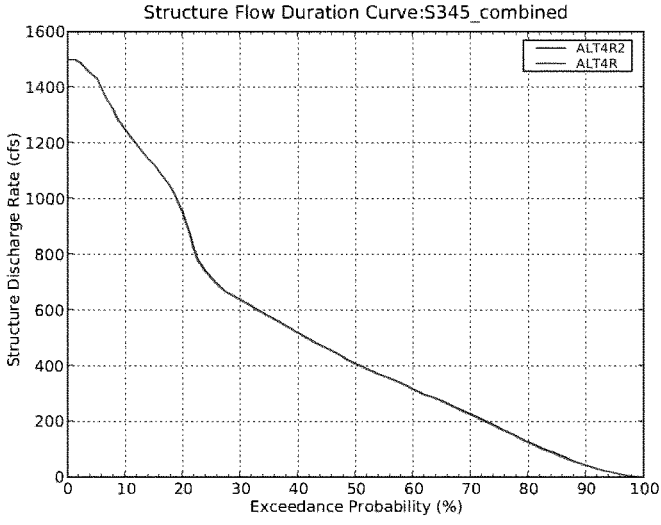

Figure 93B: Combined flow duration curve for WCA-3A outflow structures: S-345C, S-345D, S-345E, S-345F, and S-345G (CEPP proposed new WCA-3B inflow structures)

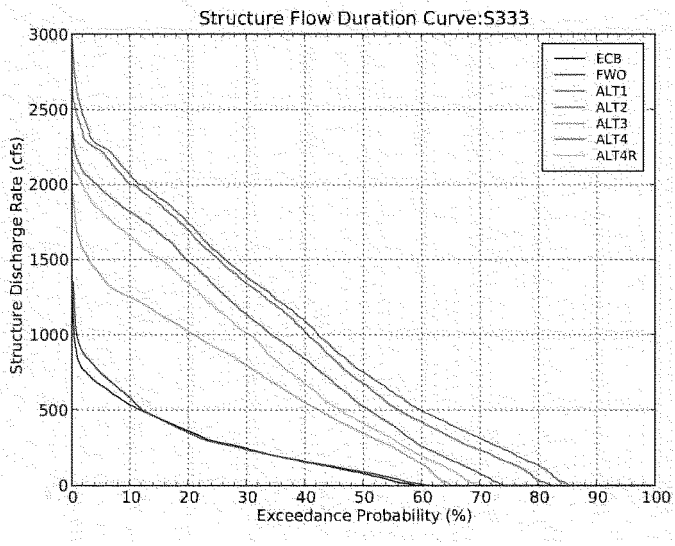

Figure 94A: Flow duration curve for WCA-3A outflow structure S-333

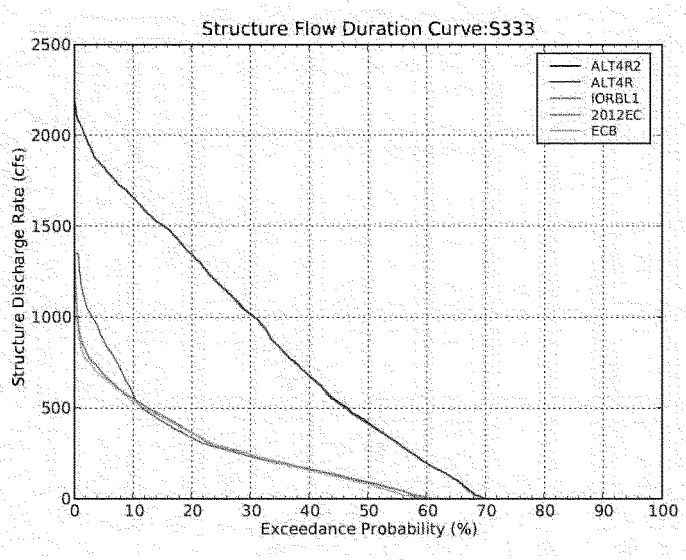

Figure 94B: Flow duration curve for WCA-3A outflow structure S-333

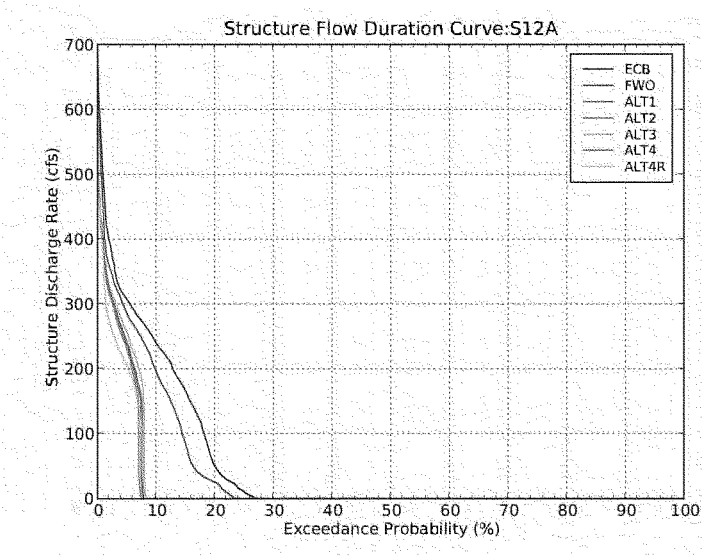

Figure 95A: Flow duration curve for WCA-3A outflow structure S-12A

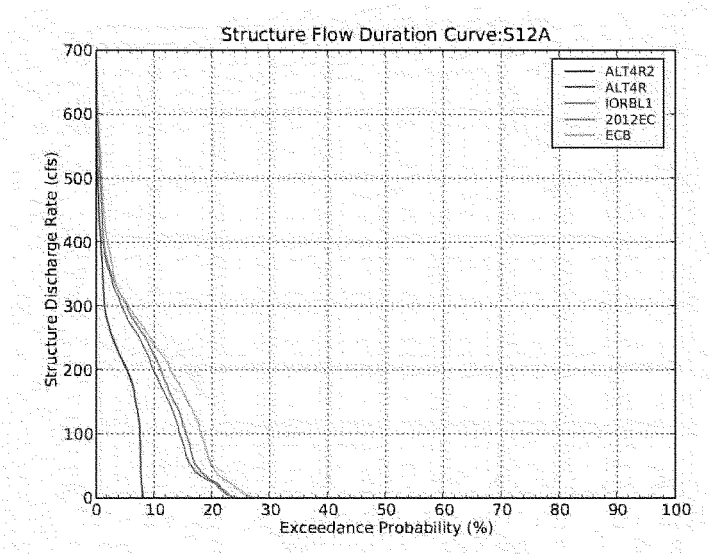

Figure 95B: Flow duration curve for WCA-3A outflow structure S-12A

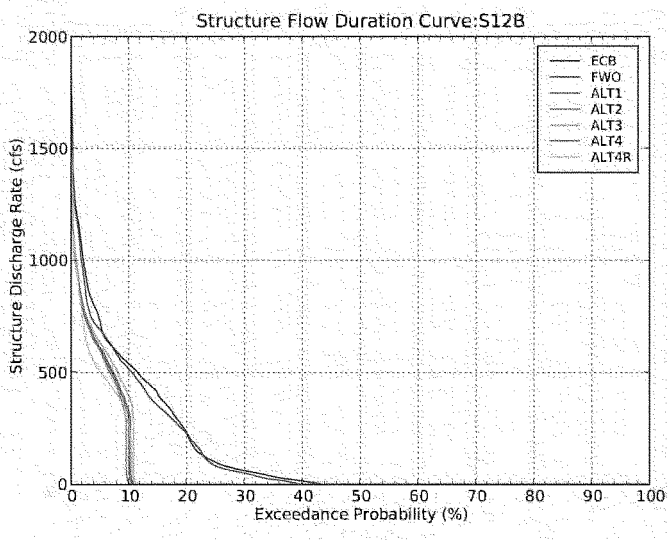

Figure 96A: Flow duration curve for WCA-3A outflow structure S-12B

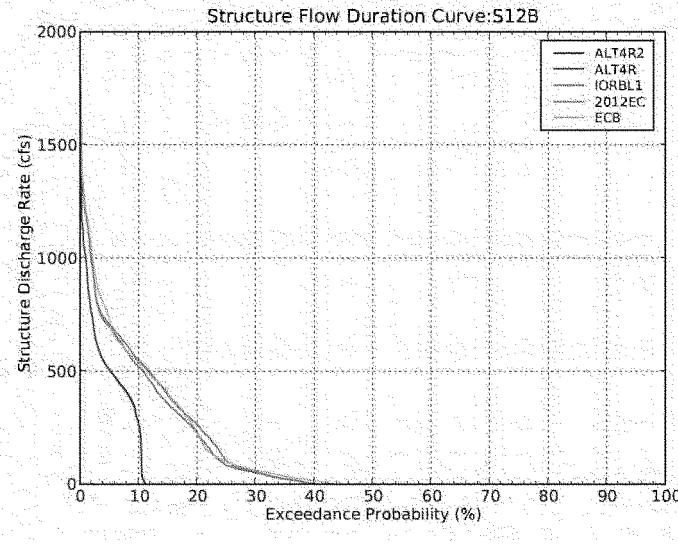

Figure 96B: Flow duration curve for WCA-3A outflow structure S-12B

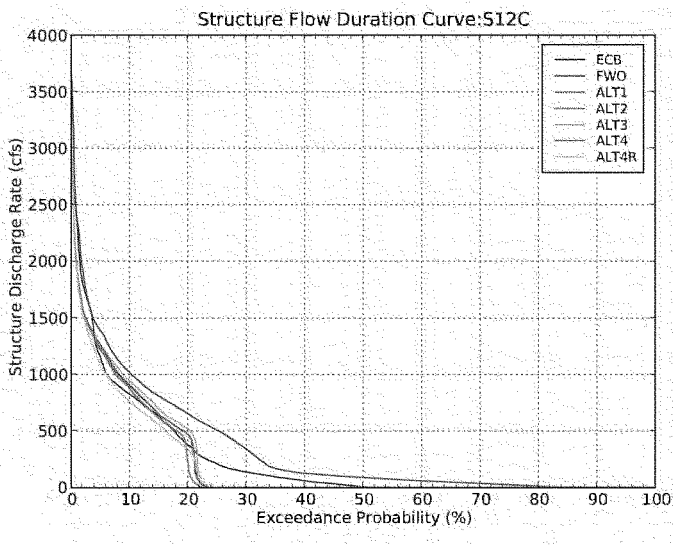

Figure 97A: Flow duration curve for WCA-3A outflow structure S-12C

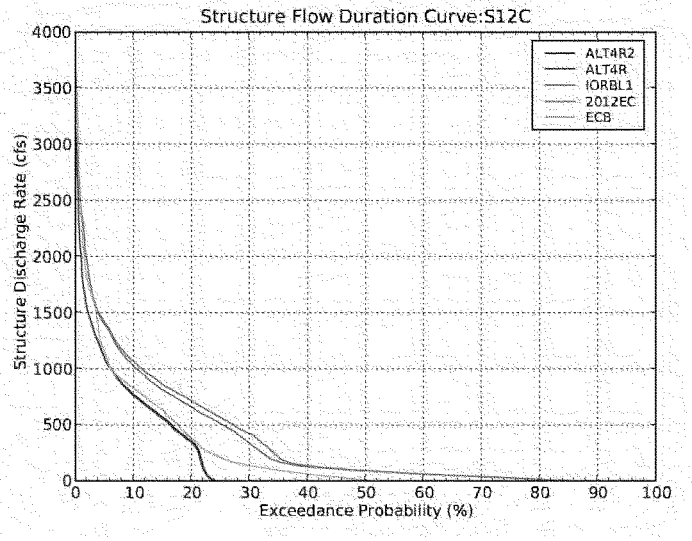

Figure 97B: Flow duration curve for WCA-3A outflow structure S-12C

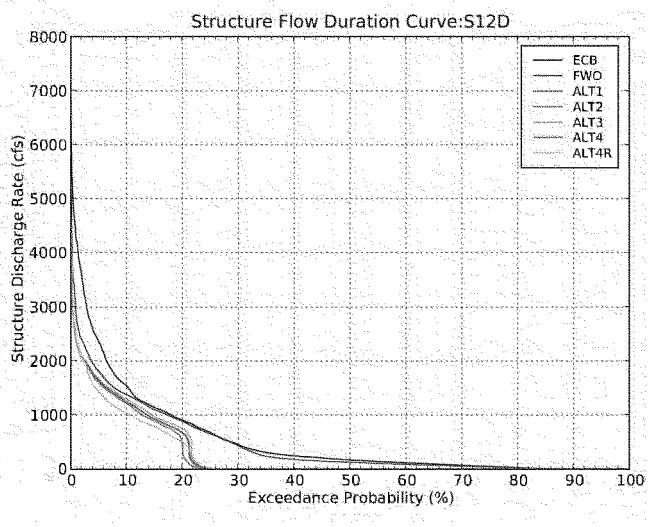

Figure 98A: Flow durotion curve for WCA-3A outflow structure S-12D

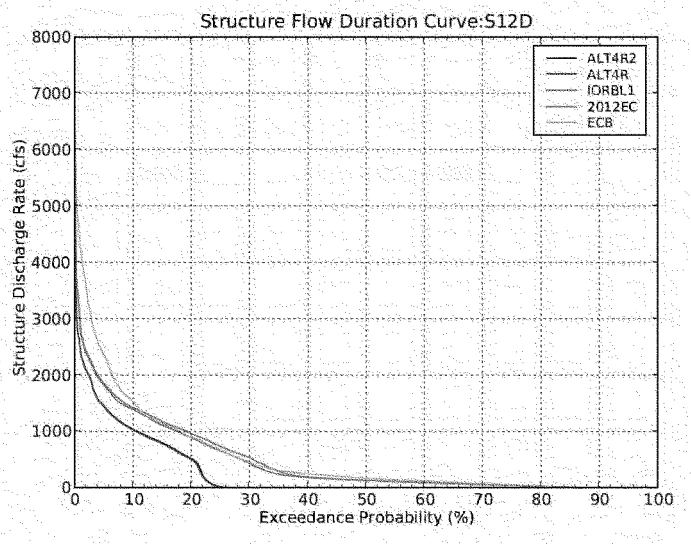

Figure 98B: Flow duration curve for WCA-3A outflow structure S-12D

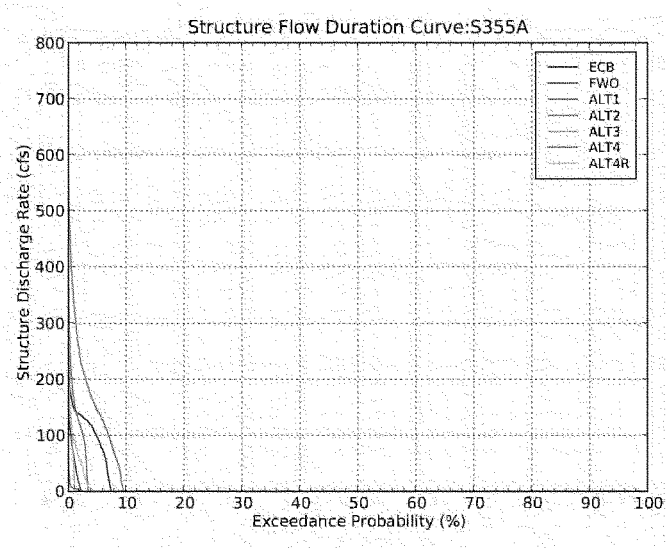

Figure 99A: Flow duration curve for WCA-3B outflow structure S-355A

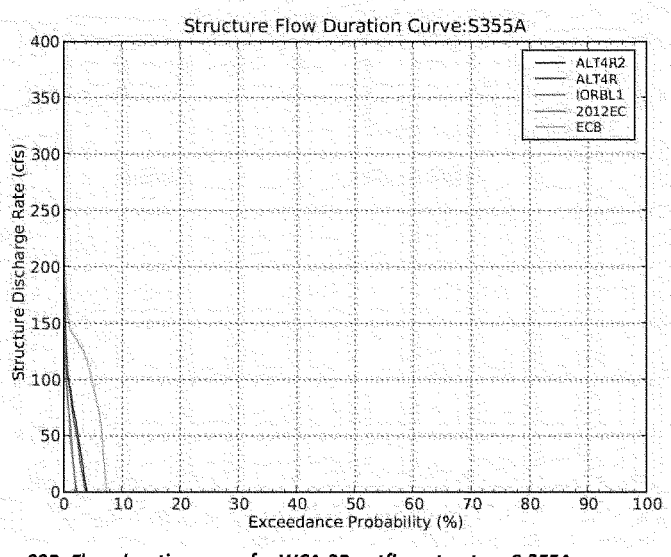

Figure 99B: Flow duration curve for WCA-3B outflow structure S-355A

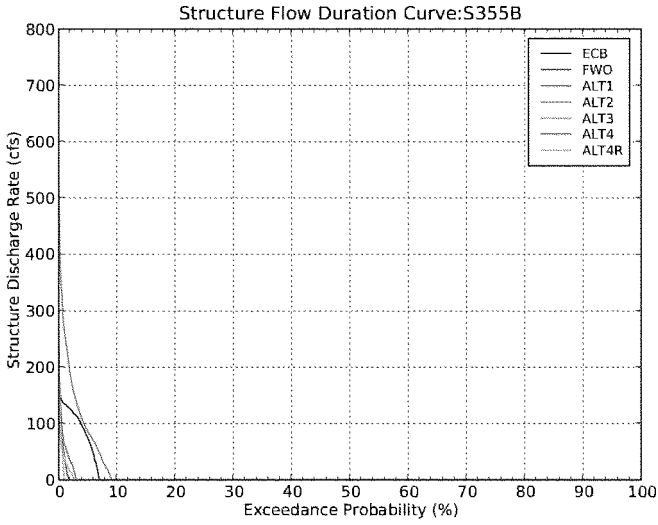

Figure 100A: Flow duration curve for WCA-3B outflow structure S-355B

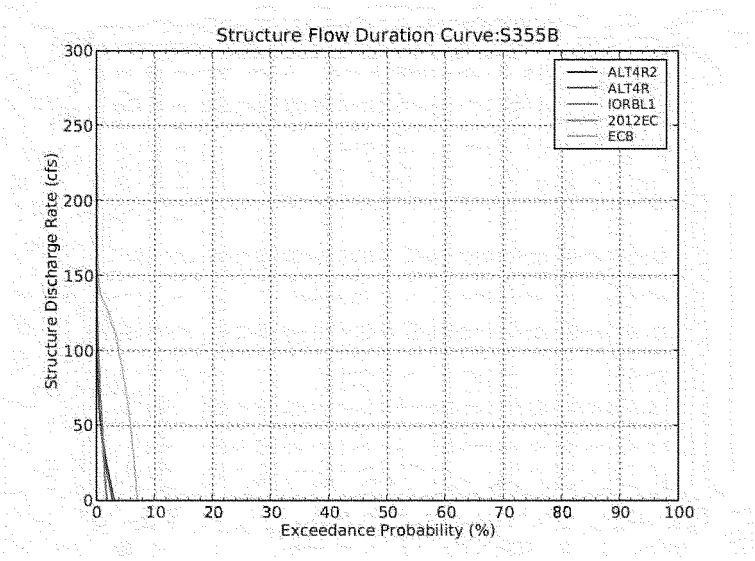

Figure 100B: Flow duration curve for WCA-3B outflow structure S-355B

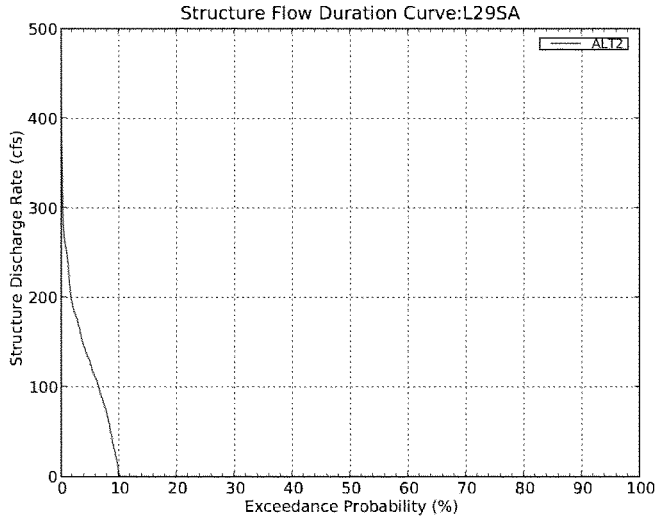

Figure 101A: Flow duration curve for WCA-3B outflow structure L-29SA

Note: Structure L-29SA is not included in the simulations displayed in the part B graphics.

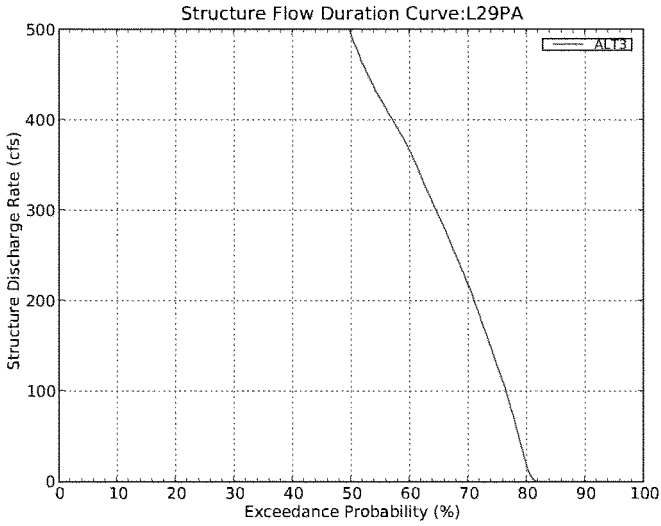

Figure 102A: Flow duration curve for WCA-3B outflow structure L-29PA

Note: Structure L-29PA is not included in the simulations displayed in the part B graphics.

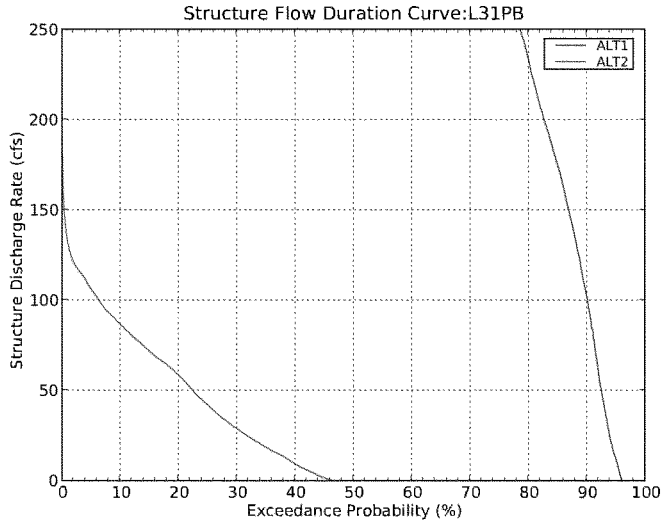

Figure 103A: Flow duration curve for WCA-3B outflow structure L-29PB

Note: Structure L-29PB is not included in the simulations displayed in the part B graphics.

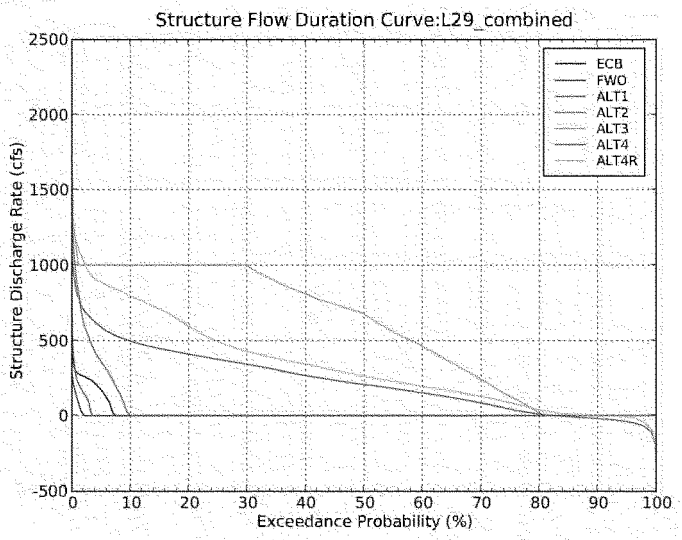

Figure 104A: Combined flow duration curve for WCA-3B outlet structures to L-29 Canal

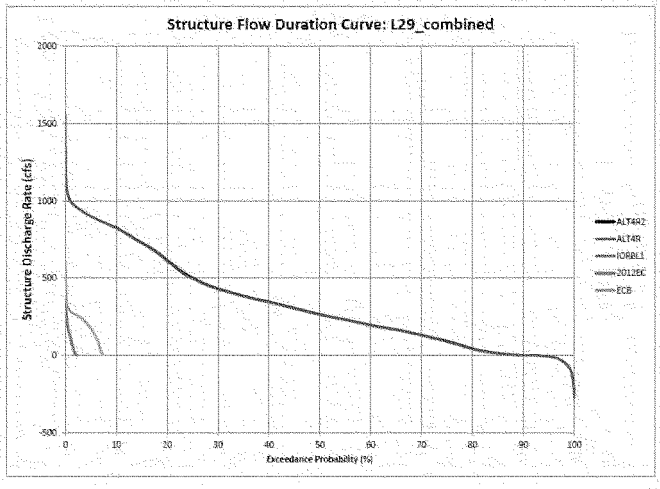

Figure 104B: Combined flow duration curve for WCA-3B outlet structures to L-29 Canal

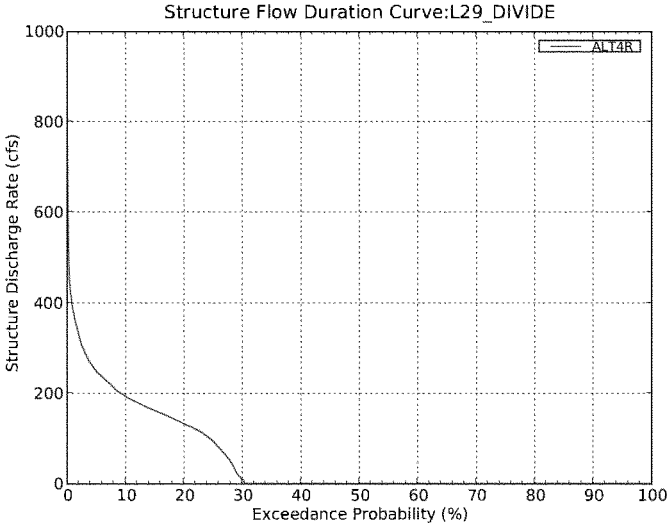

Figure 105A: Flow duration curve for L-29 Canal divide structure

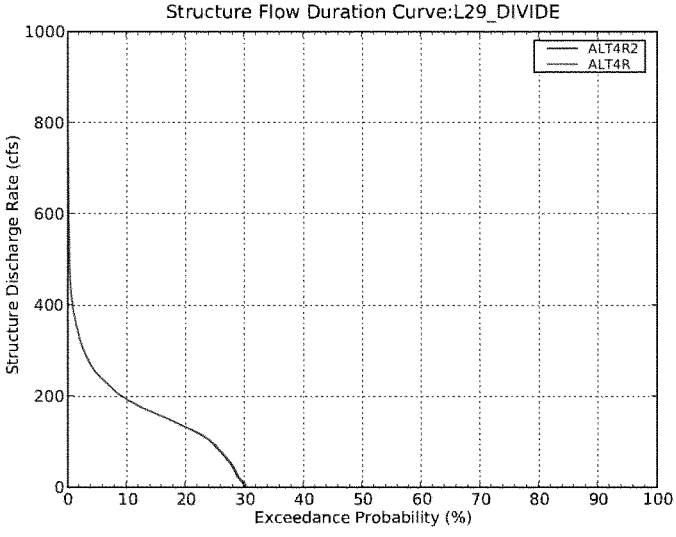

Figure 105B: Flow duration curve for L-29 Canal divide structure

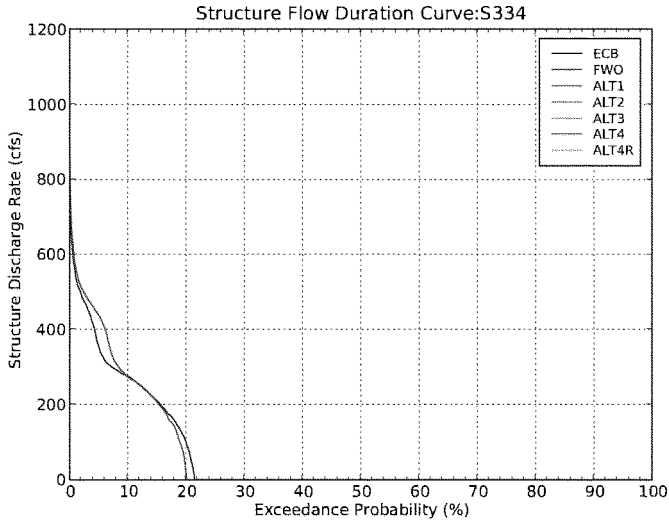

Figure 106A: Flow duration curve for L-29 Canal outlet structure S-334 to SDCS

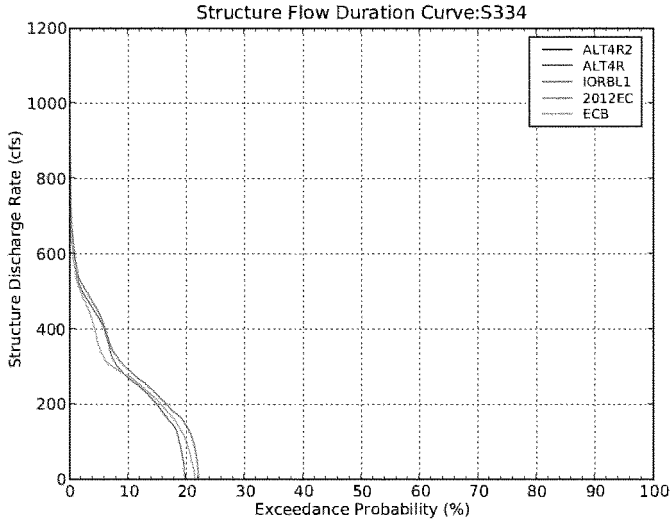

Figure 106B: Flow duration curve for L-29 Canal outlet structure S-334 to SDCS

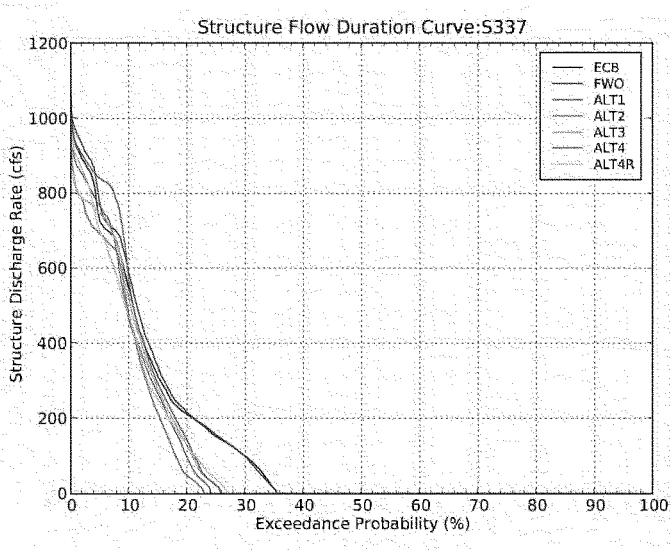

Figure 107A: Flow duration curve for WCA-3B outlet structure S-337 to SDCS

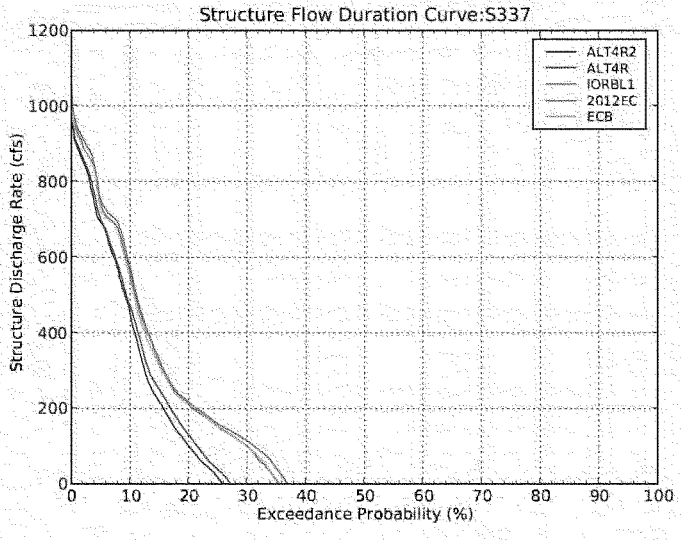

Figure 107B: Flow duration curve for WCA-3B outlet structure S-337 to SDCS

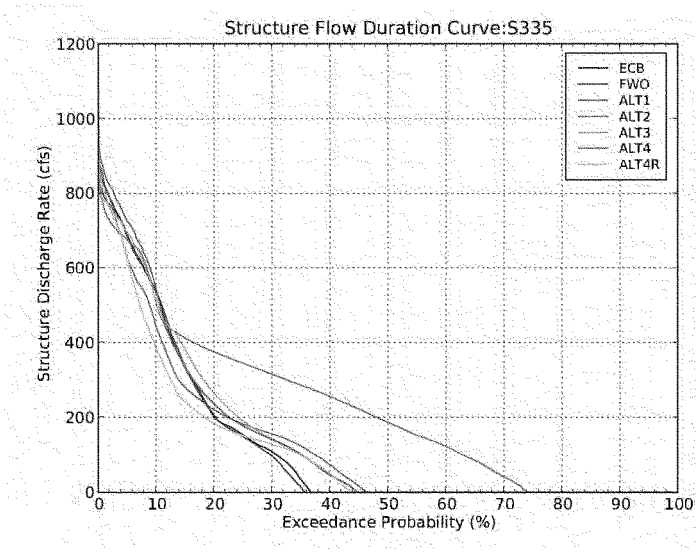

Figure 108A: Flow duration curve for SDCS L-30 Canal outlet structure S-335

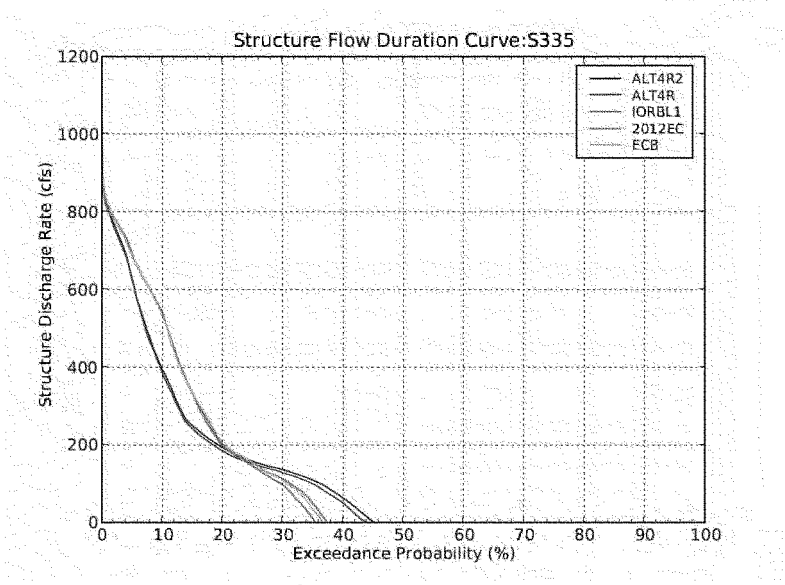

Figure 108B: Flow duration curve for SDCS L-30 Canal outlet structure S-335

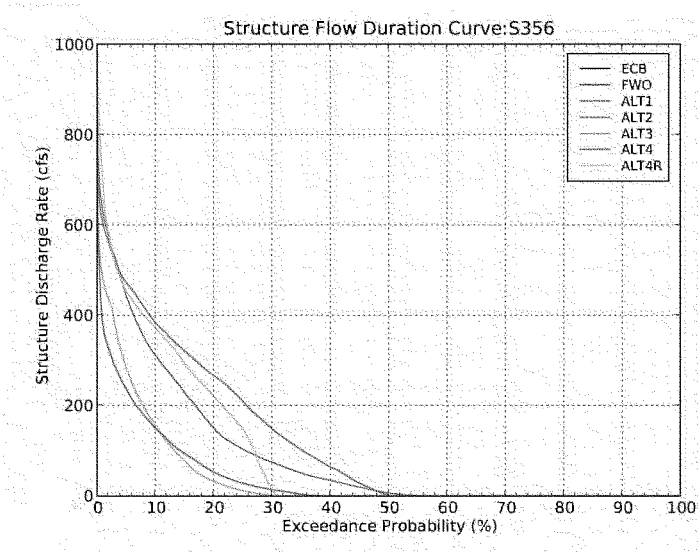

Figure 109A: Flow duration curve for S-356 NESRS seepage return pump station

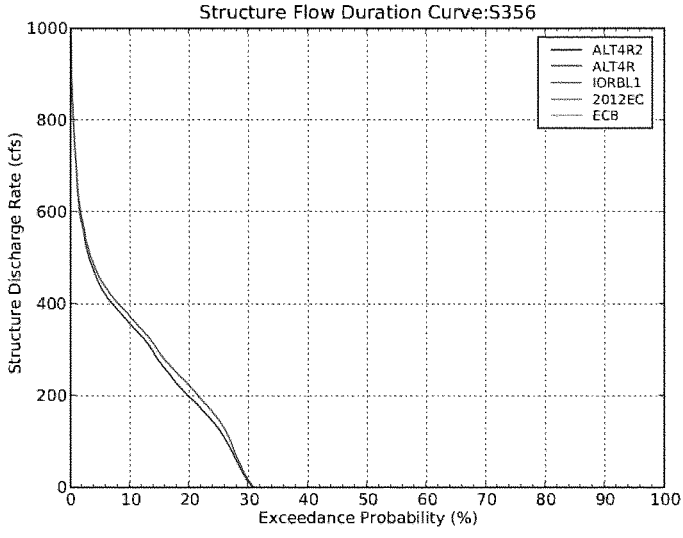

Figure 109B: Flow duration curve for S-356 NESRS seepage return pump station

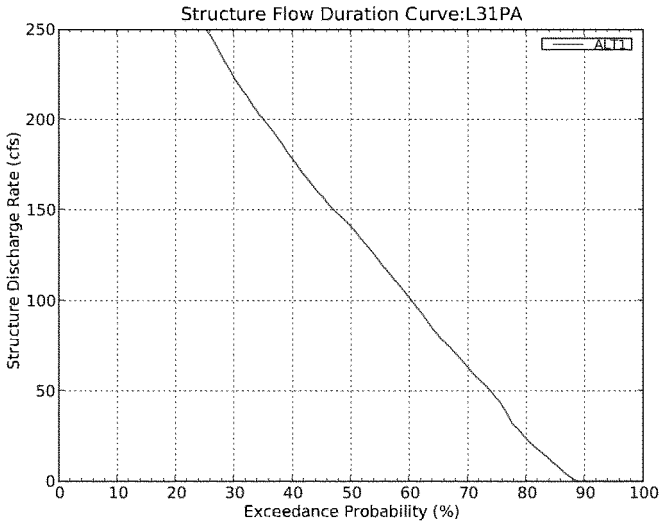

Figure 110A: Flow duration curve for L-31N northern NESRS seepage return pump station L31PA

Note: Structure L-31PA is not included in the simulations displayed in the part B graphics.

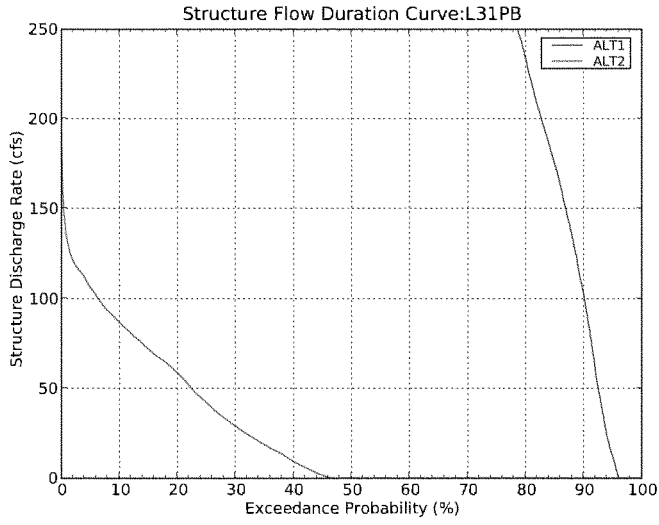

Figure 111A: Flow duration curve for L-31N northern NESRS seepage return pump station L31PB

Note: Structure L-31PB is not included in the simulations displayed in the part B graphics.

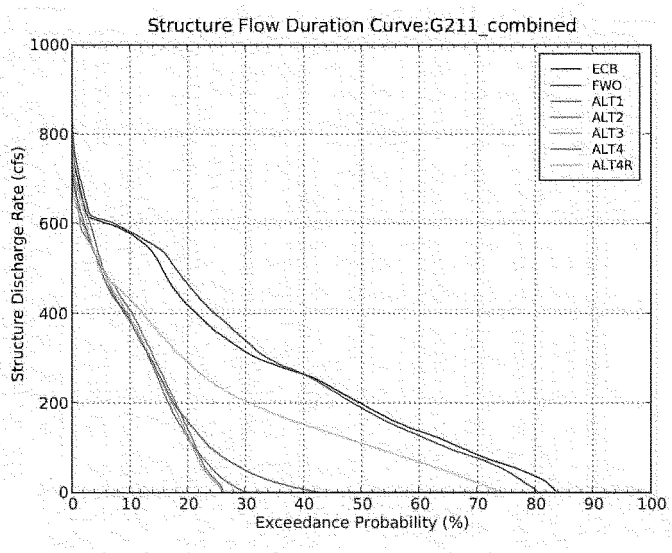

Figure 112A: Flow duration curve for SDCS L-31N Canal outlet structure G-211

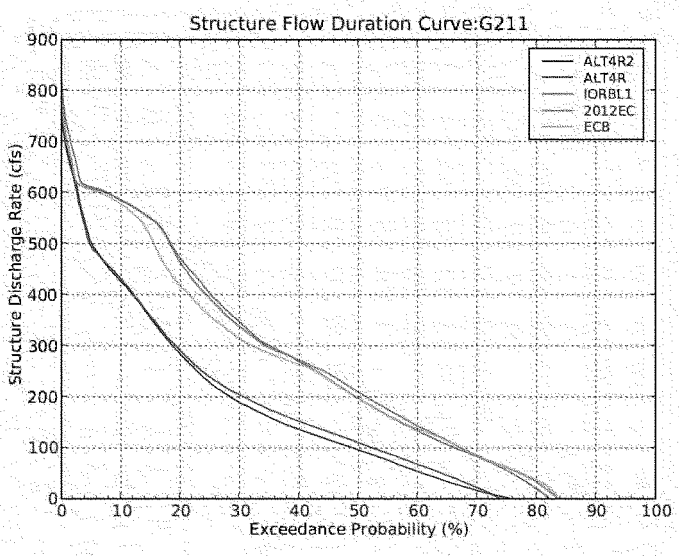

Figure 112B: Flow duration curve for SDCS L-31N Canal outlet structure G-211

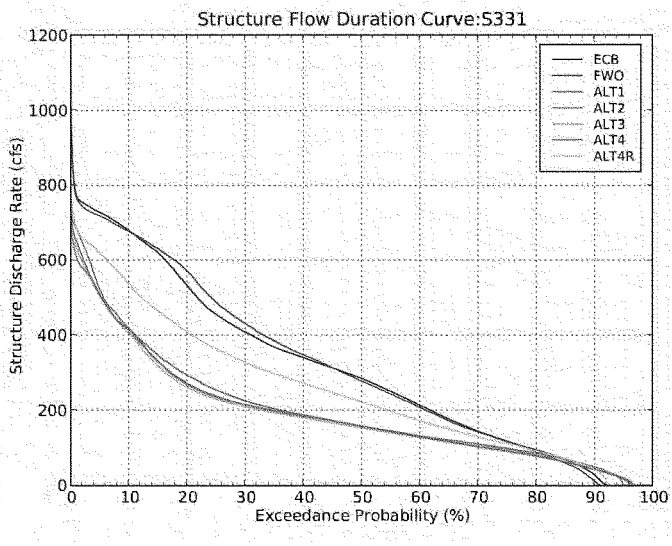

Figure 113A: Flow duration curve for SDCS L-31N Canal outlet structure S-331

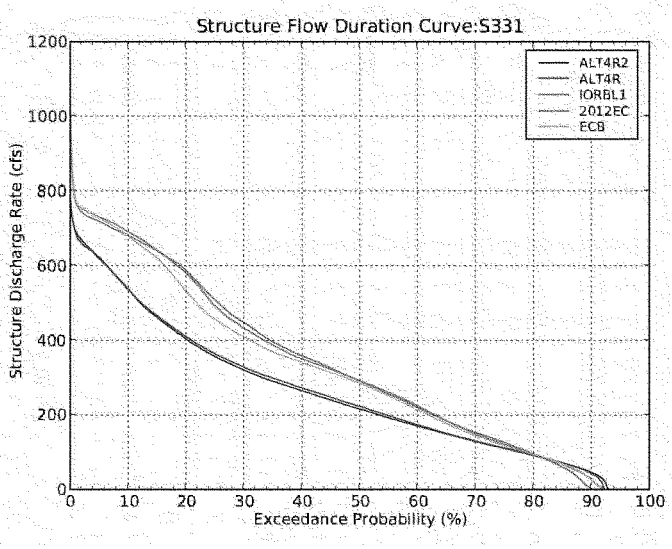

Figure 113B: Flow duration curve for SDCS L-31N Canal outlet structure S-331

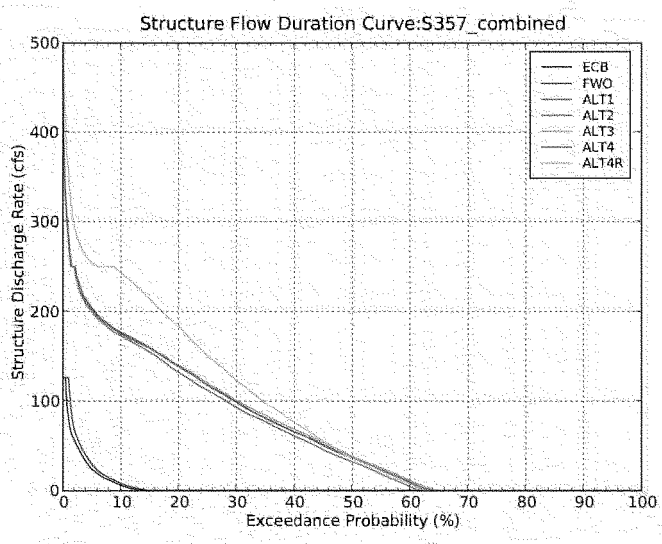

Figure 114A: Combined flow duration curve for 8.5 SMA seepage collection canal outlet structure S-357

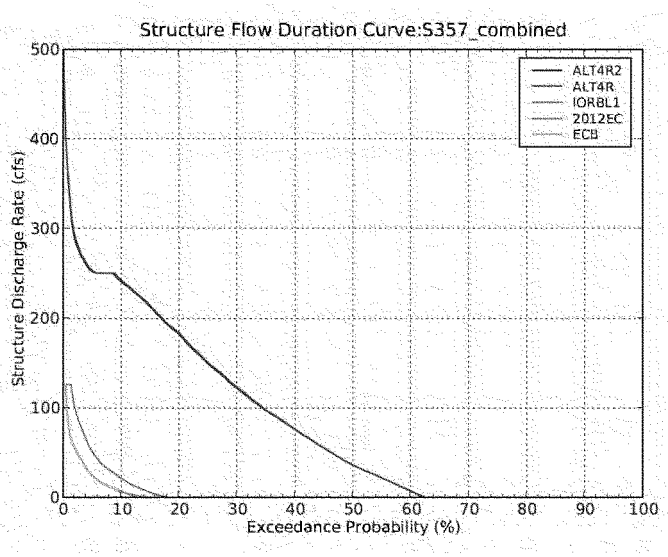

Figure 114B: Combined flow duration curve for 8.5 SMA seepage collection canal outlet structure S-357

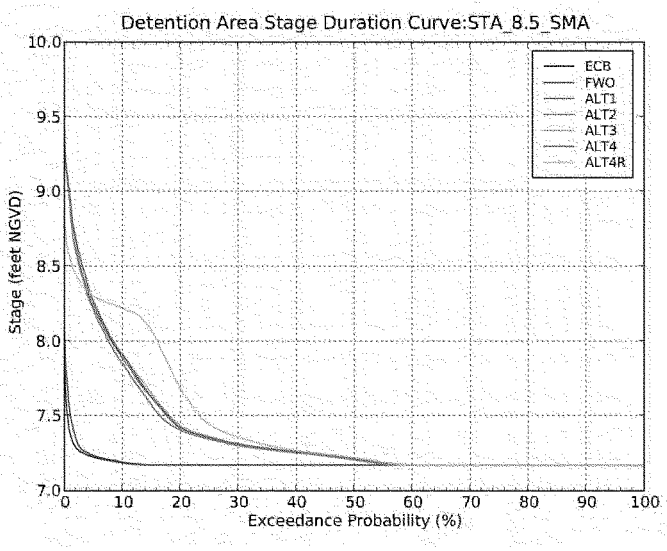

Figure 115A: Stage duration curve for 8.5 SMA detention cell

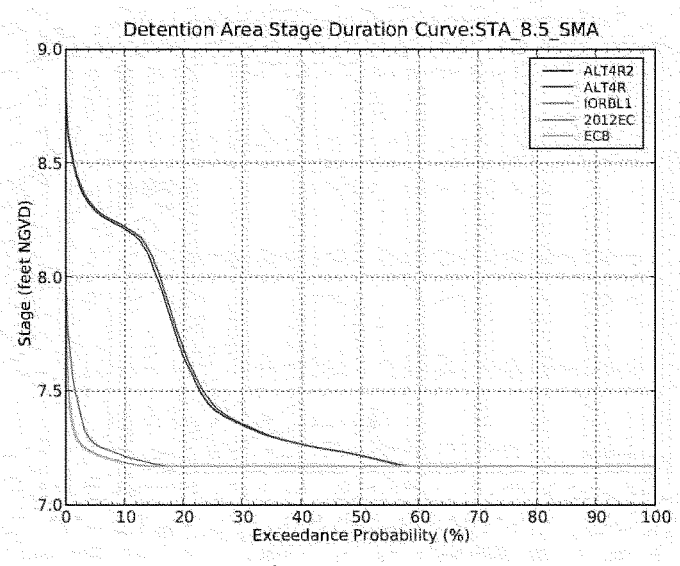

Figure 115B: Stage duration curve for 8.5 SMA detention cell

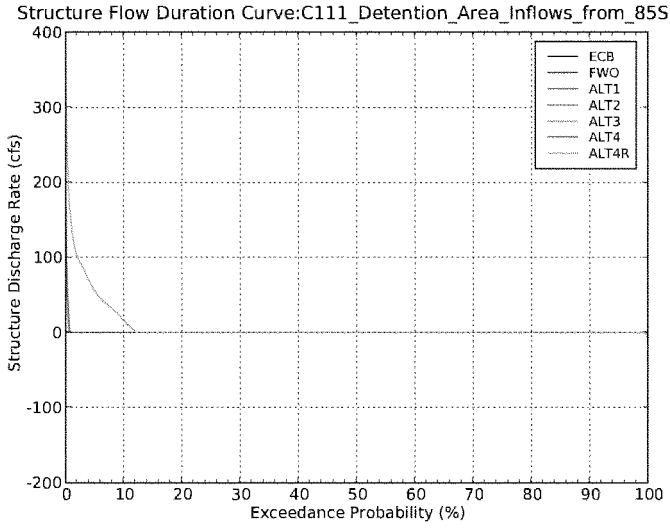

Figure 116A: Combined flow duration curve for 8.5 SMA detention cell outlet structures S-360W and S-360E

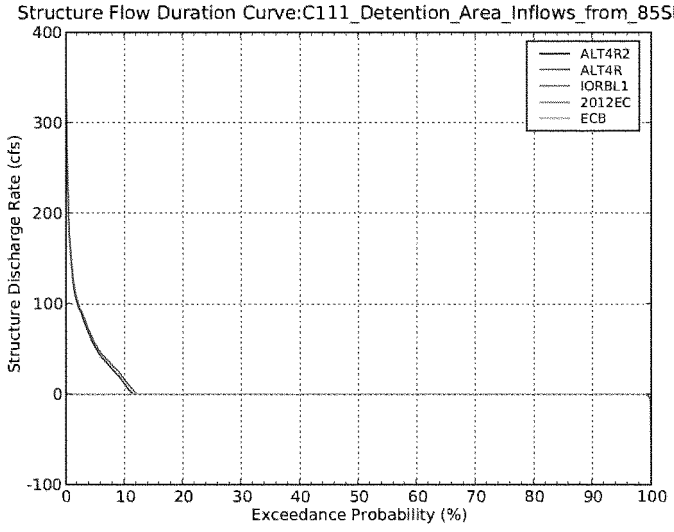

Figure 116B: Combined flow duration curve for 8.5 SMA detention cell outlet structures S-360W and S-360E

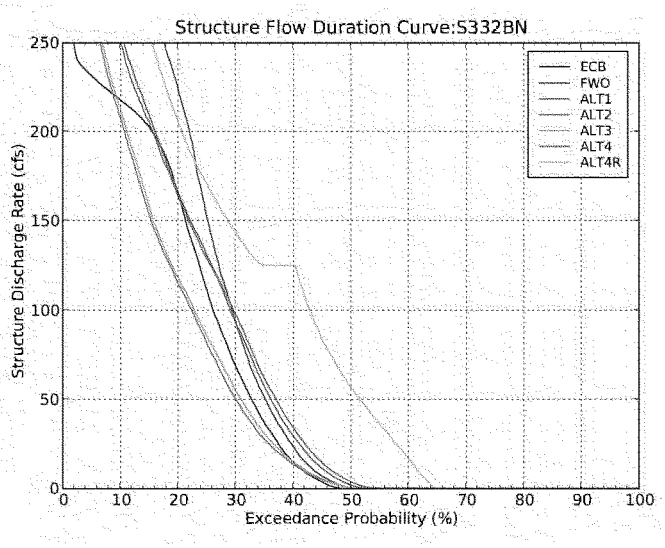

Figure 117A: Flow duration curve for SDCS L-31N Canal outlet structure S-332B to C-111 NDA

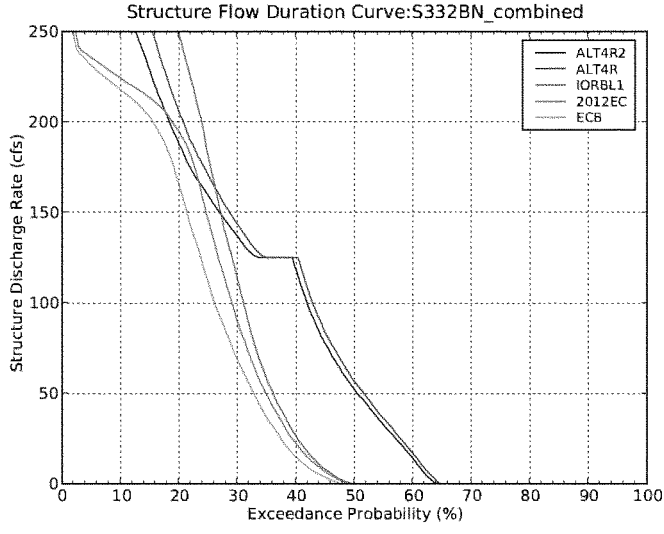

Figure 117B: Flow duration curve for SDCS L-31N Canal outlet structure S-332B to C-111 NDA

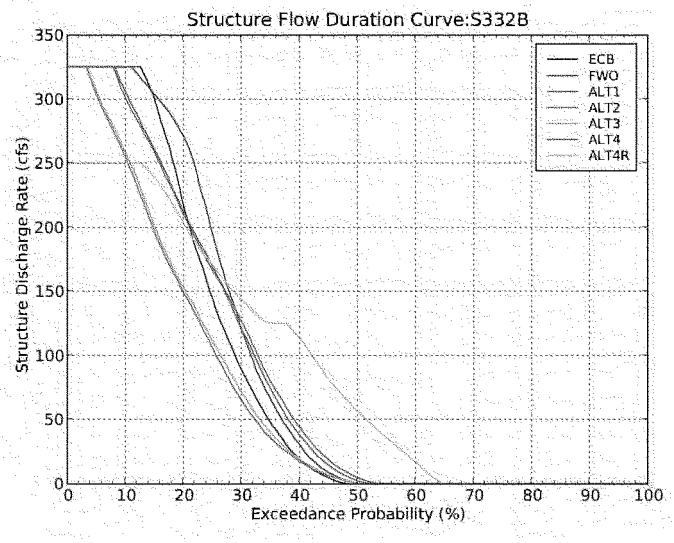

Figure 118A: Flow duration curve for SDCS L-31N Canal outlet structure S-332B to C-111 SDA

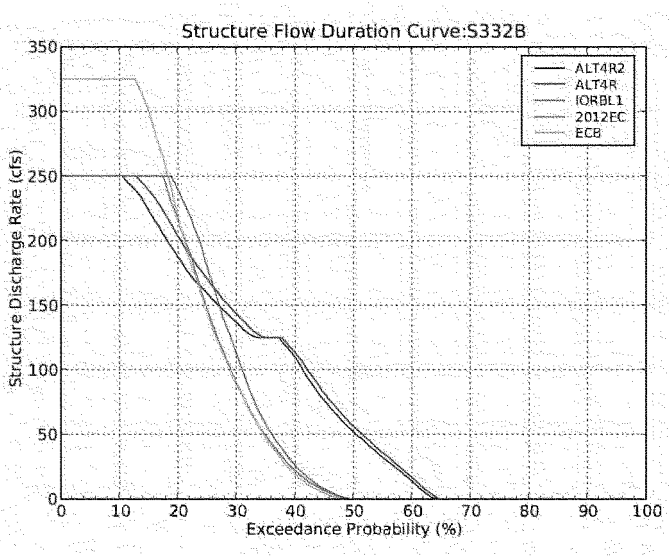

Figure 118B: Flow duration curve for SDCS L-31N Conol outlet structure S-332B to C-111 SDA

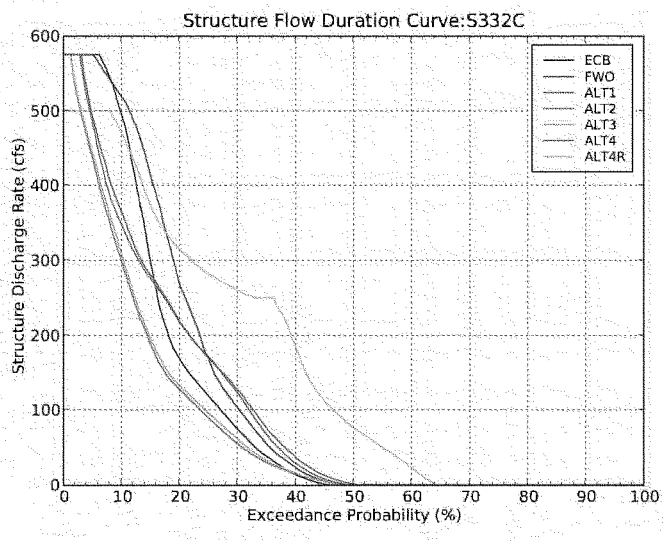

Figure 119A: Flow duration curve for SDCS L-31N Canal outlet structure S-332C to C-111 SDA

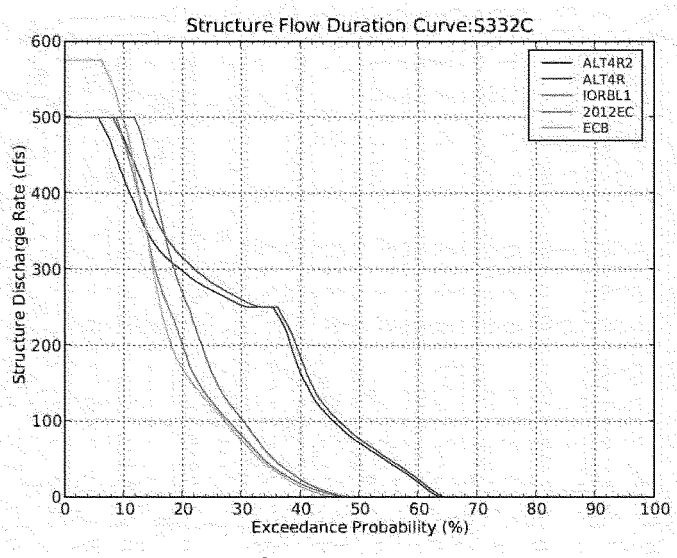

Figure 119B: Flow duration curve for SDCS L-31N Canal outlet structure S-332C to C-111 SDA

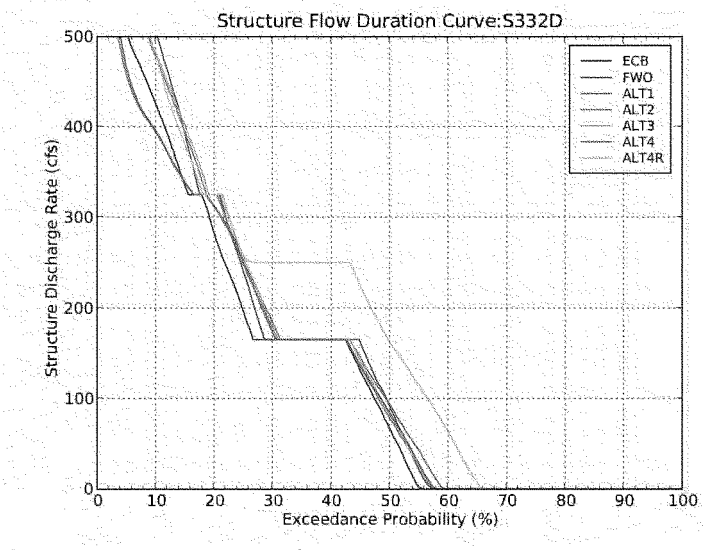

Figure 120A: Flow duration curve for SDCS L-31N Canal outlet structure S-332D to Taylar Slough

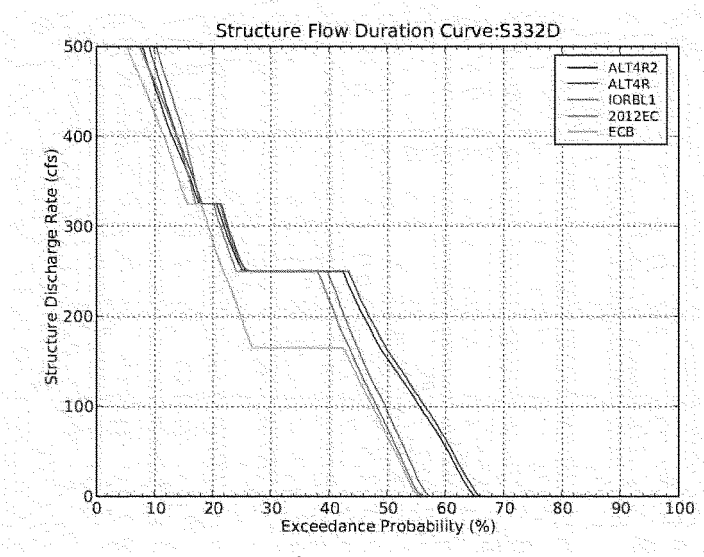

Figure 120B: Flow duration curve for SDCS L-31N Canal outlet structure S-332D to Taylor Slough

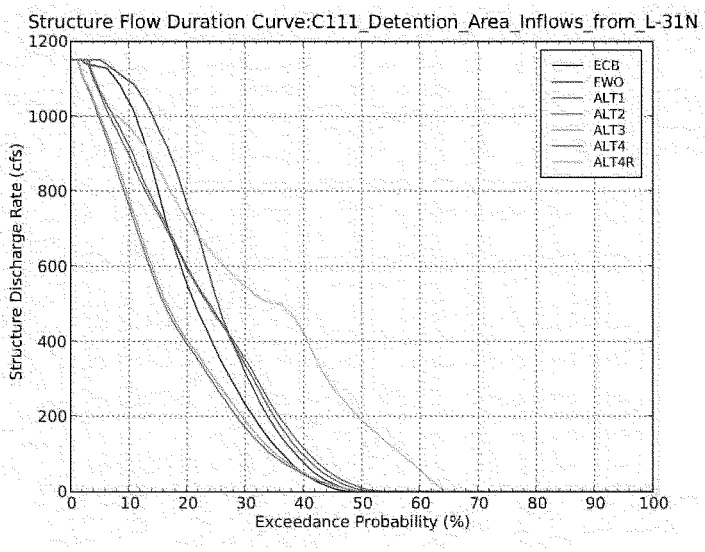

Figure 121A: Combined flow duration curve for SDCS L-31N Canal outlet structures S-332B and S-332C

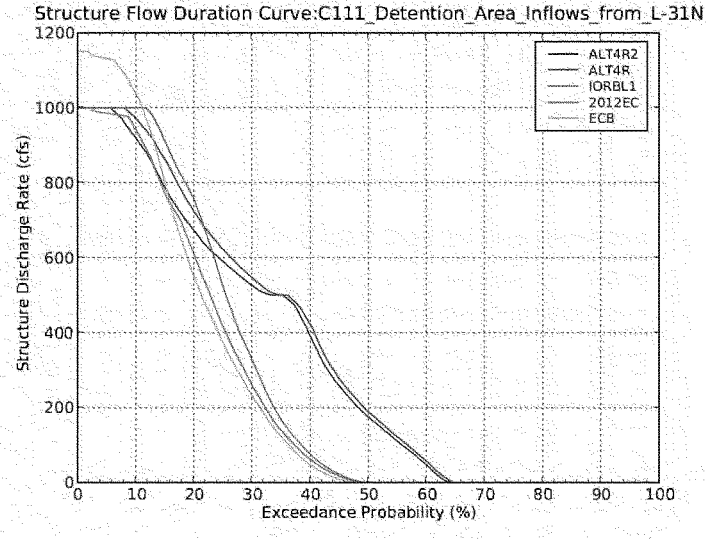

Figure 121B: Combined flow duration curve for SDCS L-31N Canal outlet structures S-332B and S-332C

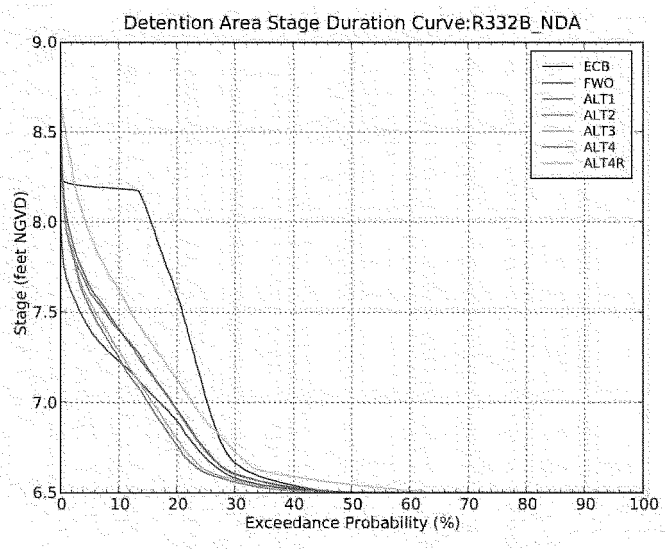

Figure 122A: Stage duration curve for C-111 North Detention Area

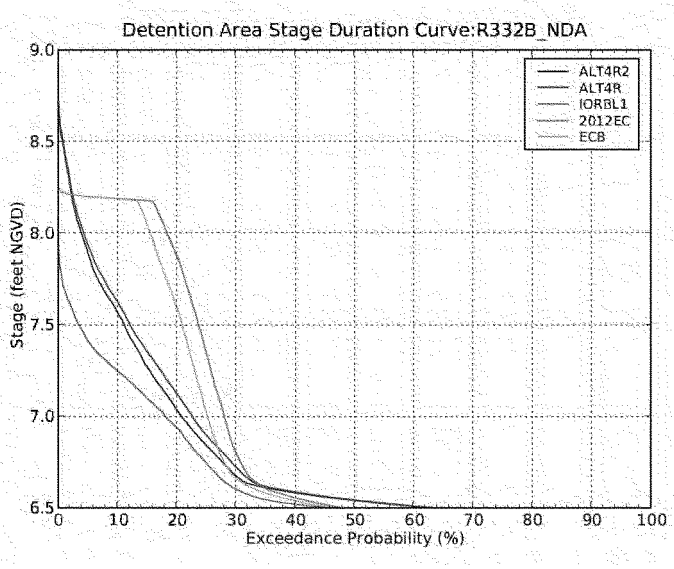

Figure 122B: Stage duration curve for C-111 North Detention Area

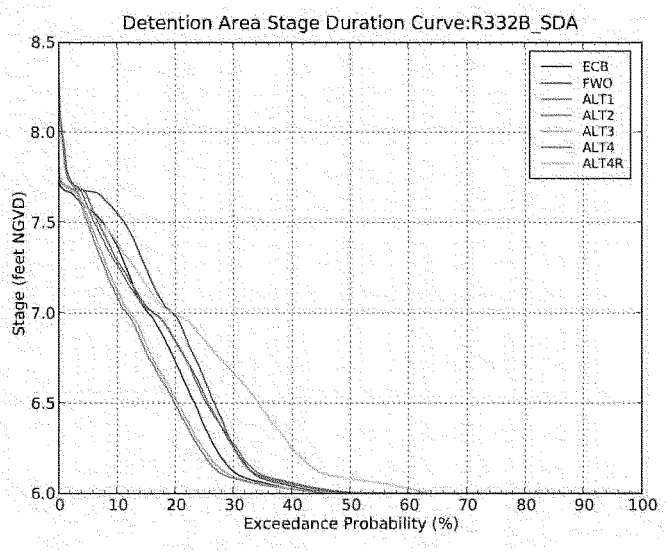

Figure 123A: Stage duration curve for C-111 South Detention Area

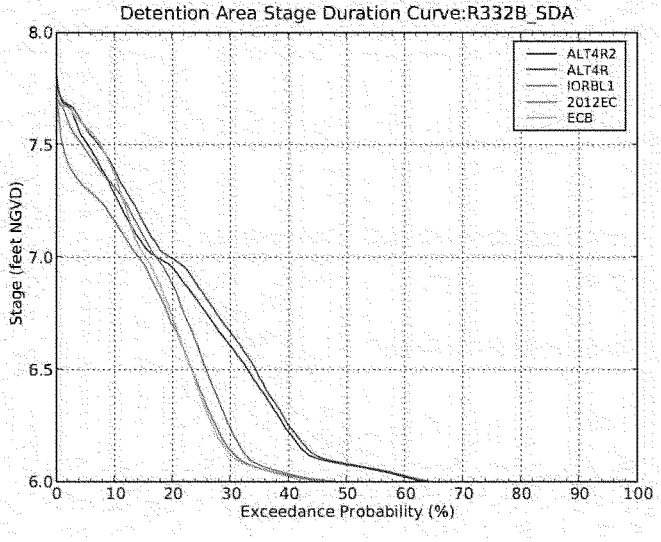

Figure 123B: Stage duration curve for C-111 South Detention Area

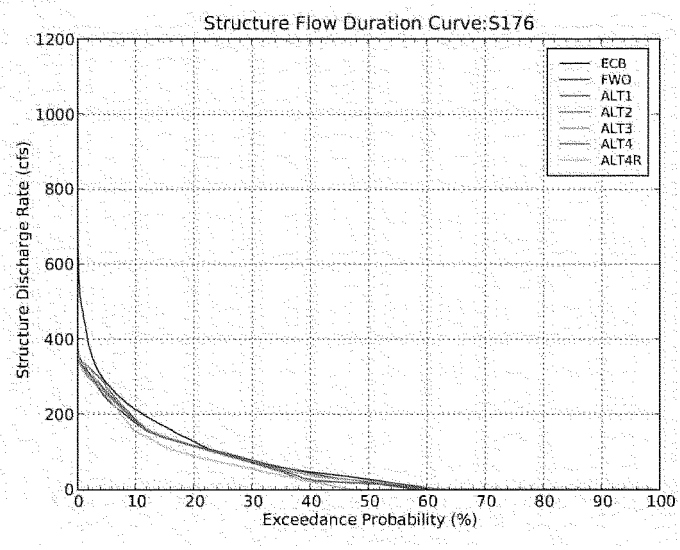

Figure 124A: Flow duration curve for SDCS L-31N Canal outlet structure S-176

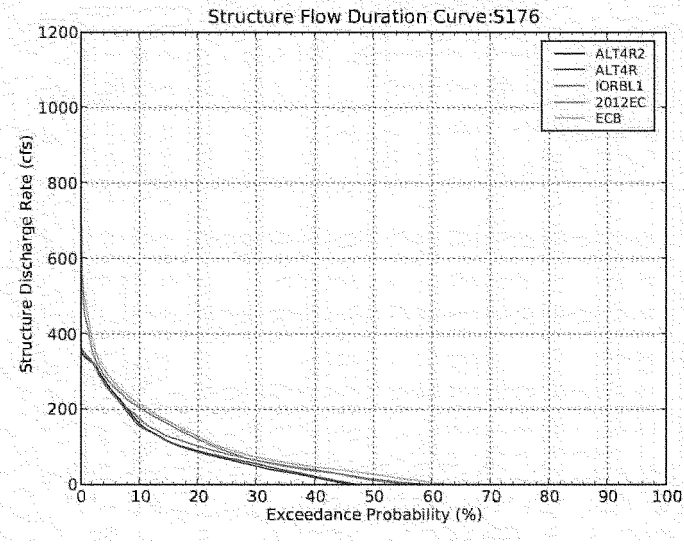

Figure 124B: Flow duration curve far SDCS L-31N Canal outlet structure S-176

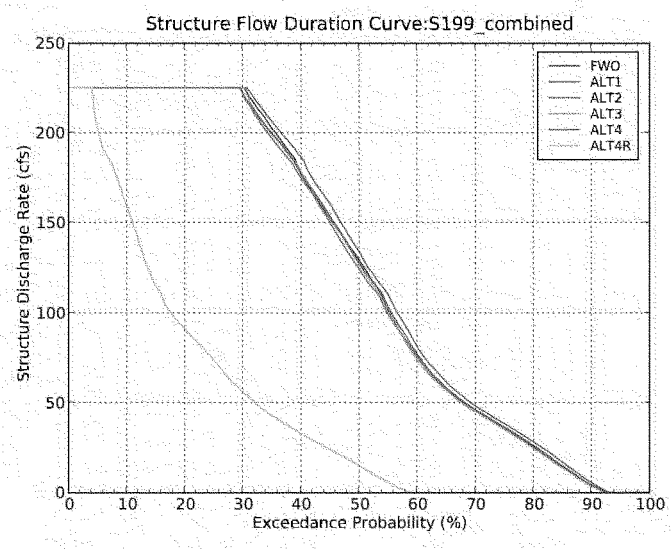

Figure 125A: Combined flow duration curve for CERP C-111 Spreader Canal Western PIR pump station S-199

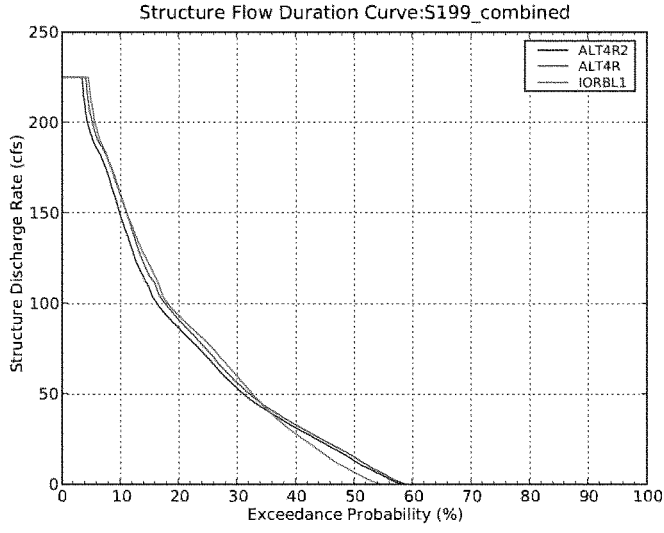

Figure 125B: Combined flow duration curve for CERP C-111 Spreader Canal Western PIR pump station S-199

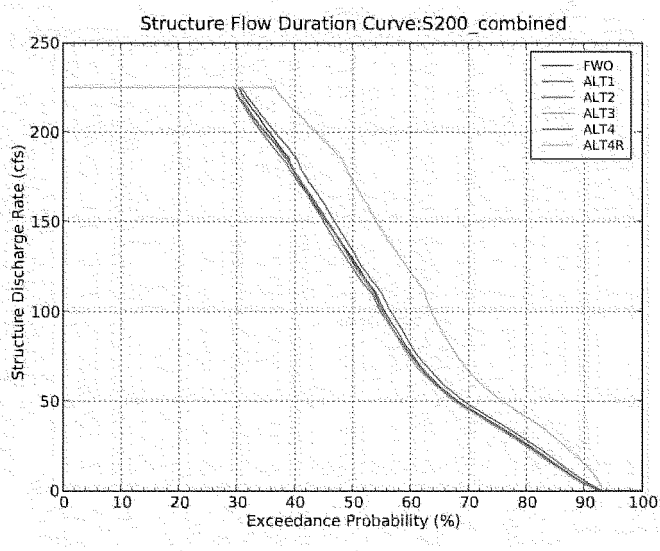

Figure 126A: Combined flow duration curve for CERP C-111 Spreader Canal Western PIR pump station S-200

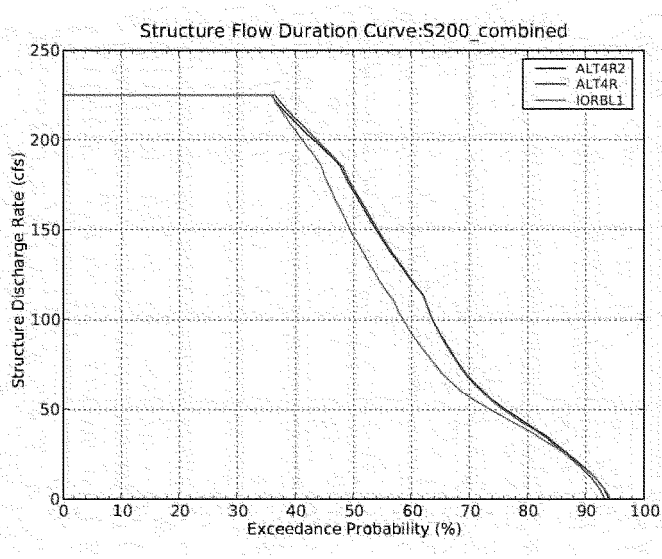

Figure 126B: Combined flow duration curve for CERP C-111 Spreader Canal Western PIR pump station S-200

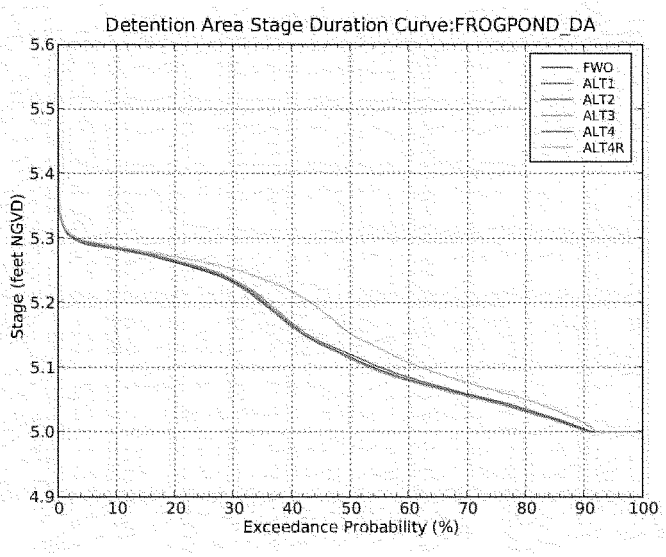

Figure 127A: Stage duration curve for CERP Spreader Canal Western PIR Frog Pond Detention Area

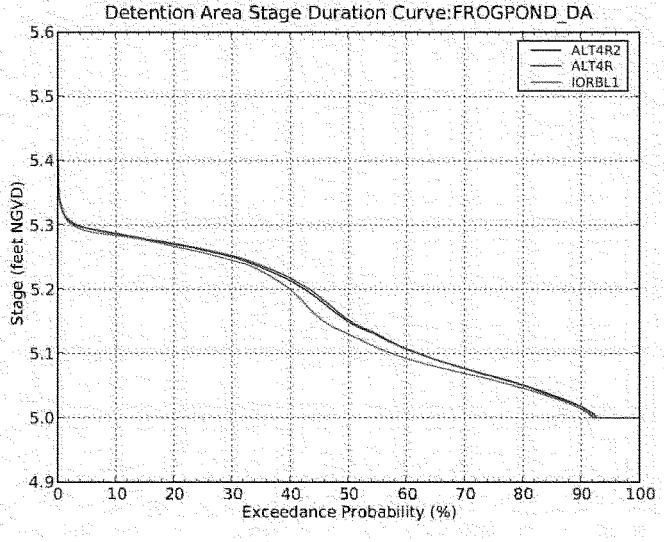

Figure 127B: Stage duration curve for CERP Spreader Canal Western PIR Frog Pond Detention Area

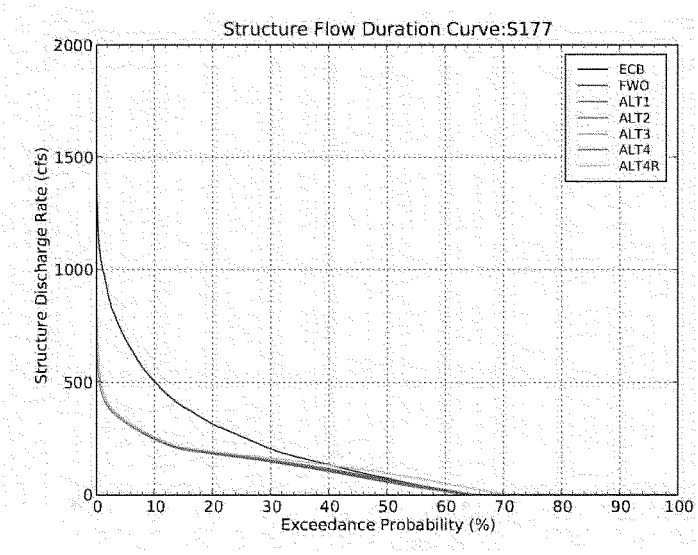

Figure 128A: Flow duration curve for SDCS C-111 Canal outlet structure S-177

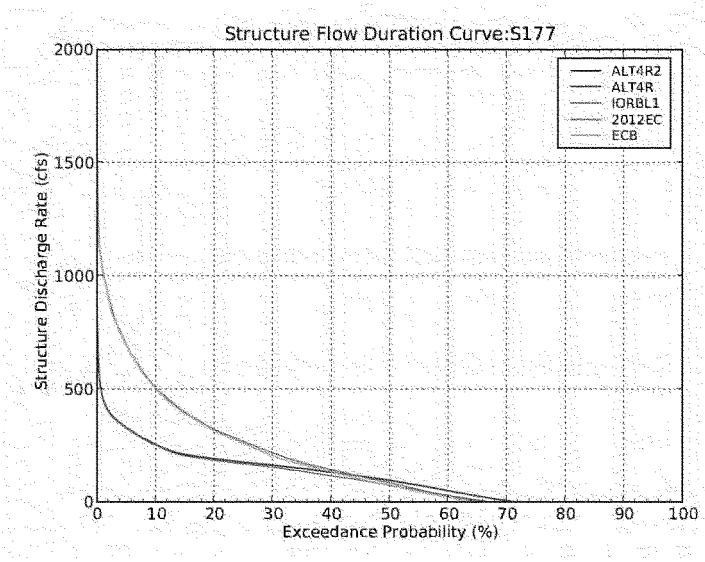

Figure 128B: Flow duration curve for SDCS C-111 Canal outlet structure S-177

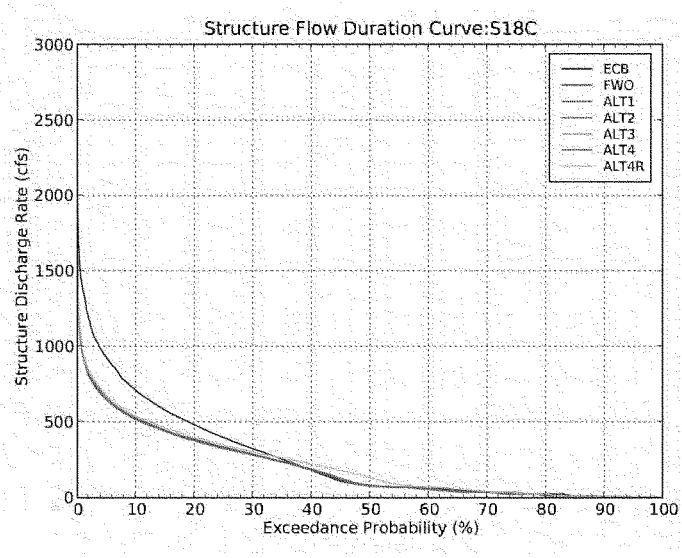

Figure 129A: Flow duration curve for SDCS C-111 Canal outlet structure S-18C

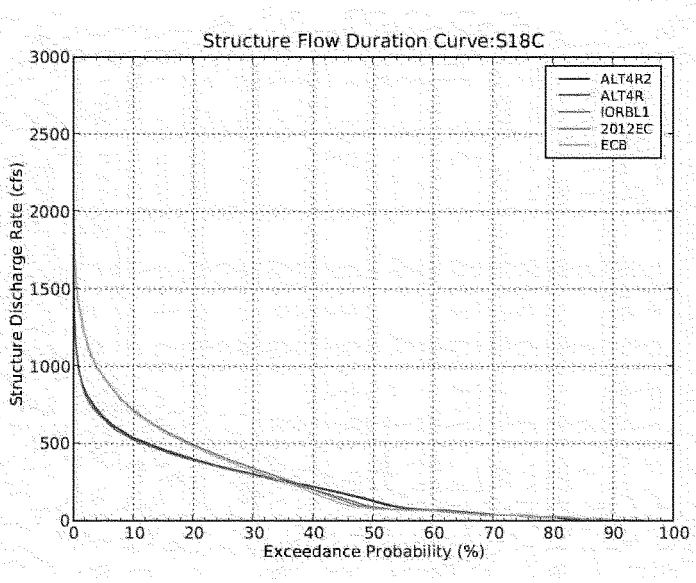

Figure 129B: Flow duration curve for SDCS C-111 Canal outlet structure S-18C

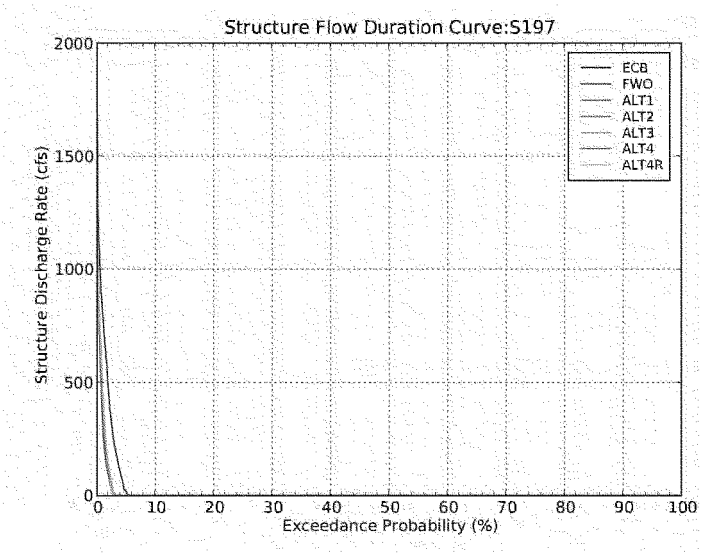

Figure 130A: Flow duration curve for SDCS C-111 Canal outlet structure S-197 to Florida Bay

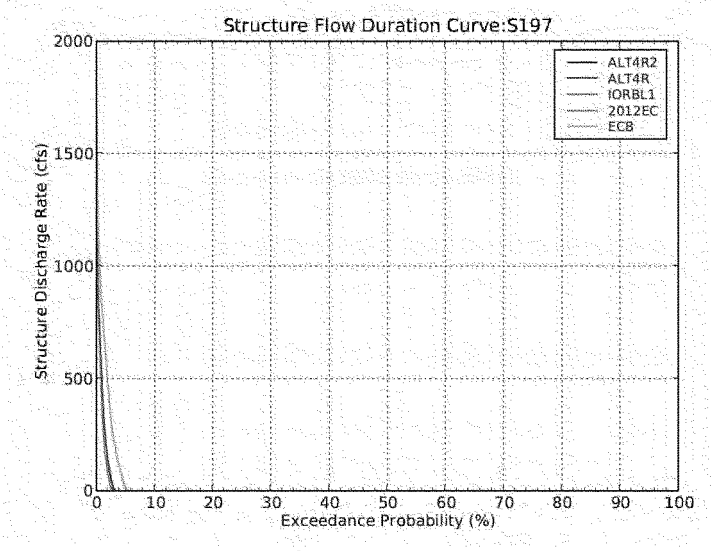

Figure 130B: Flow duration curve for SDCS C-111 Canal outlet structure S-197 to Florida Bay

ANNEX A-2: REFERENCE 1

CEPP MODELING STRATEGY

Central Everglades Planning Project Modeling Strategy

10/26/2012

Central Everglades Planning Project
Modeling Strategy
10/26/2012

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1.0 Introduction

The Central Everglades Planning Project (CEPP) is an expedited planning effort undertaken as part of the overall Comprehensive Everglades Restoration Plan (CERP), a program led by the United States Army Corps of Engineers (USACE) with the South Florida Water Management District (SFWMD) as local sponsor. This effort will seek to develop a Project Implementation Report (PIR) that combines planning and design activities for three primary areas of interest as follows: 1) Storage & water treatment facilities in the Everglades Agricultural Area, 2) Decompartmentalization of levees within the Everglades Protection Area (EPA) and 3) Levee seepage management features along the Everglades / urban boundary in southeastern Florida. Modeling support to the CEPP effort will be primarily provided by a team comprised of modelers from the Hydrologic & Environmental Systems Modeling Section of the SFWMD and the Interagency Modeling Center (IMC), although direct support from USACE, Department of the Interior (DOI) or contracted staff will likely be needed as the project requirements are more fully identified.

Due to the expedited nature of the CEPP, all modeling activities will need to be completed within an aggressive twelve month schedule (**Figure 1.1**). Additionally, it is anticipated that the range of alternatives to be assessed may be greater than in more traditional CERP planning efforts due to the project goal of increased public interaction in the planning process for CEPP. In consideration of these factors, modeling tools that provide flexible inputs to accommodate uncertain planning outcomes were selected over other available tools. It is also recognized that the evaluation strategies for the CEPP are still being developed, with the level of complexity and scope of evaluation remaining undefined as of the development of this strategy. Despite this, it is expected that the modeling tools described in this document will provide adequate hydrologic information to feed evaluation of the entire south Florida system for the needs of the CEPP.

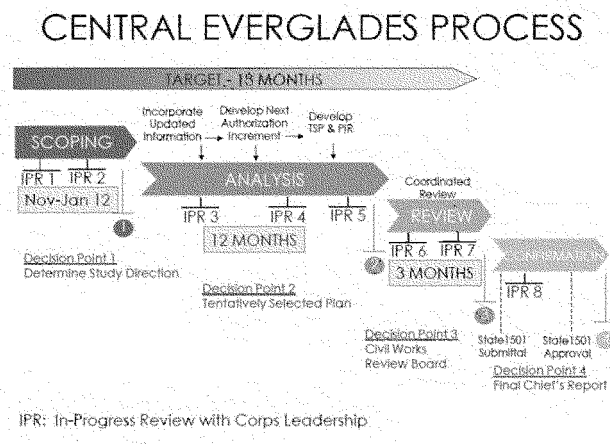

Figure 1.1 Completion of modeling activities within an aggressive 12 month schedule.

2.0 Use of Models in CEPP

The primary application of models in the CEPP will be in the assessment of regional-level hydrologic planning. More detailed models will also be brought to bear on specific questions related to hydraulic and water quality constraints. At this time, the modeling strategy does not consider the application of detailed flood event modeling (or hydrodynamic levee assessment) or water quality fate / succession modeling within the EPA given the schedule of the CEPP. Depending on the outcomes of the CEPP scoping phase and risk registry development, it is possible that key elements of this strategy may need to be revisited.

In general, the primary elements of the CEPP modeling support fall under the following three categories of the analysis phase of CEPP: 1) Updated Conceptual CERP Framework, 2) Plan Formulation (for next construction increment) and 3) Project Assurances for Tentatively Selected Plan (TSP). The specific model applications associated with each of these categories are listed in **Table 2.1** (model descriptions will be provided later in this document). In order to account for the entire south Florida domain from a planning modeling perspective, a decoupled approach as shown in **Figure 2.1** is proposed utilizing one set of tools to model the northern portion of the system with a different set of tools to represent the southern portion of the system. These tools will communicate iteratively using a set of shared boundary conditions along the EPA border – a transect known in the south Florida stakeholder community as the "Red Line". A methodology for resolving the temporal and spatial characteristics of flow at the red line in order to provide seamless translation of boundary conditions across models will need to be developed as part of the modeling effort.

From a schedule perspective, the CEPP has a very aggressive modeling timeframe (**Table 2.2**). Obviously, this will limit the number of alternatives that can be reasonably assessed and the level at which the evaluation can occur. Due to this consideration, CEPP will utilize a modified approach to the traditional modeling workflow of narrowing and refining alternatives incrementally over longer periods of time. In CEPP, where possible, batch processing of model information and/or inverse modeling techniques will be performed up front to identify to decision-makers key performance or tradeoff issues. An example of this type of approach can be observed in **Figure 2.2** where the orange line was developed by running hundreds of model scenarios to identify the trend in expected performance for a given performance metric with the inclusion of simulated storage. Once these types of curves have been developed, alternative development can be facilitated by selecting desired points on the curve based on project objectives or cost constraints. As such, a typical modeling "cycle" for CEPP would involve months of up-front work to develop these types of curves and model alternatives close to those anticipated in the plan. Then, alternative-specific modeling can be completed in a shorter turnaround (4 to 6 weeks for 3-4 alternatives in a given process step) since close-to-alternative

modeling already exists. In this paradigm, QAQC of modeling outcomes will not be sacrificed, but full documentation may be deferred to occur later in the 12 month modeling schedule and not coincident with the development of each alternative.

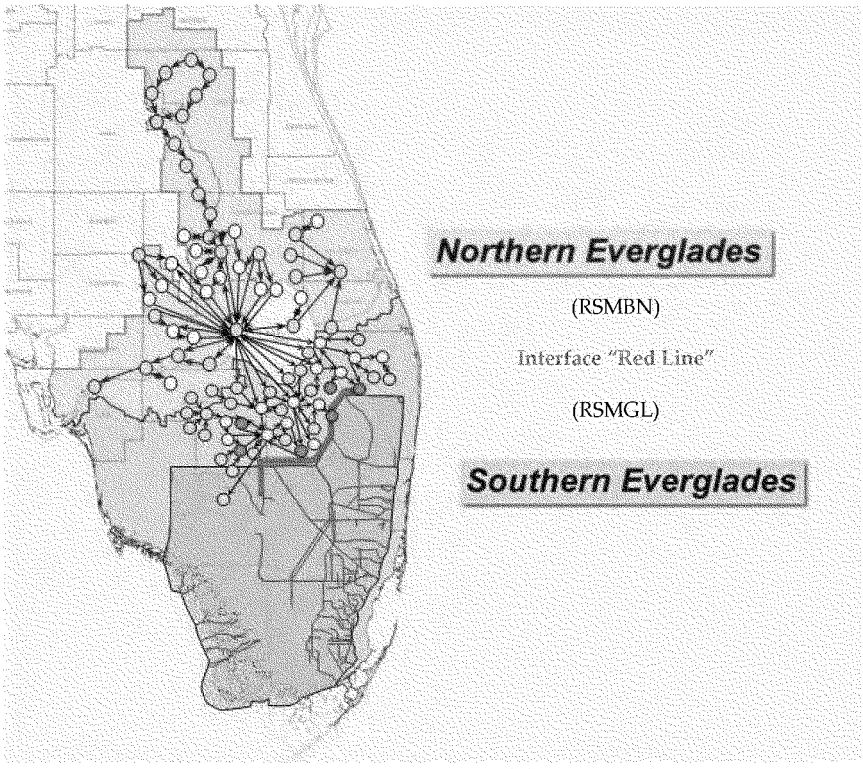

Figure 2.1. Decoupled CEPP Modeling Approach

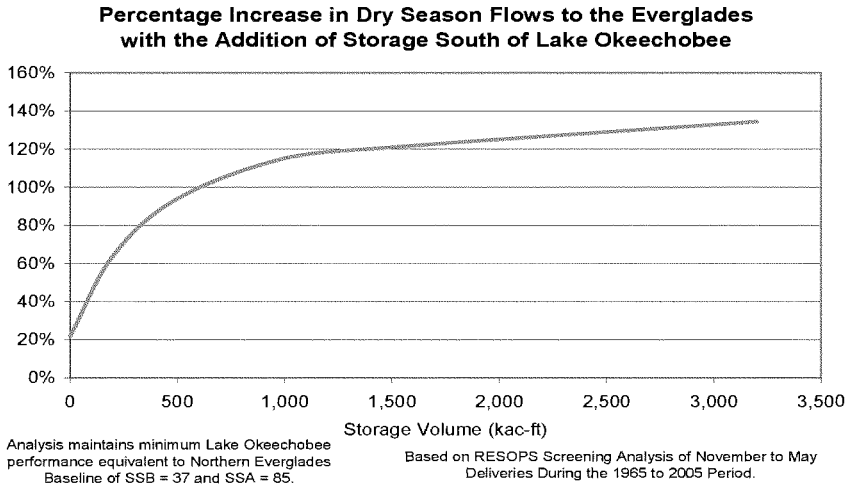

Figure 2.2. Example of Batch-Processing Model Application to Inform Decision Making

Table 2.1. Anticipated Modeling during the analysis phase of the Central Everglades Planning Project.

	Goals	Strategy	Model
Project Analysis Phase	**Updated Conceptual Framework** (~ 3 Months) • Restoration Flow Targets • Everglades Flow Scenarios	To provide modeling representations of the range of long-term restoration goals (of which CEPP will achieve an increment), the SFWMM will be used to represent the CERP configuration and the RSMGL will be used to represent updated concepts (e.g. River of Grass scenarios). RESOPS could be used to provide information of long-term northern storage and treatment needs.	RSMGL SFWMM RESOPS
	Plan Formulation (~6 Months) (Develop Next Increment) • EAA Storage and Treatment ○ Identify Formulation Scope/Constraints ○ Alternatives Screening ○ Alternatives Formulation/Evaluation ○ Identify Preferred Concept • DECOMP & Seepage Management ○ Identify Formulation Scope/Constraints ○ Alternatives Screening ○ Alternatives Formulation/Evaluation ○ Identify Preferred Concept	In plan formulation of the CEPP increment, up-front screening of alternatives above the red line will be performed primarily using the RESOPS, LOOPS and C-43 models. Additionally, use of batch processing and inverse modeling techniques will allow DMSTA to be applied during the screening phase of the effort to answer water quality questions north of the red line. Similar techniques will be applied to iModel and RSMGL to provide screening input south of the red line. Flow volumes will be translated across the models as boundary conditions and iteration between solutions north and south of the red line may be needed. Upon completion of the screening phase and identification of input assumptions for alternative assessment, final alternatives will be modeled using the RSMBN and RSMGL with detailed evaluation information being post-processed. Simulation of these alternatives will incorporate information gained from the screening, and DMSTA applications. HEC-RAS may also need to be applied in this final step to inform conveyance limitations or design requirements to the representation of alternatives.	RESOPS LOOPS C-43 RSMBN DMSTA HEC-RAS iModel RSMGL
	Project Assurances (~3 Months) ○ Finalize environmental assessments ○ Project Assurances ○ Water Made Available ○ Interim Operating Plan	Assurances assessment for saving clause, water made available and flood protection will primarily rely on post processing of the RSMBN and RSMGL representation of the CEPP Tentatively Selected Plan. Depending on public interest and management direction, other detailed models may also be needed for assessment of flood protection.	RSMBN RSMGL

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Table 2.2. Original key modeling milestones and deliverables of the analysis phase of the CEPP SFWMD/IMC Modeling Team. This schedule was revised in August due to a change in project resourcing (**Table 2.3**).

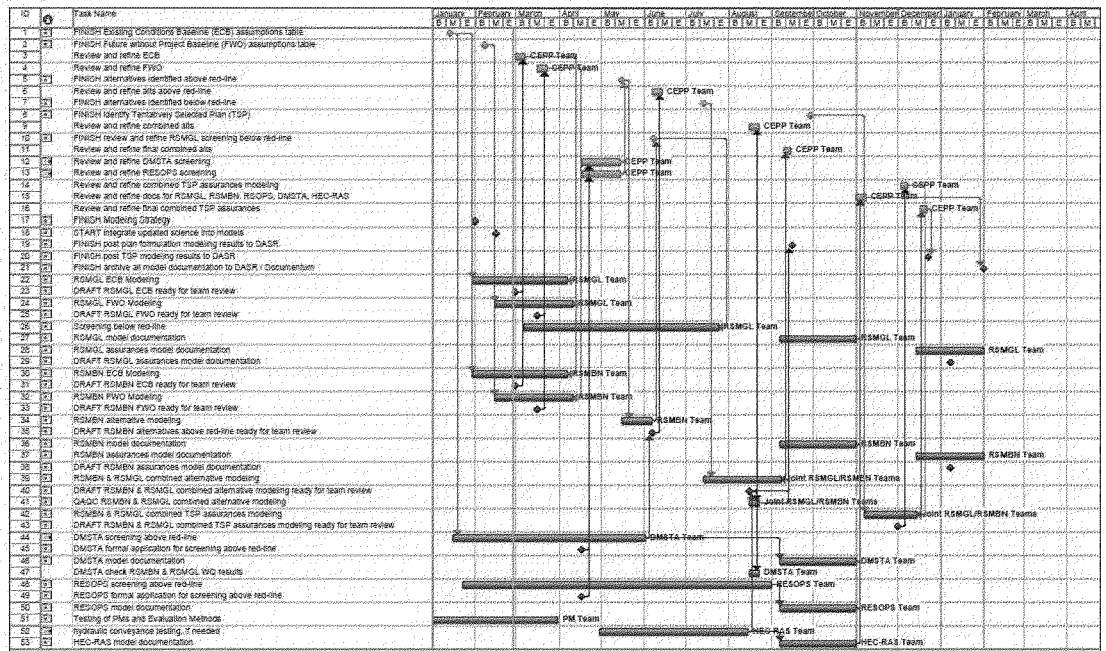

Table 2.3. Revised key modeling milestones and deliverables of the analysis phase of the CEPP SFWMD/IMC Modeling Team.

CEPP Staffing Level	
SFWMD	4 FTE
USACE IMC & DOI	3 FTE
Commitment of Resources	Through March 2013

Task Group	CEPP Modeling Work Product	Deliverable	Date
1.0	**Baselines**		
	1.1	FWO Update with A1 FEB	10/12/12
	1.2	Updated ECB and FWO (per team feedback)	11/15/12
2.0	**North Redline Screening / Alternatives**		
	2.1	Meet with Ag	8/3/12
	2.2	Meet with Est	8/9/12
	2.3	FEB scenario with RSMBN	8/22/12
	2.4	FEB scenario with RSMBN inc Holeyland	8/28/12
	2.5	Present to PDT	8/28/12
3.0	**Blueline Screening**		
	3.1	NSM0 - NSM100 Sensitivities	7/27/12
	3.2	Additional Sensitivities as needed	9/30/12
4.0	**South Redline Screening**		
	4.1	RL1 - RL4 Sensitivities	7/31/12
5.0	**L28 Sensitivities**		
	5.1	Updated to RSMGL	8/15/12
	5.2	L28 Scenarios	8/22/12
	5.3	Meet with Tribe	8/23/12
	5.4	Present to PDT	8/28/12
6.0	**Greenline Screening**		
	6.1	Meet with CEPP Team to set targets & conceptual configs	8/15/12
	6.2	WG presentation on targets / ideas	8/30/12
	6.3	Complete IModel implementation	9/6/12
	6.4	IModel application to CEPP team	9/19/12
	6.5	Present to PDT	10/2/12
	6.6	Meet with CEPP Team to set Measures	10/10/12
	6.7	Present Measures to PDT	10/25/12
7.0	**Yellow Line Sensitivities**		
	7.1	Alternative Testing	11/15/12
8.0	Final Array of Alternatives		Mid-December
9.0	Project Assurances		Mid-February
10.0	Technical Review / Model Certification		End-December
11.0	Documentation		End March

3.0 Screening Model Overview

The screening techniques outlined in section 2.0 can be applied to any of the planning models identified in this strategy document. In addition to use of these methodologies, the specific use of the RESOPS and LOOPS models for screening purposes are proposed.

3.1 REservoir Sizing and OPerations Screening (RESOPS)

To assist with the preliminary analyses and testing of alternative storage configurations that consider the interconnectivity of Lake Okeechobee, the Lake Okeechobee Service Area, the northern estuary watershed systems, and the Everglades, a spreadsheet-based screening model was developed. The REservoir Sizing and OPerations Screening (RESOPS) Model is a coarse-scale water management simulation model that was developed to quickly test alternative reservoir sizes and system operating rules for the region surrounding and including Lake Okeechobee (**Figure 3.1.1**).

The RESOPS Model is, as its name states, a screening-level model. The RESOPS Model has a limited scope and is not a replacement for the detailed regional hydrologic simulation models that have traditionally been used for the analysis and planning of south Florida's water resources. Those detailed models, the South Florida Water Management Model (SFWMM or 2x2) and the Regional Simulation Model (RSM), are necessary for the comprehensive in-depth analysis of the existing and future components of the water management system in south Florida. Although the detailed regional models are the best available tools for performing the finer-scale evaluation, they are not as appropriate for quickly testing a broad range of alternative reservoir sizes and Lake Okeechobee operation configurations. The strength of the RESOPS Model is with its ability to quickly test the performance of alternative configurations which can provide guidance for more-detailed modeling. Such a hierarchical process can allow the detailed models to focus on a smaller number of more-promising alternative plans.

The RESOPS Model was built using Microsoft® Excel 2003. It performs monthly time-step, 41-year continuous simulations of the hydrology and operations of south Florida's regional water management system and the interaction with proposed reservoir and wetland treatment area features. Within one second, the RESOPS Model executes a simulation and automatically produces a wide variety of graphical and statistical summary measures of performance that can be used to compare up to four test scenarios. The model also contains an optimization routine that enables selection of superior operating rules for Lake Okeechobee. Performance summary graphics are another useful feature which facilitates the comparison of multiple simulations. Much of the basic input data to RESOPS is provided by the detailed regional simulation models,

specifically the SFWMM. Although the RESOPS Model simulates flows to the northern boundary of the Everglades Water Conservation Areas (WCAs), it does not simulate the complexity of the spatial distribution of flows and stages within the Everglades.

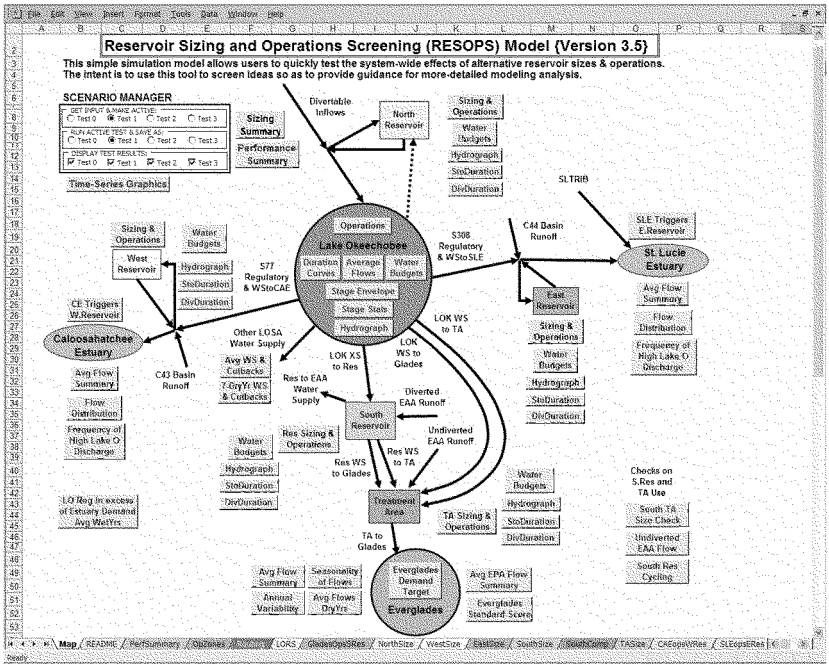

Figure 3.1.1. Schematic representation of study area hydrology as seen by the RESOPS Model.

3.2 Lake Okeechobee OPerations Screening (LOOPS)

The LOOPS model **(Neidrauer et al, 2006)** is a hydrologic simulation tool that provides rapid screening-level testing of alternative operating rules and strategies for Lake Okeechobee, including Regulation Schedules, Water Shortage Plans, and protocols for defining release amounts when the Regulation Schedule guidance only provides ranges of flows. Inputs include daily time-series values for the Lake net inflow, basin runoff from the Caloosahatchee and St. Lucie basins, lake evaporation rates, and the hydrologic state and forecast information that drive Lake regulation schedules. The strength of the LOOPS Model is with its ability to quickly test the performance of alternative operating scenarios to screen ideas and perform sensitivity tests for the primary lake-management objectives.

The LOOPS Model was developed with Excel 2003, and performs 41-year continuous simulations with a daily time-step of the hydrology and operations of the water management system, including Lake Okeechobee, the Lake Okeechobee Service Area, and the Caloosahatchee and St. Lucie watersheds and estuaries. The time-series of Lake releases south, to the WCAs via STA-3/4 and to C-51 via L-8, are assumed boundary conditions and are derived from the SFWMM or the RESOPS model as appropriate for the application. An input parameter/multiplier is available to adjust these time-series.

The basic structure of LOOPS is illustrated in **Figure 3.2.1**. Data management is simple and transparent to the user. Macros do the work of copying the pertinent information from the "active schedule" sheet to separate sheets for each alternative.

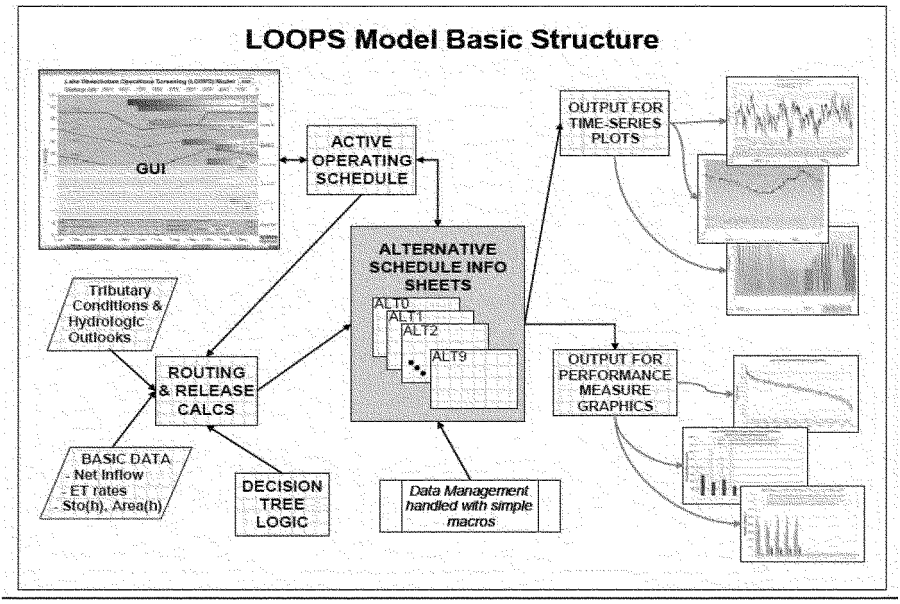

Figure 3.2.1. Basic Structure of the LOOPS Model

The LOOPS model can be run in batch mode by setting ranges for various parameters to be varied. Key outputs are identified and values are stored for each run processed in batch. At the end of the set of runs, all of the values can be plotted and compared to other key outputs to find optimal parameter values for all key modeling objectives. A small subset of optimal parameter values can then be run using more complex models to make policy decisions. **Figure 3.2.2** shows an example graphic comparing tradeoffs between two performance measures. LOOPS allows setting preferred ranges on the performance measures, and all points that fall within the ranges of all the performance measures show on the graphic in red.

Because the LOOPS model does not simulate storage in the C-43 basin, it was necessary to use the C-43 Spreadsheet Model for an accurate depiction of changes in the effects of Lake Okeechobee releases to the west. That model is described briefly in the next section. However, since C-44 project features are not designed to capture Lake Okeechobee releases, any discharges to the St. Lucie Estuary to the east will discharge directly at structure S-80, and therefore did not require the use of a specialized model.

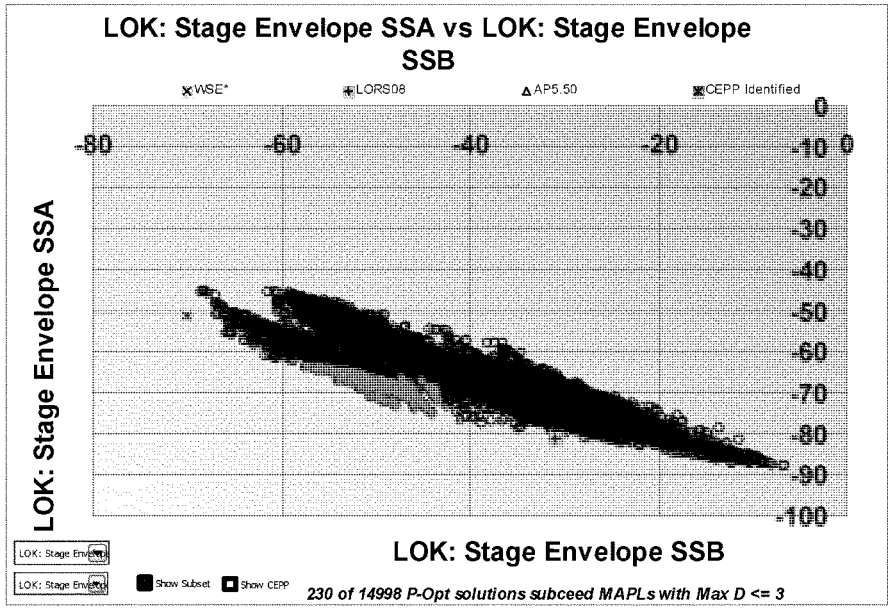

Figure 3.2.2. Example graphic showing tradeoffs between two performance measures after completion of batch runs of different parameter combinations.

3.3 C-43 Spreadsheet Model

The C-43 Spreadsheet Model "C43_PIR-model_Final.xls" was developed for the CERP Project "C-43 Reservoir Phase I" **(Starnes & Marlowe, 2007)** to compare with-project discharge over S-79 (the downstream point at which the basin discharges into the estuary) to both the pre-project discharge over S-79 and to a time series representing restoration target flows over S-79 for a 41-year, daily period of simulation. The model also shows a water budget for the reservoir and tracks reservoir inflows, releases and storage.

3.4 iModel©

Instead of modeling the cause effect-relationship typically identified in physically based engineering models such as the RSM, the iModel is a unique inverse modeling tool that reverses the process of a traditional, direct model. iModel computes a system's required input to achieve a system's desired response. iModel emulates the reversal of the physical process using Artificial Neural Networks and Genetic algorithm theories. The iModel is comprised of two primary components:

1) Hydrologic Model Emulators (HME) which are developed for each waterbody of interest (e.g., Everglades areas) to predict stage and transect flows at the identified target locations as a function of inflows and outflows and net rainfall, as shown conceptually in **Figure 3.4.1** (Ali, 2009)
2) A neural network optimization framework that manages and optimizes concurrent performance of the different waterbodies' HMEs to approach the desired targets subject to linear and nonlinear constraints and weights.

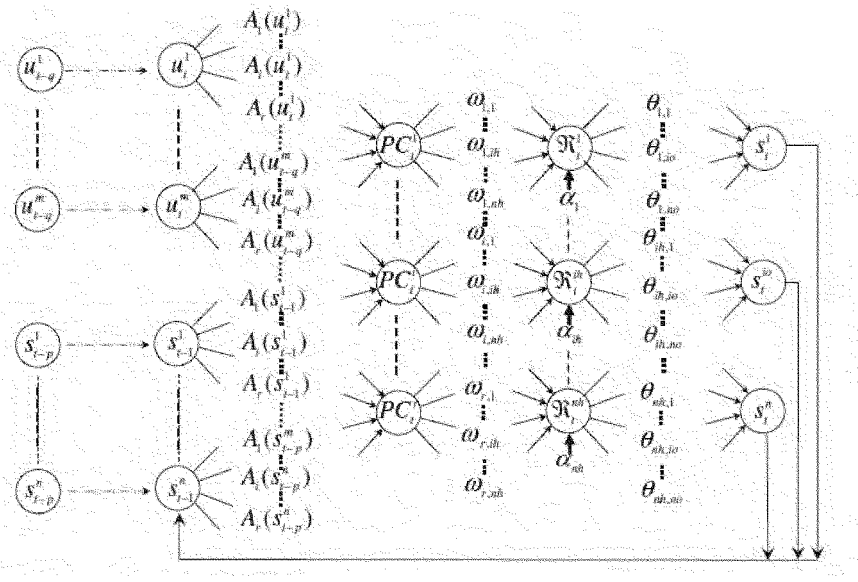

Figure 3.4.2 Schematic diagram for Hydrologic Model Emulator

The primary goal of iModel application is the efficient utilization of the available water and storage facilities to achieve desirable environmental benefits while maintaining flood control and water supply requirements. It can guide, and reduce the run time of, traditional models by offering optimal solutions that would otherwise require hundreds of traditional model runs. It provides simple operational functions for complex systems towards Operational Protocols Development. The iModel's predicted inflows/outflows can be used as input to a traditional direct model to check that the simulated response of the traditional model matches the desired response of the iModel.

Given the rapid pace of the CEPP process, traditional analysis of multiple configurations is a logistics challenge. The IModel will be utilized in CEPP screening to help identify a limited set

of system operational protocols and optimal infrastructure that are needed to approach CEPP planning objectives. Ultimately these configurations will be modeled using the detailed physical model (RSMGL) prior to final project evaluation. By employing this approach, a wide range of potential outcomes can be quickly analyzed and a feasible range of high performing alternatives can be identified using a systematic and robust process.

4.0 Planning Models Overview

Regional hydrologic models are the primary modeling tools to be used for Central Everglades assessment. The models provide daily, detailed estimates of hydrology across the planning domain. They simulate detailed daily rainfall-runoff processes and flow routing within the Central Everglades planning region as a function of existing infrastructure and proposed configurations. The strategy is to use a decoupled link-node model (RSMBN) for the EAA, STAs and northern areas in combination with a detailed meshed model (RSMGL) for the Everglades-Lower East Coast areas.

4.1 RSM Basin (RSMBN)

The Regional Simulation Model -Basins (RSM Basins or RSMBN) uses the same source code as the mesh-based Regional Simulation Model which, in turn, was recently implemented in the evaluation of alternatives for the Water Conservation Area 3 Decompartmentalization Project (using RSMGL described in section 4.2). Both implementations are based on object-oriented concepts and principles. The object-oriented nature of the model not only describes the physical connectivity of the waterbodies but, likewise, describes the computational engine of RSMBN. This feature allows new objects to be added without the need to significantly alter the previously coded modules and objects in the computer program. For example, adding the operation of a new reservoir would be simulated as adding a discrete "object" that is automatically assigned with the features and functions commonly defined for a reservoir in the water management system.

The RSMBN is a link-node based model designed to simulate the transfer of water from a pre-defined set of watersheds, lakes, reservoirs or any "waterbody" that either receives or transmits water to another adjacent waterbody. The model assumes that water in each waterbody is held in level pools. The model domain covers Lake Okeechobee and four major watersheds: Kissimmee, Lake Okeechobee, St. Lucie River, Caloosahatchee River and the Everglades Agricultural Area, the latter being the latest addition. The watersheds are further divided into sub-watersheds until fundamental waterbodies can be considered as separate model nodes. Individual operating rules were encapsulated into the model that defines how water is moved between two nodes. Taken together, the set of management rules define the linkage of all nodes within the model domain.

The model is considered a lumped model in hydrologic engineering terms. Thus, local-scale features within a watershed, e.g. stages at individual gauging stations or flows across specific transects, are not simulated. Simulated stages represent average water level conditions for the entire waterbody. No systematic detailed verification relative to historical data was done during initial model set-up; however, the model was validated by making comparative runs with established legacy models currently in use within the model domain: the UKISS for the Upper Kissimmee Watershed (Fan, 1986) and selected sub-areas in South Florida Water Management Model (SFWMD, 2005). Additionally, historical information (in some cases, full calibration efforts) has been used in the development of nodes representing the C-139 basin, Stormwater Treatment Areas and 298 districts within the EAA, a procedure never employed in previous regional hydrologic modeling of these areas.

Input data for the model includes daily records of hydrologic and meteorological data (rainfall and potential evapotranspiration), as well as discharges at the boundaries for a 41-year period between 1965 and 2005. Other model input data includes the physical description of management features (e.g., reservoir stage-storage relationship and structure capacities) and corresponding operating rules (e.g., maximum operating levels and reservoir outflow priorities).

Runoff and supplemental irrigation demands can be simulated in the different waterbodies in RSMBN, or they can be read-in as time series boundary conditions, as in the case for the Caloosahatchee and St. Lucie basins (where hydrology is calibrated offline using the AFSIRS-WATBAL model (Smajstrla, 1990)). Stages in waterbodies and flows at inlet and outlet structures are basic output data from the model.

The RSMBN model provides a very good tool for assessing the water budget interaction in a complex hydrologic system. The model input requirements are not as rigorous and computational needs are not as CPU-intensive as other mesh–based models. The model executes in only a few minutes for a system representation as in **Figures 4.1.1 and 4.1.2**. The model is also an effective tool in comparing the relative performance of the proposed alternatives. In order to make an effective comparison, raw model outputs are summarized in a way that fits the basins or metrics associated with the selected performance measure. Post-processing scripts are available that temporally (weekly, monthly, seasonal, etc.) and spatially (individual waterbody or collection of waterbodies) summarize model output. Generation of some performance measure graphics are automated as they have been previously defined and vetted in other model application projects, e.g. CERP, LECPLAN, etc. The RSMBN precursor, the Northern Everglades Regional Simulation Model (NERSM), has been implemented to assess the hydrologic impact of selected alternatives for SFWMD planning efforts under the Northern Everglades program, specifically the Lake Okeechobee Phase 2 Technical Plan (LOP2TP) and the River Watershed Protection Plan (RWPP).

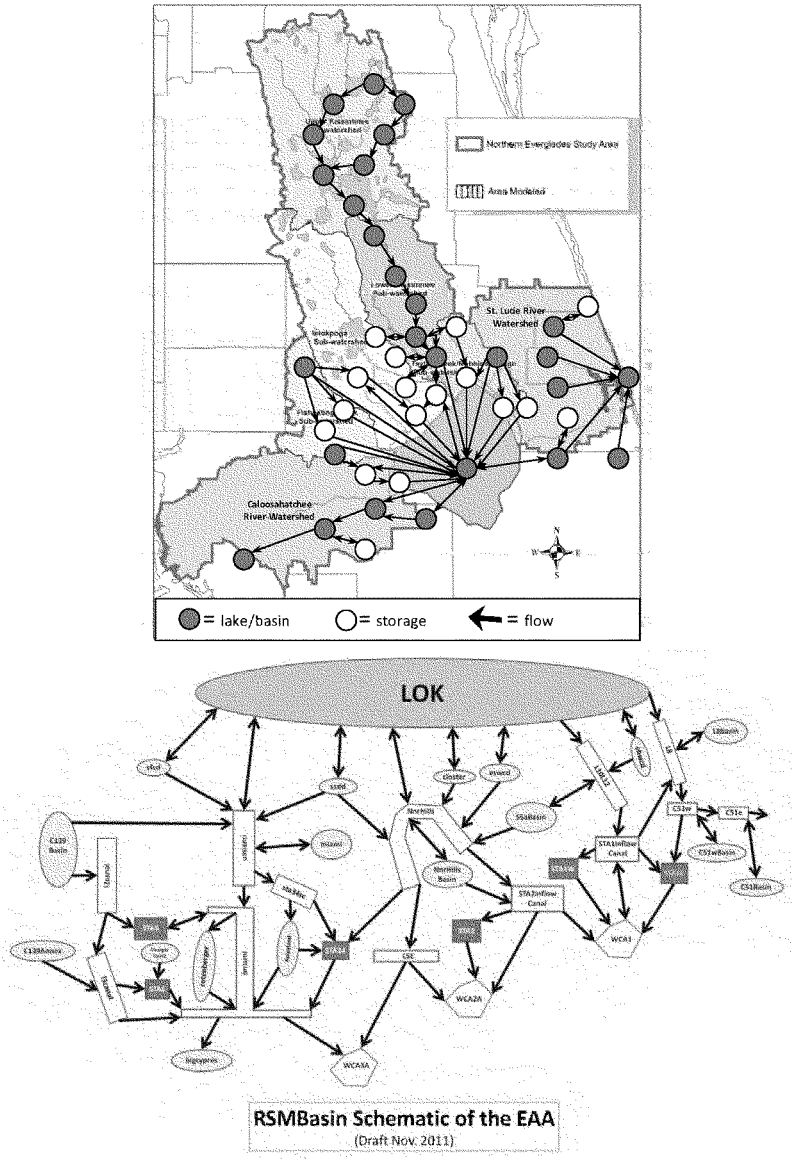

Figure 4.1.1. & Figure 4.1.2. RSM Link-Node Representation for Central Everglades Project

4.2 RSM Glades-LECSA (RSMGL)

The Glades-LECSA model provides a tool to simulate the natural hydrology and the water management operations of several important basins in south Florida. The Glades-LECSA implementation uses the Regional Simulation Model (RSM) developed by the Hydrologic and Environmental Systems Modeling Section of the South Florida Water Management District. The RSM is an implicit, finite-volume, continuous, distributed, and integrated surface-water and ground-water model. It can simulate one-dimensional canal/stream flow and two-dimensional overland and groundwater flow in arbitrarily shaped areas using a variable triangular mesh. The overland and groundwater flow components are fully coupled in the RSM for a more realistic representation of runoff generation. It has physically-based formulations for the simulation of overland and groundwater flow, evapotranspiration, infiltration, levee seepage, and canal and structure flows. The model uses the diffusive wave approximation of Saint-Venant's equation to simulate canal and overland flows. This model is capable of simulating features that are unique to south Florida such as low-relief topography, high water tables, saturation-excess runoff, depth-dependent roughness and very permeable soils. The Glades-LECSA model also has the capability to predict the results of implementing physical and operational alternatives being considered to address changing water management priorities and issues in south Florida's regional system. The Glades-LECSA model has been applied in PIR1 of the WCA-3 Decompartmentalization and Sheetflow Enhancement (Decomp) Project.

The Glades-LECSA model encompasses an area of 5,825 square miles. It covers six counties (some partially) and 13 hydrologic basins. The area of the model-domain includes the Everglades National Park, Water Conservation Areas, Big Cypress National Preserve, and the Lower East Coast Service Areas south of the C-51 canal in Palm Beach County (see **Figure 4.2.1**). The Glades-LECSA model mesh consists of 5,794 triangular cells with an average cell size of approximately one square mile. The mesh is designed to conform to all important flow controlling features, such as roads and levees within the model domain. The Glades-LECSA model simulates an extensive canal network. This network includes all primary canals that are maintained by the SFWMD. It also includes several secondary canals that are of importance. In addition, the model uses the Water Control District feature available in the RSM to simulate some secondary and tertiary canals as well. A one-day time step was used for the calibration and validation of the Glades-LECSA model. Other models (e.g., SFWMM) have used similar time steps in the past. Northern boundary flows are imposed based on output from the SFWMM or other regional models such as the RSM Basins model which incorporates areas north of the Water Conservation Areas.

Only the surficial aquifer is simulated in the Glades-LECSA model. Thus, the horizontal saturated hydraulic conductivity values as well as aquifer bottom elevation values that are used

in this model are pertinent to that layer only. The Water Conservation Areas as well as the Everglades National Park contain a significant peat layer that affects stages within those areas. Consequently, it is simulated explicitly in the Glades-LECSA model using a stage-volume converter feature that is unique to the RSM. The model-domain contains several hundred Public Water Supply (PWS) wells that tap the surficial aquifer. These are also simulated in the model through the use of time-series data. The model-domain contains several roads and levees that act as overland flow barriers. The canal and regional groundwater seepage contributions across these levees are explicitly simulated in the Glades-LECSA model.

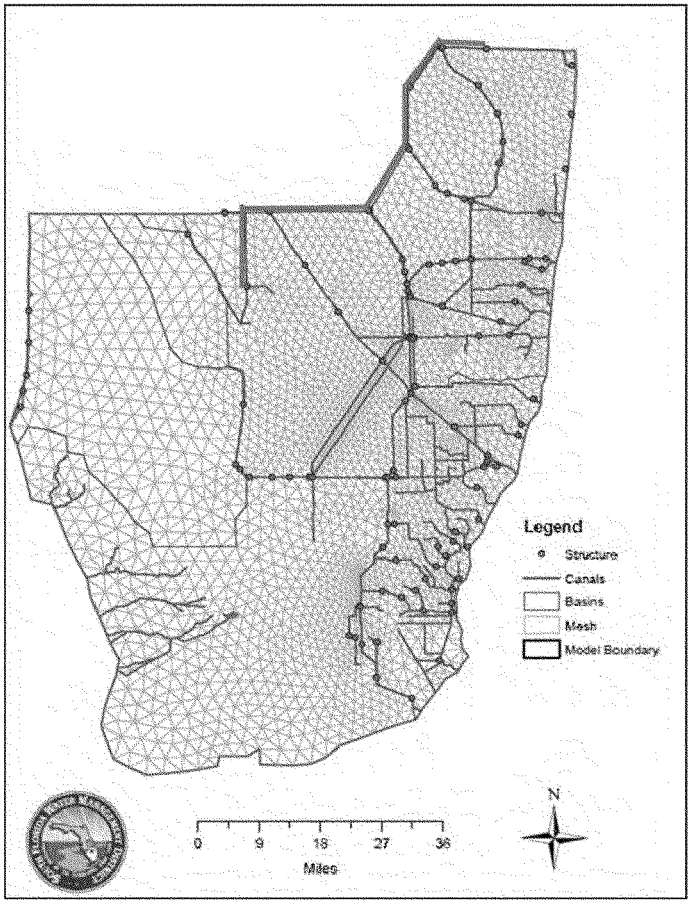

Figure 4.2.1. Glades-LECSA Modeling Domain with Major Canals and Structures

4.3 South Florida Water Management Model (SFWMM)

For the Central Everglades project, the South Florida Water Management Model (SFWMM) will be used as a source of boundary conditions to the other planning or detailed models and also as the representation of the full CERP condition in the "updating conceptual framework" portion of the project. The SFWMM is a physically-based simulation model that combines the hydrology and management aspects of a greater portion of the South Florida Water Management District (SFWMD). The model is regional in spatial extent (covering most of south Florida) and it encompasses an area of substantial heterogeneity in both natural and managed hydrology. It covers an area of 7600 square miles using a mesh of 2 mile x 2 mile cells. **Figure 4.3.1** shows the model boundary relative to south Florida.

The SFWMM is a coupled surface water-groundwater model which incorporates overland flow, canal routing, unsaturated zone accounting and two-dimensional single layer aquifer flow. The model simulates the major components of the hydrologic cycle in south Florida including rainfall, evapotranspiration, infiltration, overland and groundwater flow, canal flow, canal groundwater seepage, levee seepage and groundwater pumping. The model is site-specific because it was exclusively developed for the south Florida region. In addition to simulating the natural hydrology in south Florida, the model also simulates the management processes that satisfy policy-based rules (both existing and proposed) to meet flood control, water supply and environmental needs. It incorporates current or proposed water management control structures and current or proposed operational rules.

The model is conceptualized at varying levels of detail for three different geographic areas, as shown in **Figure 4.3.1**:

(1) for Lake Okeechobee,
(2) for the combined extent of the Everglades Agricultural Area (EAA), the Everglades Protection Area (EPA) and the Lower East Coast (LEC) south of Lake Okeechobee, and
(3) for non-EAA Lake Okeechobee Service Area (LOSA) basins.

In addition, the model includes inflows from Kissimmee River, and runoff and demands in the Caloosahatchee River and St. Lucie canal basins. Lake Okeechobee is modeled as a lumped system, or regarded as a single point in space without dimensions where simulated water levels and/or flow rates are spatially averaged. The gridded portion of the model domain describes the extent of the finite difference solution to the governing overland and groundwater flow equations and is defined south of Lake Okeechobee. For the rest of LOSA excluding the EAA, a simple flow balance procedure is used. In these basins, pre-processed user-input demand and runoff characteristics are combined with appropriate system operational rules to calculate flow distributions.

The SFWMM simulates hydrology on a daily basis using climatic data for the 1965-2005 period which includes many droughts and wet periods. The model has been calibrated and verified using water level and discharge measurements at hundreds of locations distributed throughout the region within the model boundaries.

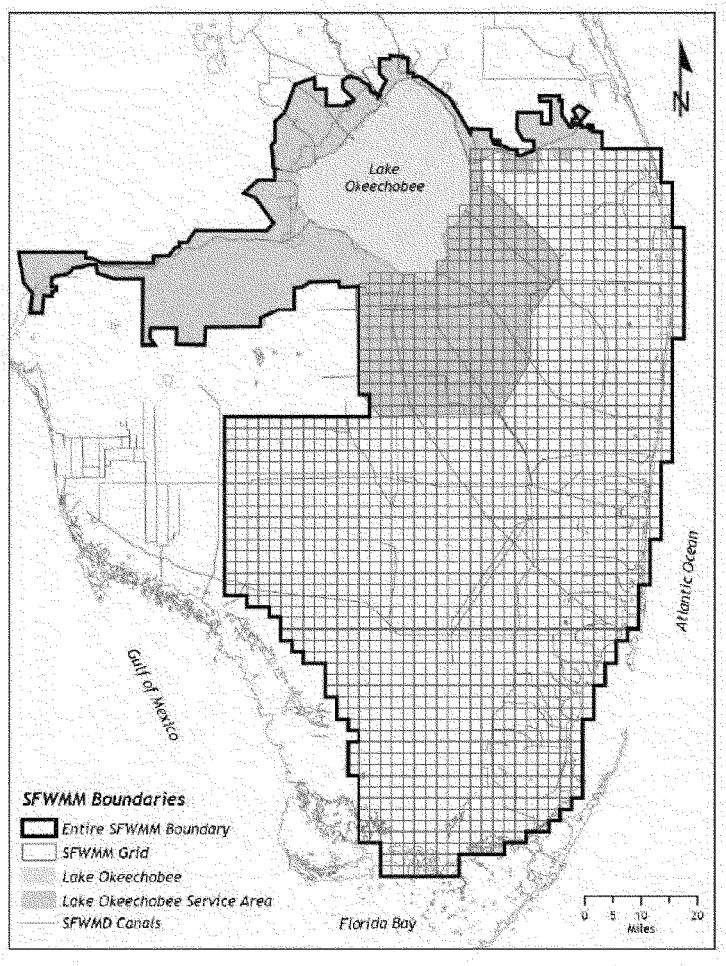

Figure 4.3.1. South Florida Water Management Model domain showing three geographic areas—1) Lake Okeechobee, 2) gridded portion of EAA, EPA, and LEC and 3) non-EAA LOSA basins.

5.0 Detailed Models Overview

On an as-needed basis, additional models may be applied to complement or assist the regional hydrologic models in analyzing system features. Examples of this type of model application will be shown for assessing water quality considerations and conveyance of water. The list of detailed models may expand or contract based on project requirements. The expedited schedule may also require that hydrologic surrogates be used in place of detailed modeling. Detailed flood assessment modeling is not envisioned within the Central Everglades Planning Project at this time.

5.1 Dynamic Model for Stormwater Treatment Areas (DMSTA)

The Dynamic Model for Stormwater Treatment Areas (DMSTA) was developed for the U.S. Department of the Interior and the U.S. Army Corps of Engineers (Walker and Kadlec 2005, http://wwwalker.net/dmsta/). DMSTA was developed and calibrated to information specific to south Florida and to predict phosphorus removal performance of Stormwater Treatment Areas (STAs) and storage reservoirs, and has been commonly used by both state and federal agencies for STA design and evaluation since 2001. The 2005 version of DMSTA was calibrated to data from 35 fully functional treatment cells with viable vegetation communities of various types. The model provides detailed output on the water and phosphorus balances of individual treatment cells and entire STAs, regional networks of STAs and storage reservoirs. Warning messages are generated in cases where simulated conditions exceed the calibration boundaries for phosphorus concentration, depth, dryout frequency, and/or flow velocities.

Model input requirements include daily values for flow, phosphorus concentration, rainfall, evapotranspiration (ET), depth (optional input or simulated value) and releases (optional input or simulated), treatment area configuration, cell size, flow path width, vegetation type, estimates of hydraulic mixing, outflow hydraulics, and seepage estimates. Phosphorus removal rates (settling rate; *K*) and other P cycling parameters can be either user-defined or calculated within DMSTA based on calibration data sets. DMSTA assumes that the specified vegetation types (emergent, submersed, periphyton) will be maintained in the long-term, but does not take into account areas subject to periodic disturbance such as hurricanes, droughts and other extreme conditions that are not reflected in the calibration datasets where vegetation management may be difficult.

DMSTA is the best available tool for simulating phosphorus removal performance of existing or planned storage basins and STAs. An input template has been developed to facilitate linkage to daily output from the regional hydrologic models. For the Central Everglades Planning Project, evaluation of planning-level water quality constraints in the Everglades Agricultural Area will be accomplished through the use of DMSTA. Ultimately, the amount of flow directed into the

northern boundary of the Everglades Protection Area will be dependent on the assumptions made relative to water quality objectives and the resulting application of the DMSTA model.

5.2 Hydrologic Engineering Center's River Analysis System (HEC-RAS)

The Everglades Agricultural Area (EAA) is an area with complex drainage features comprised of mostly man-made canals and structures that move water from the primary canal system to the secondary and tertiary local drainage system via small canals and control structures. In many instances when draining storm water from large storm events, the drainage system may be overtaxed resulting in local flooding.

Evaluation of hydraulic capacity of canal systems can be performed with the Hydrologic Engineering Center's River Analysis System (HEC-RAS) model developed by USACE. The unsteady flow solver in HEC-RAS has been adapted from the UNET model which was developed to perform sub-critical or super-critical, gradually varied unsteady flow analysis. Hydraulic losses through the channel, bridge, culverts, spillways and other hydraulic structures can be modeled in both the steady state and unsteady state modules. In addition, the unsteady flow module can simulate storage areas, pumping stations, and levee failures. These model features can be useful in identifying conveyance deficiencies in canals and structures under steady state or dynamic flow conditions for particular flood events.

The most recent release of HEC-RAS (version 4.2) includes capabilities that allow the model to apply complex operation of gated structures and pump stations. Such operations can change in time or water level conditions anywhere in the system. A new feature in HEC-RAS will allow the 1-dimensional channel flow to interact with 2-dimensional floodplain flow, allowing for more accurate floodplain mapping. In areas where the interaction of open channel flow and aquifer groundwater needs to be explicitly modeled, a new integrated tool based on the original HEC-RAS and MODFLOW models can now be used to accurately simulate the aquifer/canal flow exchange. This new modeling tool is near completion and has been successfully used to simulate flood event conditions in the C-4 Basin in central Miami-Dade County. In this model application, flood control infrastructure and operations are being reevaluated to improve flooding conditions in municipalities along the C-4 canal. Application of RAS-MODFLOW may have to wait until HEC releases it into production.

For the Central Everglades project, evaluation of hydraulic performance of individual canal/structures can be accomplished with HEC-RAS under design flow conditions. Existing data from previous modeling efforts can be used to define the physical characteristics of canal and structures. Canal cross-sectional data and structure information are available from previous models such as Mike-11 and District's databases. HEC-RAS is applicable for 1-

dimensional flow conditions, however, for hydraulic analysis of flow-way conveyance that occurs in floodplains or STAs, the new 2-dimensional floodplain feature of HEC-RAS mentioned above can be employed.

5.3 MIKE Marsh Model of ENP (M3ENP)

Everglades National Park (ENP) is a large wetland surrounded on the north and east sides by developed areas in Miami-Dade County which are protected from flooding by levees and drainage canals bordering ENP. The large transmissivity of the underlying aquifer coupled with the operations of these canals results in large quantities of groundwater flowing from the wetlands to the east, resulting in potential flood control issues during periods of high water levels and/or rainfall.

To assess the impacts of water control strategies, ENP has developed a hydrologic model simulating both surface water and groundwater which covers approximately 1050 square miles of ENP and adjacent lands, as well as 110 miles of canals and associated structural components. These components include the detention areas adjacent to the South Dade Conveyance System (SDCS). The model is a combined MIKE SHE/MIKE 11 model, named the MIKE Marsh Model of ENP (M3ENP), which is capable of predicting hydrologic impacts of proposed structural and operational alternatives. In addition to evaluating wetland impacts, the model extends east into the developed areas and is thus able to determine potential flood impacts in the lands immediately east of the SDCS, along canals L-31N/C-111.

The M3ENP allows input of complex canal architecture and structure operational strategies. Along the northern and eastern boundaries of ENP the relevant canals, structures, and pumps are fully modeled and interact with both the surface water and groundwater regimes. The model grid contains 155 rows and 158 columns with a resolution of 400 meter square cells. Current simulations cover the time period from 1987 to 2005 using rainfall, potential evapotranspiration, and groundwater head boundary condition (except for a southern flux boundary) input at a daily resolution. The model outputs data for the canal system and overland flow with a 30 minute time step, and the unsaturated and saturated zones with time step of 2 and 12 hours, respectively.

The M3ENP model can provide the Central Everglades project a detailed evaluation of impacts on the ENP wetlands and adjacent developed areas under proposed alternative formulations. Structural and operational strategies considered along Tamiami Trail and the SDCS are not currently available but could be incorporated into the M3ENP. Due to these limitations, utilization of the model for CEPP may either (1) not be fully advocated by USACE; or (2) need to be applied with recognition of limitations, with results used only for a specific purpose and within a specific portion of the CEPP project area.

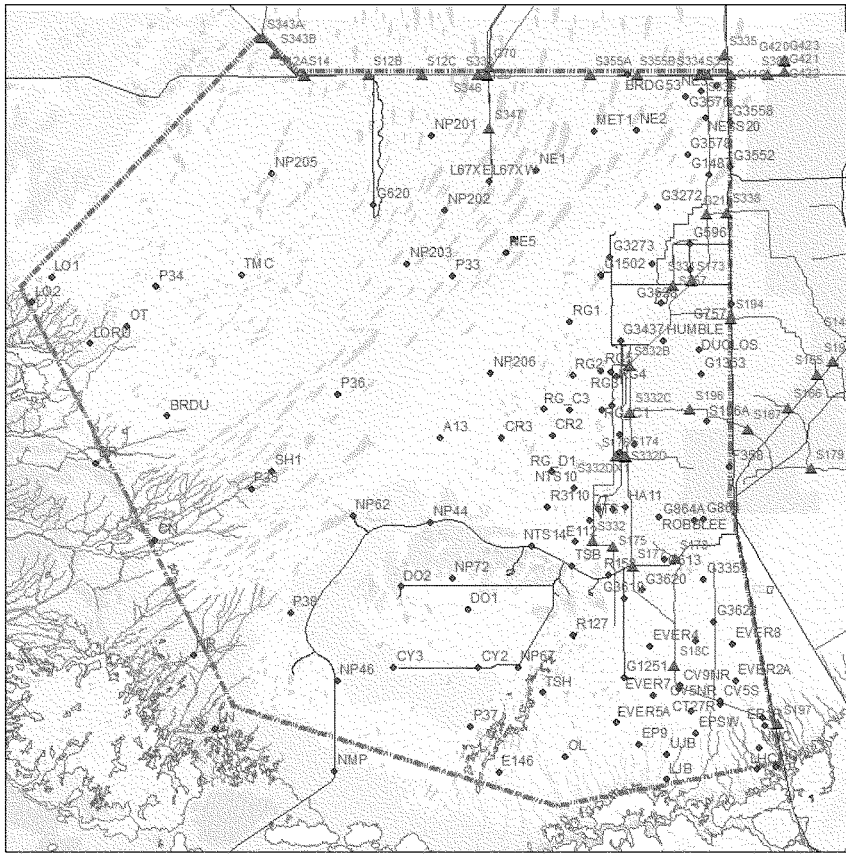

Figure 5.3.1. M3ENP MIKE-SHE/MIKE-11 model domain, showing monitoring points.

5.4 Everglades Landscape Model (ELM)

The DECOMP project plans on using the Everglades Landscape Model (ELM) to test the sensitivity of water quality loading on pristine areas for a range of potential water quality condiitons. However, for CEPP, project formulation will ensure that water quality standards will be met on all water deliveries across the red line. In addition, using ELM would be a challenge within the timeframe since it would need to be updated to adequately simulate the hydrology of alternative plans in order to represent the succession response of the landscape. For these reasons, use of ELM is not proposed for CEPP.

6.0 Model Performance Measures and Evaluation Tools

Performance measures are indicators of conditions in the natural system that have been determined to be characteristic of a healthy, restored ecosystem. Performance measures are used to predict performance of alternative plans. The CEPP team has identified a preliminary list of project performance measures to be used in the planning effort, reviewing performance measures used previously for CERP projects to quantify ecosystem benefits, as well as system-wide performance measures reviewed by RECOVER. The intent is to comprehensively evaluate all aspects of the system in a concise manner. **Table 6.1** lists a known subset of performance measures that are proposed for use. **Table 6.2** lists other indicators and evaluation tools that will be used to post-process model data. While other tools are likely to be used, these tables summarize the tools to be provided by the Modeling Team.

While this preliminary list of performance measures has been identified, evaluation strategies for the CEPP are still being developed, with the level of complexity and scope of evaluation remaining undefined as of the development of this strategy. As previously stated, the modeling tools described in this document will provide adequate hydrologic information to allow assessment of the identified performance measures to date.

Table 6.1. Performance Measures to be provided by HESM

Planning Region	Performance Measure / Evaluation Tool	Description	Original Model	Development Need
Lake Okeechobee	**Lake Stage** Extreme High and Low Water Levels in Greater Everglades Wetlands	Measure of the number and duration of extreme high and low water depth events.	NERSM	None identified
Northern Estuaries	**Salinity Envelopes** Oyster Habitat and Submerged Aquatic Vegetation	Measure of oyster and sea grass habitat based on frequency of flows from S-79 and S-80.	NERSM	None identified
Greater Everglades	**Hydrologic Surrogate for Soil Oxidation**	Measure of cumulative drought intensity to reduce exposure of peat to oxidation.	RSM DECOMP	41 yr extension
	Inundation Pattern in Greater Everglades Wetlands	Measure of the number and duration of inundation events used to calculate the percent period of record of inundation.	RSM DECOMP	41 yr extension
	Number and Duration of Dry Events in Shark River Slough	Measure of the number of times and mean duration in weeks that water level drops below ground.	SFWMM	Read RSM data
	Sheet flow in the Everglades Ridge and Slough Landscape	Measure of the timing and distribution of sheet flow across the landscape.	RSM DECOMP	41 yr extension
	Slough Vegetation Suitability	Measure to evaluate the hydrologic suitability for slough vegetation.	RSM DECOMP	41 yr extension

Table 6.2. Other Indicators and Evaluation Tools to be provided by HESM

Performance Measure / Evaluation Tool	Original Model	Development Need
Lake Okeechobee Minimum Flows & Levels Evaluation	NERSM	None identified
Lake Okeechobee Service Area Water Supply 4 in 1	NERSM	Use RSMBN data for eaa
Lake Okeechobee Service Area Water Supply Worst Years	NERSM	Use RSMBN data for EAA
Lower East Coast 1983-93 Window Performance Measure	SFWMM	Read RSM data
Everglades Viewing Windows	ALL	None identified
Hydrologic Maps (Flow Vector, Hydroperiod, Ponding, etc.)	RSM DECOMP	None identified
Everglades Restoration Transition Plan Performance Measures and Ecological Targets		Migrate from xls app to PMS
Cape Sable Seaside Sparrow	SFWMM	Read RSM data
Florida Bay Salinity	SFWMM	41 yr extension; Read RSM data; check on regression validities

7.0 Model Certification / Approval for Use

In parallel with the CEPP modeling analysis phase, the USACE processes for seeking model approval for use will be initiated on models that currently have not received the preferred designation. It is anticipated that staff from the USACE Jacksonville Engineering branch will work with the CEPP modeling team to generate and submit any necessary packages of information and facilitate working through any necessary responses as the process progresses.

8.0 Sources of Additional Information

The following sources represent a partial reference list:

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ANNEX A-2: REFERENCE 2

RSM-BN AND RSM-GL MODELING ASSUMPTIONS TABLES

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN)
2010 / 2011 Existing Conditions Baseline (ECB)
Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/12, as reflected in the LOSA Ledger produced by the Water Use Bureau • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE. ○ A regional hydrologic surrogate for the 2010 Adaptive Protocol operations utilized. This attempts to mimic desired timing of releases without estimating salinity criteria • Lake Okeechobee Water Shortage Management (LOWSM) Plan • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and s-3 is to be minimized) • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages

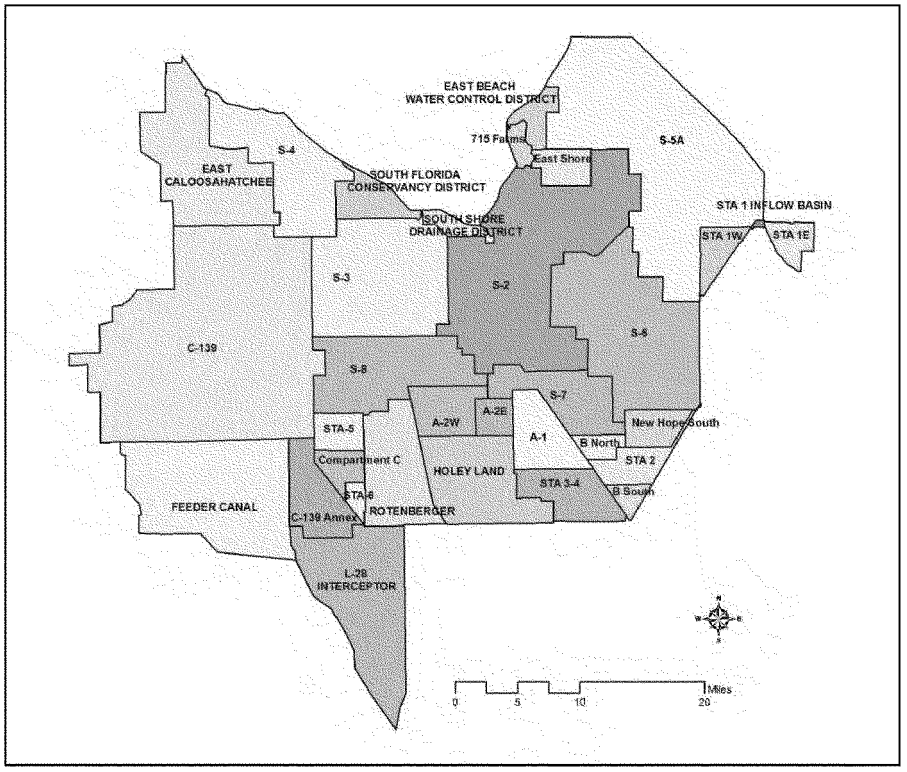
Feature	
	recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Kissimmee River inflows based on interim schedule for Kissimmee Chain of Lakes using the UKISS model • Restored reaches / pools of Kissimmee River as of 2010 • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Public water supply daily intake from the river is included in the analysis.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if the lake stage is 0.25 ft below the Zone D pulse release line. • Basin demands include the Florida Power & Light reservoir at Indiantown.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons/month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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

Feature	
Everglades Agricultural Area	• Model water-body components as shown in Figure 1 below. • Simulated runoff from the North New River – Hillsboro basin will be apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin • EAA runoff and irrigation demand compared to SFWMM (ECB) simulated runoff and demand from 1965-2005 for reasonability • Compartment C land in the Miami Canal Basin between STA-5 and STA-6 is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area. • Compartment B (excluding cell 4) land in the North New River/Hillsboro is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area.

Stormwater Treatment Areas	• STAs are simulated as single waterbodies
	• STA-1E: 6,546 acres total area
	• STA-1W: 7,488 acres total area
	• S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E
	• STA-2: includes first four cells: 9,910 acres total area
	• STA-3/4: 17,126 acres total area
	• STA-5: includes first 3 cells: 7,619 acres total area
	• STA-6: 2,486 acres total area
	• Assumed operations of STAs:
	  • 0.5 ft minimum depth below which supply from external sources is triggered
	  • 4 ft maximum depth above which inflows are discontinued
	• STA-3/4 receives Lake Okeechobee regulatory releases approximately at 60,000 acre-feet annual average for the entire period of record.

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL ECB.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5; G406 flows routed to STA6 • C139 basin demand is met primarily by local groundwater
Water Shortage	• Reflects the existing water shortage policies as in South Florida

Feature	
Rules	Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2W
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + A-1 + B North
+ B South + New Hope South
WPB Water-Body = S-5A

Fig. 1 RSMBSN Basin Definition within the EAA: Existing Conditions Baseline Simulation

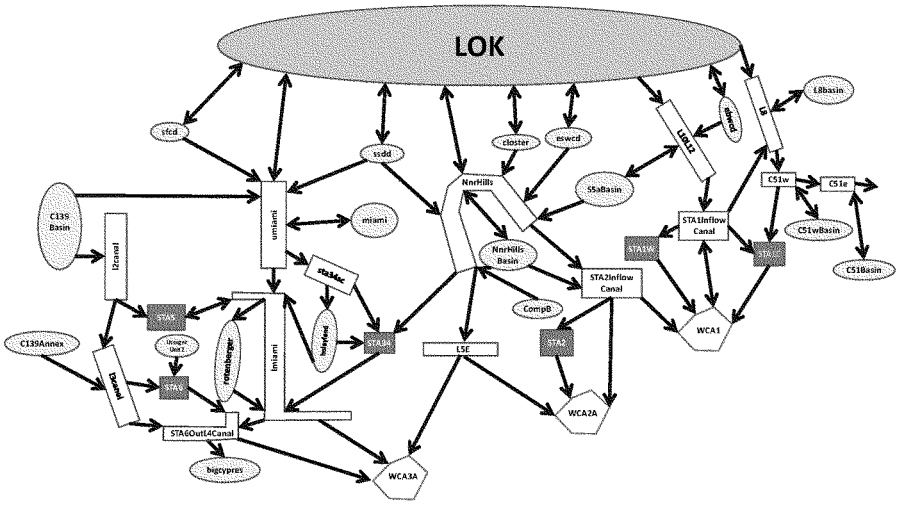


Fig. 2 RSMBSN Link-Node Routing Diagram: Existing Conditions Baseline Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) 2010 / 2011 Existing Conditions Baseline (ECB) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • 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 and in the Western Basins assumed.
Lake Belt Lakes	• Based on 2005 Lake Belt Lake coverage obtained from USACE.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional System

Feature	
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule. 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	• Current C&SF regulation schedule for WCA-3A, as per Water Control Plan –Interim Operational Plan (IOP) for protection of the Cape Sable seaside sparrow- C&SF Project for Flood Control and other Purposes (USACE, June 2006) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon the Interim Operational Plan (IOP) • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • Tamiami Trail culverts east of the L67 Extension are simulated. • 5.5 miles remain of the L-67 Extension Levee. • S-355A & S-355B are operated. • S-356 is not operated. • Partial construction of C-111 project reservoirs consistent with the 2009 as-built information from USACE (does not include contract 8 or contract 9). A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • S-332DX1 is not operated. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay

Feature	
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Industrial pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2010
	• 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)
	• S-25B and S-26 pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary
	• 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 flood control discharges are sent to STA-1E through the S-319 structure
	• Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Interim Operational Plan (IOP):
	  ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15
	  ○ Structure S-12B is closed Jan. 1 to July 15
	  ○ Structure S-12C is closed Feb. 1 to July 15
	• South Dade Conveyance System operations will follow IOP for protection of the Cape Sable seaside sparrow

Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • 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.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) 2012 Existing Conditions (2012EC) Baseline Table of Assumptions

Note: RSMBN CEPP 2012EC (2/28/13) is identical to the RSMBN CEPP ECB (12/13/12)

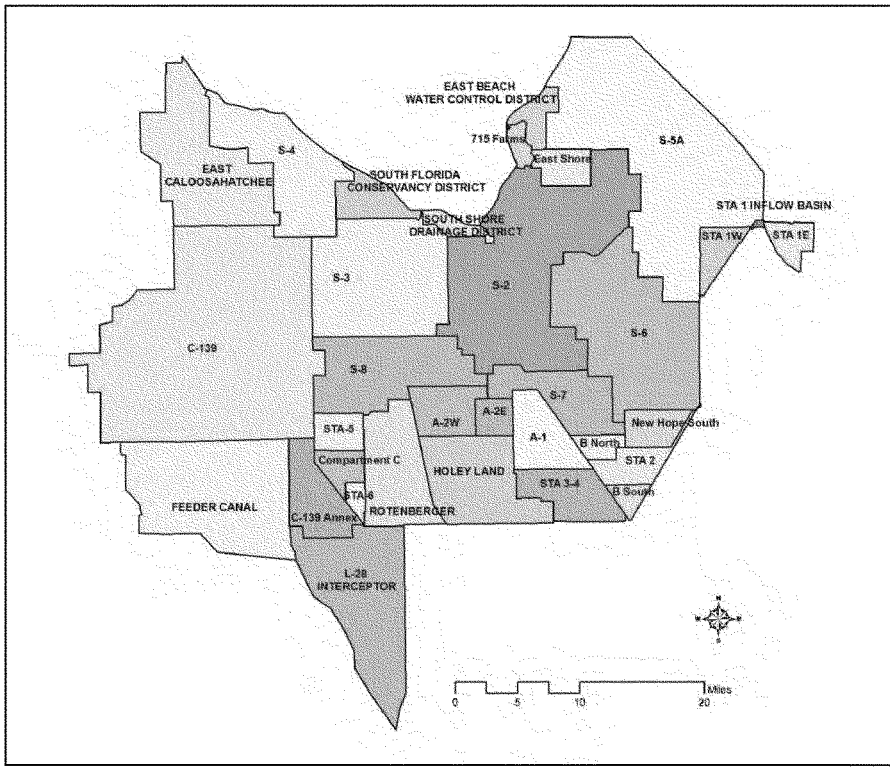
Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/12, as reflected in the LOSA Ledger produced by the Water Use Bureau • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).

Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008)
	  ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals
	  ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE.
	  ○ A regional hydrologic surrogate for the 2010 Adaptive Protocol operations utilized. This attempts to mimic desired timing of releases without estimating salinity criteria
	• Lake Okeechobee Water Shortage Management (LOWSM) Plan
	• Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized)
	• "Temporary" forward pumps as follows:
	  ○ S354 – 400 cfs
	  ○ S351 – 600 cfs
	  ○ S352 – 400 cfs

Feature	
	○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Kissimmee River inflows based on interim schedule for Kissimmee Chain of Lakes using the UKISS model • Restored reaches / pools of Kissimmee River as of 2010 • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Public water supply daily intake from the river is included in the analysis.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if the lake stage is 0.25 ft below the Zone D pulse release line. • Basin demands include the Florida Power & Light reservoir at Indiantown.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage • The 2-in10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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

Feature	
Everglades Agricultural Area	• Model water-body components as shown in Figure 1 below. • Simulated runoff from the North New River – Hillsboro basin will be apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin • EAA runoff and irrigation demand compared to SFWMM (ECB) simulated runoff and demand from 1965-2005 for reasonability • Compartment C land in the Miami Canal Basin between STA-5 and STA-6 is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area. • Compartment B (excluding cell 4) land in the North New River/Hillsboro is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area.
Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: includes first four cells: 9,910 acres total area • STA-3/4: 17,126 acres total area • STA-5: includes first 3 cells: 7,619 acres total area • STA-6: 2,486 acres total area • Assumed operations of STAs: o 0.5 ft minimum depth below which supply from external sources is triggered o 4 ft maximum depth above which inflows are discontinued • STA-3/4 receives Lake Okeechobee regulatory releases approximately at 60,000 acre-feet annual average for the entire period of record.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL ECB.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5; G406 flows routed to STA6 • C139 basin demand is met primarily by local groundwater

Feature	
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2W
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + B North
+ B South + New Hope South
WPB Water-Body = S-5A

Fig. 1 RSMBSN Basin Definition within the EAA: 2012 Existing Conditions Simulation

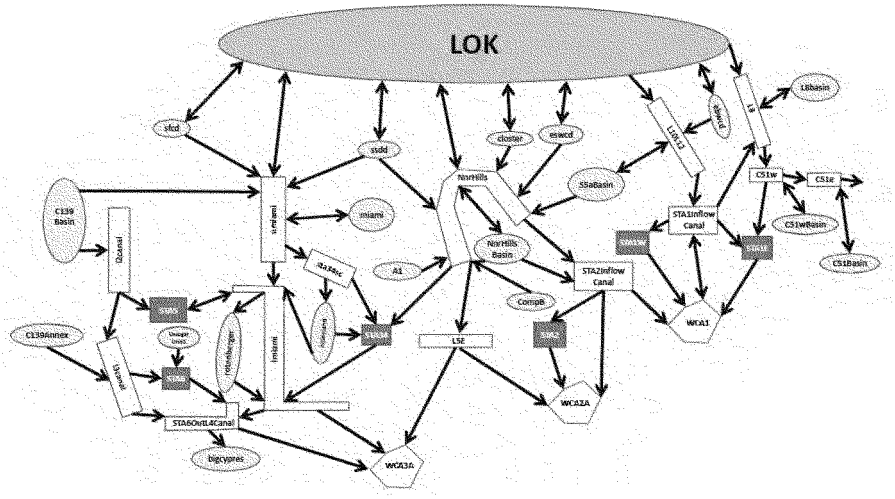


Fig. 2 RSMBSN Link-Node Routing Diagram: 2012 Existing Conditions Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- 2012EC assumptions were updated from the CEPP 12/13/2012 ECB scenario at the time that the CEPP tentatively selected plan was identified.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) 2012 Existing Conditions (2012EC) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • 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 and in the Western Basins assumed.
Lake Belt Lakes	• Based on 2005 Lake Belt Lake coverage obtained from USACE.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional System

Feature	
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012). • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • Tamiami Trail culverts east of the L67 Extension are simulated. • 5.5 miles remain of the L-67 Extension Levee. • S-355A & S-355B are operated. • S-356 is not operated. • Partial construction of C-111 project reservoirs consistent with the 2009 as-built information from USACE (does not include contract 8 or contract 9). A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • S-332DX1 is not operated. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay

Feature	
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Industrial pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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). ○ S9/S9A operations modified for performance consistency with SFWMM ECB. • S-25B and S-26 pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 ○ Structure S-12B is closed Jan. 1 to July 15 • South Dade Conveyance System operations will follow ERTP for protection of the Cape Sable seaside sparrow
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal.
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. The Lower East Coast Subregional (LECsR) model is the source of this data.

Feature	
	• 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.
- 2012EC assumptions were updated from the CEPP 12/13/2012 ECB scenario at the time that the CEPP tentatively selected plan was identified.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN)
2050 Future Without Project Baseline (FWO)
Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE. ○ Releases via S-77 can be diverted into C43 Reservoir • No Lake Okeechobee environmental releases. • Lake Okeechobee Water Shortage Management (LOWSM) Plan • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and s-3 is to be minimized) • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages

Feature	
	recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.

St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row).
	• Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is 0.25 ft. below the Zone D pulse release line before being pumped into the C-44 reservoir.
	• Basin demands include the Florida Power & Light reservoir at Indiantown.
	• Indian River Lagoon South Project features
	  • Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin
	  • C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint
	  • C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint
	  • C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint
	  • All proposed reservoirs meet estuary demands

Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons/month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal

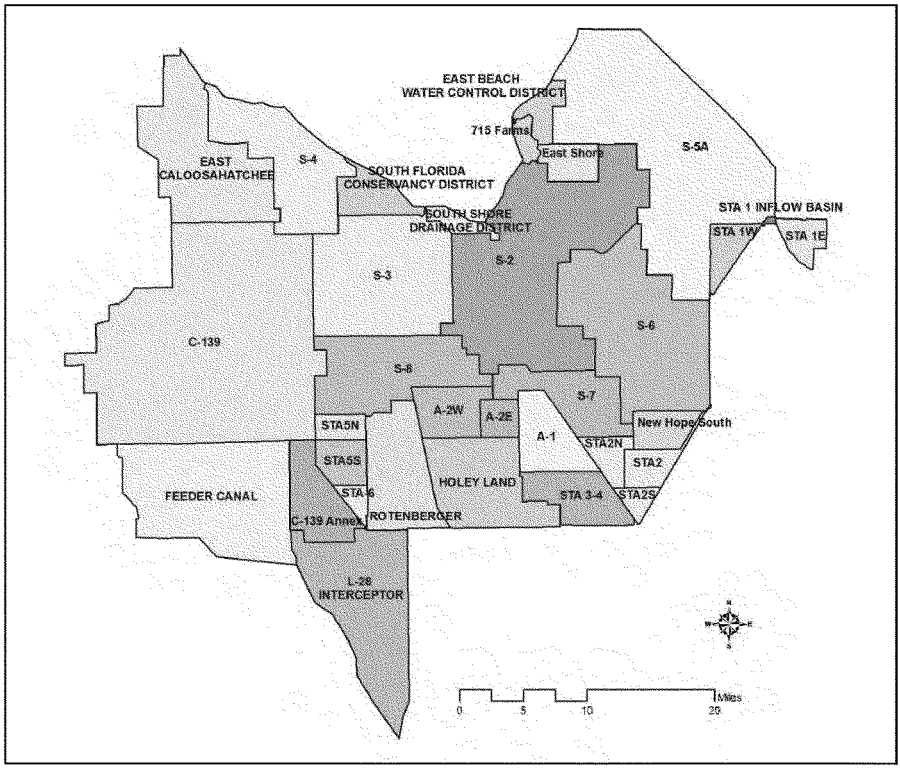
Feature	
	rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.

Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies
	• STA-1E: 6,546 acres total area
	• STA-1W: 7,488 acres total area
	• S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E
	• STA-2: cells 1,2 & 3: 7,681 acres total area
	• STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area
	• STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area
	• STA-3/4: 17,126 acres total area
	• STA-5N: includes cells 1 & 2: 5,081 acres total area
	• STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area
	• STA-6: expanded with phase 2: 3,054 acres total area
	• Assumed operations of STAs:
	  • 0.5 ft minimum depth below which supply from external sources is triggered
	  • 4 ft maximum depth above which inflows are discontinued
	  • Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK regulatory discharge and available A1FEB storage.
	  • STA-3/4 receives Lake Okeechobee regulation target releases approximately at 60,000 acre-feet annual average for the entire

Feature	

	period of record.
	• A 15,853-acre Flow Equalization Basin (FEB) located north of STA-3/4.
	• Assumed operations of A1FEB:
	  • FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south
	  • FEB outflows are used to help meet established inflow targets (as estimated using the Dynamic Model for Stormwater Treatment Areas) at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK regulatory discharge are not sufficient.
	  • 0.5 ft minimum depth below which no releases are allowed
	  • 3.8 ft maximum depth above which inflows are discontinued
	  • Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures.
	  • Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower North New River canal.

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL FWO.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6C139 basin demand is met primarily by local groundwater
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan



Water-Body Components:
Miami Water-Body = S3 + S8
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + New Hope South
WPB Water-Body = S-5A
A1FEB = A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Future Without Project Baseline Simulation

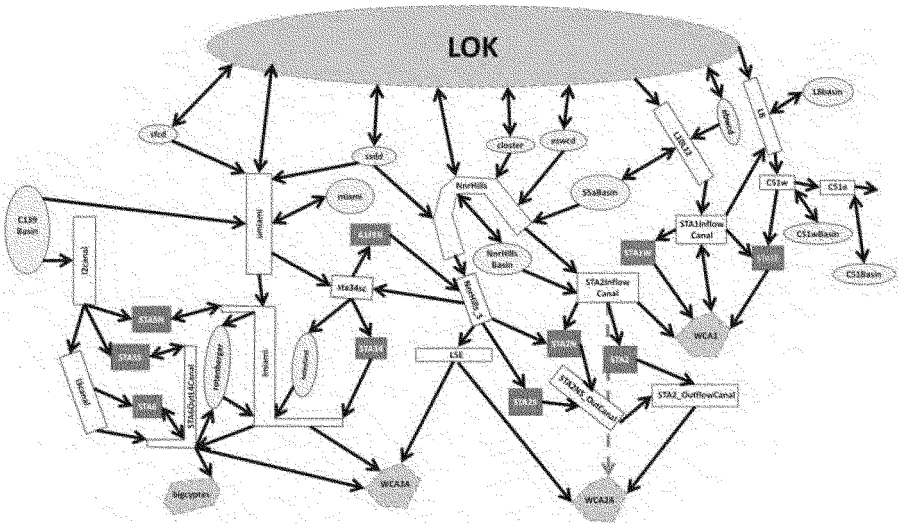


Fig. 2 RSMBSN Link-Node Routing Diagram: Future Without Project Baseline Simulation

Note:

- 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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
2050 Future Without Project Baseline (FWO)
Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.

Feature	
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 Tamiami Trail Limited Reevaluation Report is modeled as a one mile weir. Located east of the L67 extension and west of the S334 structure. • 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. • S-356 is not operated. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2010 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is based on 2010 permits. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2010 • 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

Feature	
	• C-11 Water Quality Treatment Critical Project (S-381 and S-9A) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal and CERP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO 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.

`Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

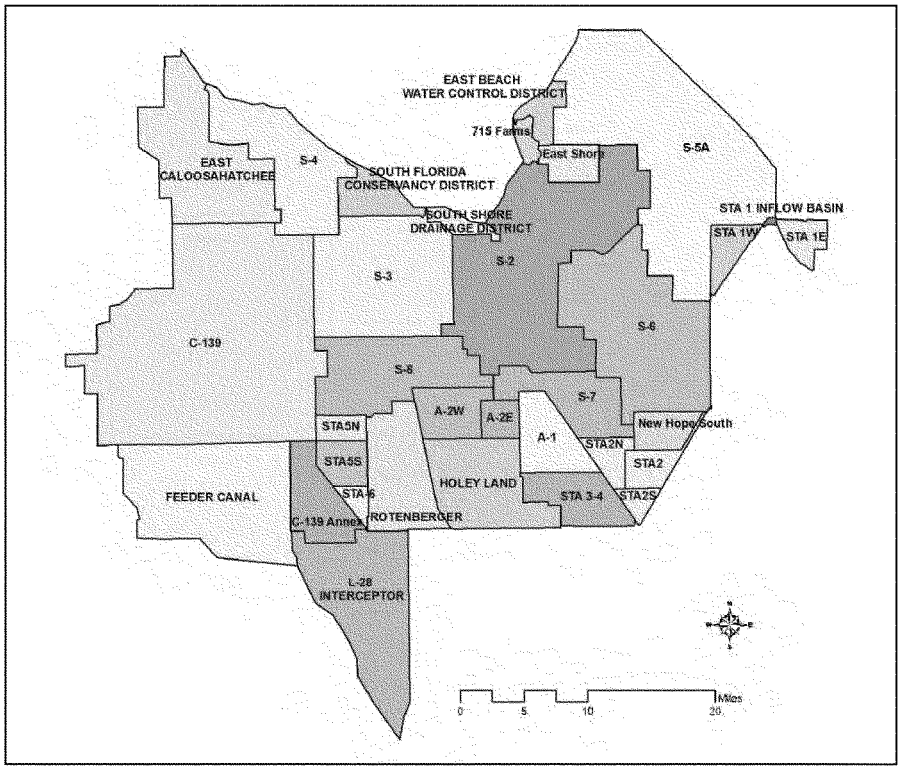
Regional Simulation Model Basins (RSMBN)
Initial Operating Regime Baseline 1 (IORBL1)
Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The topography dataset for RSM was updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE. ○ Releases via S-77 can be diverted into C43 Reservoir • No Lake Okeechobee environmental releases. • Lake Okeechobee Water Shortage Management (LOWSM) Plan • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized) • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs

Feature	
	○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is 0.25 ft. below the Zone D pulse release line before being pumped into the C-44 reservoir. • Basin demands include the Florida Power & Light reservoir at Indiantown. • Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint ○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint ○ All proposed reservoirs meet estuary demands ○ IRL operations assumed are consistent with the March 2010 St. Lucie River Water Reservation Rule update. ○ Excess C23 basin water not needed to meet estuary demands can be diverted to the C44 reservoir if capacity exists.
Seminole Brighton	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage.

Feature	
Reservation	• The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area • STA-3/4: 17,126 acres total area • STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area • Assumed operations of STAs: ○ 0.5 ft minimum depth below which supply from external sources is triggered

Feature	
	○ 4 ft maximum depth above which inflows are discontinued ○ Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK regulatory discharge and available A1FEB storage. ○ STA-3/4 receives Lake Okeechobee regulation target releases approximately at 60,000 acre-feet annual average for the entire period of record. • A 15,853-acre Flow Equalization Basin (FEB) located north of STA-3/4 with assumed operations as follows: ○ FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south. ○ FEB outflows are used to help meet established inflow targets (as estimated using the Dynamic Model for Stormwater Treatment Areas) at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK regulatory discharge are not sufficient. ○ 0.5 ft minimum depth below which no releases are allowed ○ 3.8 ft maximum depth above which inflows are discontinued ○ Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures. ○ Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower North New River canal. ○ Structure capacities and water quality operating rules are consistent with modeling assumptions assumed during the A-1 FEB EIS application process.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6C139 basin demand is met primarily by local groundwater
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2W
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + New Hope South
WPB Water-Body = S-5A
A1FEB = A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Initial Operating Regime Baseline Simulation

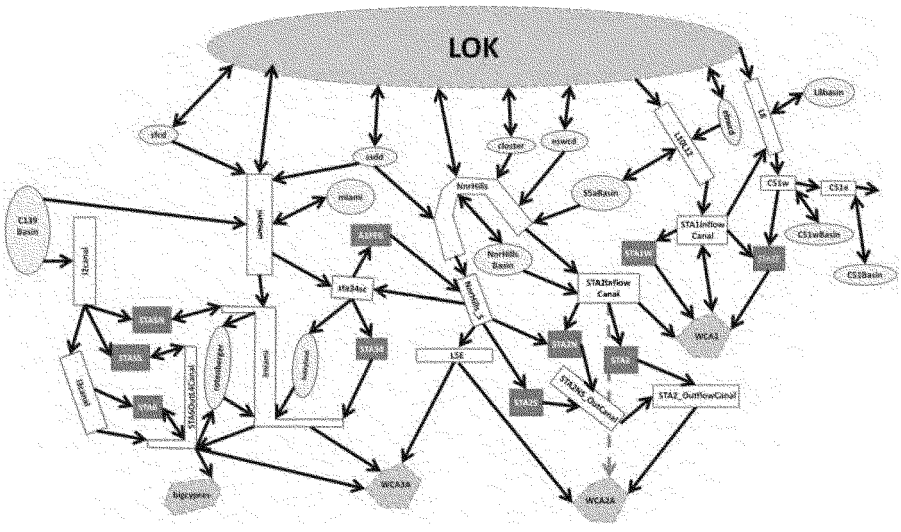


Fig. 2 RSMBSN Link-Node Routing Diagram: Initial Operating Regime Baseline Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- IORBL assumptions were updated from the CEPP 12/13/2012 FWO scenario at the time that the CEPP tentatively selected plan was identified and then adjusted for the IRL project to produce the IORBL1.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
Initial Operating Regime Baseline 1 (IORBL1)
Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. Operations refined in RSM model to closer represent project intent and outcomes.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.

Feature	
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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. • S-356 is not operated. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. o An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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.

Feature	
Canal Operations	• C&SF system and operating rules in effect in 2012 • 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 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal and CERP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the RSMBN FWO 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.
- IORBL assumptions were updated from the CEPP 12/13/2012 FWO scenario at the time that the CEPP tentatively selected plan was identified and then adjusted for the Broward County WPA project to produce the IORBL1.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) Alternative 4 Revised (ALT4R) Scenario Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005. • Rainfall estimates have been revised and updated for 1965-2005. • Revised evapotranspiration methods have been used for 1965-2005.
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004; • High Accuracy Elevation Data, US Geological Survey 2007; • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004; • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007; • Palm Beach County LiDAR Surve, Dewberry and Davis, 2004; and • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information . • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass.
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ CEPP optimized release guidance in order to improve selected performance within LOK, the northern estuaries and LOSA while meeting environmental targets in the Glades. ○ Lake Okeechobee can send flood releases south through the Miami Canal and North New River Canal to the FEB when the LOK stage is above the bottom of Zone D and the FEB depth is below 2' (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Lake Okeechobee can send flood releases south to help meet water-quality based flow targets at STA-3/4, STA-2N, and STA-2S when the LOK stage is above the bottom of the Baseflow Zone (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Includes Lake Okeechobee regulatory releases to tide via L8 canal.

Feature	
	○ Releases via S-77 can be diverted into C43 Reservoir • Lake Okeechobee Water Shortage Management (LOWSM) Plan. • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized). • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model. • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is 0.25 ft. below the Zone D pulse release line before being pumped into the C-44 reservoir. • Basin demands include the Florida Power & Light reservoir at Indiantown. • Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin; ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint; C44 reservoir releases water back to Lake Okeechobee when Lake stages are below the bottom of the Baseflow Zone. ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint; ○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint; and ○ All proposed reservoirs meet estuary demands.

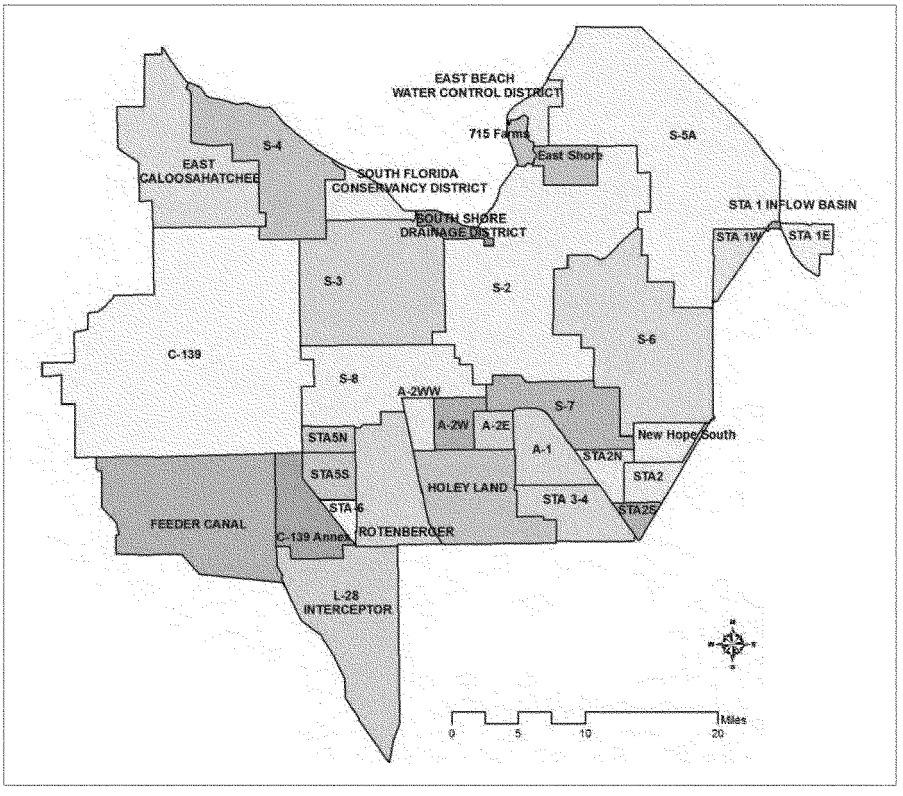
Feature	
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved. • LOWSM applies to this agreement.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. • 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.
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area • STA-3/4: 17,126 acres total area • STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area

Feature	

	• Assumed operations of STAs:
	  ○ 0.5 ft minimum depth below which supply from external sources is triggered;
	  ○ 4 ft maximum depth above which inflows are discontinued; and
	  ○ Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK flood releases and available FEB storage.
	• A 29,617-acre Flow Equalization Basin (FEB) located north of STA-3/4 and Holeyland. The total footprint represents the original 15,853-acre A-1 footprint plus the additional 13,764-acre A-2 footprint operated as follows:
	  ○ Assumed average topography of 9.63 ft NGVD. FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south;
	  ○ FEB outflows are used to help meet established inflow targets at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK flood releases are not sufficient;
	  ○ 0.5 ft minimum depth below which no releases are allowed;
	  ○ 3.8 ft maximum depth above which inflows are discontinued;
	  ○ No supplemental water supply provided to FEB;
	  ○ Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures; and
	  ○ Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower Miami and lower North New River canals.

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for keeping the water table from going lower than half a foot below land surface elevation. • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FL Fish and Wildlife Conservation (FWC) Commission and the SFWMD.
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA. (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL FWO.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6. • C139 basin demand is met primarily by local groundwater.

Feature	
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2WW
NNR/HILLS Water-Body = S2 + S6 + S7 + New Hope South
WPB Water-Body = S-5A
FEB = A-2W + A-2E + A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Alternative 4 Revised (ALT4R) Scenario

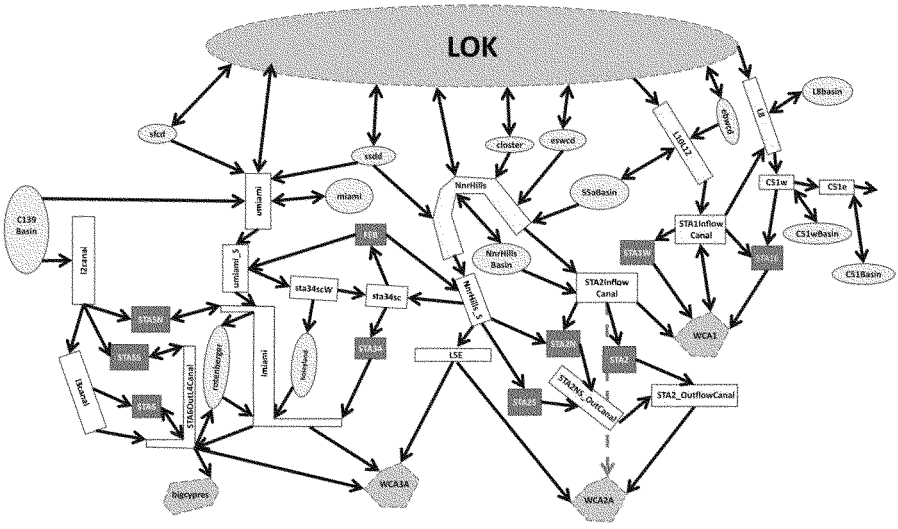


Fig. 2 RSMBSN Link-Node Routing Diagram: Alternative 4 Revised (ALT4R) Scenario

Note:

- 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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) Tentatively Selected Plan (ALT4R) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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.Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. • 2nd Generation CERP – C-111 Spreader Canal Project includes the

Feature	
	Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Diversion of L-6 flows with additional 500 cfs structure and improvements to the L-5 canal • STA-3/4 outflows routed based on Rainfall Driven Operations (RDO) – a maximum of 2500 cfs is routed to S8 and G404, with the remainder being sent to S7 • Western L-4 levee degrade (west of S-8 = 3,000 cfs capacity) • Miami Canal backfilled and spoil mound removed 1.5 miles south of S-8 to I-75 • L-28 Triangle – levee gap and canal backfill approximately 9000 ft. • Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • One 500 cfs gated structure in L-67A north of Blue Shanty levee (S345D) and associated gap in L-67C levee • Two 500 cfs gated structures in L-67A (S345F & S345G) discharging into Blue Shanty Flowway

Feature	

	• Environmental target deliveries through the S345s are determined through RDO and is spatially distributed as 40% to 345D, 35% to 345F and 25% to 345G
	• Blue Shanty Flowway assumed as follows:
	  ○ Construction of ~8.5 mile levee in WCA 3B, connecting L-67A to L-29
	  ○ Removal of L-67C levee in Blue Shanty Flowway (no canal back fill)
	  ○ Removal of L-29 levee in Blue Shanty Flowway.
	• Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002)
	• 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 or CA3 canal stage fall below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.

Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. The environmental component of the schedule is defined by RDO. If hydraulic capacity exists at the 345s, then flood control discharges are made into 3B instead of at the S12s. • S-333 capacity increased to 2,500 cfs • L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft. • L29 canal can receive inflow up to 9.7 ft (applies to both E and W segments / i.e. S333 & S356) • G-3273 constraint for operation of S-333 assumed to be 9.5 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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. • Removal of the entire 5.5 miles L-67 Extension levee, with backfill of L-67 Extension canal • S-355A & S-355B are operated.

Feature	
	• Capacity of S-356 pump increased to 1000 cfs. S-356 is operated to manage seepage. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. o An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation. • Partial depth, approximately 4 mile long seepage barrier south of Tamiami Trail (along L-31N)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure

Feature	

	• Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1
	  ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15
	  ○ Structure S-12B is closed Jan. 1 to July 15
	• Water supply deliveries from regional system (from WCA3A: S-151/S-337) are used to maintain the L30 canal with a minimum seasonal level varying from 6.25 ft in the dry season to 5.2 ft. at the beginning of the wet season
	• G-211 / S338 operational refinements; use coastal canals to convey seepage toward Biscayne Bay during drier times.

Canal Configuration	• Canal configuration same as calibration except no L-67 Extension Canal and CERP & CEPP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO simulation.

DRAFT

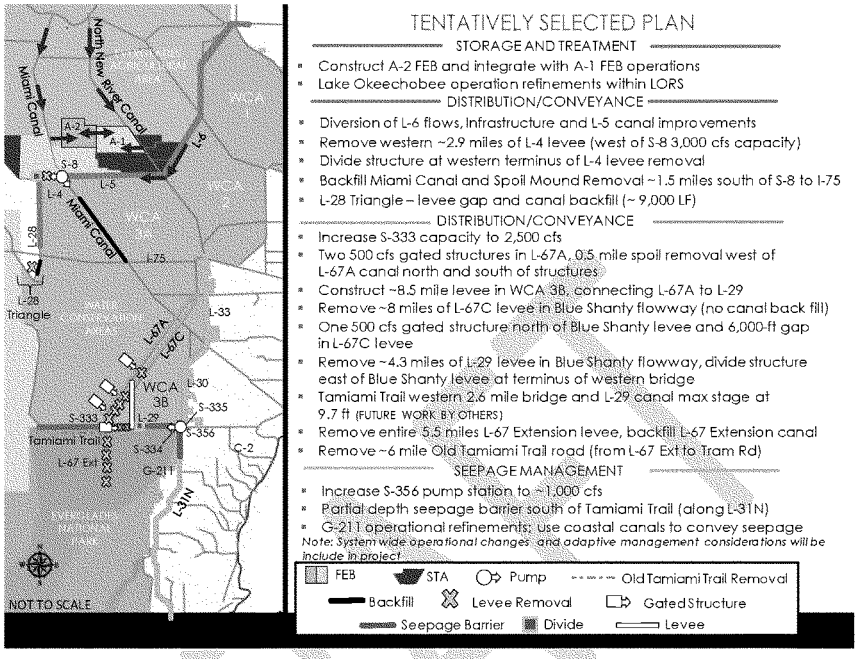


Fig. 1 CEPP ALT4R Features as defined by CEPP project team

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.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) Updated Tentatively Selected Plan (ALT4R2) Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005. • Rainfall estimates have been revised and updated for 1965-2005. • Revised evapotranspiration methods have been used for 1965-2005.
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004; • High Accuracy Elevation Data, US Geological Survey 2007; • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004; • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007; • Palm Beach County LiDAR Surve, Dewberry and Davis, 2004; and • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information . • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass.
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ CEPP optimized release guidance in order to improve selected performance within LOK, the northern estuaries and LOSA while meeting environmental targets in the Glades. ○ Lake Okeechobee can send flood releases south through the Miami Canal and North New River Canal to the FEB when the LOK stage is above the bottom of Zone D and the FEB depth is below 2' (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Lake Okeechobee can send flood releases south to help meet water-quality based flow targets at STA-3/4, STA-2N, and STA-2S when the LOK stage is above the bottom of the Baseflow Zone (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Includes Lake Okeechobee regulatory releases to tide via L8 canal.

Feature	
	○ Releases via S-77 can be diverted into C43 Reservoir • Lake Okeechobee Water Shortage Management (LOWSM) Plan. • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized). • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model. • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	○ St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). ○ Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is 0.25 ft. below the Zone D pulse release line before being pumped into the C-44 reservoir. ○ Basin demands include the Florida Power & Light reservoir at Indiantown. ○ Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin; ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint; C44 reservoir releases water back to Lake Okeechobee when Lake stages are below the bottom of the Baseflow Zone. ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint; ○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint;

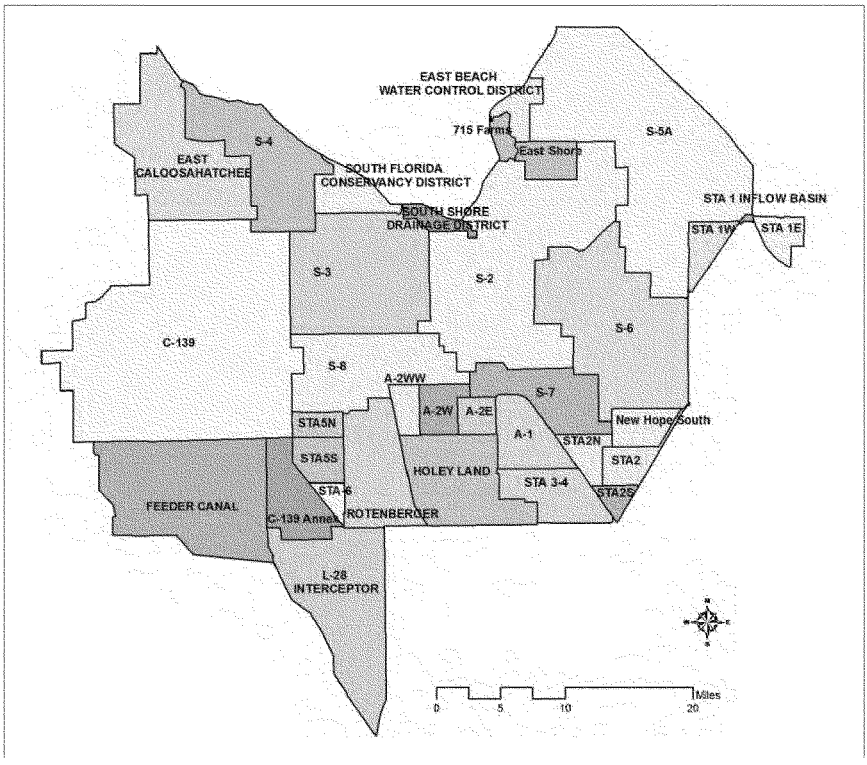
Feature	
	○ All proposed reservoirs meet estuary demands. ○ IRL operations assumed are consistent with the March 2010 St. Lucie River Water Reservation Rule update. ○ Excess C23 basin water not needed to meet estuary demands can be diverted to the C44 reservoir if capacity exists. ○ C44 reservoir can discharge to C44 canal and backflow to Lake Okeechobee when the lake is below the baseflow zone.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved. • LOWSM applies to this agreement.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. • 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.
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area • STA-3/4: 17,126 acres total area

Feature	
	• STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area • Assumed operations of STAs: o 0.5 ft minimum depth below which supply from external sources is triggered; o 4 ft maximum depth above which inflows are discontinued; and o Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK flood releases and available FEB storage. • A 29,617-acre Flow Equalization Basin (FEB) is located north of STA-3/4 and Holeyland. The total footprint represents the original 15,853-acre A-1 footprint plus the additional 13,764-acre A-2 footprint operated as follows: o Assumed average topography of 9.63 ft NGVD. FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south; o FEB outflows are used to help meet established inflow targets at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK flood releases are not sufficient; o 0.5 ft minimum depth below which no releases are allowed; o 3.8 ft maximum depth above which inflows are discontinued; o No supplemental water supply provided to FEB; o Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures; and o Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower Miami and lower North New River canals.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for keeping the water table from going lower than half a foot below land surface elevation. • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FL Fish and Wildlife Conservation (FWC) Commission and the SFWMD.
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA. (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL FWO.

Feature	
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6. • C139 basin demand is met primarily by local groundwater.
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- The RSMBN CEPP representation of ALT4R2 is the same as the June 2, 2013 ALT4R1 scenario.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2WW
NNR/HILLS Water-Body = S2 + S6 + S7 + New Hope South
WPB Water-Body = S-5A
FEB = A-2W + A-2E + A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Updated Tentatively Selected Plan (ALT4R2)

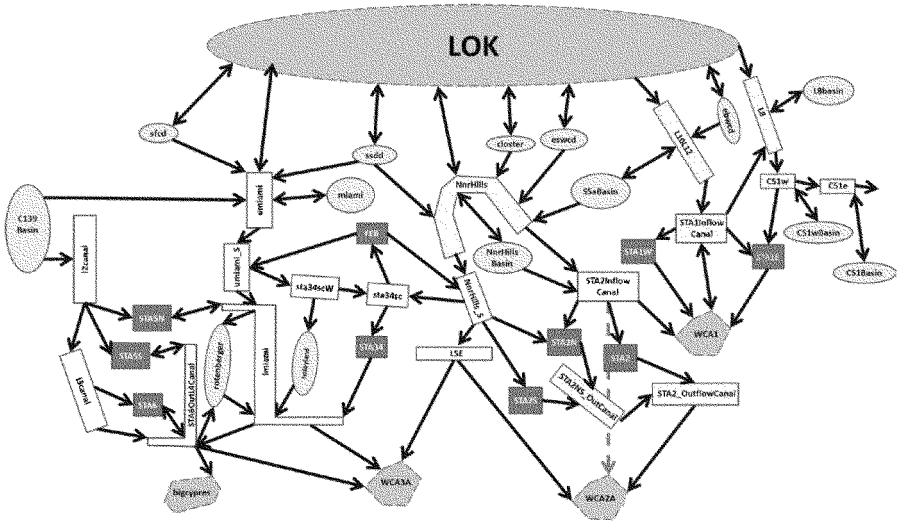


Fig. 2 RSMBSN Link-Node Routing Diagram: Updated Tentatively Selected Plan (ALT4R2)

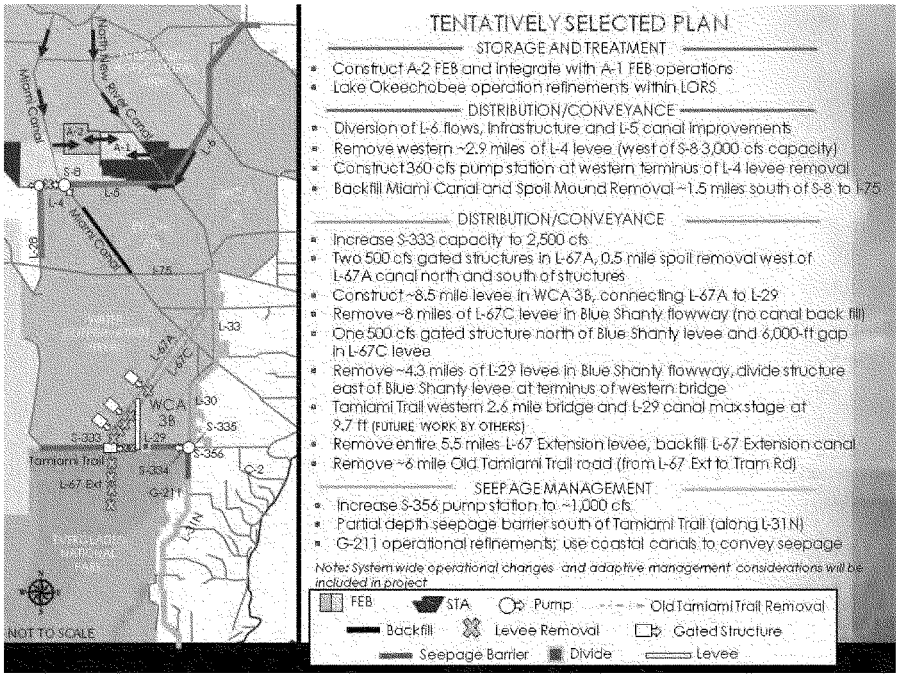


Fig. 3 CEPP ALT4R2 Features as defined by CEPP project team

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) Updated Tentatively Selected Plan (ALT4R2) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. Operations refined in RSM model to closer represent project intent and outcomes.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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 10.5 ft in WCA-2A, defined as when WCA2-U1 marsh gauge falls below 10.5 ft or L38 canal stage falls below 10.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Water Conservation Area 3A & 3B	• Diversion of L-6 flows with additional 500 cfs structure and improvements to the L-5 canal • STA-3/4 outflows routed based on Rainfall Driven Operations (RDO) – a maximum of 2500 cfs is routed to S8 and G404, with the remainder being sent to S7 • Western L-4 levee degrade with 1.5 miles retained west of S8 (west of S-8 = 3,000 cfs capacity) • Miami Canal backfilled and spoil mound removed 1.5 miles south of S-8 to I-75 • Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • One 500 cfs gated structure in L-67A north of Blue Shanty levee (S345D) and associated gap in L-67C levee

Feature	

	• Two 500 cfs gated structures in L-67A (S345F & S345G) discharging into Blue Shanty Flowway
	• Environmental target deliveries through the S345s are determined through RDO and is spatially distributed as 40% to 345D, 35% to 345F and 25% to 345G
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	  ○ Construction of ~8.5 mile levee in WCA 3B, connecting L-67A to L-29
	  ○ Removal of L-67C levee in Blue Shanty Flowway (no canal back fill)
	  ○ Removal of L-29 levee in Blue Shanty Flowway.
	• Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002)
	• 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 or CA3 canal stage falls below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.

Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. The environmental component of the schedule is defined by RDO. If hydraulic capacity exists at the 345s, then flood control discharges are made into 3B instead of at the S12s. • S-333 capacity increased to 2,500 cfs • L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft. • L29 canal can receive inflow up to 9.7 ft (applies to both E and W segments / i.e. S333 & S356 as well as S345F & S345G structure on Blue Shanty Flowway) • G-3273 constraint for operation of S-333 assumed to be 9.5 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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.

Feature	
	• Removal of the entire 5.5 miles L-67 Extension levee, with backfill of L-67 Extension canal • S-355A & S-355B are operated. • Capacity of S-356 pump increased to 1000 cfs. S-356 is operated to manage seepage. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. ○ An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation. • Partial depth, approximately 4 mile long seepage barrier south of Tamiami Trail (along L-31N)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Modeling of the TSP assumes an additional public water supply withdrawal of 12 MGD in Service Area 2 and 5 MGD in Service Area 3. • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary

Feature	
	• 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 ○ Structure S-12B is closed Jan. 1 to July 15 • Water supply deliveries from regional system (from WCA3A: S-151/S-337) are used to maintain the L30 canal with a minimum seasonal level varying from 6.25 ft in the dry season to 5.2 ft. at the beginning of the wet season • G-211 / S338 operational refinements; use coastal canals to convey seepage toward Biscayne Bay during drier times.
Canal Configuration	• Canal configuration same as calibration except no L-67 Extension Canal and CERP & CEPP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO simulation.

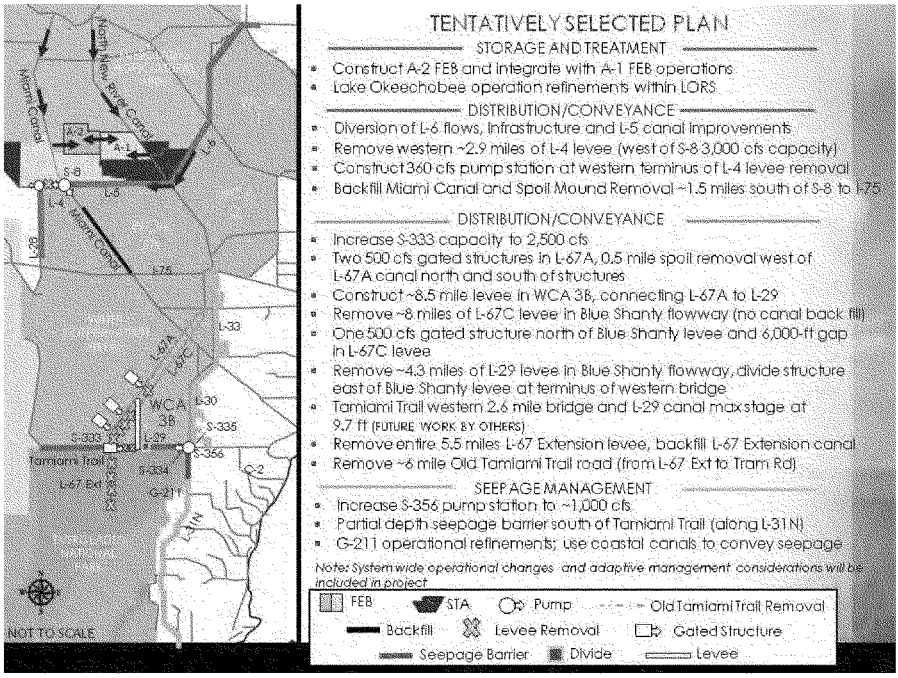


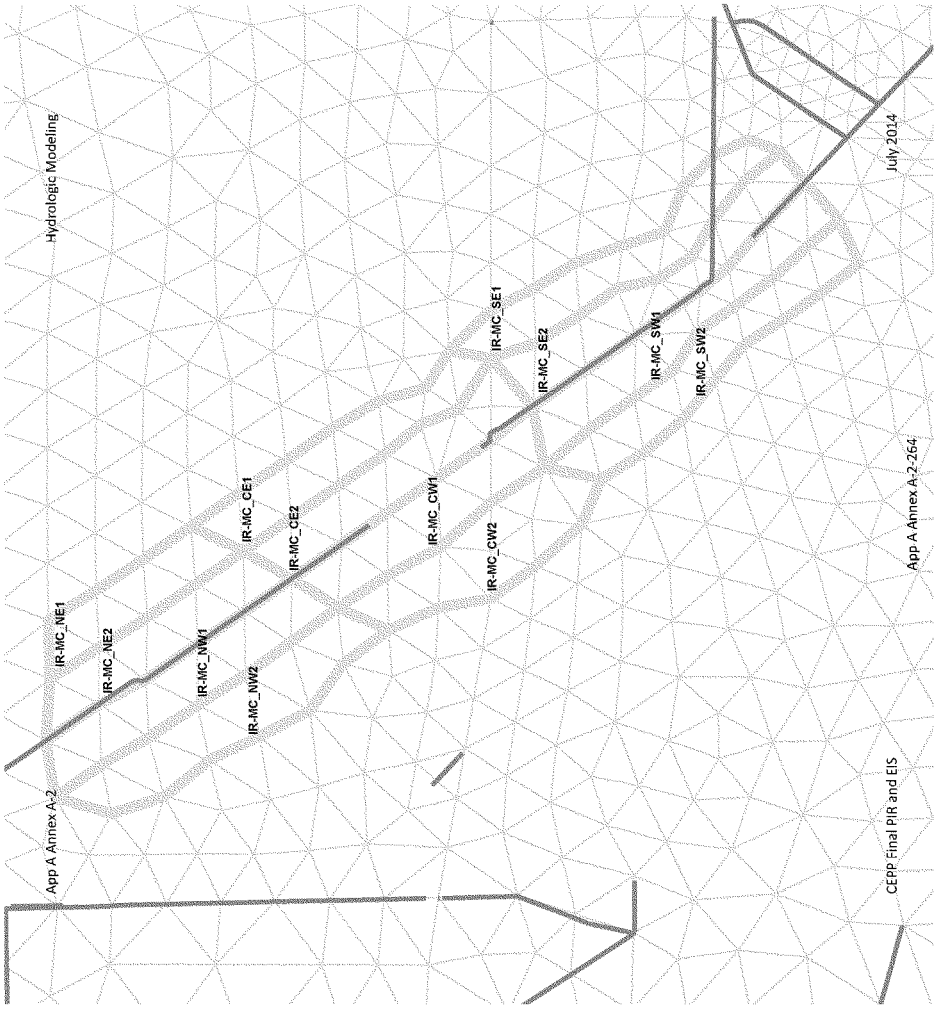
Fig. 1 CEPP ALT4R2 Features as defined by CEPP project team

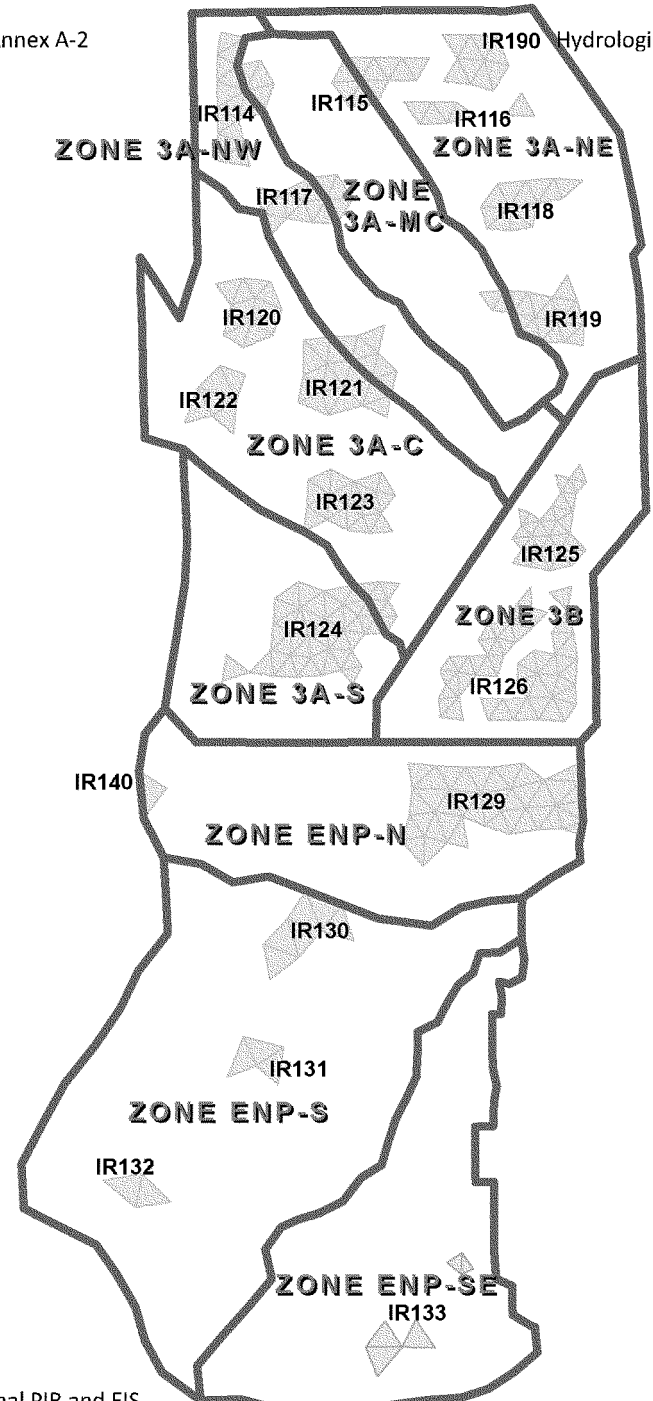
Notes:

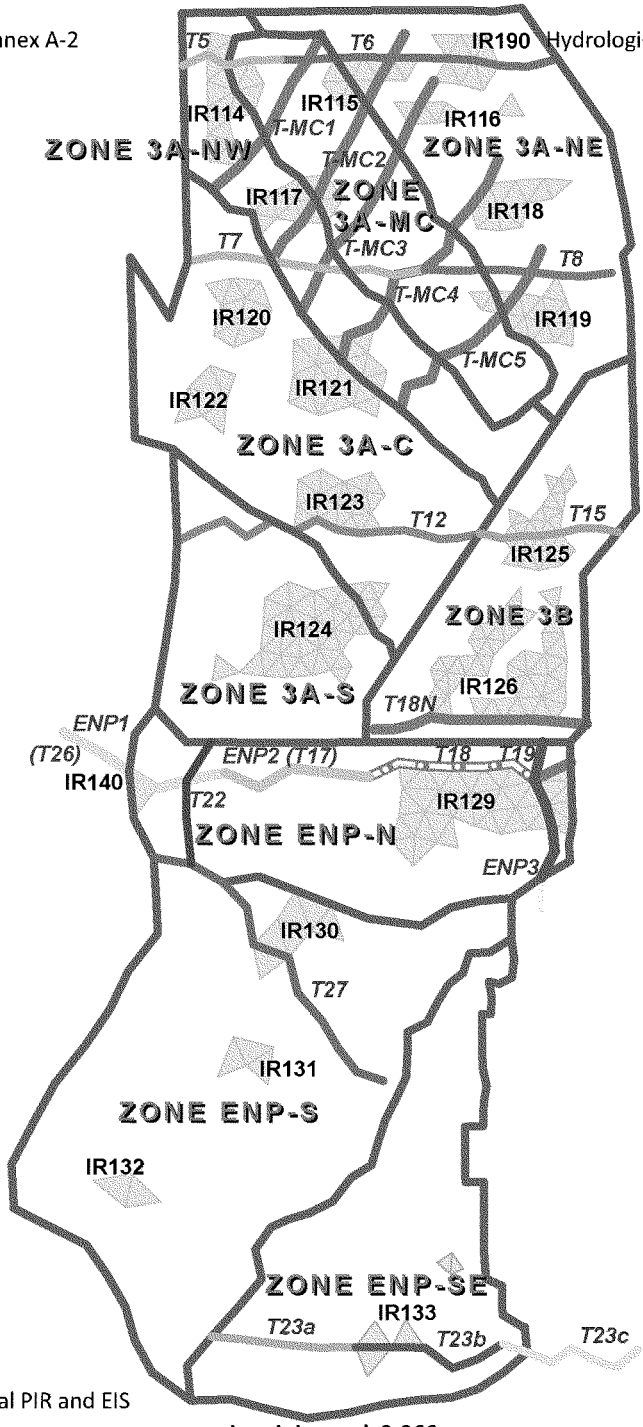
- The RSM is a robust and complex regional scale model. Due to the scale of the model, it is frequently necessary to implement abstractions of system infrastructure and operations that will, in general, mimic the intent and result of the desired project features while not matching the exact mechanism 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.

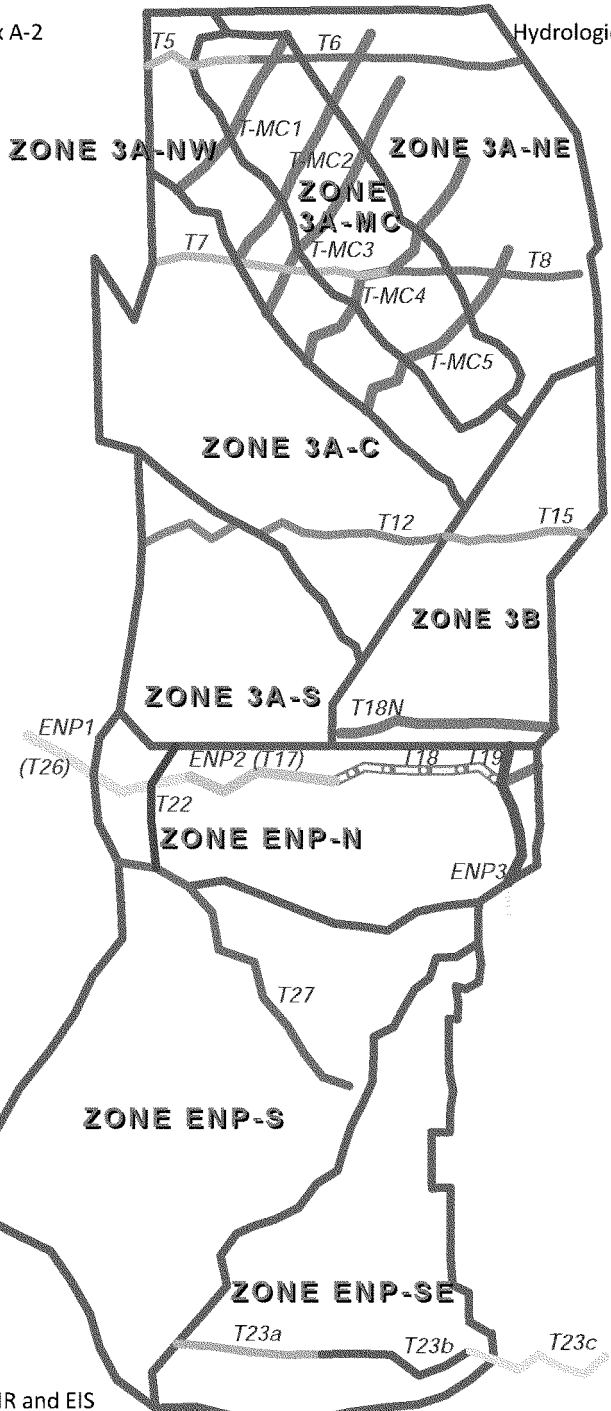
ANNEX A-2: REFERENCE 3

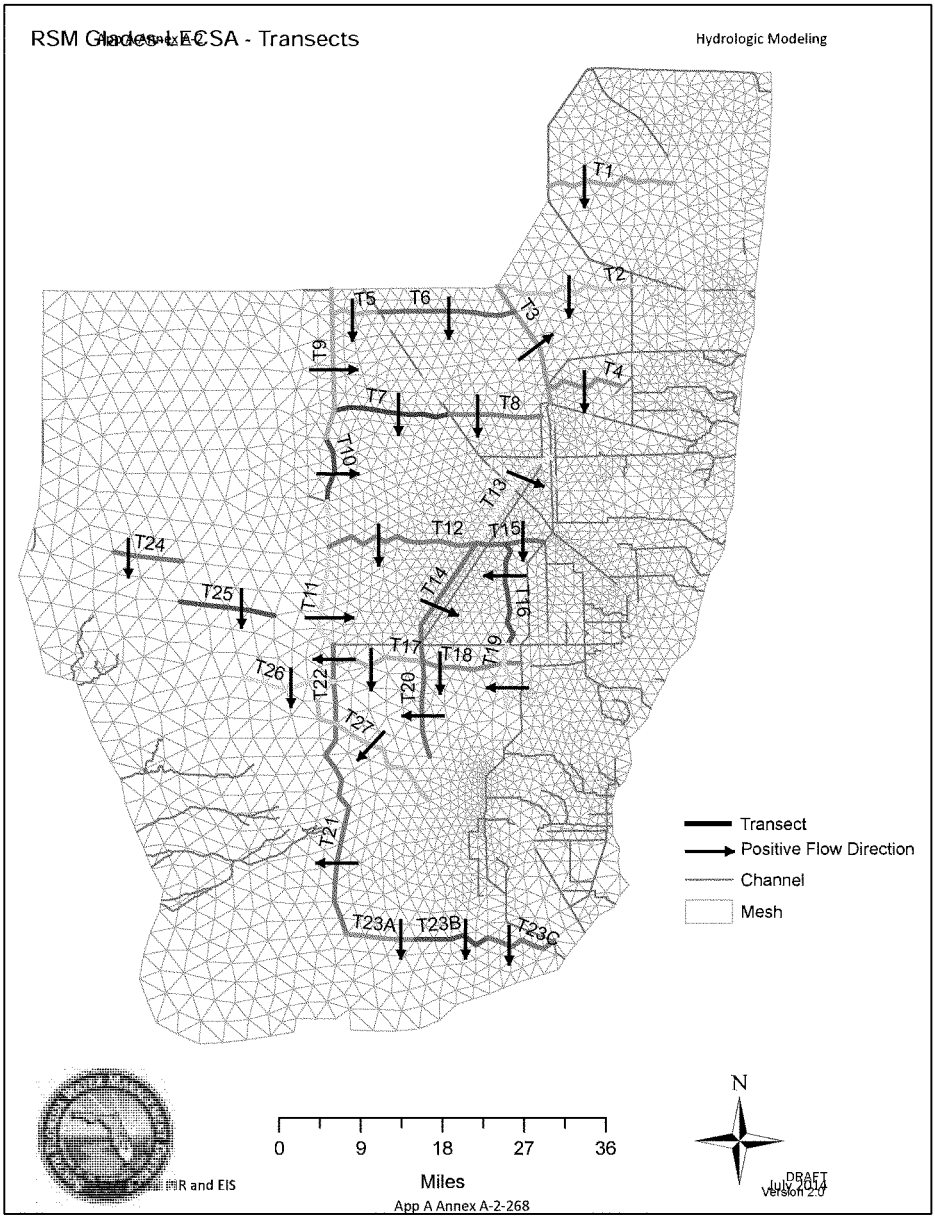
RSM-GL REFERENCE MAPS


Hydrologic Modeling
App A Annex A-2
IR-MC_NE1
IR-MC_NE2
IR-MC_NW1
IR-MC_NW2
IR-MC_CE1
IR-MC_CE2
IR-MC_CW1
IR-MC_CW2
IR-MC_SE1
IR-MC_SE2
IR-MC_SW1
IR-MC_SW2
CEPP Final PIR and EIS
App A Annex A-2-264
July 2014

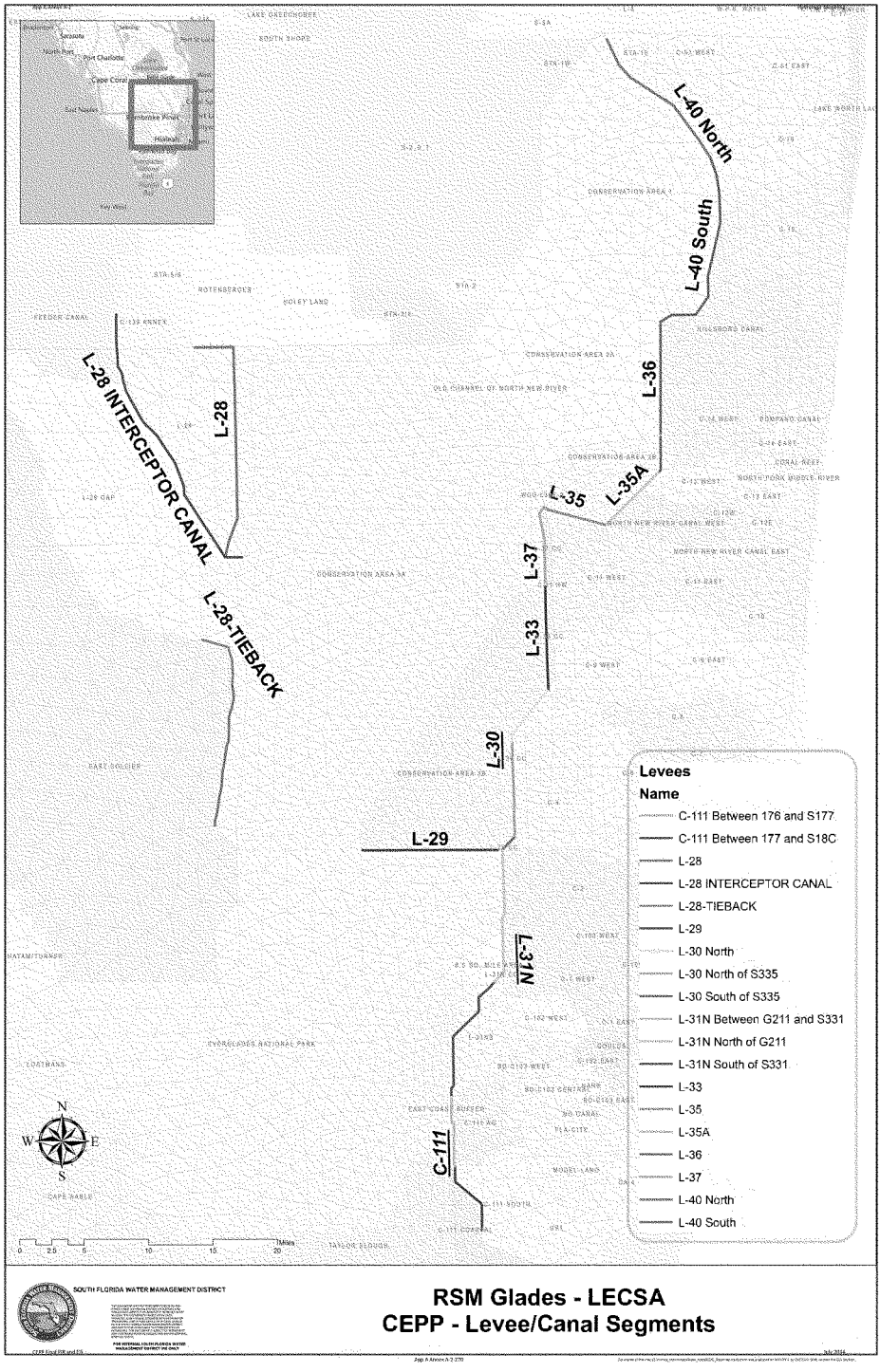

IR190
IR114
IR115
IR116
ZONE 3A-NW
ZONE 3A-NE
IR117
ZONE 3A-MC
IR118
IR120
IR119
IR122
IR121
ZONE 3A-C
IR123
IR125
ZONE 3B
IR124
ZONE 3A-S
IR126
IR140
IR129
ZONE ENP-N
IR130
IR131
ZONE ENP-S
IR132
ZONE ENP-SE
IR133

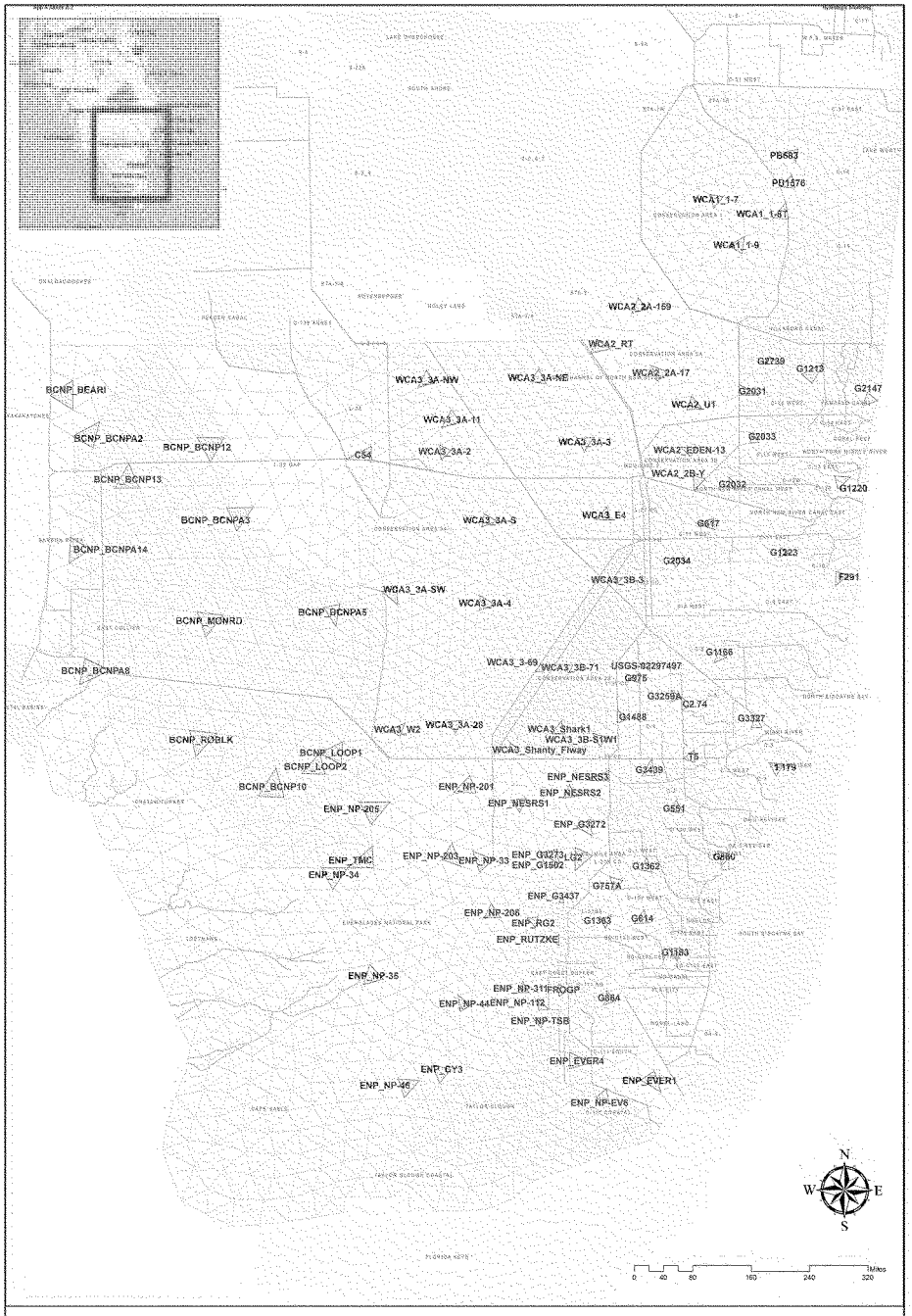

T5
T6
IR190
IR114
IR115
T-MC1
IR116
ZONE 3A-NW
T-MC2
ZONE 3A-NE
IR117
ZONE 3A-MC
IR118
T7
T-MC3
T8
T-MC4
IR120
IR119
T-MC5
IR122
IR121
ZONE 3A-C
IR123
T12
T15
IR125
ZONE 3B
IR124
ZONE 3A-S
IR126
T18N
ENP1
(T26)
ENP2 (T17)
T18
T19
IR140
T22
IR129
ZONE ENP-N
ENP3
IR130
T27
IR131
ZONE ENP-S
IR132
ZONE ENP-SE
IR133
T23a
T23b
T23c


T5
T6
ZONE 3A-NW
T-MC1
T-MC2
ZONE 3A-NE
ZONE 3A-MC
T7
T-MC3
T8
T-MC4
T-MC5
ZONE 3A-C
T12
T15
ZONE 3B
ZONE 3A-S
T18N
ENP1
(T26)
ENP2 (T17)
T18
T19
T22
ZONE ENP-N
ENP3
T27
ZONE ENP-S
ZONE ENP-SE
T23a
T23b
T23c


RSM Glades LEC SA - Transects
Hydrologic Modeling
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
T21
T22
T23A
T23B
T23C
T24
T25
T26
T27
Transect
Positive Flow Direction
Channel
Mesh
0
9
18
27
36
Miles
N
DRAFT
July 2014
Version 2.0
R and EIS
App A Annex A-2-268

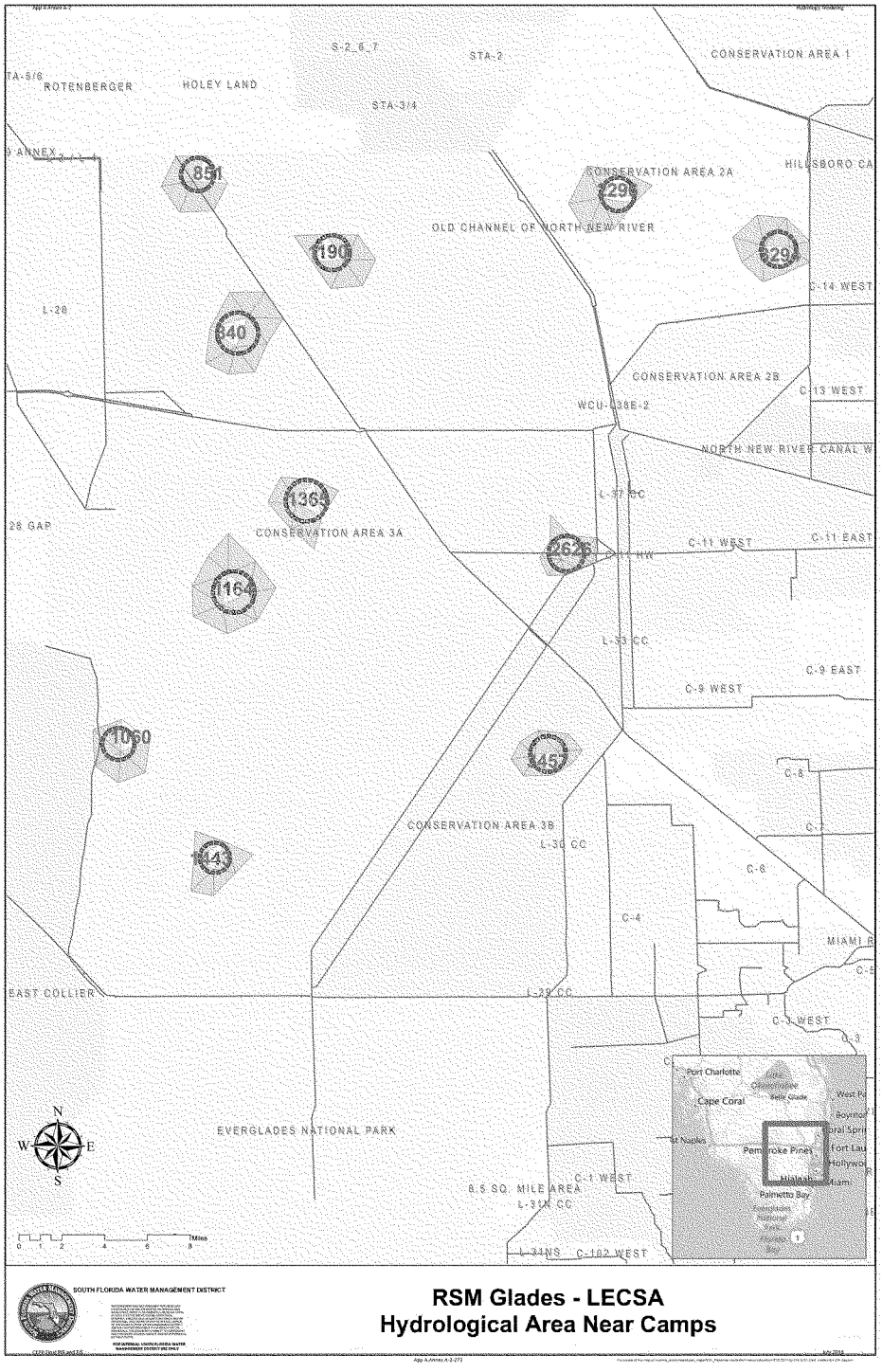
Transect	Description
T1	Southward flow in WCA-1
T2	Southward flow in WCA-2A
T3	Flow across L-38 (from WCA-3A to WCA-2)
T4	Southward flow in WCA-2B
T5	Southward flows in Northern WCA-3A (west of Miami Canal)
T6	Southward flows in Northern WCA-3A (east of Miami Canal)
T7	Southward flow in Central WCA-3A (south of Alligator Alley & west of Miami Canal)
T8	Southward flow in Central WCA-3A (south of Alligator Alley & east of Miami Canal)
T9	Eastward flows across North Western WCA-3A boundary
T10	Eastward flows across Central WCA-3A boundary
T11	Eastward flows across South Western WCA-3A boundary
T12	Southward flow in Southern WCA-3A
T13	Flows across L-67 North (from WCA-3A to WCA-3B)
T14	Flows across L-67 South (from WCA-3A to WCA-3B)
T15	Southward flow in Northern WCA-3B
T16	Westward flow in Eastern WCA-3B
T17	Southward flows in Northern ENP (South of Tamiami Trail & West of L-67 extension)
T18	Southward flows in Northern ENP (South of Tamiami Trail & East of L-67 extension)
T19	Westward flow in North Eastern ENP (west of L-31N & north of G-211)
T20	Westward flow in North-Central ENP (south of Tamiami Trail at L-67 extension)
T21	Westward flow in Western Shark River Slough
T22	Westward flow in North Western Shark River Slough
T23A	Southward flow in Southern ENP (Craighead Basin)
T23B	Southward flow in Southern ENP (Taylor Slough)
T23C	Southward flow in Southern ENP (Eastern Panhandle)
T24	Southward flow in South-Western BCNP
T25	Southward flow in South-Eastern BCNP
T26	Southward flow in Lostmans
T27	Southwestward flow in Central Shark River Slough


L-40 North
L-40 South
L-36
L-35A
L-35
L-37
L-33
L-28
L-28 INTERCEPTOR CANAL
L-28-TIEBACK
L-30
L-29
L-31N
C-111
Levees
Name
C-111 Between 176 and S177
C-111 Between 177 and S18C
L-28
L-28 INTERCEPTOR CANAL
L-28-TIEBACK
L-29
L-30 North
L-30 North of S335
L-30 South of S335
L-31N Between G211 and S331
L-31N North of G211
L-31N South of S331
L-33
L-35
L-35A
L-36
L-37
L-40 North
L-40 South
N
S
W
E
0
2.5
5
10
15
20
Miles
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM Glades - LECSA
CEPP - Levee/Canal Segments



SOUTH FLORIDA WATER MANAGEMENT DISTRICT

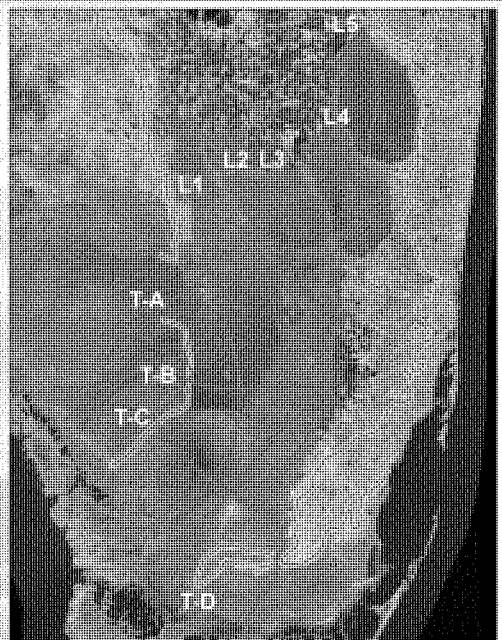
RSM Glades - LECSA
CEPP - Gauge/Cell Locations

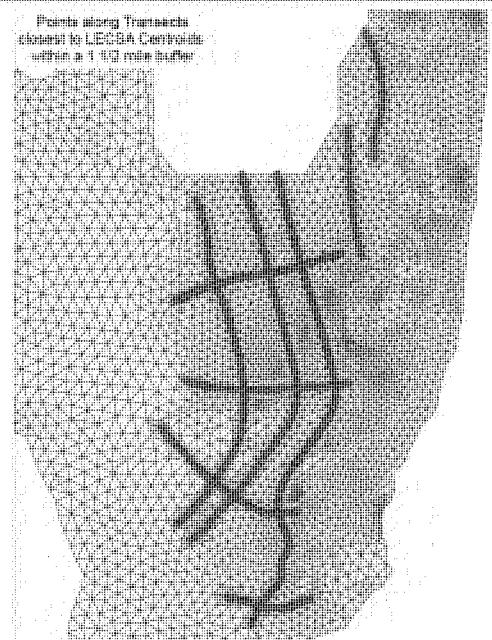

S-2, 6, 7
STA-2
CONSERVATION AREA 1
ROTENBERGER
HOLEY LAND
STA-3/4
ANNEX
851
CONSERVATION AREA 2A
HILLSBORO CA
29
OLD CHANNEL OF NORTH NEW RIVER
190
29
C-14 WEST
L-28
340
CONSERVATION AREA 2B
C-13 WEST
WCU-L38E-2
NORTH NEW RIVER CANAL W
L-37 CC
28 GAP
1363
CONSERVATION AREA 3A
2625
C-11 WEST
C-11 EAST
1164
L-33 CC
C-9 EAST
C-9 WEST
1060
457
C-8
CONSERVATION AREA 3B
L-30 CC
C-6
C-4
MIAMI R
EAST COLLIER
L-29 CC
C-3 WEST
EVERGLADES NATIONAL PARK
8.5 SQ. MILE AREA
L-31N CC
C-1 WEST
L-31NS
C-102 WEST
Port Charlotte
Cape Coral
Pembroke Pines
Palmetto Bay
Miles
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RSM Glades - LECSA
Hydrological Area Near Camps

"Everglades Viewing Window" Transects

Aligned with Landscape Directionality

RESTORATION PLANNING





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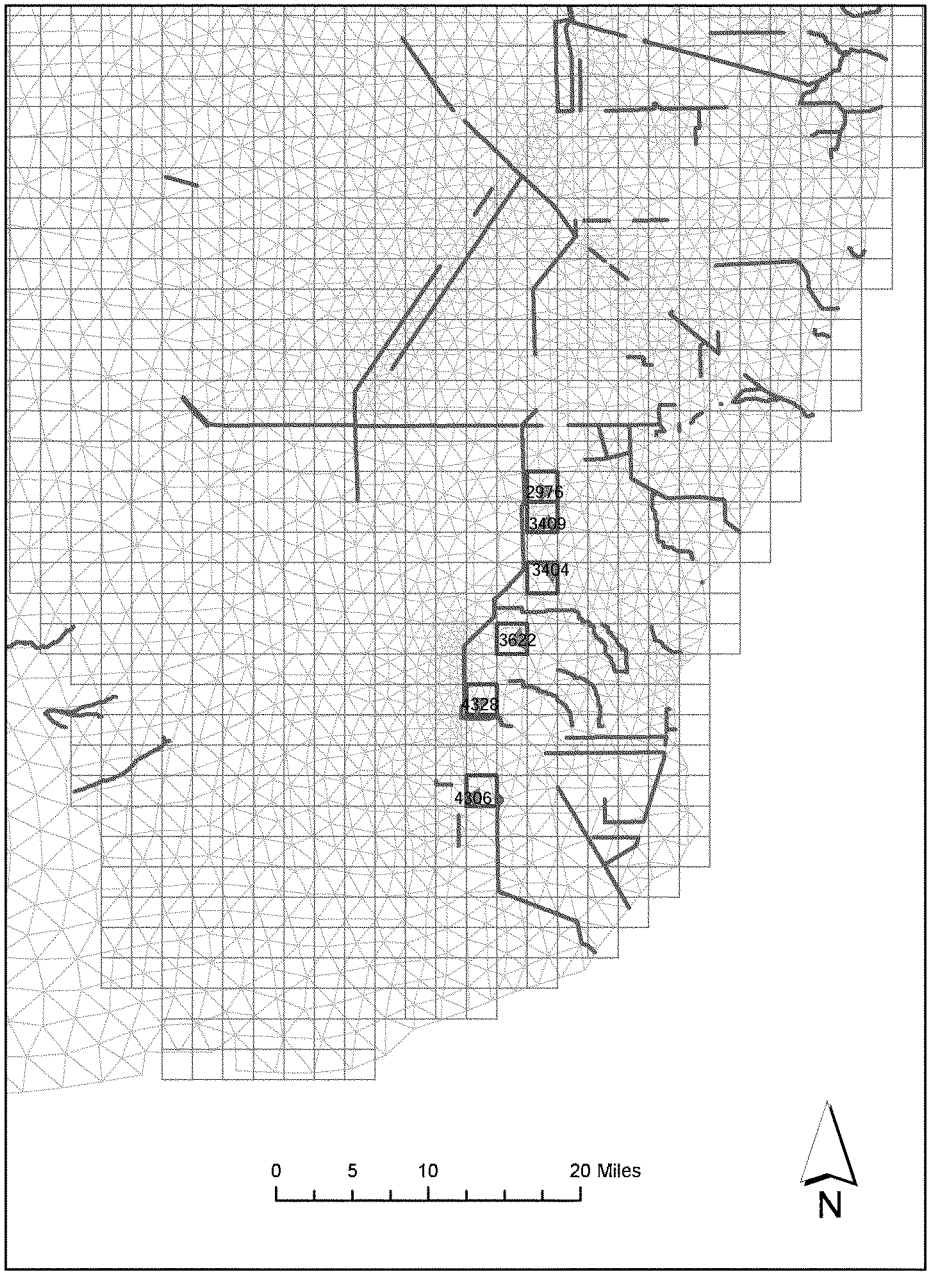
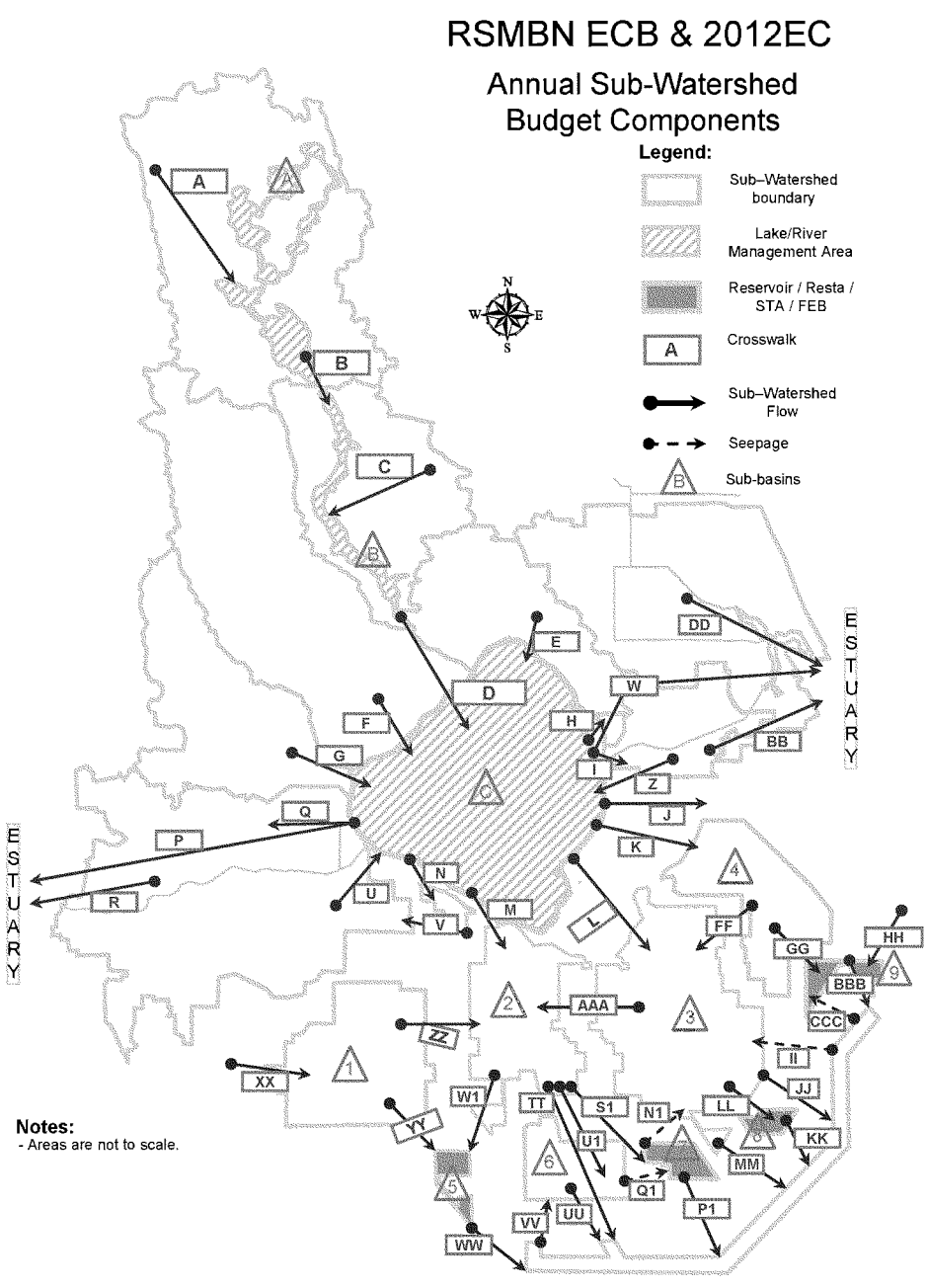


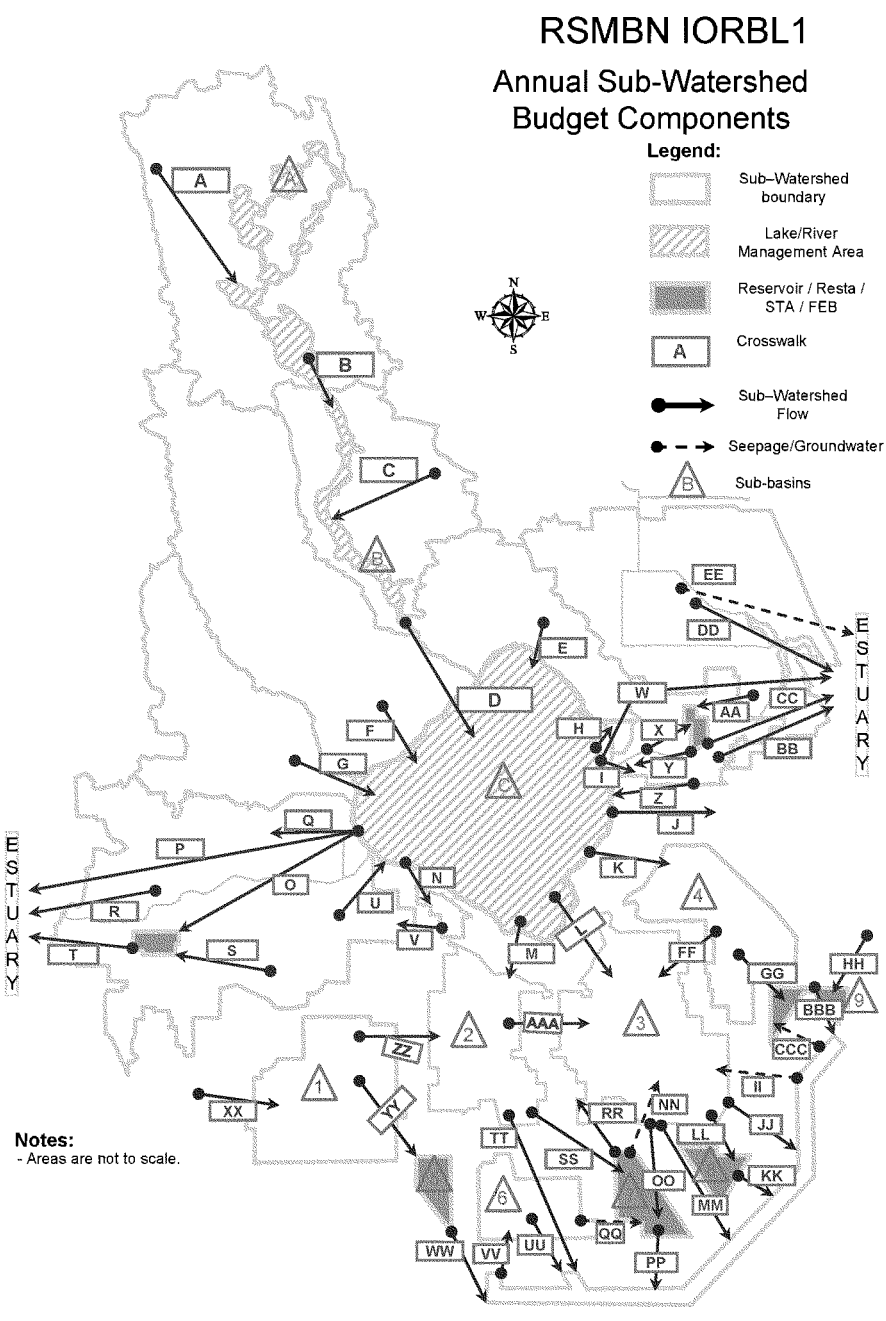
ANNEX A-2: REFERENCE 4

RSM-BN WATER BUDGET MAPS FOR BASELINES AND ALT4R2


RSMBN ECB & 2012EC
Annual Sub-Watershed
Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
Crosswalk
Sub–Watershed Flow
Seepage
Sub-basins
N
W
E
S
ESTUARY
ESTUARY
Notes:
- Areas are not to scale.

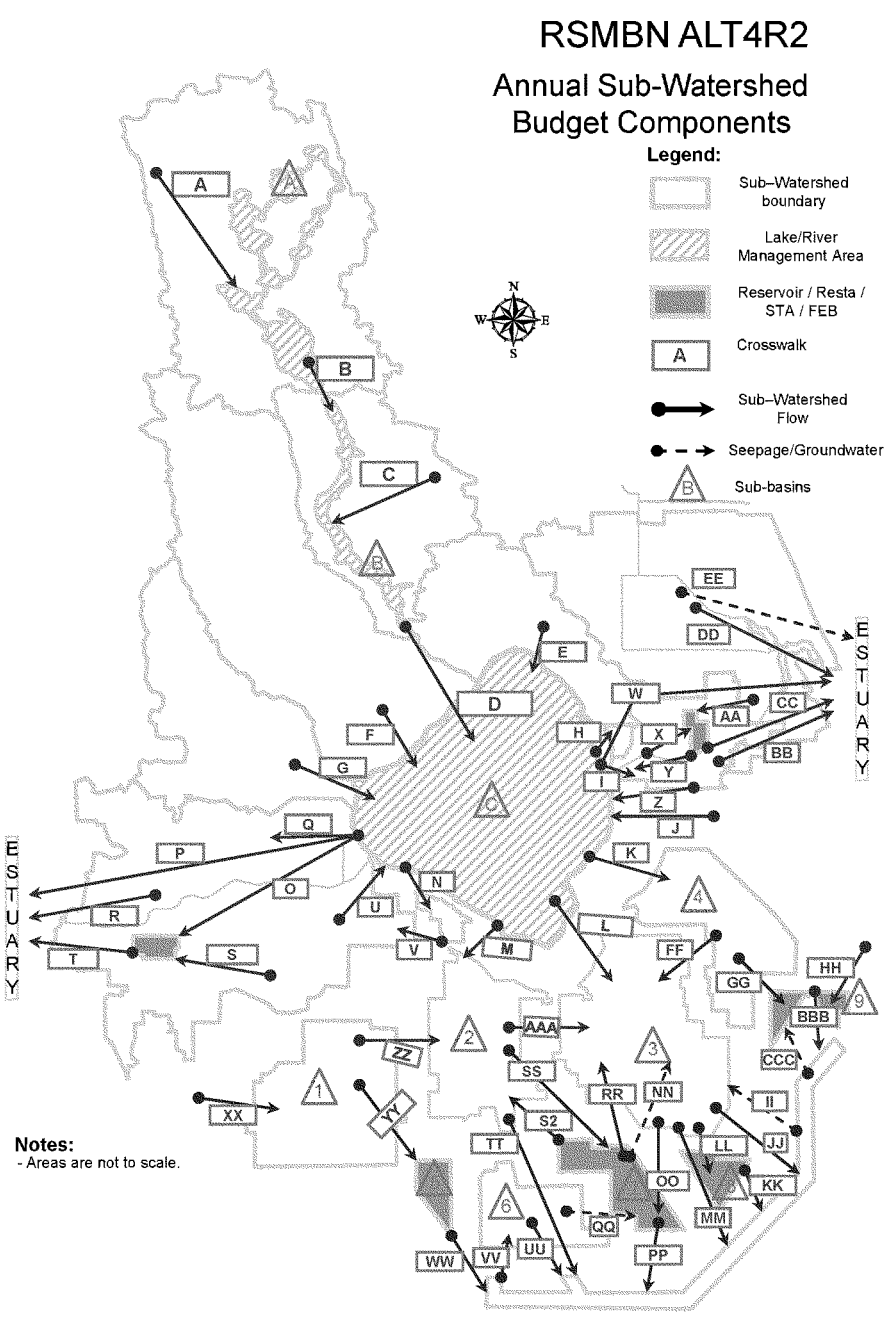
RSMBN ECB & 2012EC

A	**Sub-basins (Red Text on Map)**
A	Upper Kissimmee Lake Management Areas
B	Lower Kissimmee River Management Areas
C	Lake Okeechobee
1	C-139
2	EAA Miami
3	EAA NNR-Hillsboro
4	EAA WPB
5	STA5&6
6	Rotenberger& Holeyland
7	STA3/4
8	STA2
9	STA1W&1E


RSMBN IORBL1
Annual Sub-Watershed
Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
Crosswalk
Sub–Watershed Flow
Seepage/Groundwater
Sub-basins
N
W
E
S
ESTUARY
ESTUARY
Notes:
- Areas are not to scale.

RSMBN IORBL1

A	**Sub-basins (Red Text on Map)**
A	Upper Kissimmee Lake Management Areas
B	Lower Kissimmee River Management Areas
C	Lake Okeechobee
1	C-139
2	EAA Miami
3	EAA NNR-Hillsboro
4	EAA WPB
5	STA5&6
6	Rotenberger& Holeyland
7	STA3/4 & A1FEB
8	STA2
9	STA1W&1E


RSMBN ALT4R2
Annual Sub-Watershed
Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
Crosswalk
Sub–Watershed Flow
Seepage/Groundwater
Sub-basins
N
W
E
S
ESTUARY
ESTUARY
Notes:
- Areas are not to scale.

RSMBN ALT4R2

A	**Sub-basins (Red Text on Map)**
A	Upper Kissimmee Lake Management Areas
B	Lower Kissimmee River Management Areas
C	Lake Okeechobee
1	C-139
2	EAA Miami
3	EAA NNR-Hillsboro
4	EAA WPB
5	STA5&6
6	Rotenberger& Holeyland
7	STA3/4 & FEB
8	STA2
9	STA1W&1E

RSMBN ECB/2012EC/IORBL1/ALT4R2 Crosswalk.

The following letters correspond to blue text in rectangles on maps. A

A. Upper Kissimmee basin total watershed flows.

B. Lake Kissimmee total flows.

C. Lower Kissimmee basin total watershed flows.

D. S65E total flows to Lake Okeechobee.

E. Net total flows from Taylor Creek/Nubbin Slough basin, Northeast Lake Shore & North Lake Shore to Lake Okeechobee.

F. Net total flows from Istokpoga/Brighton to Lake Okeechobee.

G. Fisheating creek runoff to Lake Okeechobee.

H. Lake Okeechobee flows to FPL reservoir.

I. Total Lake Okeechobee flows to C44 basin.

J. Total net Lake Okeechobee flows to L8 canal/basin.

K. Total net Lake Okeechobee flows to West Palm Beach basin.

L. Total net Lake Okeechobee flows to North New River/Hillsboro basin.

M. Total net Lake Okeechobee flows to Miami basin.

N. Total Lake Okeechobee flows to S4 basin.

O. Lake Okeechobee flows to C43 Reservoir.

P. Total net Lake Okeechobee flows to Caloosahatchee estuary.

Q. Lake Okeechobee flows to C43 Basin.

R. C43 basin flows to Caloosahatchee estuary.

S. C43 basin flows to C43 Reservoir.

T. C43 Reservoir flows to Caloosahatchee Estuary.

U. C43 basin flows to Lake Okeechobee.

V. S4 basin flows to C43 basin.

W. Net Lake Okeechobee flows to St. Lucie estuary.

X. C44 basin flows to C44 reservoir/sta.

Y. C44 reservoir/sta flows to C44 basin.

Z. C44 Basin flows to Lake Okeechobee.

AA. C23 basin flows (non-C44 basin) to C44 reservoir/sta.

BB. C44 basin flows to St. Lucie estuary.

CC. C44 reservoir/sta to St. Lucie estuary.

DD. Non-C44 basins (Runoff from tributaries of the St. Lucie Estuaries) to St. Lucie estuary.

EE. Non-C44 basins Groundwater to St. Lucie estuary.

FF. West Palm Beach basin flows to North New River basin.

GG. West Palm Beach basin flows to STA1W.

HH. Net L8/C51/LWDD flows to STA1E.

II. L7/L6 canal flows to North New River/Hillsboro basin.

JJ. North New River/Hillsboro basin flows to L7 canal.

KK. STA2 flows to L6 canal.

LL. North New River/Hillsboro basin flows to STA2.

MM. North New River/Hillsboro basin flows to L6 canal.

NN. STA34&A1FEB(or FEB) flows to North New River/Hillsboro basin.

N1. STA34 flows to North New River/Hillsboro basin (ECB).

OO. North New River/Hillsboro flows basin to STA34&A1FEB(or FEB).

PP. STA34&A1FEB(or FEB) flows to Miami/L4/L5 canal.

P1. STA34 flows to Miami/L4/L5 canal(ECB).

QQ. Rotenberger & Holeyland flows to STA34&A1FEB(or FEB).

Q1. Rotenberger & Holeyland flows to STA34(ECB)

RR. STA34&A1FEB (or FEB) flows to North New River/Hillsboro basin.

SS. Miami basin flows to STA34&A1FEB(or FEB).

S1. Miami basin flows to STA34 (ECB).

S2. STA34&FEB flows to Miami basin(ALT4R1).

TT. Miami basin flows to Lower Miami/L4/L5 canal.

UU. Rotenberger & Holeyland flows to Miami/L4/L5 canal.

U1. Miami basin flows to Rotenberger & Holeyland. (ECB)

VV. Miami/L4/L5 canal flows to Rotenberger & Holeyland.

WW. STA56 flows to Miami/L4/L5 canal.

W1. Miami basin flows to STA56.

XX. Offsite water supply/recharge flows to C139 basin.

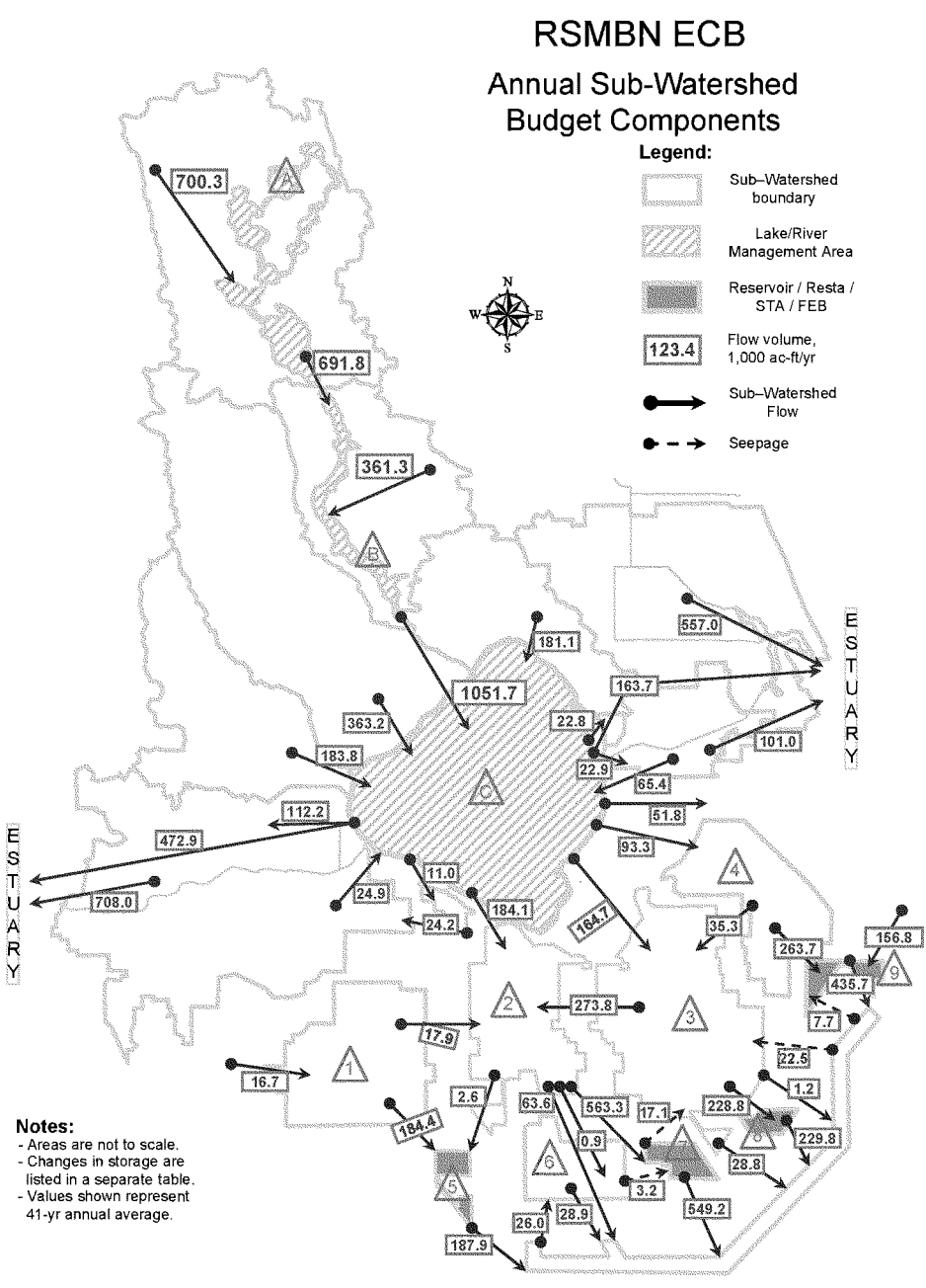
YY. C139 basin flows to STA56.

ZZ. C139 basin flows to Miami basin.

AAA. Miami basin flows to North New River/Hillsboro basin.

BBB. STA1W&STA1E flows to L7 canal.

CCC. L7 canal flows to STA1W.

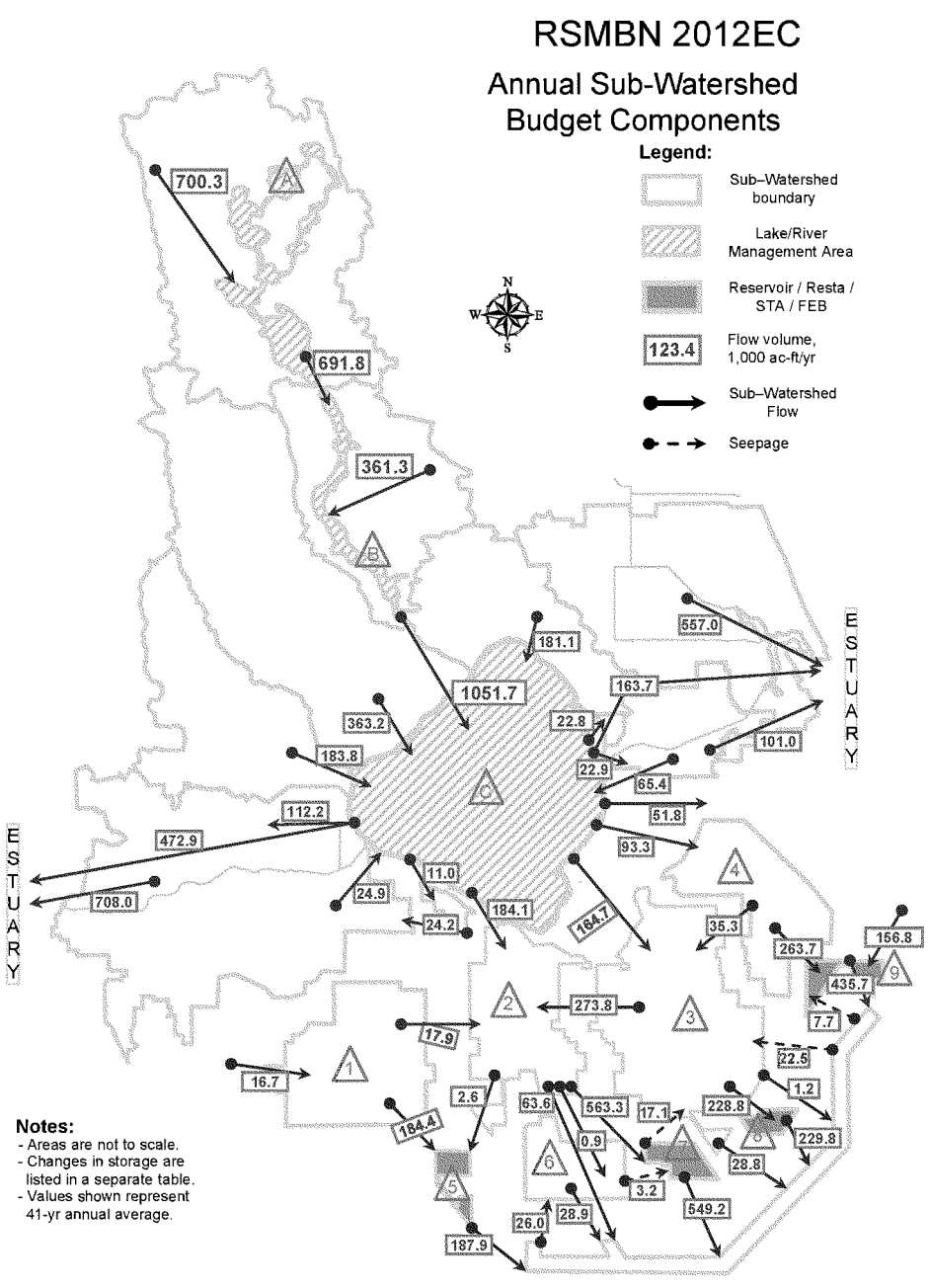

RSMBN ECB
Annual Sub-Watershed Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
123.4
Flow volume, 1,000 ac-ft/yr
Sub–Watershed Flow
Seepage
N
W
E
S
700.3
691.8
361.3
1051.7
181.1
557.0
163.7
363.2
22.8
183.8
22.9
101.0
65.4
112.2
51.8
472.9
93.3
708.0
24.9
11.0
24.2
184.1
164.7
35.3
263.7
156.8
435.7
273.8
17.9
7.7
22.5
16.7
1.2
2.6
63.6
563.3
17.1
228.8
184.4
0.9
229.8
28.8
3.2
549.2
28.9
26.0
187.9
ESTUARY
ESTUARY
A
B
C
1
2
3
4
5
6
7
8
9
Notes:
- Areas are not to scale.
- Changes in storage are listed in a separate table.
- Values shown represent 41-yr annual average.

RSMBN ECB

		RF	ET	Change in Storage	Residual
A	Upper Kissimmee Lake Management Areas	370.0	380.9	-2.4	0.0
B	Lower Kissimmee River Management Areas	36.5	37.7	0.2	0.0
C	Lake Okeechobee*	1643.0	2096.7	17.2	0.0
1	C-139	676.6	479.6	11.4	0.0
2	EAA Miami	554.8	400.3	-0.1	0.0
3	EAA NNR-Hillsboro	1037.6	744.5	0.1	0.0
4	EAA WPB	539.7	334.0	-0.1	0.1
5	STA5&6	41.7	40.9	0.0	0.0
6	Rotenberger & Holeyland	275.0	268.5	1.2	0.1
7	STA3/4	73.5	73.6	0.1	0.0
8	STA2	41.5	40.5	0.0	0.0
9	STA1W&1E	62.0	54.6	-0.1	0.1

Table: Rainfall, evapotranspiration and change in storage volumes (1,000 ac-ft/yr) for major sub-watersheds simulated in RSMBN

note*: Lake Okeechobee MDS term = -99.8 kaf/yr

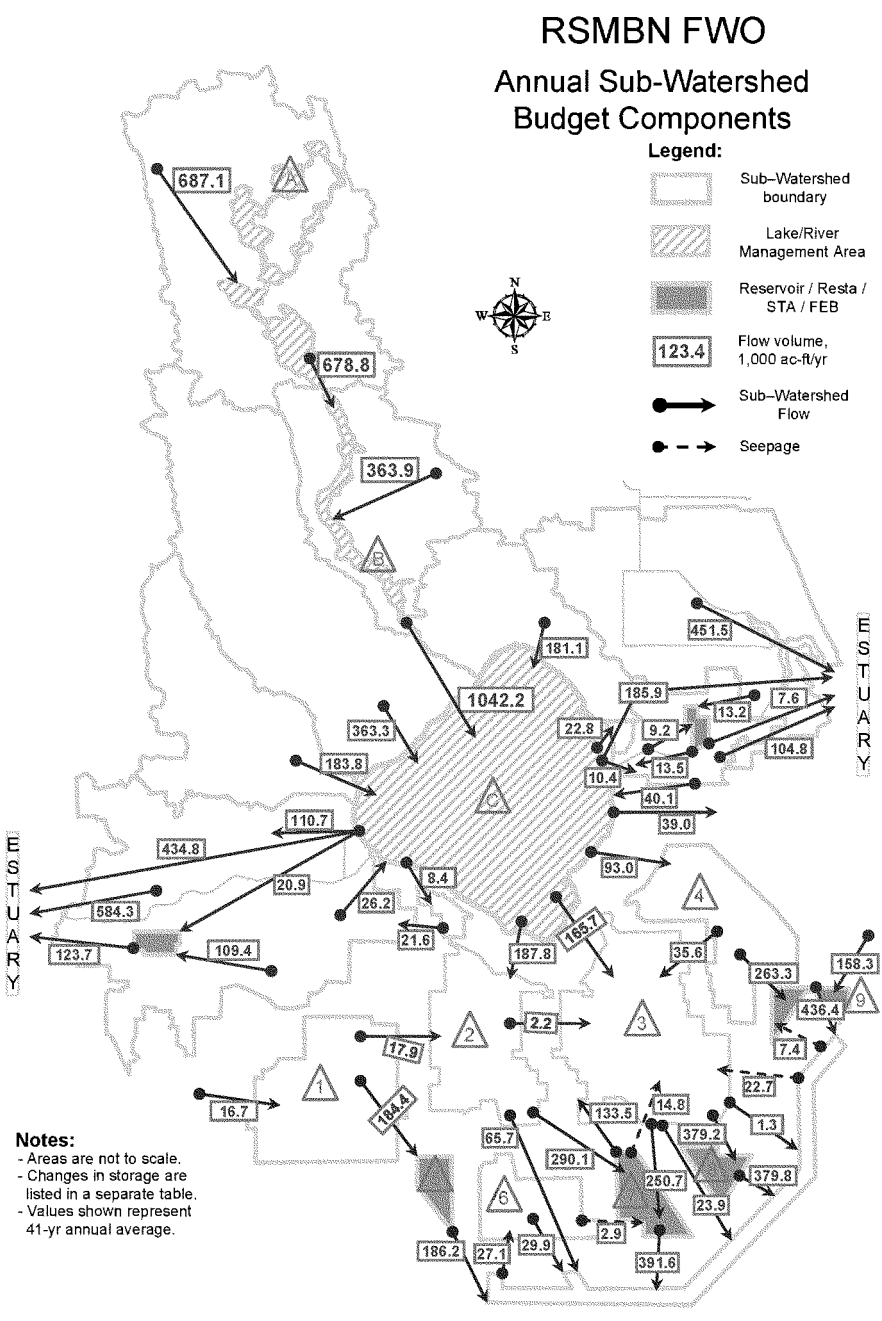

RSMBN 2012EC
Annual Sub-Watershed Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
123.4
Flow volume, 1,000 ac-ft/yr
Sub–Watershed Flow
Seepage
N
W
E
S
700.3
691.8
361.3
A
B
C
1051.7
181.1
557.0
163.7
22.8
101.0
363.2
183.8
22.9
65.4
51.8
93.3
112.2
472.9
708.0
24.9
11.0
24.2
184.1
164.7
35.3
263.7
156.8
435.7
7.7
22.5
1.2
273.8
17.9
16.7
2.6
184.4
63.6
563.3
17.1
228.8
229.8
0.9
28.8
3.2
549.2
26.0
28.9
187.9
ESTUARY
ESTUARY
1
2
3
4
5
6
7
8
9
Notes:
- Areas are not to scale.
- Changes in storage are listed in a separate table.
- Values shown represent 41-yr annual average.

RSMBN 2012EC

		RF	ET	Change in Storage	Residual
A	Upper Kissimmee Lake Management Areas	370.0	380.9	-2.4	0.0
B	Lower Kissimmee River Management Areas	36.5	37.7	0.2	0.0
C	Lake Okeechobee*	1643.0	2096.7	17.2	0.0
1	C-139	676.6	479.6	11.4	0.0
2	EAA Miami	554.8	400.3	-0.1	0.0
3	EAA NNR-Hillsboro	1037.6	744.5	0.1	0.0
4	EAA WPB	539.7	334.0	-0.1	0.1
5	STA5&6	41.7	40.9	0.0	0.0
6	Rotenberger & Holeyland	275.0	268.5	1.2	0.1
7	STA3/4	73.5	73.6	0.1	0.0
8	STA2	41.5	40.5	0.0	0.0
9	STA1W&1E	62.0	54.6	-0.1	0.1

Table: Rainfall, evapotranspiration and change in storage volumes (1,000 ac-ft/yr) for major sub-watersheds simulated in RSMBN

note*: Lake Okeechobee MDS term = -99.8 kaf/yr

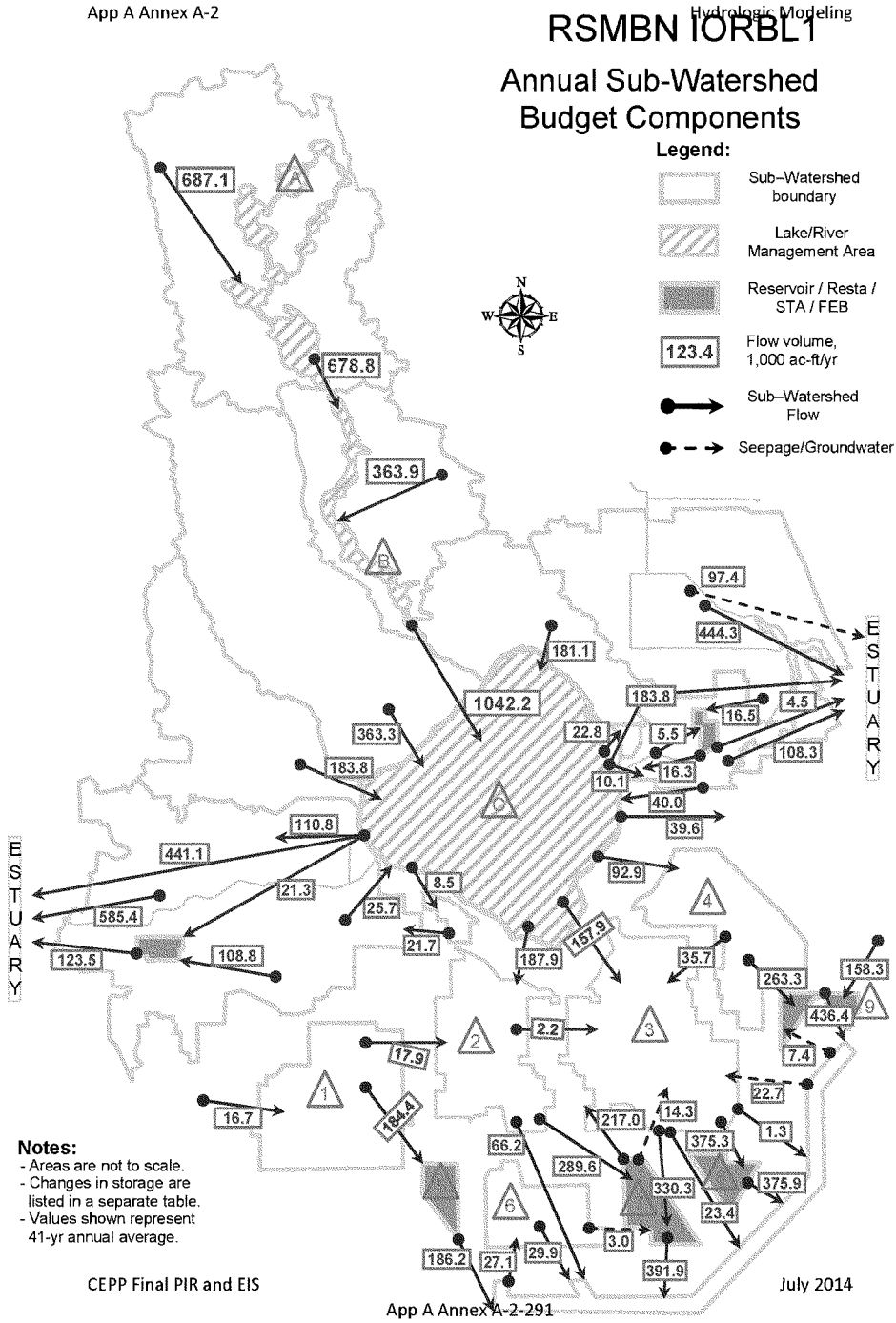

RSMBN FWO
Annual Sub-Watershed
Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
123.4
Flow volume, 1,000 ac-ft/yr
Sub–Watershed Flow
Seepage
N
W
E
S
687.1
678.8
363.9
181.1
1042.2
363.3
183.8
110.7
434.8
584.3
123.7
109.4
20.9
26.2
8.4
21.6
22.8
10.4
185.9
451.5
7.6
13.2
9.2
13.5
104.8
40.1
39.0
93.0
187.8
165.7
35.6
263.3
158.3
436.4
7.4
22.7
2.2
17.9
16.7
184.4
133.5
14.8
1.3
379.2
379.8
65.7
290.1
250.7
23.9
2.9
186.2
27.1
29.9
391.6
ESTUARY
ESTUARY
A
B
C
1
2
3
4
6
9
Notes:
- Areas are not to scale.
- Changes in storage are listed in a separate table.
- Values shown represent 41-yr annual average.

RSMBN FWO

		RF	ET	Change in Storage	Residual
A	Upper Kissimmee Lake Management Areas	405.1	414.0	-0.6	0.0
B	Lower Kissimmee River Management Areas	22.9	23.4	0.0	0.0
C	Lake Okeechobee*	1643.0	2085.1	15.3	0.1
1	C-139	676.6	479.6	11.4	0.0
2	EAA Miami	527.7	375.5	0.0	-0.1
3	EAA NNR-Hillsboro	937.1	656.6	-0.1	0.0
4	EAA WPB	539.7	333.8	-0.1	0.1
5	STA5&6	68.7	66.9	0.0	0.0
6	Rotenberger & Holeyland	275.0	268.2	1.1	0.0
7	STA3/4 & A1FEB	139.8	142.6	1.1	-0.1
8	STA2	75.0	74.4	0.1	-0.1
9	STA1W&1E	62.0	54.6	-0.1	0.1

Table: Rainfall, evapotranspiration and change in storage volumes (1,000 ac-ft/yr) for major sub-watersheds simulated in RSMBN

note*: Lake Okeechobee MDS term = -99.8 kaf/yr

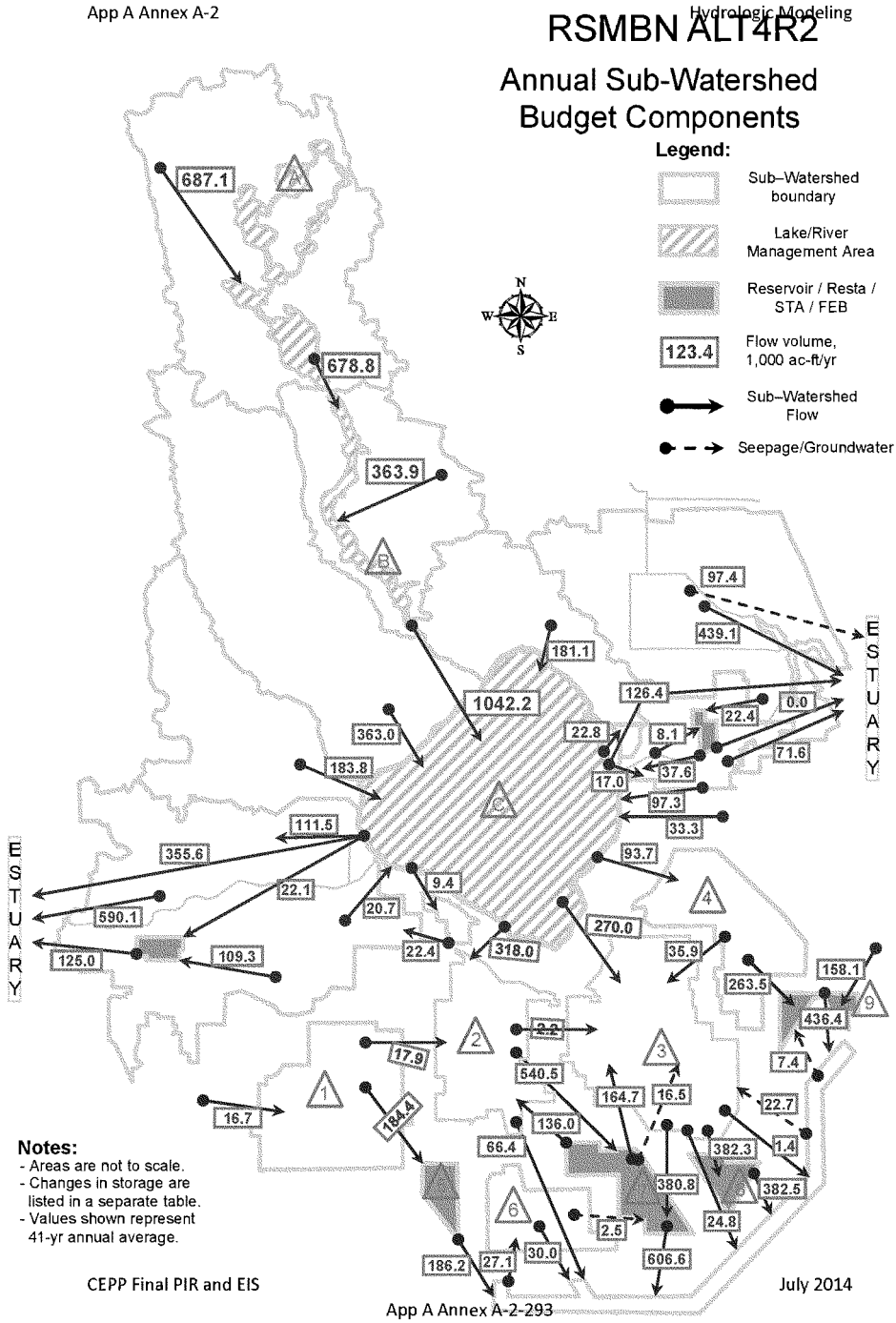

RSMBN IORBL1
Annual Sub-Watershed Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
123.4
Flow volume, 1,000 ac-ft/yr
Sub–Watershed Flow
Seepage/Groundwater
N
W
E
S
687.1
678.8
363.9
97.4
444.3
181.1
1042.2
183.8
4.5
16.5
363.3
22.8
5.5
108.3
183.8
10.1
16.3
40.0
110.8
39.6
441.1
92.9
21.3
8.5
585.4
25.7
123.5
108.8
21.7
187.9
157.9
35.7
263.3
158.3
436.4
7.4
2.2
17.9
22.7
16.7
184.4
217.0
14.3
1.3
66.2
289.6
375.3
330.3
375.9
23.4
3.0
186.2
27.1
29.9
391.9
ESTUARY
ESTUARY
A
B
C
1
2
3
4
6
9
Notes:
- Areas are not to scale.
- Changes in storage are listed in a separate table.
- Values shown represent 41-yr annual average.

RSMBN IORBL1

		RF	ET	Change in Storage	Residual
A	Upper Kissimmee Lake Management Areas	405.1	414.0	-0.6	0.0
B	Lower Kissimmee River Management Areas	22.9	23.4	0.0	0.0
C	Lake Okeechobee*	1643.0	2086.0	15.7	0.2
1	C-139	676.6	479.6	11.4	0.0
2	EAA Miami	527.7	375.5	0.0	0.1
3	EAA NNR-Hillsboro	937.1	656.6	-0.1	-0.2
4	EAA WPB	539.7	333.8	0.0	-0.1
5	STA5&6	68.7	66.9	0.0	0.0
6	Rotenberger & Holeyland	275.0	268.1	1.1	0.0
7	STA3/4 & A1FEB	139.8	139.1	0.3	0.0
8	STA2	75.0	74.4	0.1	0.0
9	STA1W&1E	62.0	54.6	-0.1	0.0

Table: Rainfall, evapotranspiration and change in storage volumes (1,000 ac-ft/yr) for major sub-watersheds simulated in RSMBN

note*: Lake Okeechobee MDS term = -99.8 kaf/yr


RSMBN ALT4R2
Annual Sub-Watershed Budget Components
Legend:
Sub–Watershed boundary
Lake/River Management Area
Reservoir / Resta / STA / FEB
123.4
Flow volume, 1,000 ac-ft/yr
Sub–Watershed Flow
Seepage/Groundwater
N
W
E
S
687.1
678.8
363.9
97.4
439.1
181.1
1042.2
126.4
0.0
22.4
363.0
22.8
8.1
71.6
183.8
17.0
37.6
97.3
33.3
111.5
355.6
93.7
9.4
22.1
20.7
590.1
270.0
125.0
109.3
22.4
318.0
35.9
158.1
263.5
436.4
2.2
17.9
7.4
540.5
164.7
16.5
22.7
16.7
184.4
136.0
66.4
382.3
1.4
380.8
382.5
2.5
24.8
186.2
27.1
30.0
606.6
ESTUARY
ESTUARY
Notes:
- Areas are not to scale.
- Changes in storage are listed in a separate table.
- Values shown represent 41-yr annual average.

RSMBN ALT4R2

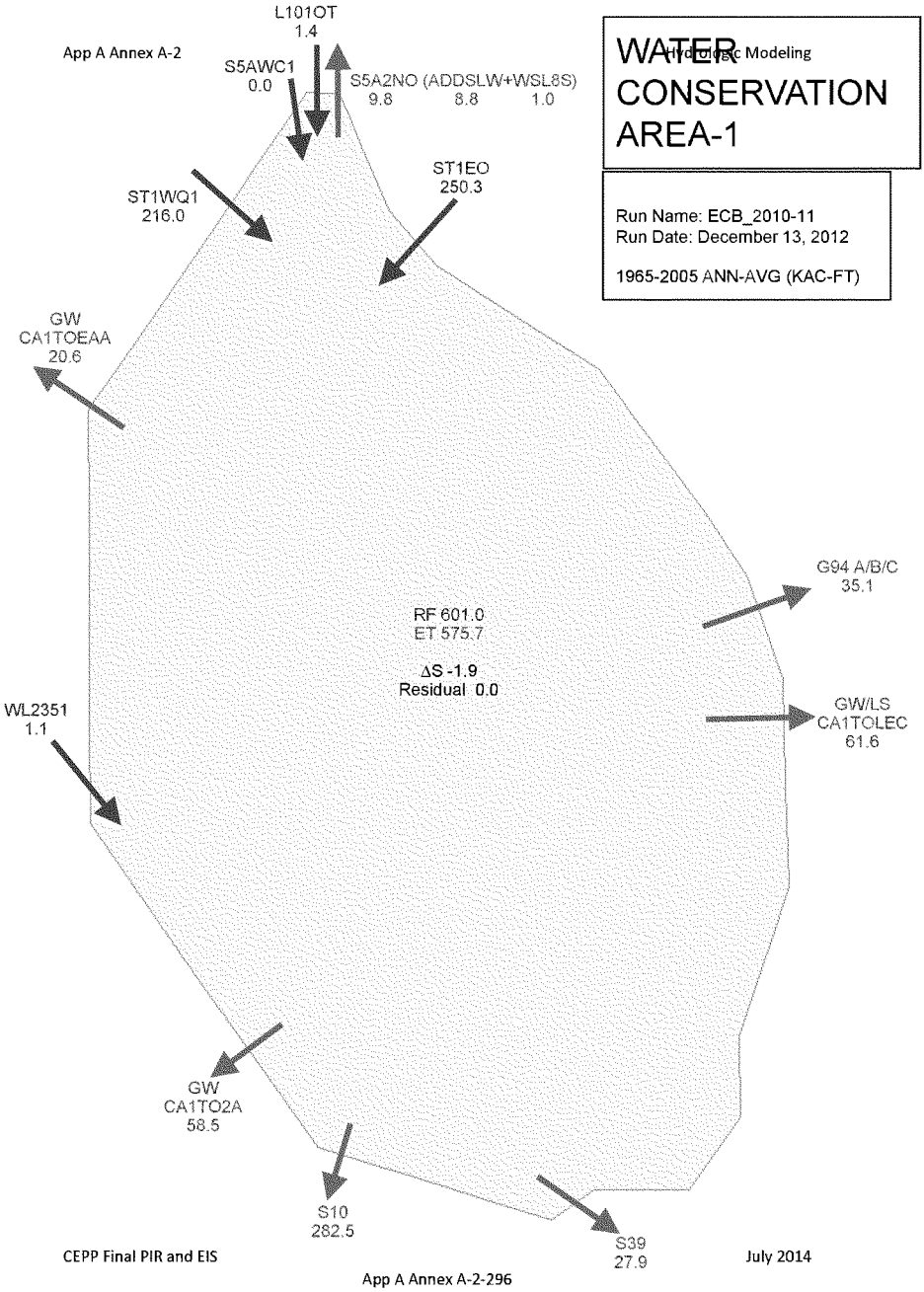
		RF	ET	Change in Storage	Residual
A	Upper Kissimmee Lake Management Areas	405.1	414.0	-0.6	0.0
B	Lower Kissimmee River Management Areas	22.9	23.4	-0.1	0.0
C	Lake Okeechobee*	1643.0	2101.6	21.5	0.0
1	C-139	676.6	479.6	11.4	0.0
2	EAA Miami	494.3	352.8	0.0	0.0
3	EAA NNR-Hillsboro	905.4	640.7	-0.1	0.6
4	EAA WPB	539.7	334.0	0.1	-0.1
5	STA5&6	68.7	66.9	0.0	0.0
6	Rotenberger & Holeyland	275.0	268.4	1.1	0.0
7	STA3/4 & FEB	197.4	195.6	1.2	0.0
8	STA2	75.0	74.6	0.2	0.0
9	STA1W&1E	62.0	54.6	-0.1	0.0

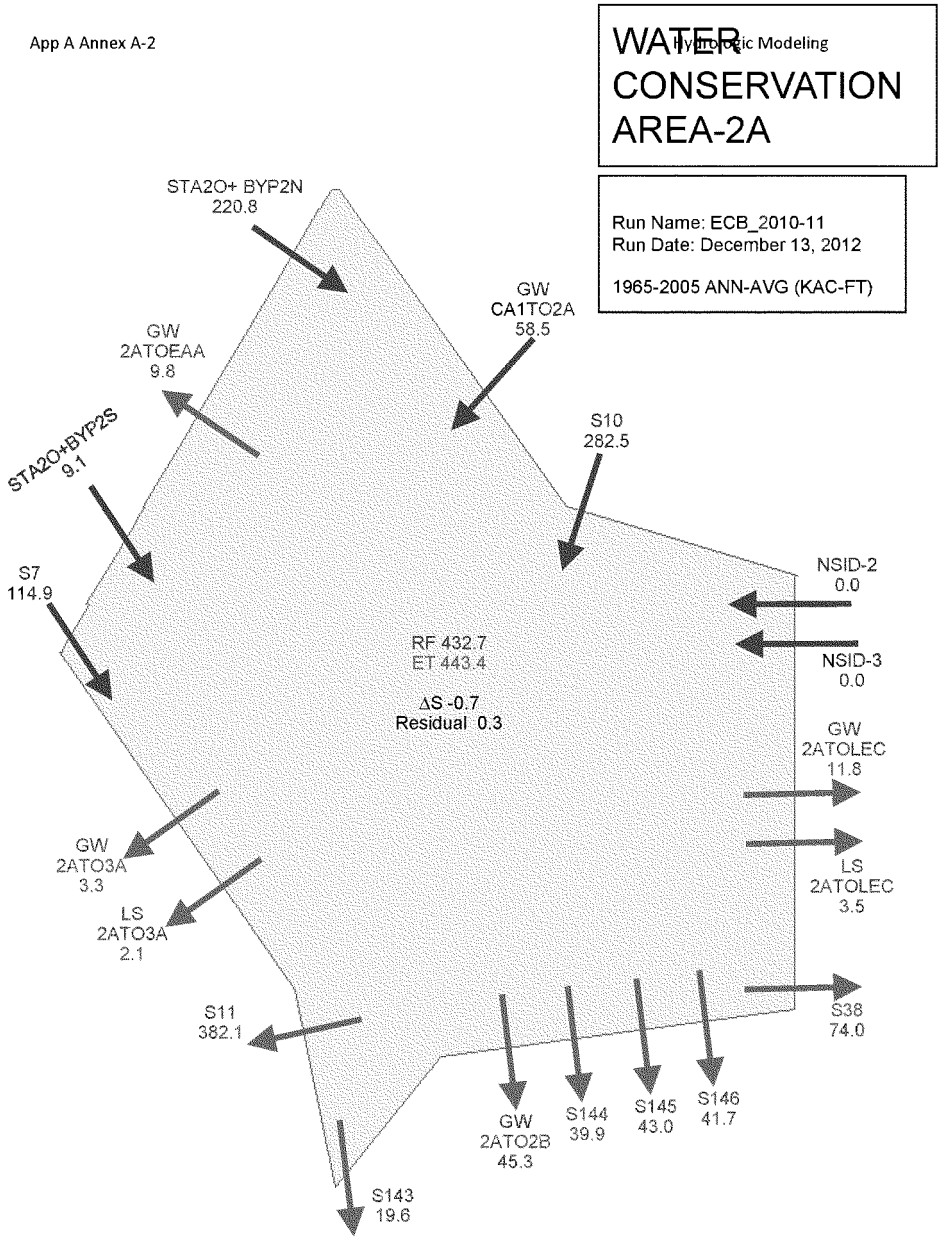
Table: Rainfall, evapotranspiration and change in storage volumes (1,000 ac-ft/yr) for major sub-watersheds simulated in RSMBN

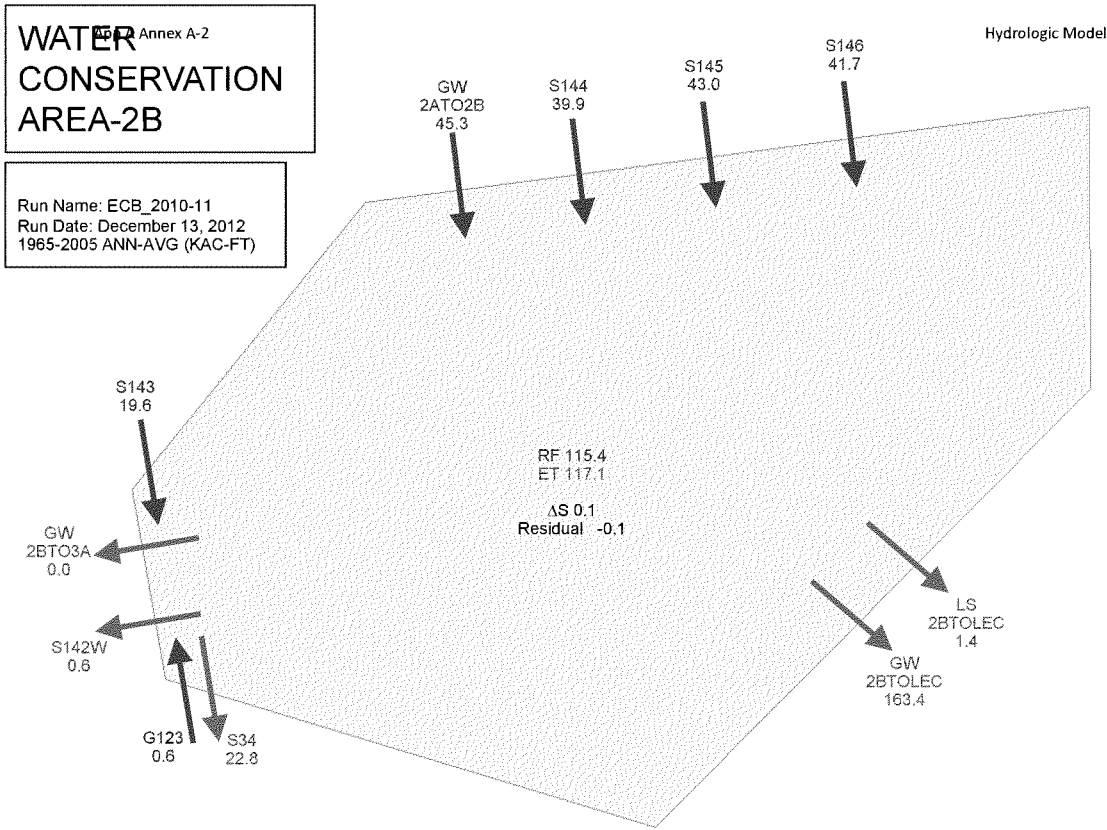
note*: Lake Okeechobee MDS term = -99.8 kaf/yr

ANNEX A-2: REFERENCE 5

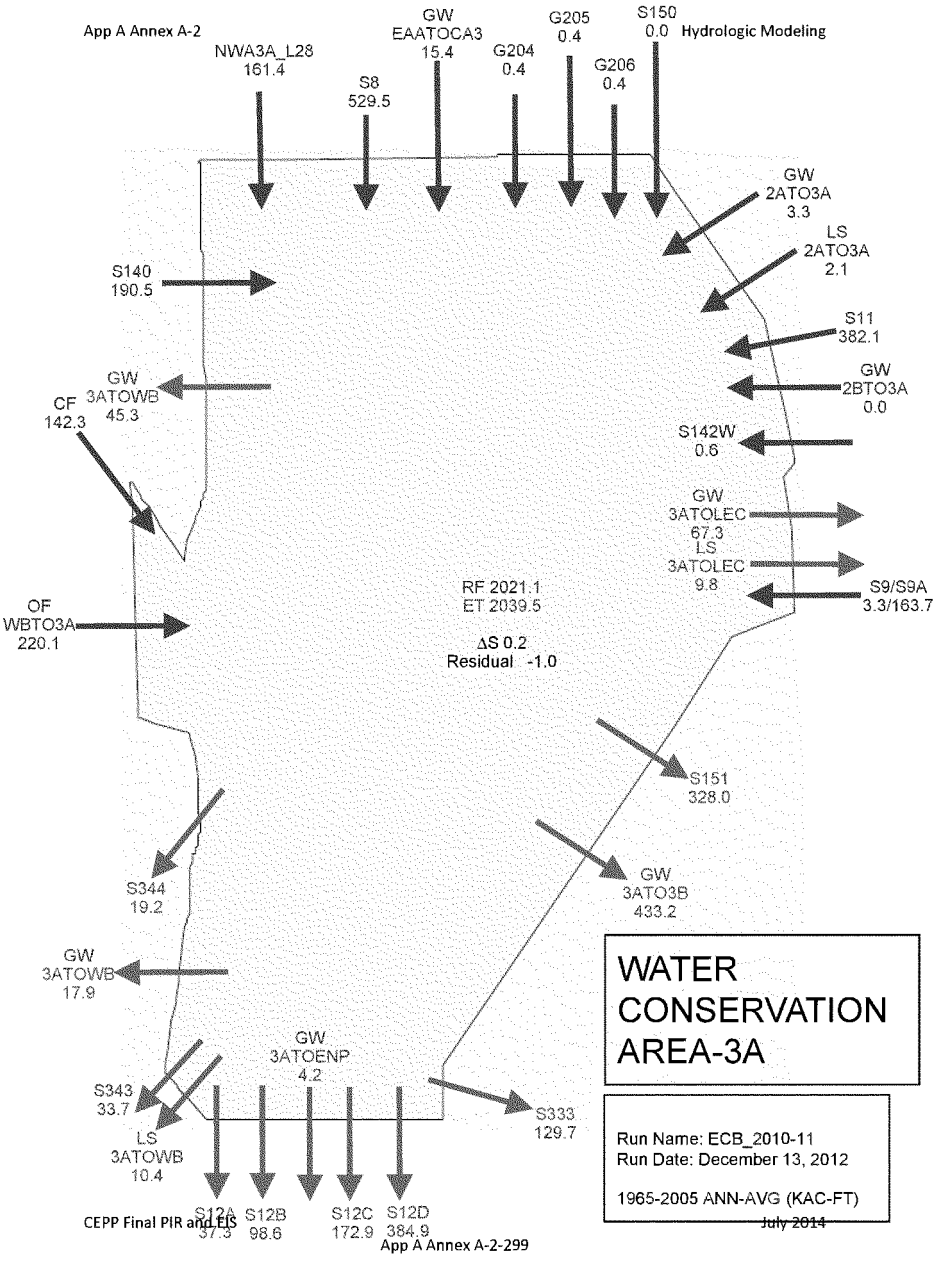
RSM-GL WATER BUDGET MAPS FOR BASELINES AND ALT4R2

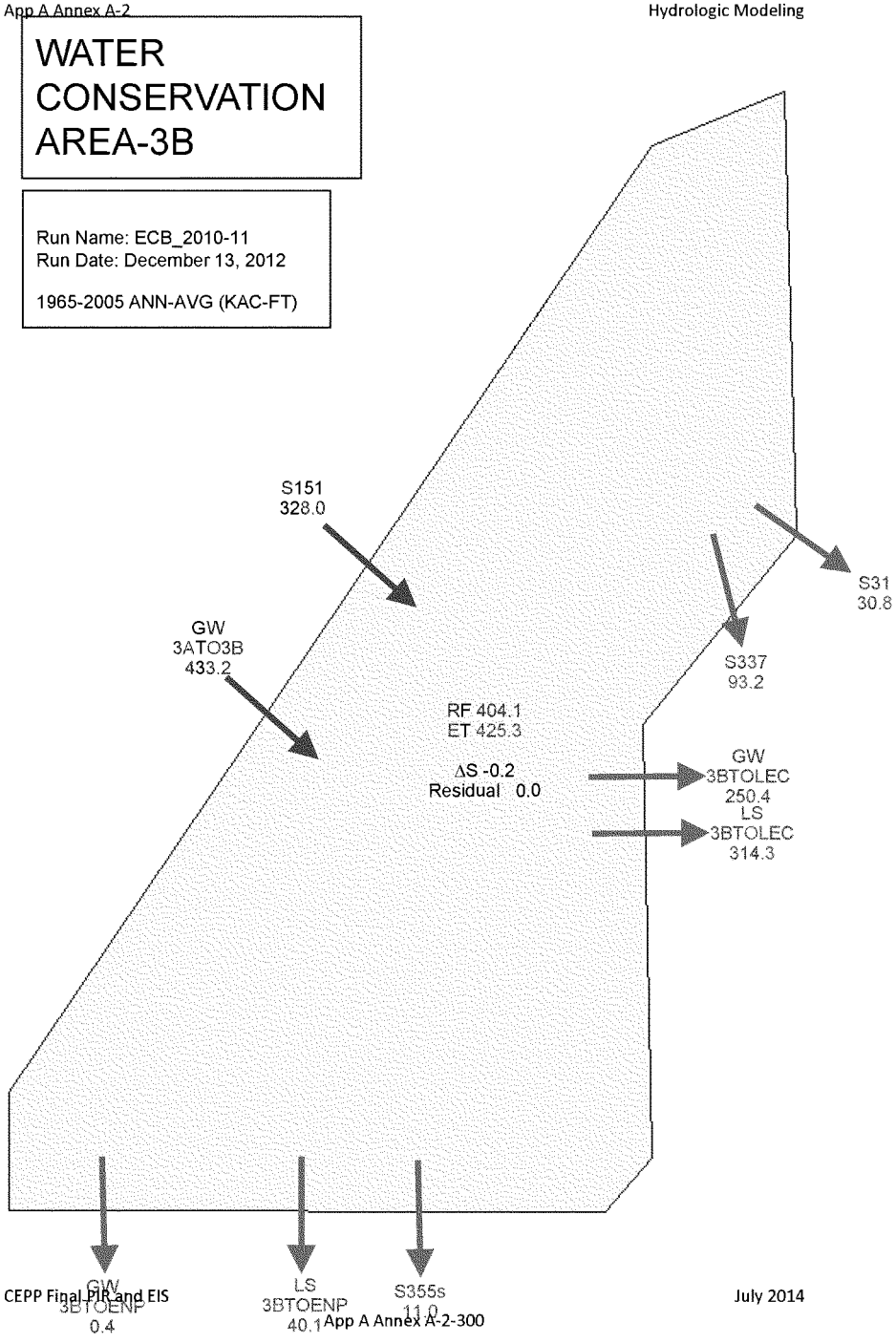

App A Annex A-2
L101OT
1.4
S5AWC1
0.0
S5A2NO (ADDSLW+WSL8S)
9.8 8.8 1.0
WATER CONSERVATION AREA-1
Hydrologic Modeling
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
ST1WQ1
216.0
ST1EO
250.3
GW
CA1TOEAA
20.6
G94 A/B/C
35.1
RF 601.0
ET 575.7
ΔS -1.9
Residual 0.0
WL2351
1.1
GW/LS
CA1TOLEC
61.6
GW
CA1TO2A
58.5
S10
282.5
S39
27.9

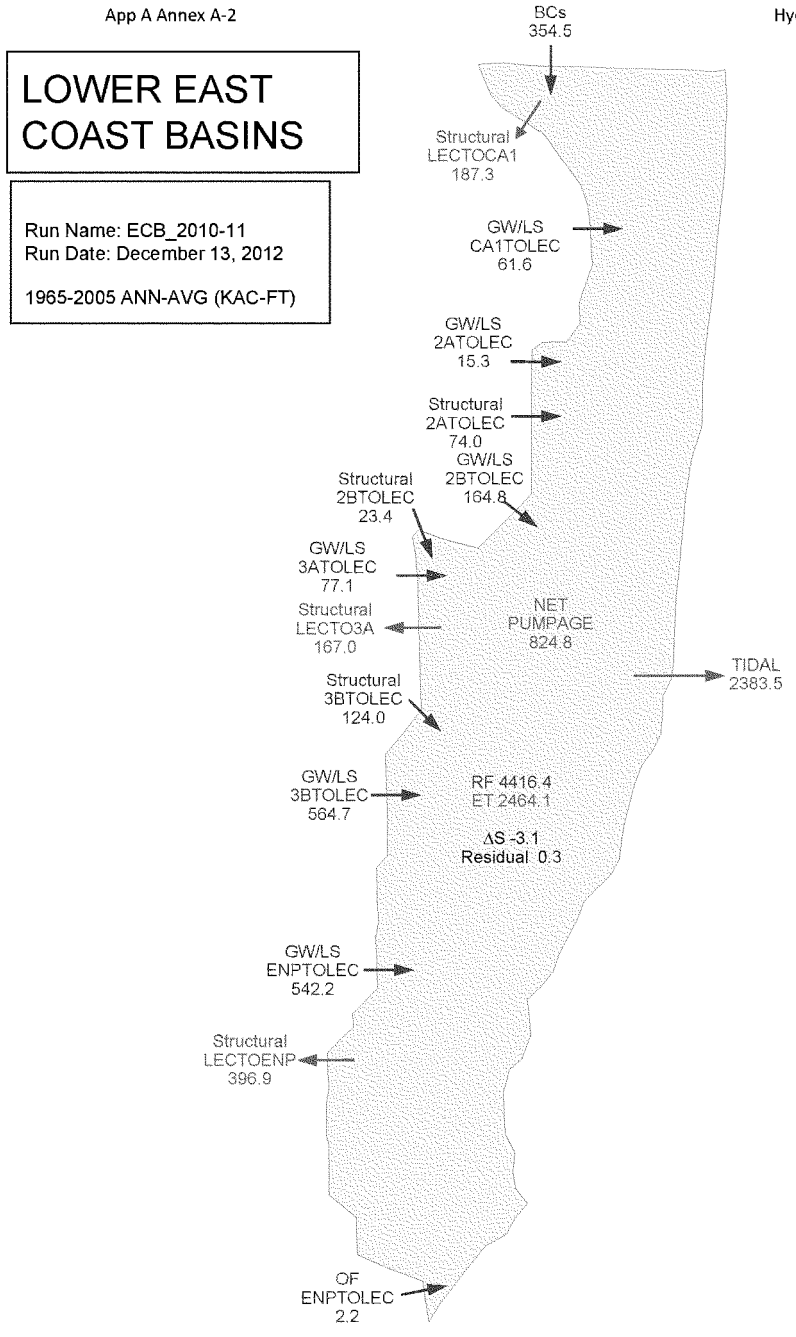

WATER CONSERVATION AREA-2A
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
STA2O+ BYP2N 220.8
GW CA1TO2A 58.5
GW 2ATOEAA 9.8
S10 282.5
STA2O+BYP2S 9.1
S7 114.9
NSID-2 0.0
NSID-3 0.0
RF 432.7
ET 443.4
ΔS -0.7
Residual 0.3
GW 2ATOLEC 11.8
LS 2ATOLEC 3.5
GW 2ATO3A 3.3
LS 2ATO3A 2.1
S11 382.1
S38 74.0
GW 2ATO2B 45.3
S144 39.9
S145 43.0
S146 41.7
S143 19.6

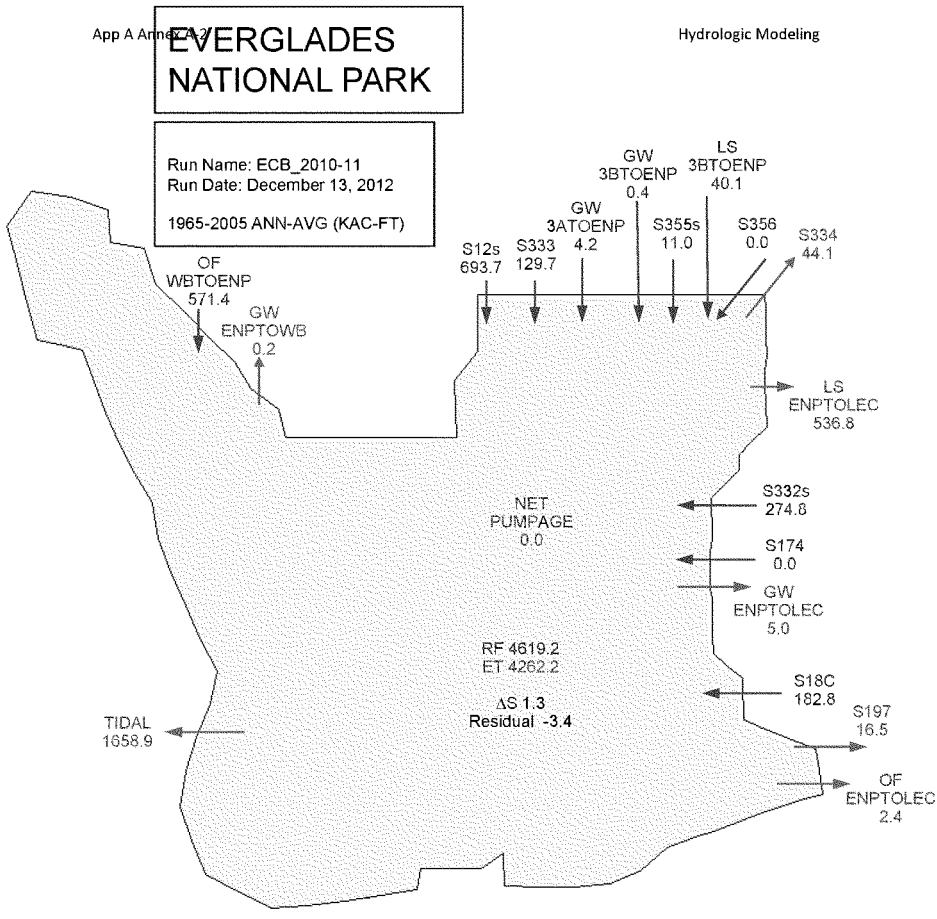

WATER CONSERVATION AREA-2B
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
GW
2ATO2B
45.3
S144
39.9
S145
43.0
S146
41.7
S143
19.6
GW
2BTO3A
0.0
S142W
0.6
G123
0.6
S34
22.8
RF 115.4
ET 117.1
ΔS 0.1
Residual -0.1
LS
2BTOLEC
1.4
GW
2BTOLEC
163.4

946


App A Annex A-2
Hydrologic Modeling
NWA3A_L28
161.4
S8
529.5
GW
EAATOCA3
15.4
G204
0.4
G205
0.4
G206
0.4
S150
0.0
GW
2ATO3A
3.3
LS
2ATO3A
2.1
S140
190.5
S11
382.1
GW
2BTO3A
0.0
GW
3ATOWB
45.3
CF
142.3
S142W
0.6
GW
3ATOLEC
67.3
LS
3ATOLEC
9.8
S9/S9A
3.3/163.7
RF 2021.1
ET 2039.5
ΔS 0.2
Residual -1.0
OF
WBTO3A
220.1
S151
328.0
S344
19.2
GW
3ATO3B
433.2
GW
3ATOWB
17.9
GW
3ATOENP
4.2
S343
33.7
LS
3ATOWB
10.4
S333
129.7
S12A
37.3
S12B
98.6
S12C
172.9
S12D
384.9
WATER
CONSERVATION
AREA-3A
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
July 2014


WATER CONSERVATION AREA-3B
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
S151
328.0
GW
3ATO3B
433.2
RF 404.1
ET 425.3
ΔS -0.2
Residual 0.0
S337
93.2
S31
30.8
GW
3BTOLEC
250.4
LS
3BTOLEC
314.3
GW
3BTOENP
0.4
LS
3BTOENP
40.1
S355s
11.0

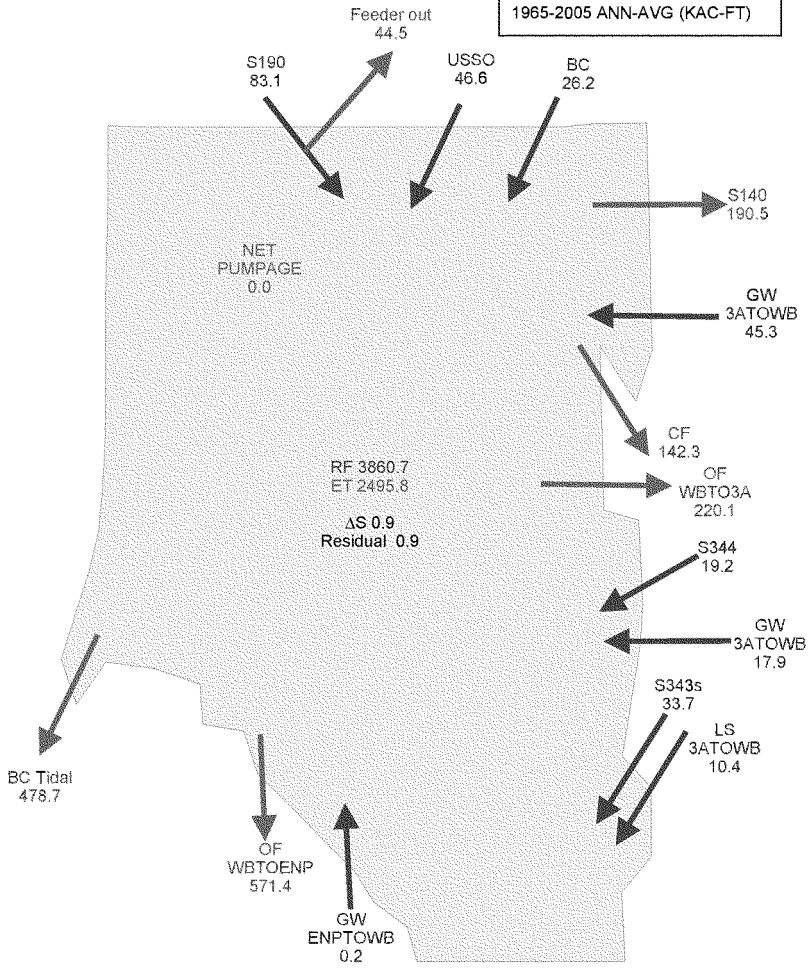

LOWER EAST COAST BASINS
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
BCs 354.5
Structural LECTOCA1 187.3
GW/LS CA1TOLEC 61.6
GW/LS 2ATOLEC 15.3
Structural 2ATOLEC 74.0
GW/LS 2BTOLEC 164.8
Structural 2BTOLEC 23.4
GW/LS 3ATOLEC 77.1
Structural LECTO3A 167.0
NET PUMPAGE 824.8
TIDAL 2383.5
Structural 3BTOLEC 124.0
GW/LS 3BTOLEC 564.7
RF 4416.4
ET 2464.1
ΔS -3.1
Residual 0.3
GW/LS ENPTOLEC 542.2
Structural LECTOENP 396.9
OF ENPTOLEC 2.2


EVERGLADES
NATIONAL PARK
Run Name: ECB_2010-11
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
OF
WBTOENP
571.4
GW
ENPTOWB
0.2
S12s
693.7
S333
129.7
GW
3ATOENP
4.2
GW
3BTOENP
0.4
S355s
11.0
LS
3BTOENP
40.1
S356
0.0
S334
44.1
LS
ENPTOLEC
536.8
NET
PUMPAGE
0.0
S332s
274.8
S174
0.0
GW
ENPTOLEC
5.0
RF 4619.2
ET 4262.2
ΔS 1.3
Residual -3.4
S18C
182.8
S197
16.5
OF
ENPTOLEC
2.4
TIDAL
1658.9

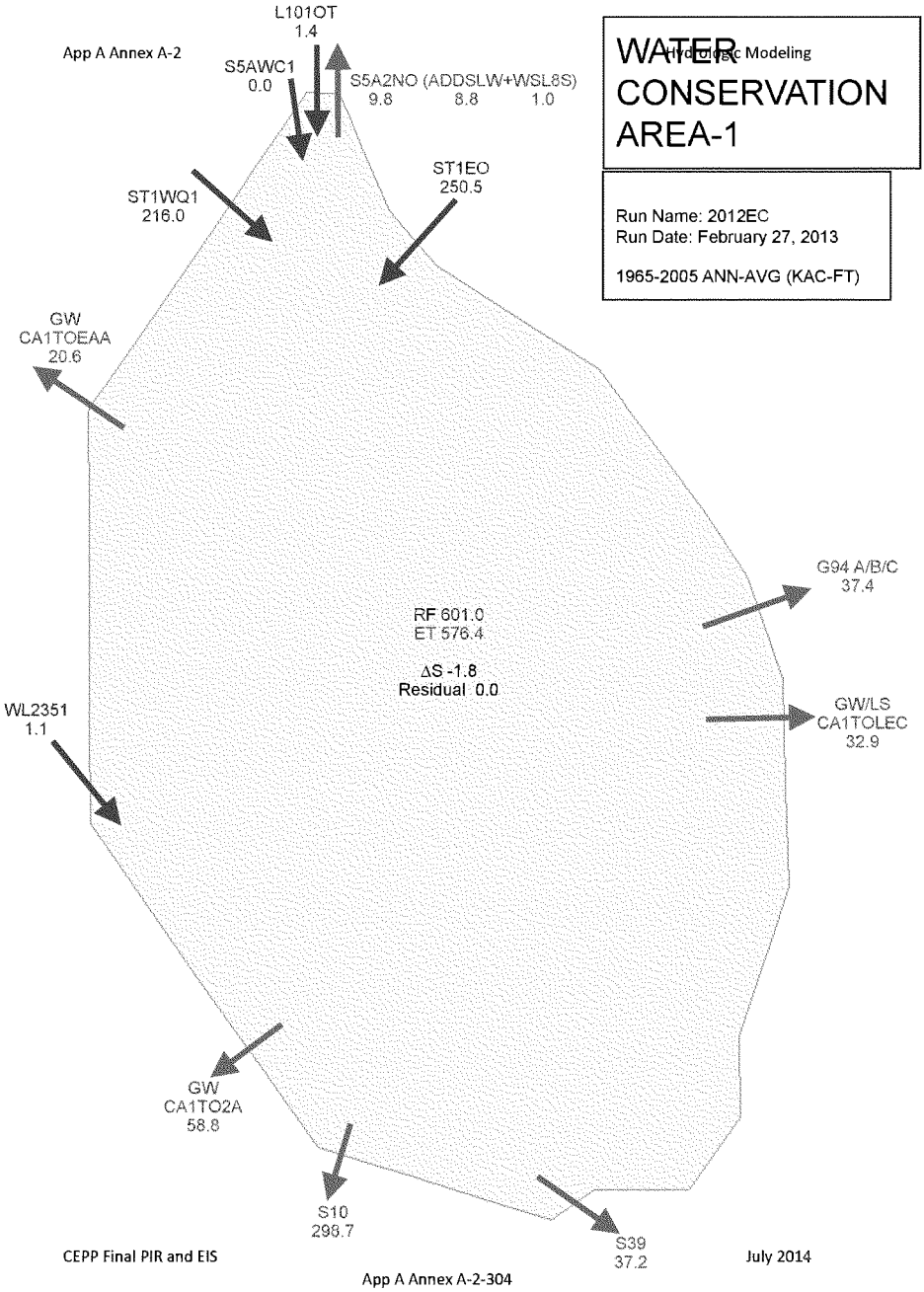
WESTERN BASINS

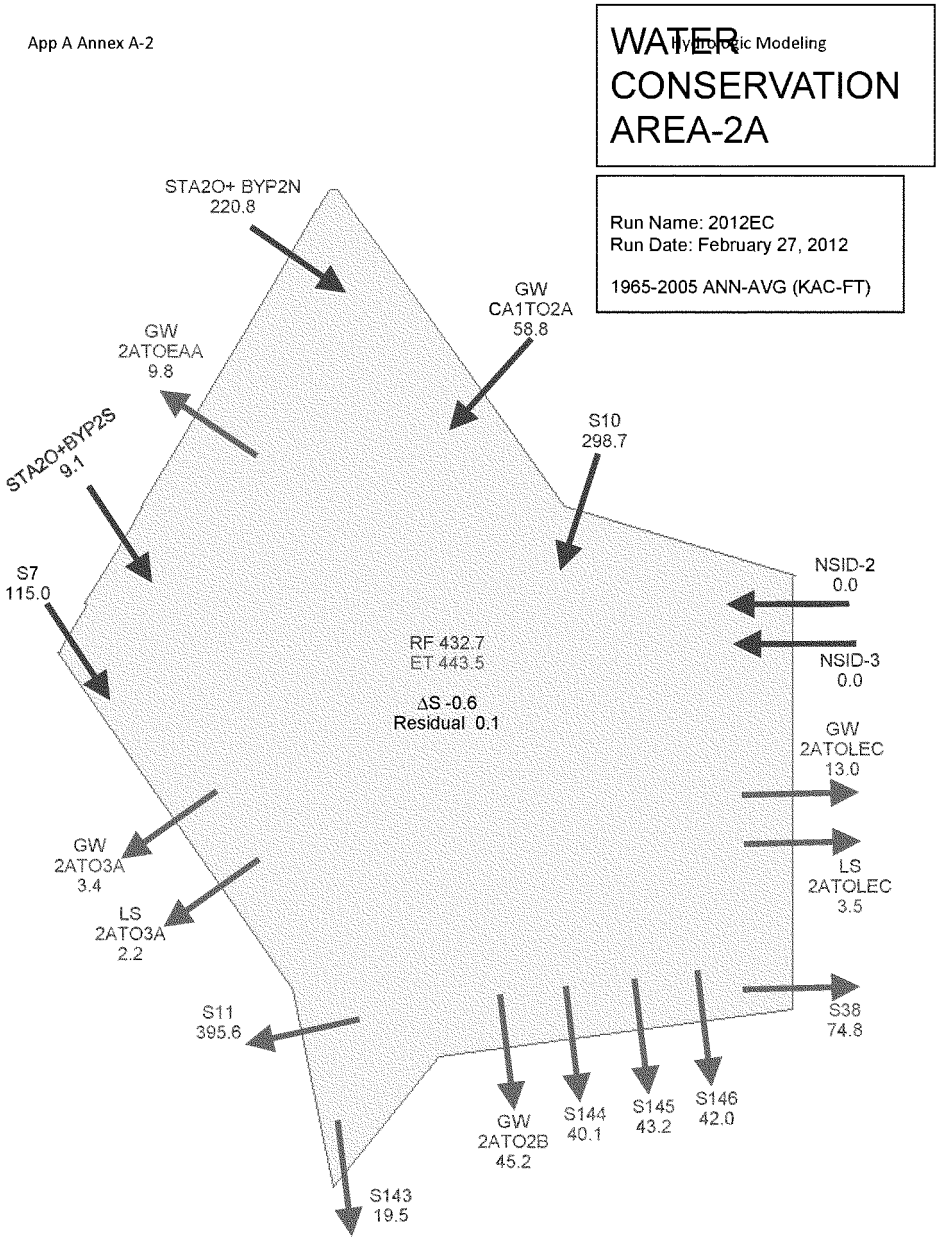
Run Name: ECB_2010-11
Run Date: December 13, 2012

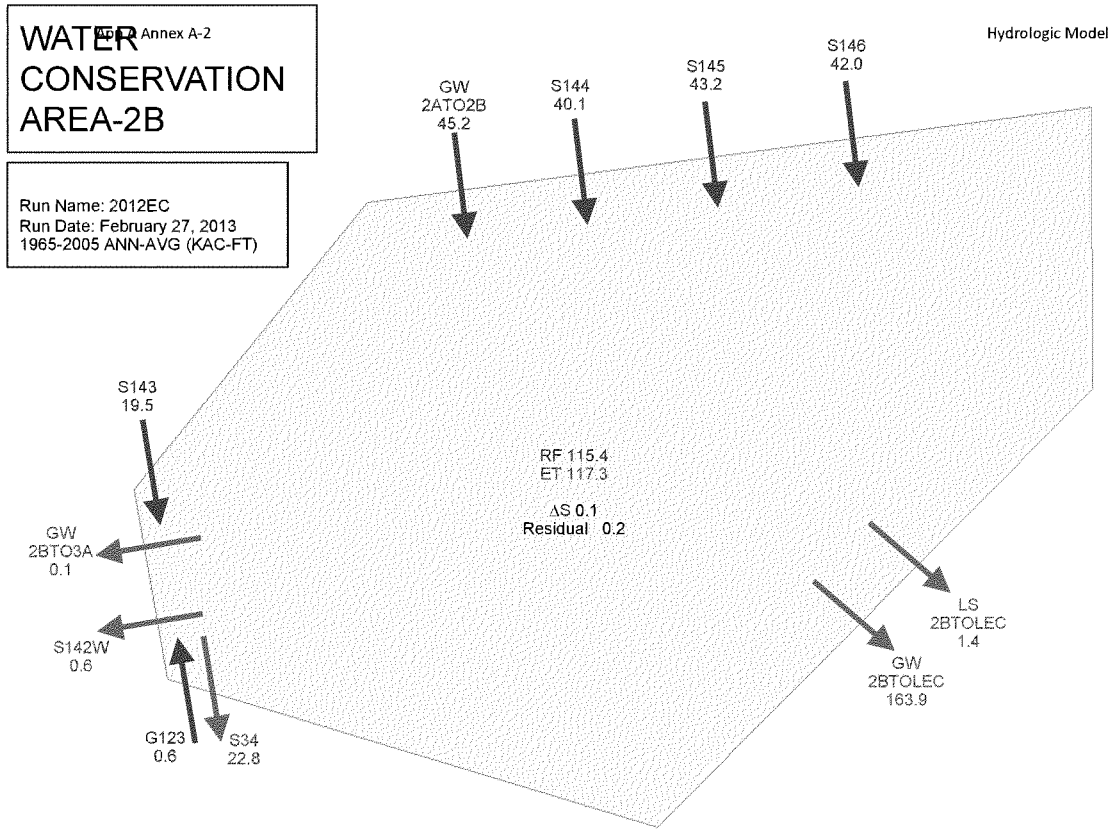
1965-2005 ANN-AVG (KAC-FT)

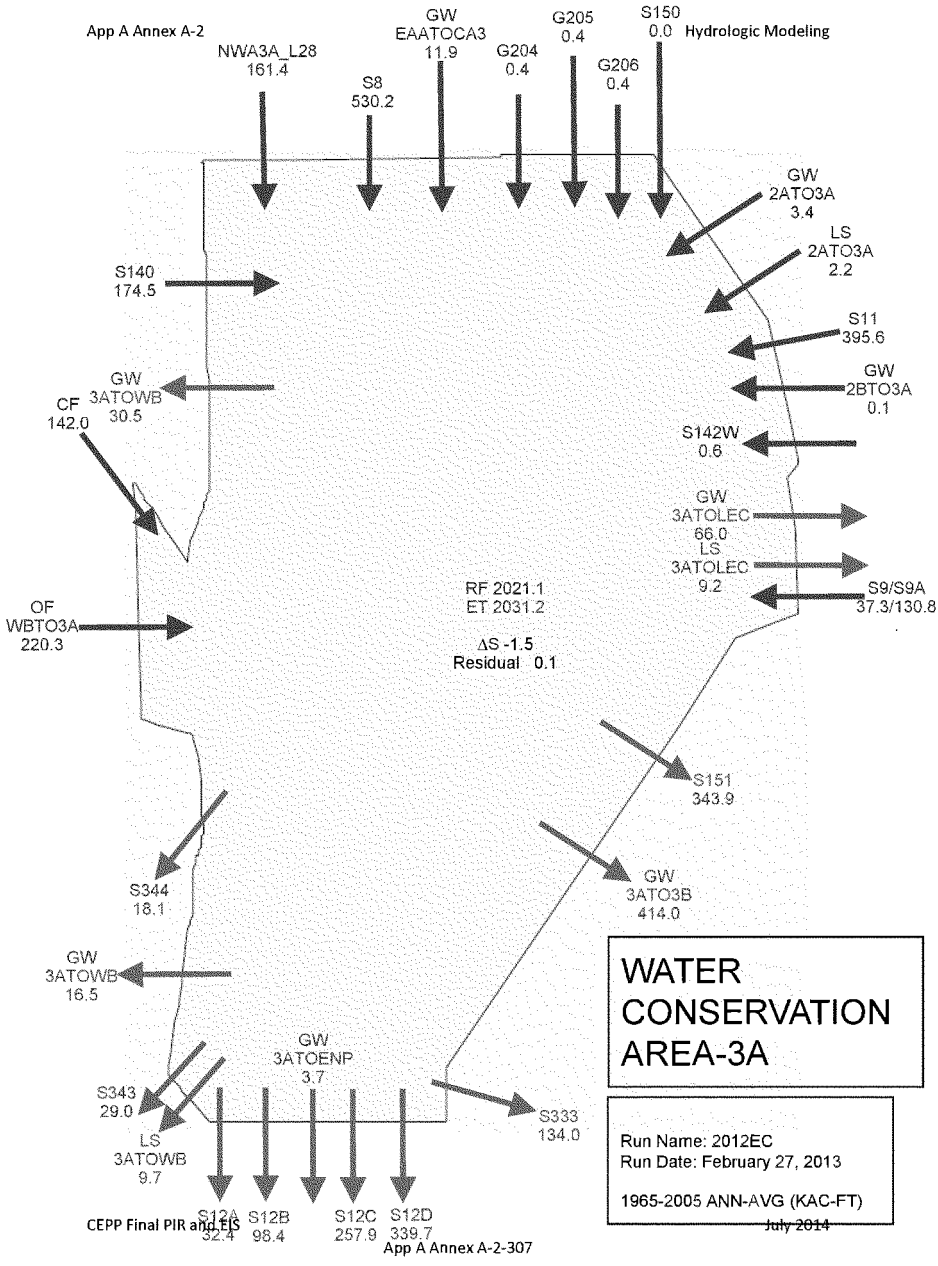


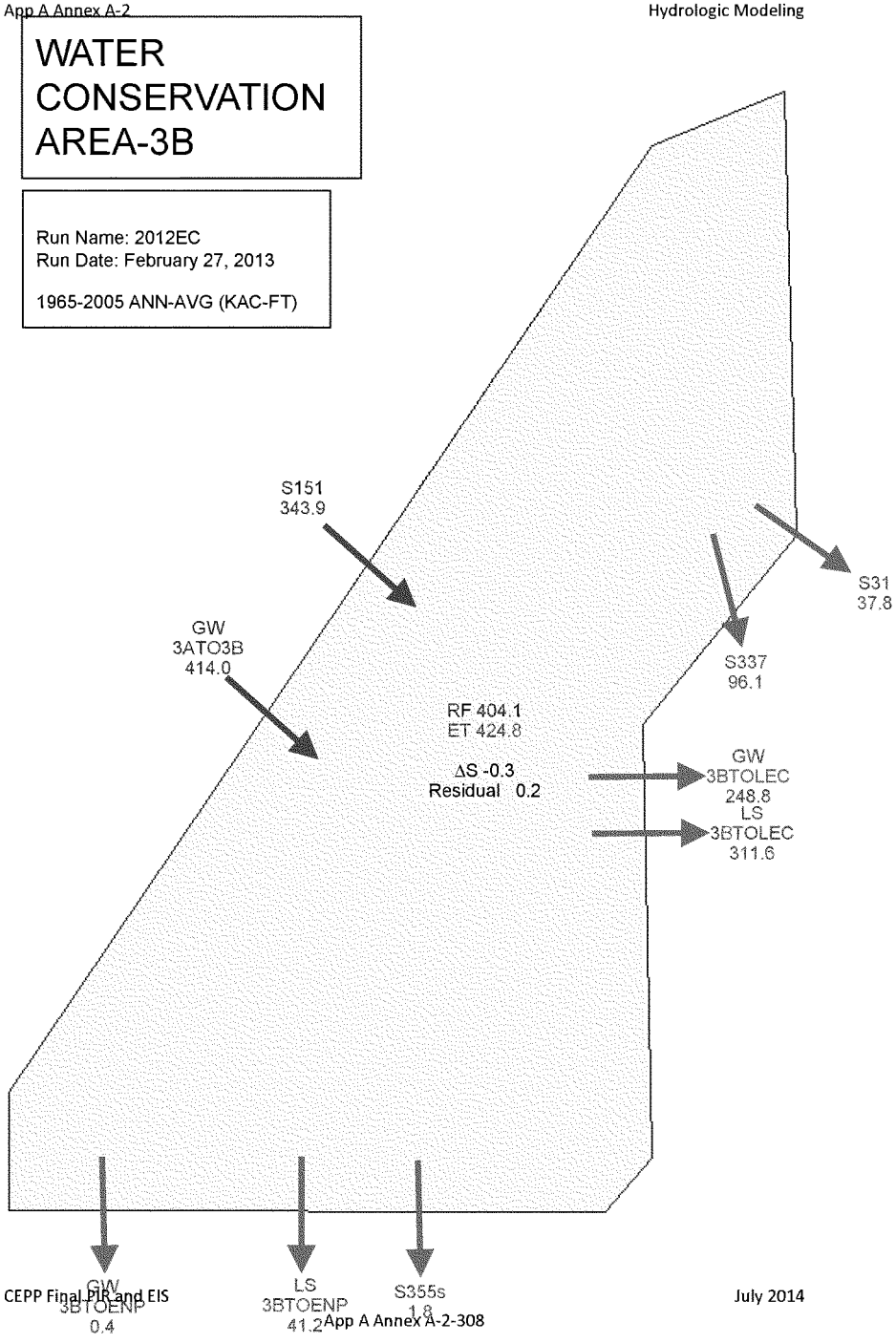
Note: Western Basins (WB) constitute L-28 Interceptor, Feeder Canal, L-28 Gap and East Collier Basins

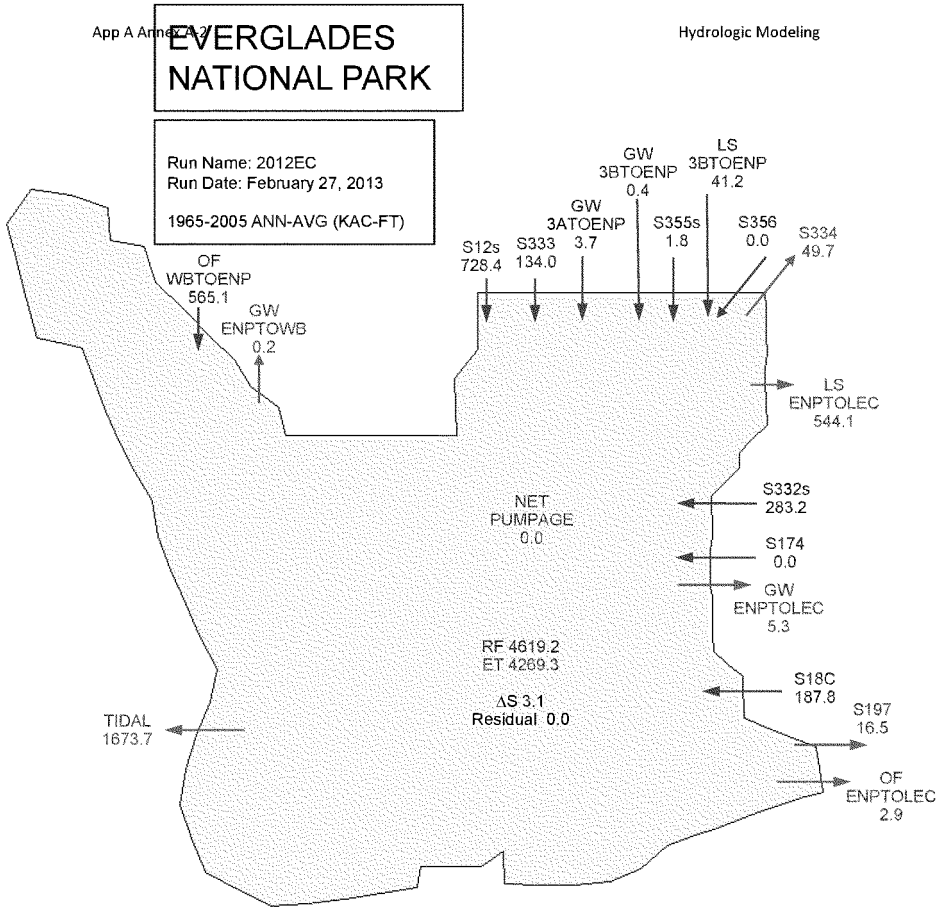

App A Annex A-2
Hydrologic Modeling
WATER CONSERVATION AREA-1
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
L101OT
1.4
S5AWC1
0.0
S5A2NO (ADDSLW+WSL8S)
9.8 8.8 1.0
ST1WQ1
216.0
ST1EO
250.5
GW
CA1TOEAA
20.6
G94 A/B/C
37.4
RF 601.0
ET 576.4
ΔS -1.8
Residual 0.0
WL2351
1.1
GW/LS
CA1TOLEC
32.9
GW
CA1TO2A
58.8
S10
298.7
S39
37.2
CEPP Final PIR and EIS
July 2014
App A Annex A-2-304

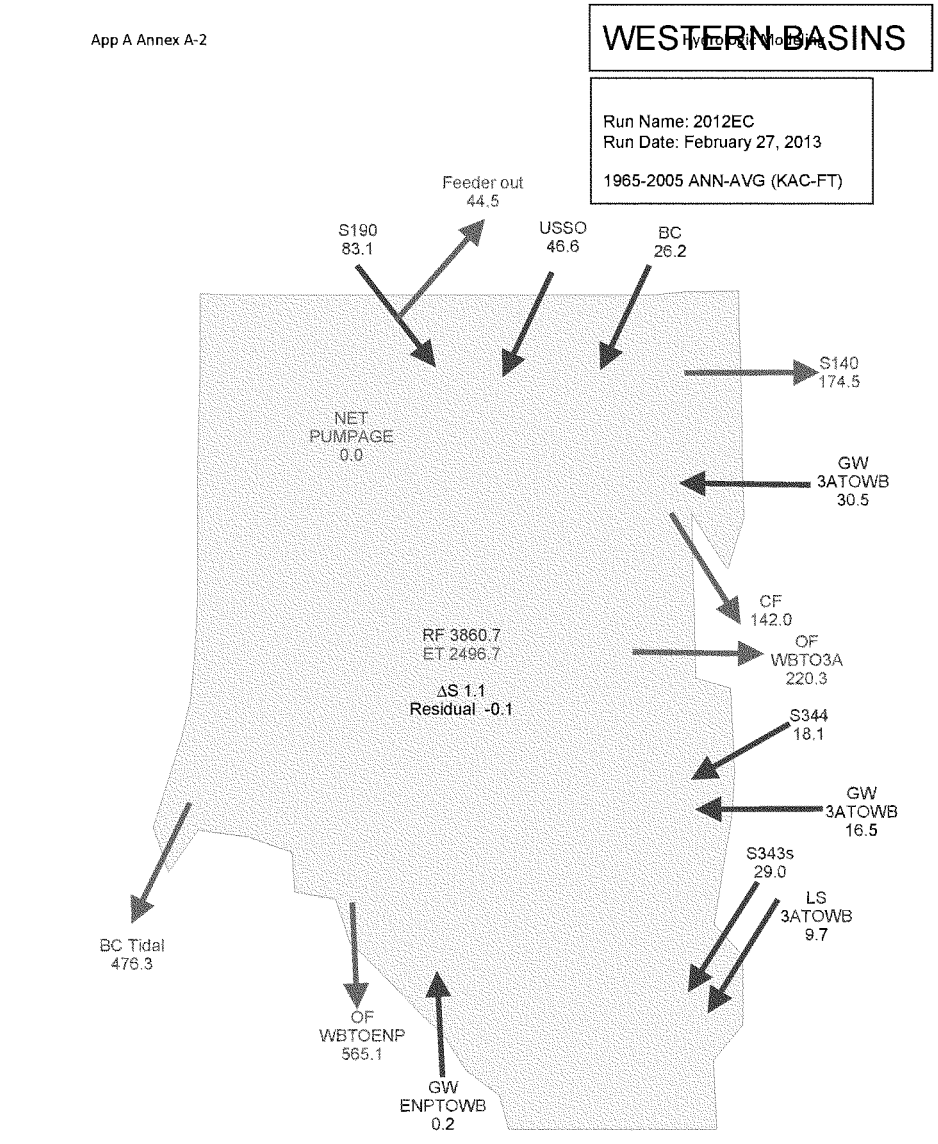

WATER CONSERVATION AREA-2A
Run Name: 2012EC
Run Date: February 27, 2012
1965-2005 ANN-AVG (KAC-FT)
STA2O+ BYP2N 220.8
GW CA1TO2A 58.8
GW 2ATOEAA 9.8
STA2O+BYP2S 9.1
S10 298.7
S7 115.0
NSID-2 0.0
NSID-3 0.0
RF 432.7
ET 443.5
ΔS -0.6
Residual 0.1
GW 2ATOLEC 13.0
LS 2ATOLEC 3.5
GW 2ATO3A 3.4
LS 2ATO3A 2.2
S11 395.6
S38 74.8
GW 2ATO2B 45.2
S144 40.1
S145 43.2
S146 42.0
S143 19.5


WATER CONSERVATION AREA-2B
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
GW
2ATO2B
45.2
S144
40.1
S145
43.2
S146
42.0
S143
19.5
GW
2BTO3A
0.1
S142W
0.6
G123
0.6
S34
22.8
RF 115.4
ET 117.3
ΔS 0.1
Residual 0.2
LS
2BTOLEC
1.4
GW
2BTOLEC
163.9

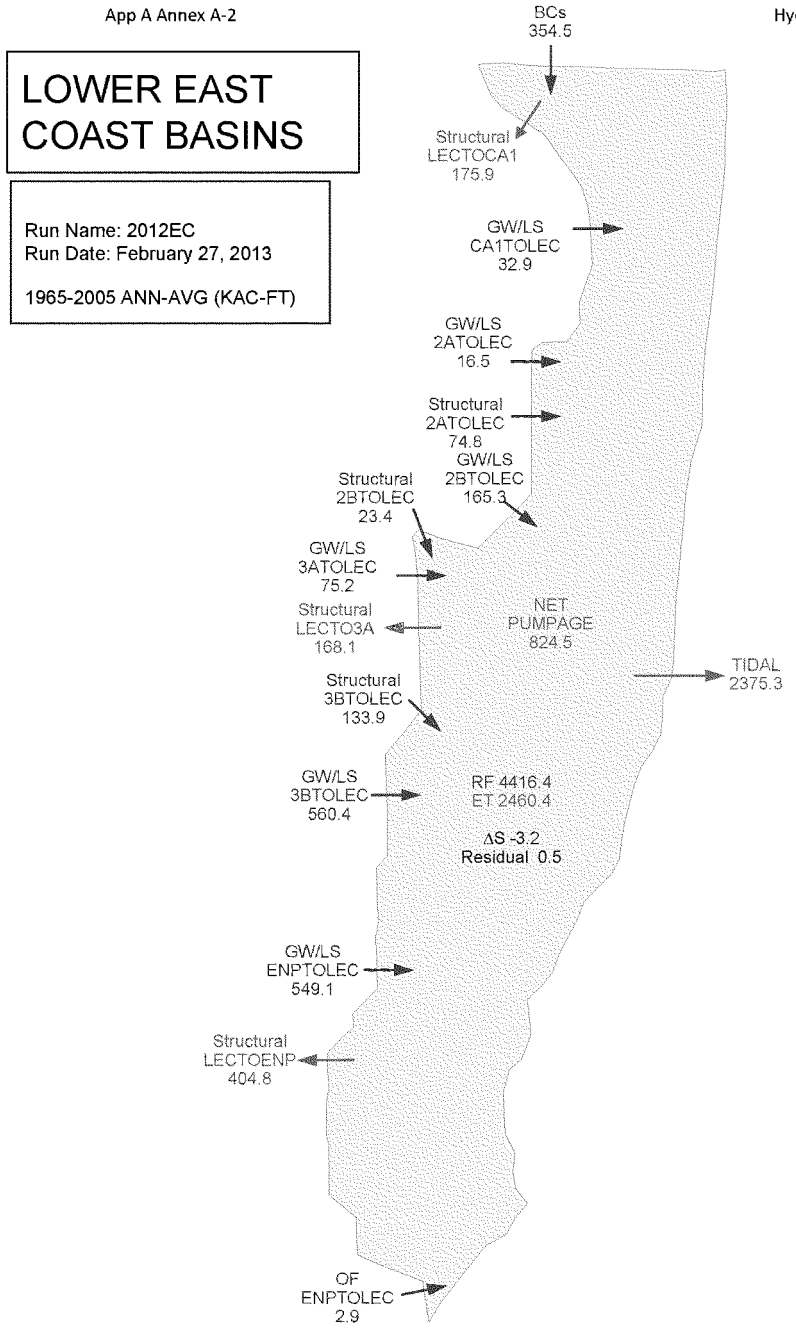

App A Annex A-2
Hydrologic Modeling
NWA3A_L28
161.4
S8
530.2
GW
EAATOCA3
11.9
G204
0.4
G205
0.4
G206
0.4
S150
0.0
GW
2ATO3A
3.4
LS
2ATO3A
2.2
S11
395.6
GW
2BTO3A
0.1
S142W
0.6
GW
3ATOLEC
66.0
LS
3ATOLEC
9.2
S9/S9A
37.3/130.8
S140
174.5
GW
3ATOWB
30.5
CF
142.0
OF
WBTO3A
220.3
RF 2021.1
ET 2031.2
ΔS -1.5
Residual 0.1
S151
343.9
GW
3ATO3B
414.0
S344
18.1
GW
3ATOWB
16.5
GW
3ATOENP
3.7
S343
29.0
LS
3ATOWB
9.7
S333
134.0
S12A
32.4
S12B
98.4
S12C
257.9
S12D
339.7
WATER
CONSERVATION
AREA-3A
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
July 2014

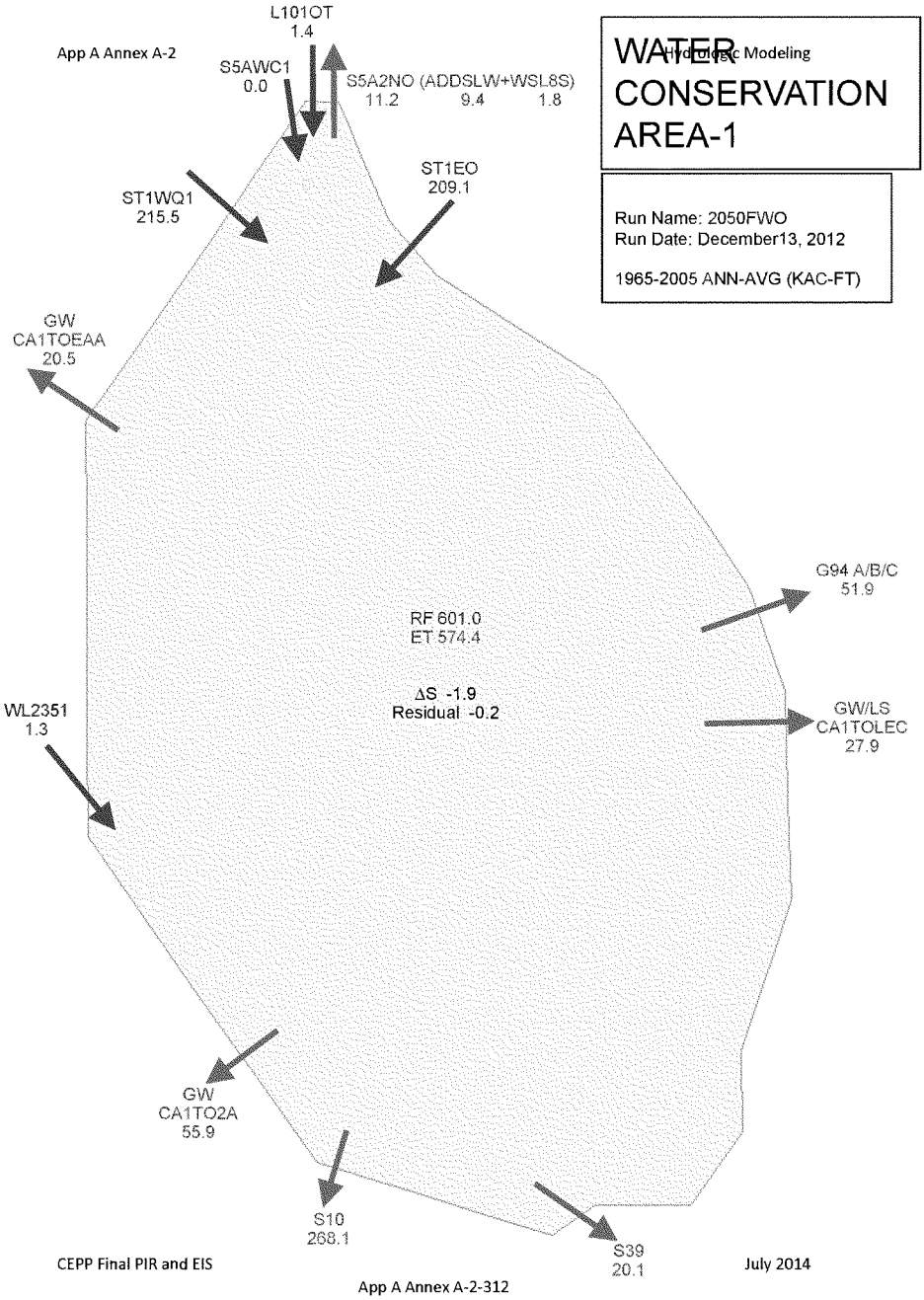

WATER CONSERVATION AREA-3B
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
S151
343.9
GW
3ATO3B
414.0
RF 404.1
ET 424.8
ΔS -0.3
Residual 0.2
S337
96.1
S31
37.8
GW
3BTOLEC
248.8
LS
3BTOLEC
311.6
GW
3BTOENP
0.4
LS
3BTOENP
41.2
S355s
1.8

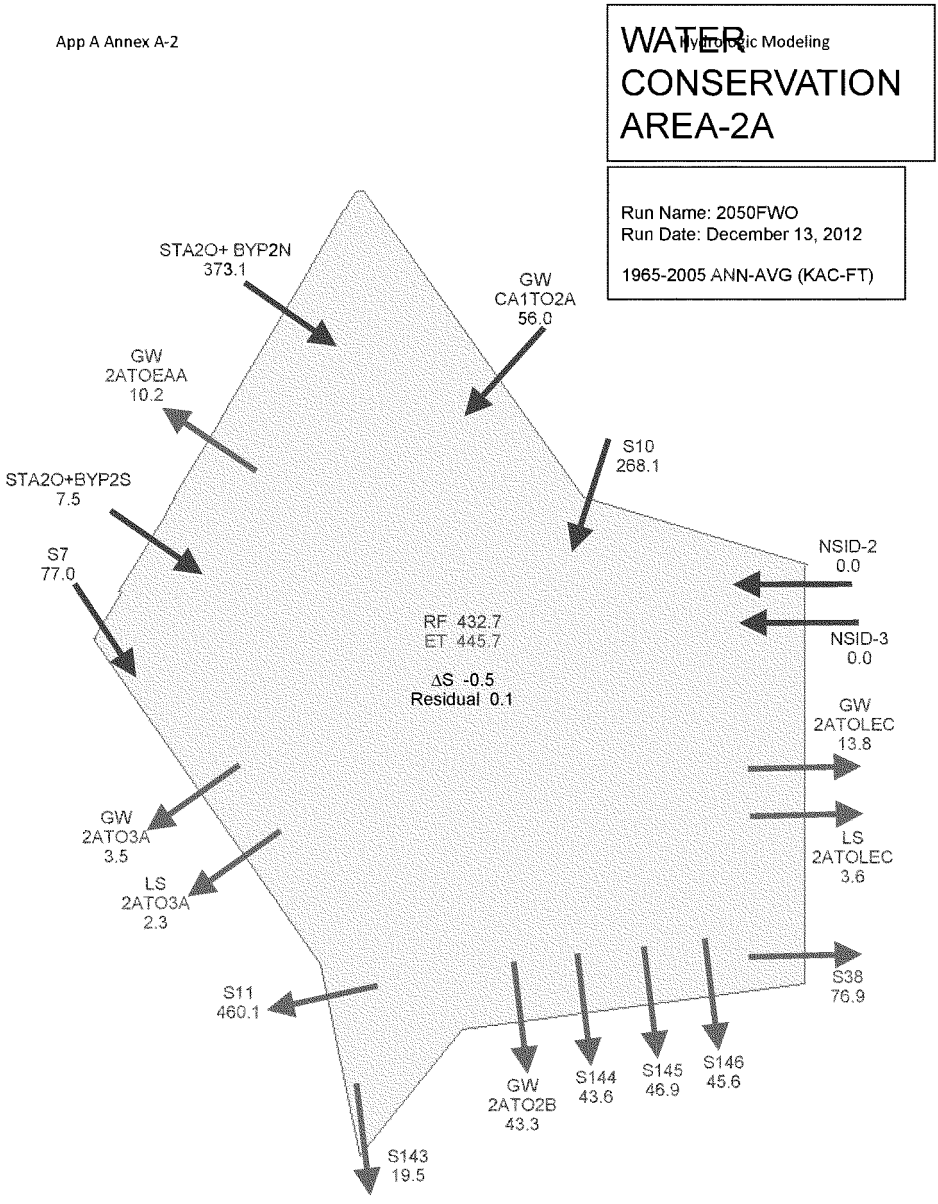

EVERGLADES
NATIONAL PARK
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
OF
WBTOENP
565.1
GW
ENPTOWB
0.2
S12s
728.4
S333
134.0
GW
3ATOENP
3.7
GW
3BTOENP
0.4
LS
3BTOENP
41.2
S355s
1.8
S356
0.0
S334
49.7
LS
ENPTOLEC
544.1
NET
PUMPAGE
0.0
S332s
283.2
S174
0.0
GW
ENPTOLEC
5.3
RF 4619.2
ET 4269.3
ΔS 3.1
Residual 0.0
S18C
187.8
S197
16.5
OF
ENPTOLEC
2.9
TIDAL
1673.7

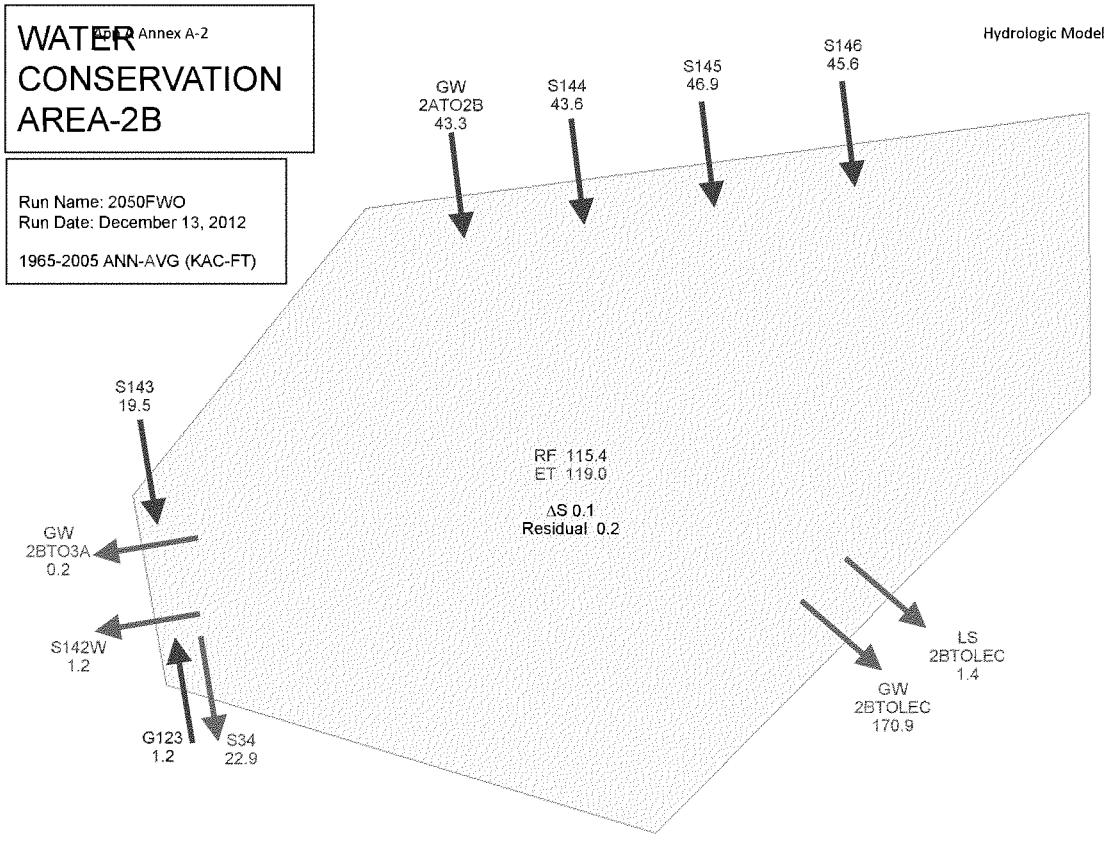


Note: Western Basins (WB) constitute L-28 Interceptor, Feeder Canal, L-28 Gap and East Collier Basins

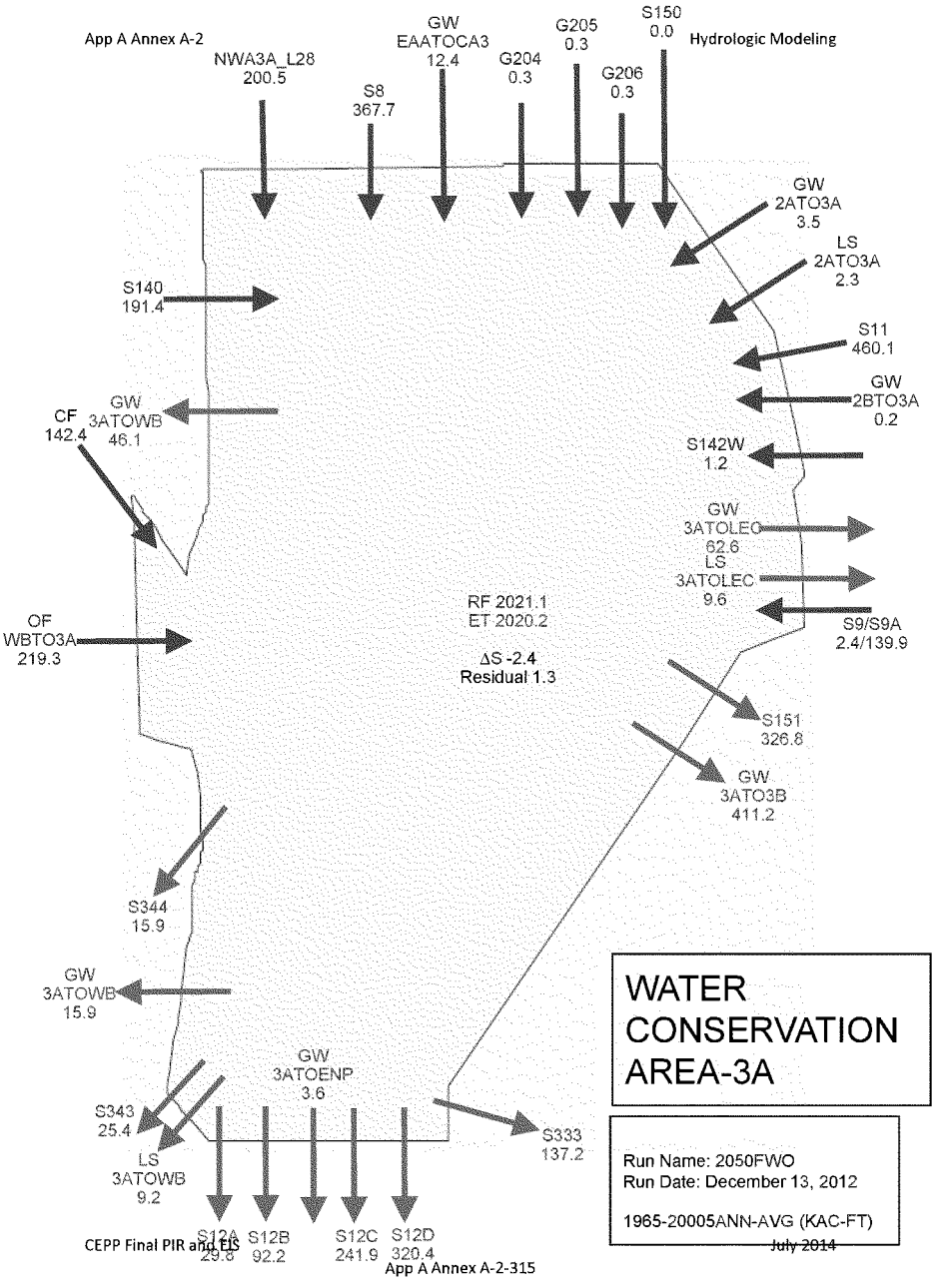

LOWER EAST COAST BASINS
Run Name: 2012EC
Run Date: February 27, 2013
1965-2005 ANN-AVG (KAC-FT)
BCs 354.5
Structural LECTOCA1 175.9
GW/LS CA1TOLEC 32.9
GW/LS 2ATOLEC 16.5
Structural 2ATOLEC 74.8
GW/LS 2BTOLEC 165.3
Structural 2BTOLEC 23.4
GW/LS 3ATOLEC 75.2
Structural LECTO3A 168.1
NET PUMPAGE 824.5
TIDAL 2375.3
Structural 3BTOLEC 133.9
GW/LS 3BTOLEC 560.4
RF 4416.4
ET 2460.4
ΔS -3.2
Residual 0.5
GW/LS ENPTOLEC 549.1
Structural LECTOENP 404.8
OF ENPTOLEC 2.9

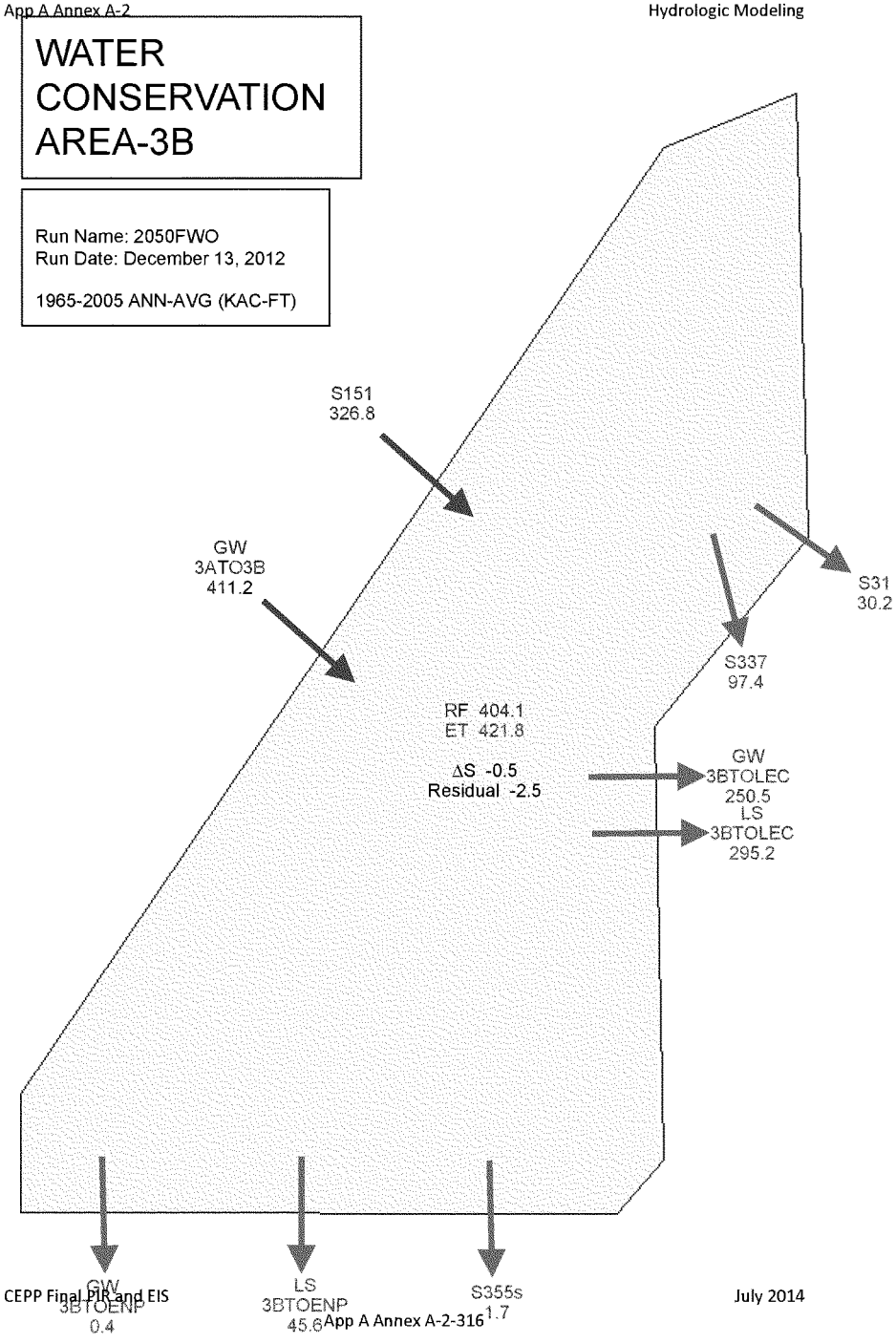

App A Annex A-2
Hydrologic Modeling
WATER CONSERVATION AREA-1
Run Name: 2050FWO
Run Date: December13, 2012
1965-2005 ANN-AVG (KAC-FT)
L101OT
1.4
S5AWC1
0.0
S5A2NO (ADDSLW+WSL8S)
11.2 9.4 1.8
ST1EO
209.1
ST1WQ1
215.5
GW
CA1TOEAA
20.5
G94 A/B/C
51.9
RF 601.0
ET 574.4
ΔS -1.9
Residual -0.2
WL2351
1.3
GW/LS
CA1TOLEC
27.9
GW
CA1TO2A
55.9
S10
268.1
S39
20.1
CEPP Final PIR and EIS
July 2014
App A Annex A-2-312

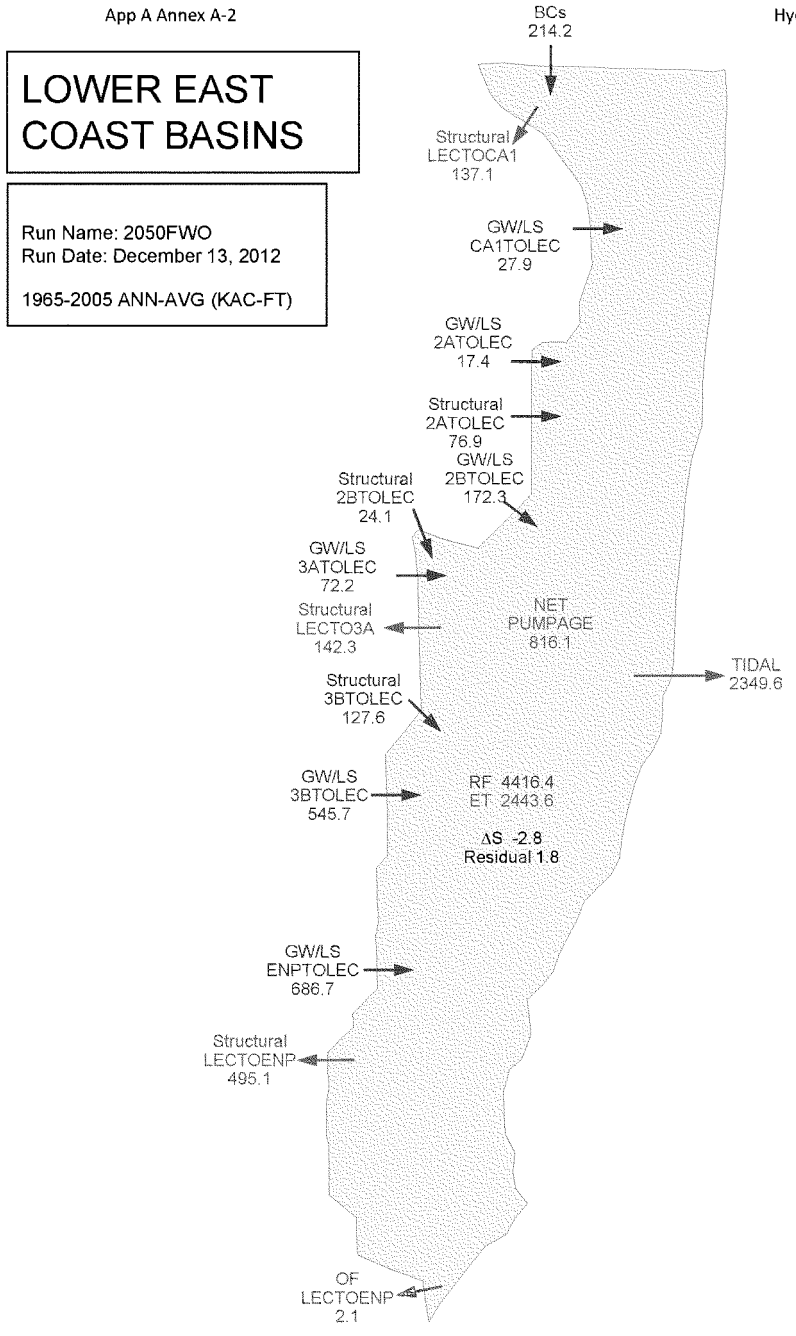

WATER CONSERVATION AREA-2A
Run Name: 2050FWO
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
STA2O+ BYP2N 373.1
GW CA1TO2A 56.0
GW 2ATOEAA 10.2
S10 268.1
STA2O+BYP2S 7.5
S7 77.0
NSID-2 0.0
NSID-3 0.0
RF 432.7
ET 445.7
ΔS -0.5
Residual 0.1
GW 2ATOLEC 13.8
LS 2ATOLEC 3.6
GW 2ATO3A 3.5
LS 2ATO3A 2.3
S11 460.1
S38 76.9
GW 2ATO2B 43.3
S144 43.6
S145 46.9
S146 45.6
S143 19.5

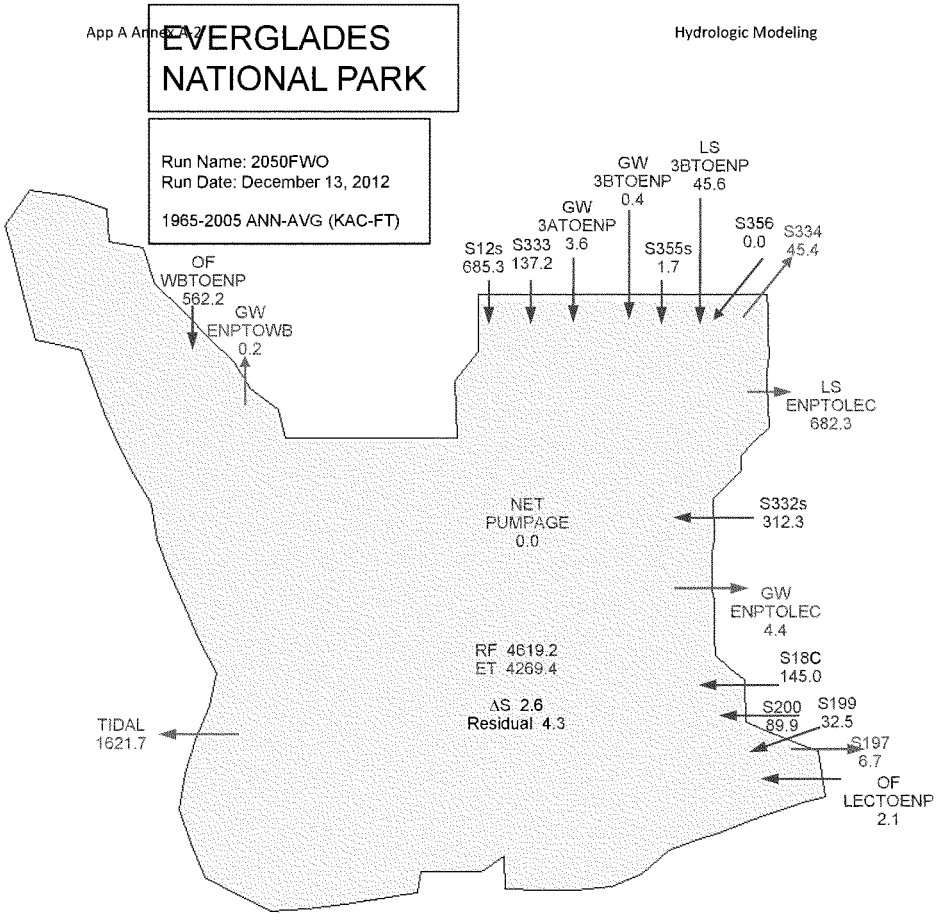

WATER CONSERVATION AREA-2B
Run Name: 2050FWO
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
GW 2ATO2B 43.3
S144 43.6
S145 46.9
S146 45.6
S143 19.5
GW 2BTO3A 0.2
S142W 1.2
G123 1.2
S34 22.9
RF 115.4
ET 119.0
ΔS 0.1
Residual 0.2
LS 2BTOLEC 1.4
GW 2BTOLEC 170.9

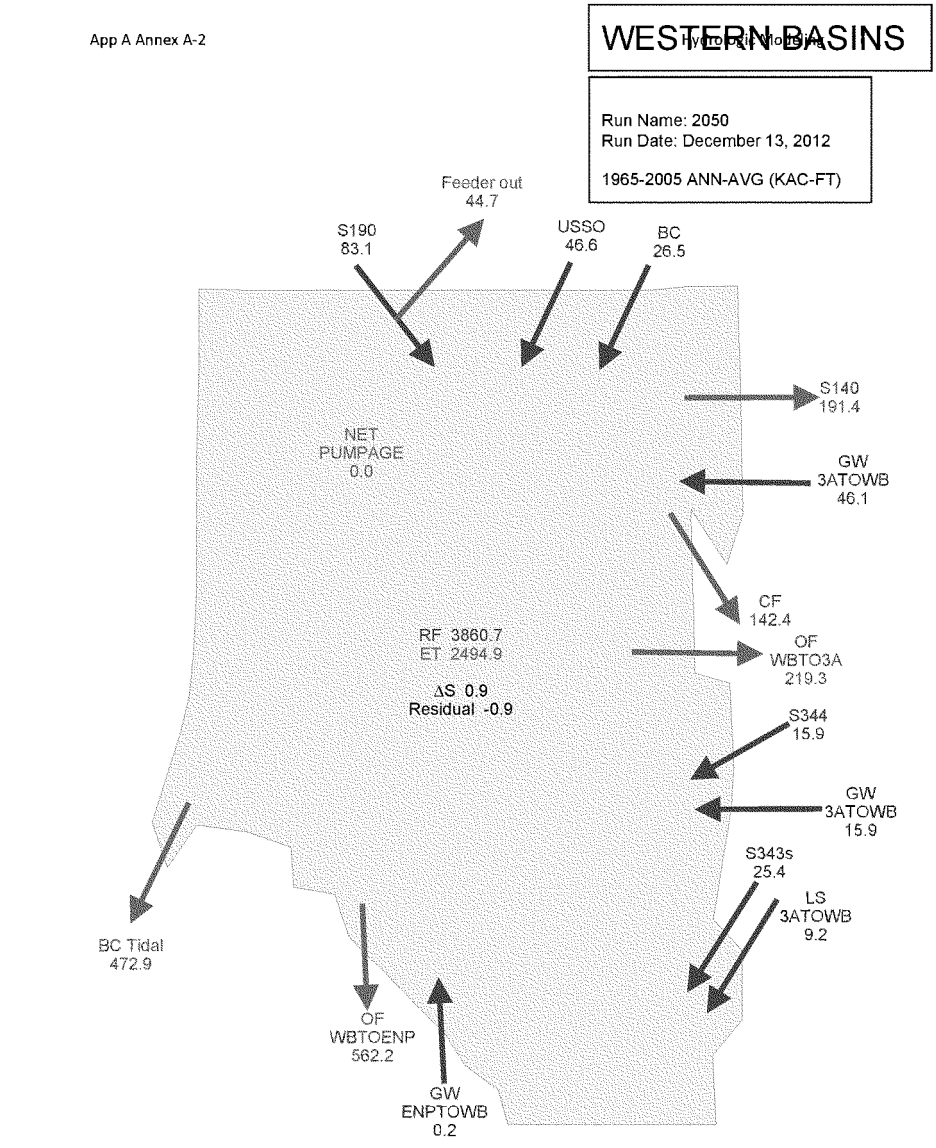
9962


App A Annex A-2
Hydrologic Modeling
NWA3A_L28
200.5
S8
367.7
GW
EAATOCA3
12.4
G204
0.3
G205
0.3
G206
0.3
S150
0.0
GW
2ATO3A
3.5
LS
2ATO3A
2.3
S11
460.1
GW
2BTO3A
0.2
S142W
1.2
GW
3ATOLEC
62.6
LS
3ATOLEC
9.6
S9/S9A
2.4/139.9
S151
326.8
GW
3ATO3B
411.2
S140
191.4
CF
142.4
GW
3ATOWB
46.1
OF
WBTO3A
219.3
RF 2021.1
ET 2020.2
ΔS -2.4
Residual 1.3
S344
15.9
GW
3ATOWB
15.9
GW
3ATOENP
3.6
S343
25.4
LS
3ATOWB
9.2
S333
137.2
S12A
29.8
S12B
92.2
S12C
241.9
S12D
320.4
WATER
CONSERVATION
AREA-3A
Run Name: 2050FWO
Run Date: December 13, 2012
1965-20005ANN-AVG (KAC-FT)
July 2014

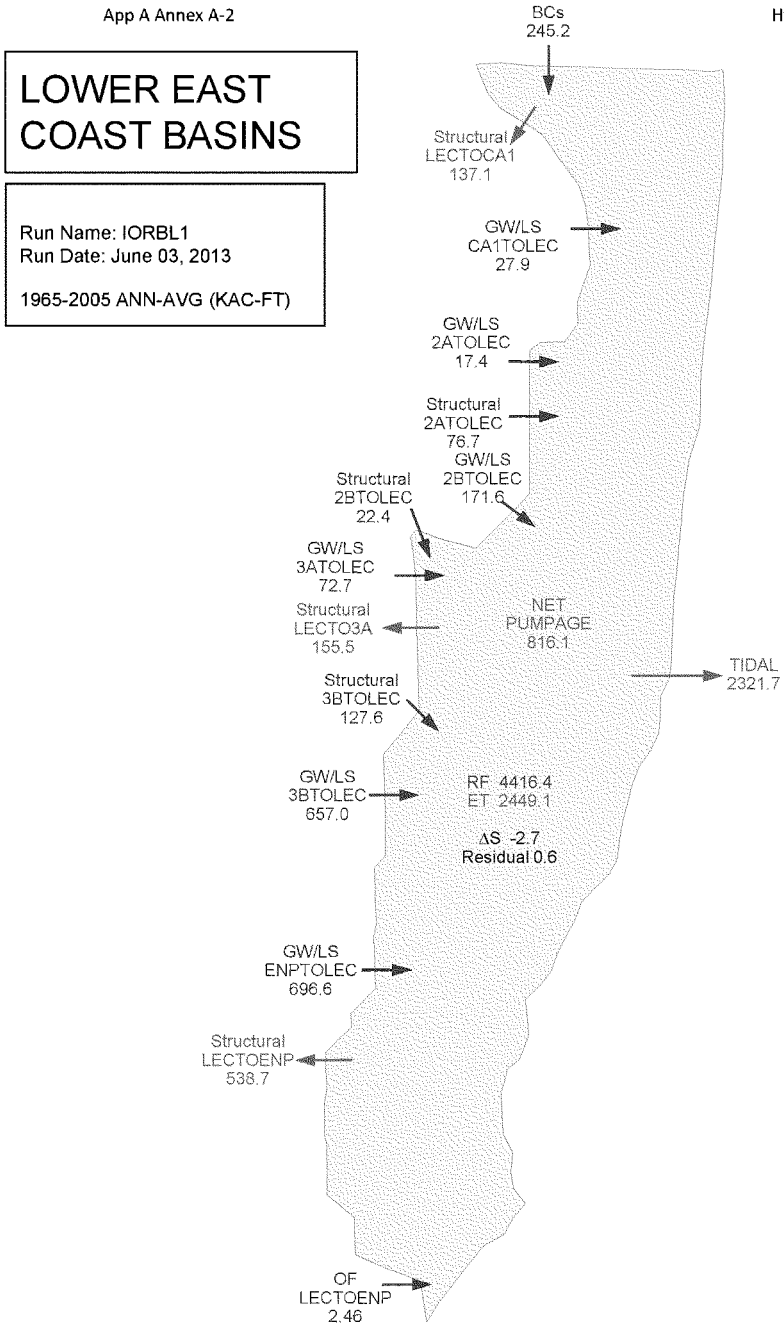

WATER CONSERVATION AREA-3B
Run Name: 2050FWO
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
S151
326.8
GW
3ATO3B
411.2
S31
30.2
S337
97.4
RF 404.1
ET 421.8
ΔS -0.5
Residual -2.5
GW
3BTOLEC
250.5
LS
3BTOLEC
295.2
GW
3BTOENP
0.4
LS
3BTOENP
45.6
S355s
1.7

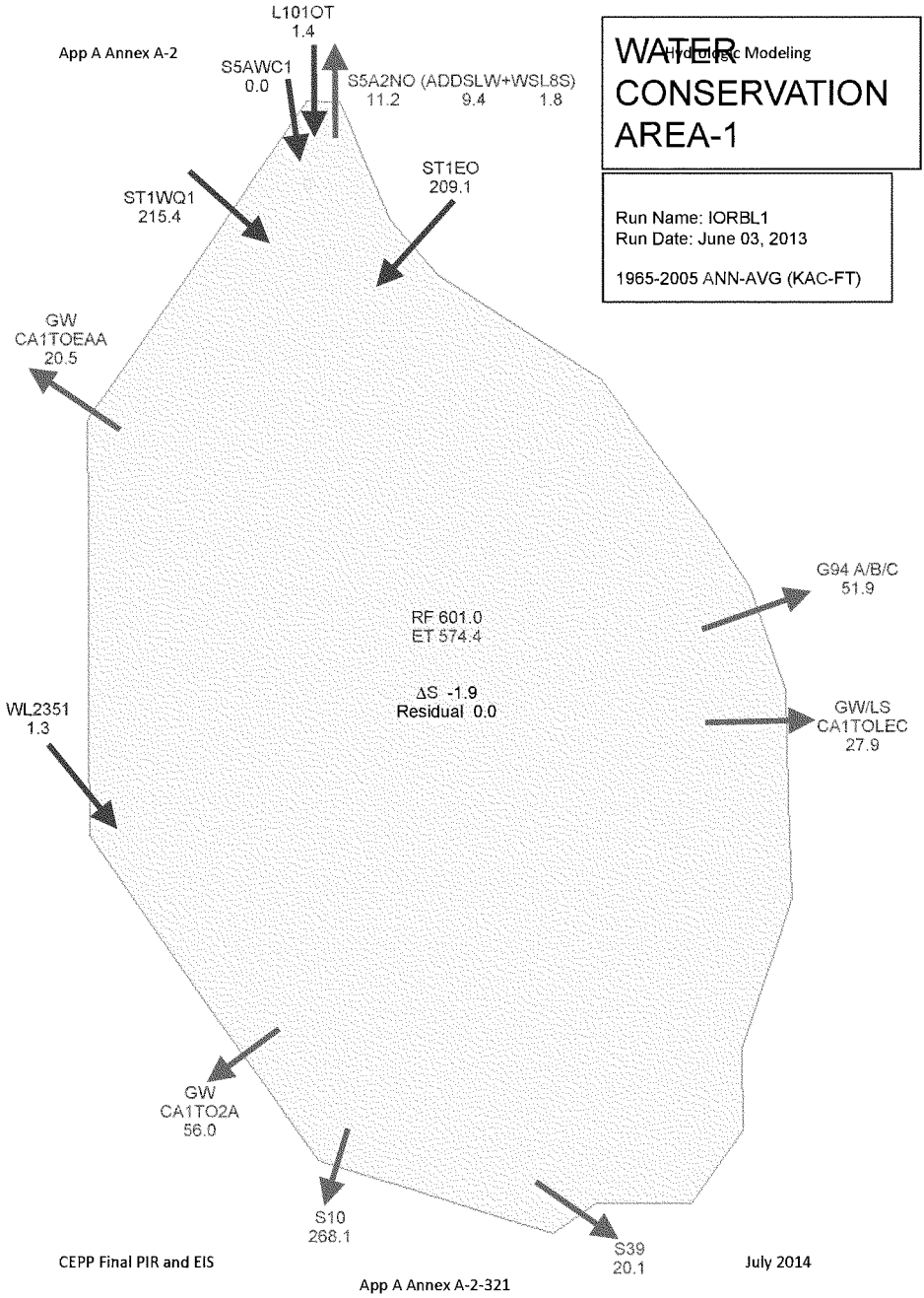

LOWER EAST COAST BASINS
Run Name: 2050FWO
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
BCs 214.2
Structural LECTOCA1 137.1
GW/LS CA1TOLEC 27.9
GW/LS 2ATOLEC 17.4
Structural 2ATOLEC 76.9
GW/LS 2BTOLEC 172.3
Structural 2BTOLEC 24.1
GW/LS 3ATOLEC 72.2
Structural LECTO3A 142.3
NET PUMPAGE 816.1
TIDAL 2349.6
Structural 3BTOLEC 127.6
GW/LS 3BTOLEC 545.7
RF 4416.4
ET 2443.6
ΔS -2.8
Residual 1.8
GW/LS ENPTOLEC 686.7
Structural LECTOENP 495.1
OF LECTOENP 2.1

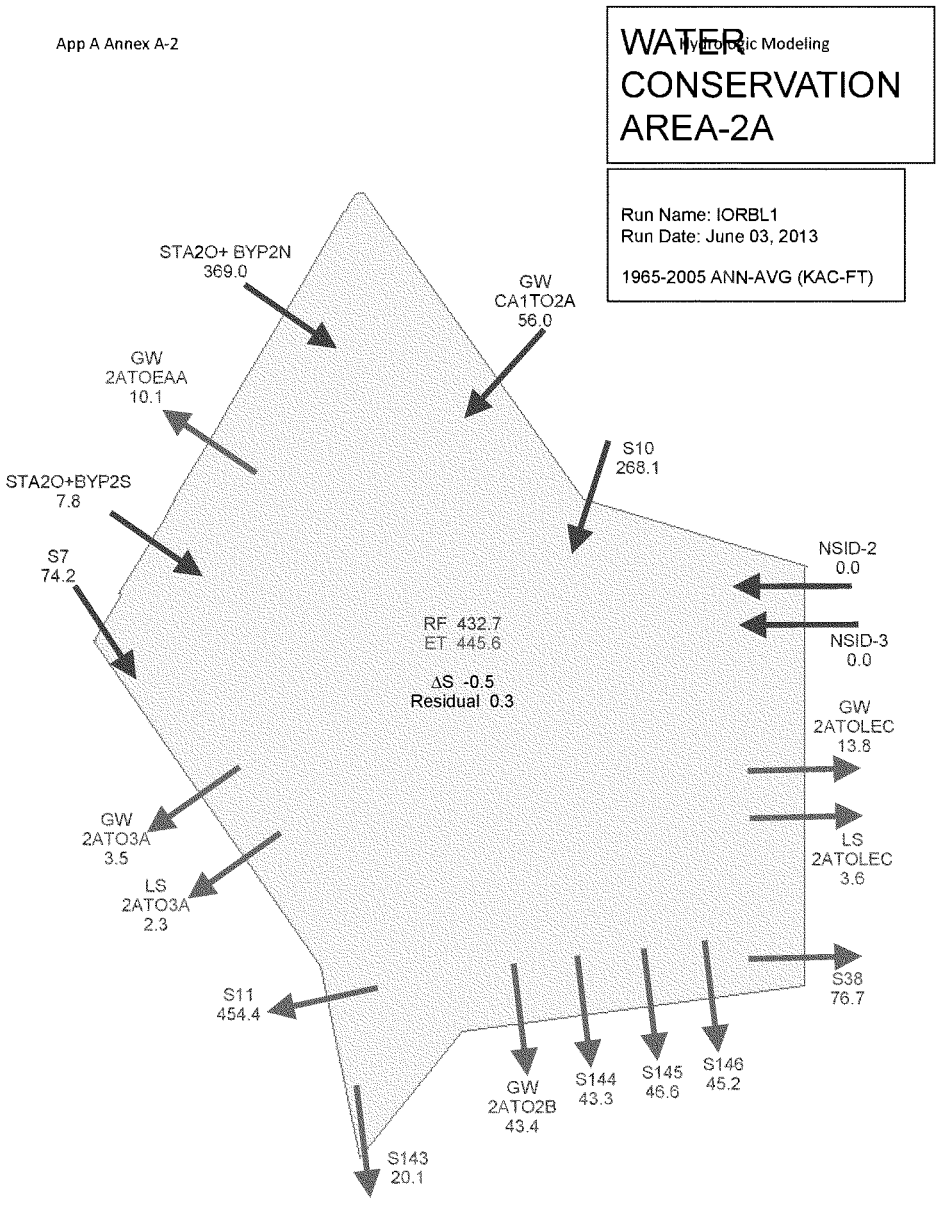

EVERGLADES
NATIONAL PARK
Run Name: 2050FWO
Run Date: December 13, 2012
1965-2005 ANN-AVG (KAC-FT)
OF
WBTOENP
562.2
GW
ENPTOWB
0.2
S12s
685.3
S333
137.2
GW
3ATOENP
3.6
GW
3BTOENP
0.4
LS
3BTOENP
45.6
S355s
1.7
S356
0.0
S334
45.4
LS
ENPTOLEC
682.3
NET
PUMPAGE
0.0
S332s
312.3
GW
ENPTOLEC
4.4
RF 4619.2
ET 4269.4
ΔS 2.6
Residual 4.3
S18C
145.0
S200
89.9
S199
32.5
S197
6.7
OF
LECTOENP
2.1
TIDAL
1621.7

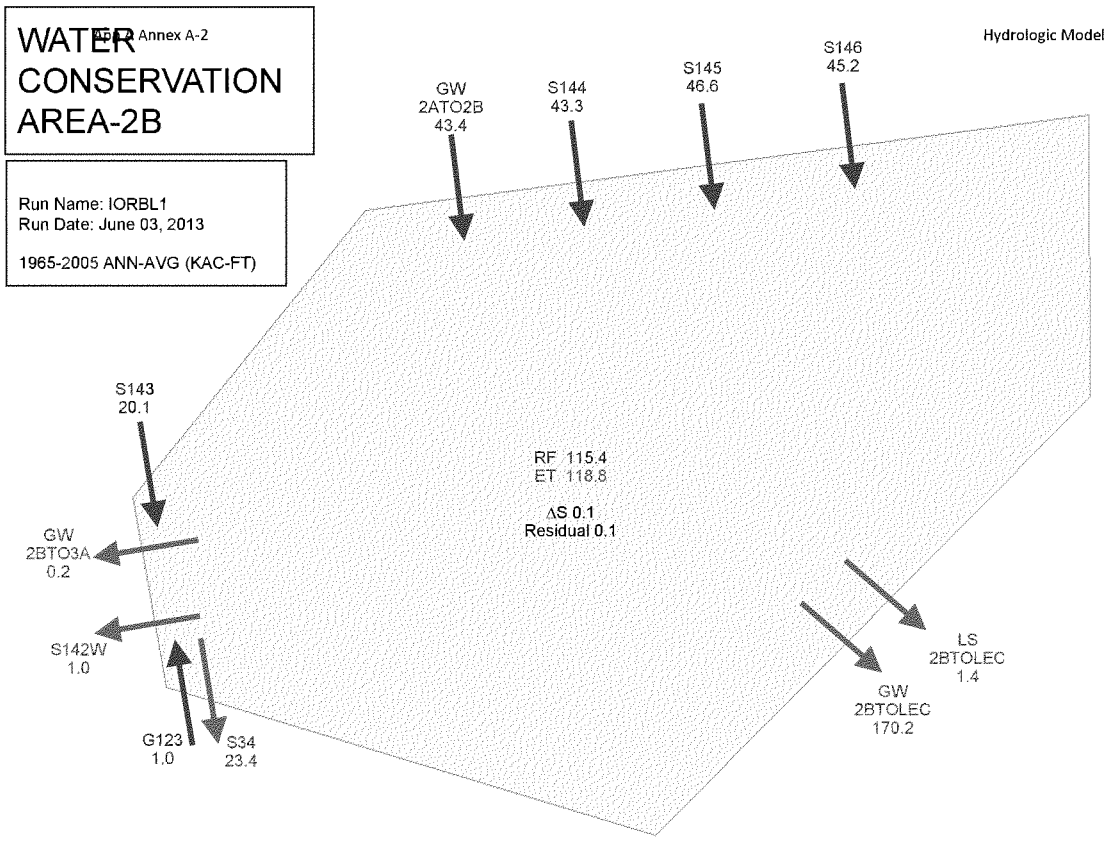


Note: Western Basins (WB) constitute L-28 Interceptor, Feeder Canal, L-28 Gap and East Collier Basins

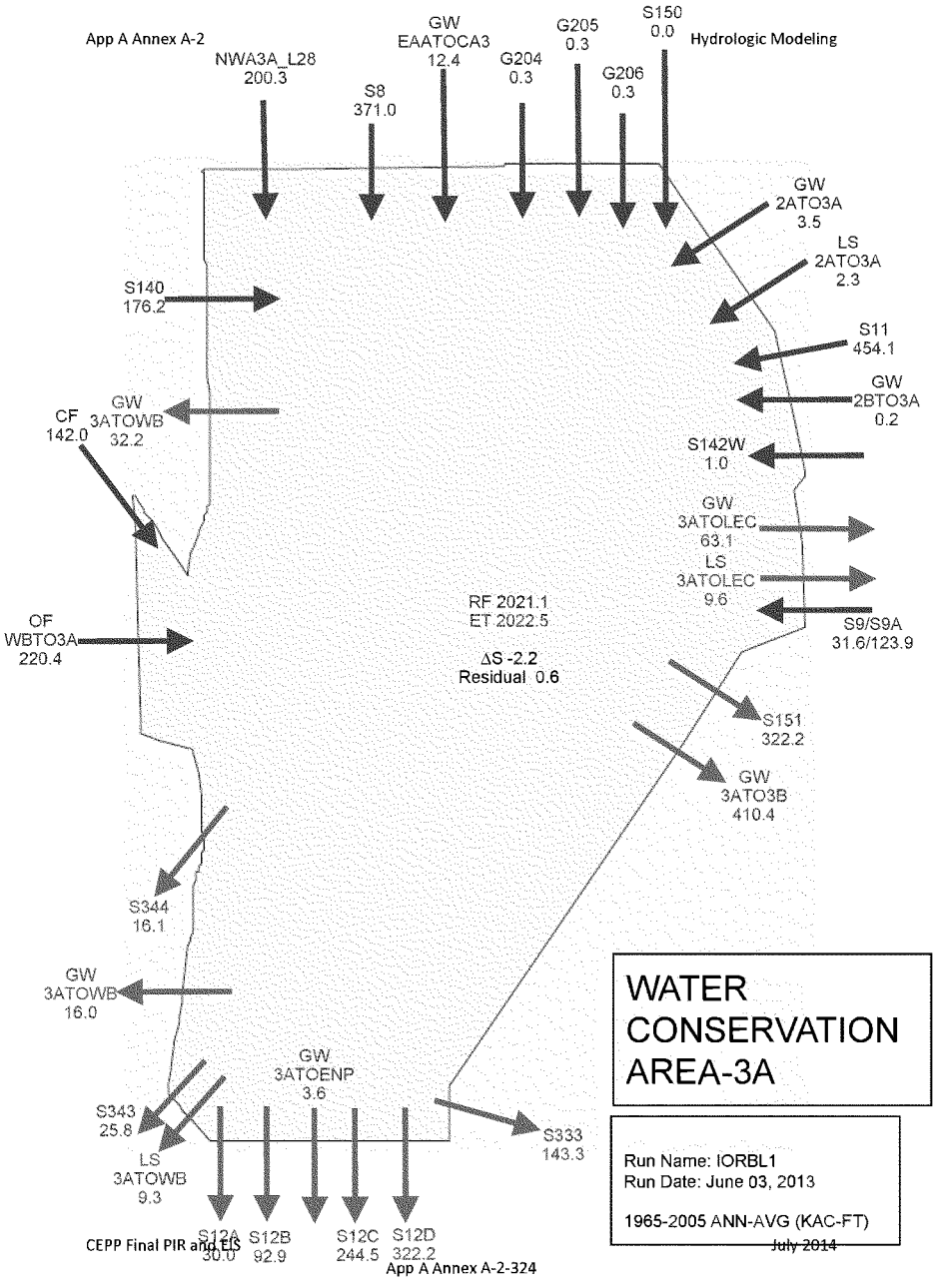

LOWER EAST COAST BASINS
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
BCs 245.2
Structural LECTOCA1 137.1
GW/LS CA1TOLEC 27.9
GW/LS 2ATOLEC 17.4
Structural 2ATOLEC 76.7
GW/LS 2BTOLEC 171.6
Structural 2BTOLEC 22.4
GW/LS 3ATOLEC 72.7
Structural LECTO3A 155.5
NET PUMPAGE 816.1
TIDAL 2321.7
Structural 3BTOLEC 127.6
GW/LS 3BTOLEC 657.0
RF 4416.4
ET 2449.1
ΔS -2.7
Residual 0.6
GW/LS ENPTOLEC 696.6
Structural LECTOENP 538.7
OF LECTOENP 2.46

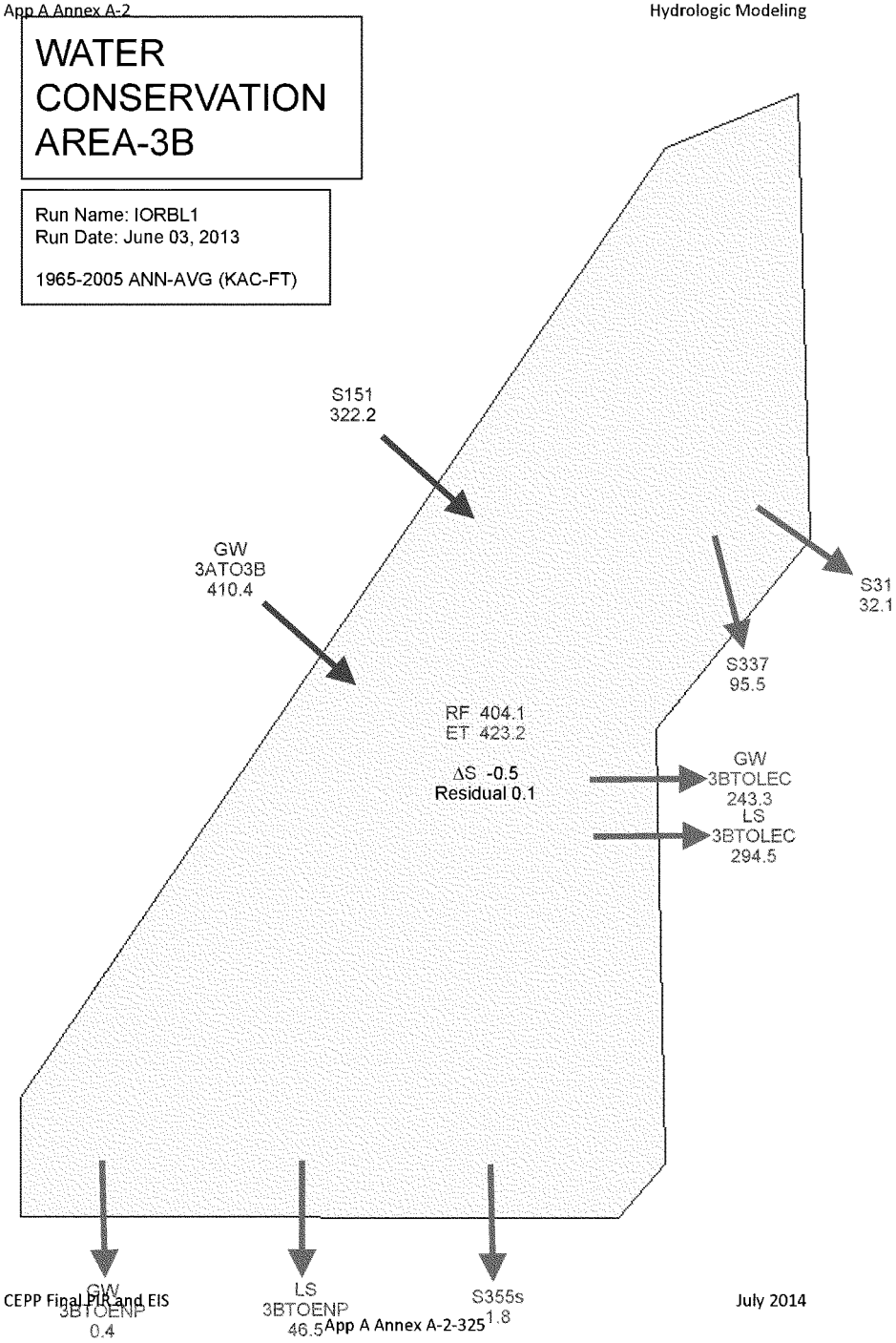

App A Annex A-2
L101OT
1.4
S5AWC1
0.0
S5A2NO (ADDSLW+WSL8S)
11.2 9.4 1.8
WATER CONSERVATION AREA-1
Hydrologic Modeling
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
ST1WQ1
215.4
ST1EO
209.1
GW
CA1TOEAA
20.5
G94 A/B/C
51.9
RF 601.0
ET 574.4
ΔS -1.9
Residual 0.0
WL2351
1.3
GW/LS
CA1TOLEC
27.9
GW
CA1TO2A
56.0
S10
268.1
S39
20.1
CEPP Final PIR and EIS
July 2014
App A Annex A-2-321

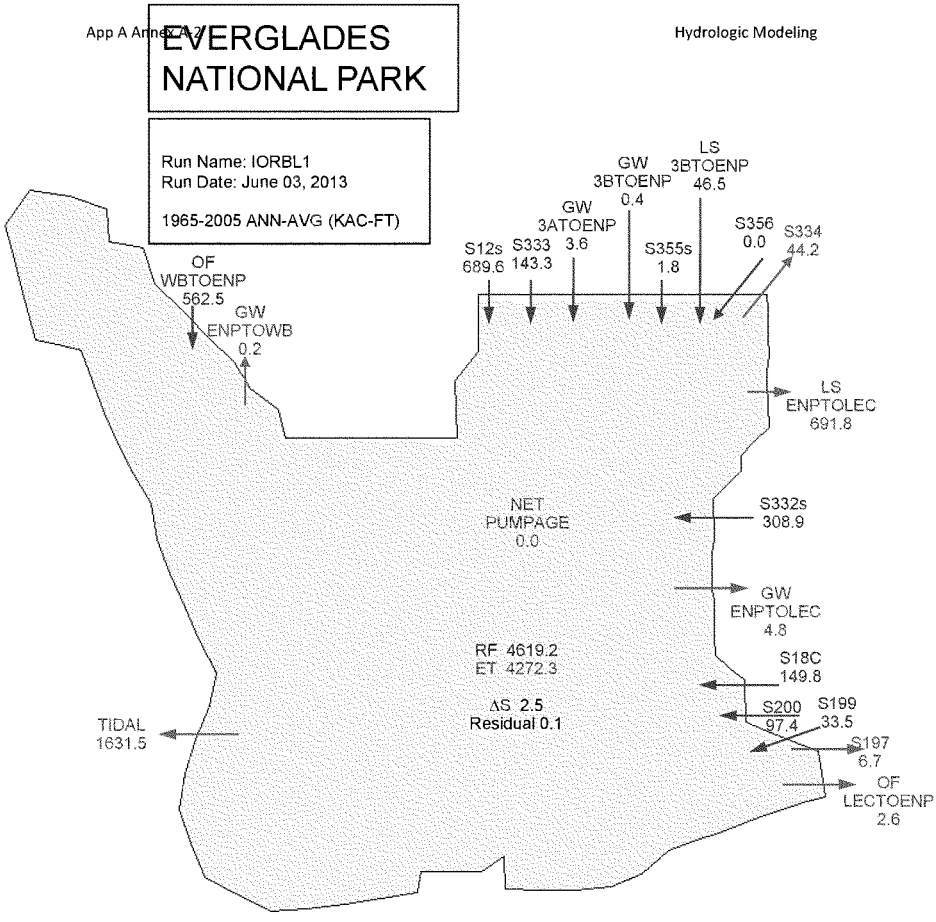

WATER CONSERVATION AREA-2A
Hydrologic Modeling
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
STA2O+ BYP2N
369.0
GW
CA1TO2A
56.0
GW
2ATOEAA
10.1
S10
268.1
STA2O+BYP2S
7.8
S7
74.2
NSID-2
0.0
NSID-3
0.0
RF 432.7
ET 445.6
ΔS -0.5
Residual 0.3
GW
2ATOLEC
13.8
LS
2ATOLEC
3.6
GW
2ATO3A
3.5
LS
2ATO3A
2.3
S11
454.4
S38
76.7
GW
2ATO2B
43.4
S144
43.3
S145
46.6
S146
45.2
S143
20.1


WATER CONSERVATION AREA-2B
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
GW 2ATO2B 43.4
S144 43.3
S145 46.6
S146 45.2
S143 20.1
RF 115.4
ET 118.8
ΔS 0.1
Residual 0.1
GW 2BTO3A 0.2
S142W 1.0
G123 1.0
S34 23.4
LS 2BTOLEC 1.4
GW 2BTOLEC 170.2

971


App A Annex A-2
Hydrologic Modeling
NWA3A_L28
200.3
S8
371.0
GW
EAATOCA3
12.4
G204
0.3
G205
0.3
G206
0.3
S150
0.0
GW
2ATO3A
3.5
LS
2ATO3A
2.3
S11
454.1
GW
2BTO3A
0.2
S142W
1.0
GW
3ATOLEC
63.1
LS
3ATOLEC
9.6
S9/S9A
31.6/123.9
S140
176.2
CF
142.0
GW
3ATOWB
32.2
OF
WBTO3A
220.4
RF 2021.1
ET 2022.5
ΔS -2.2
Residual 0.6
S151
322.2
GW
3ATO3B
410.4
S344
16.1
GW
3ATOWB
16.0
GW
3ATOENP
3.6
S343
25.8
LS
3ATOWB
9.3
S333
143.3
S12A
30.0
S12B
92.9
S12C
244.5
S12D
322.2
WATER
CONSERVATION
AREA-3A
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
July 2014

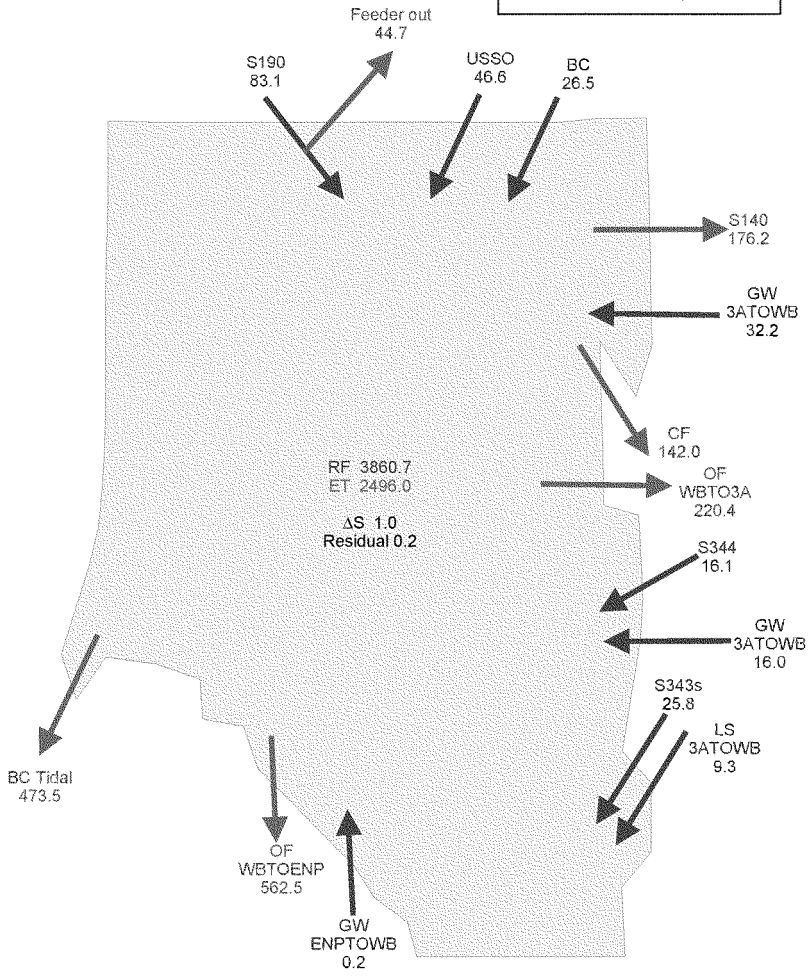

WATER CONSERVATION AREA-3B
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
S151
322.2
GW
3ATO3B
410.4
S31
32.1
S337
95.5
RF 404.1
ET 423.2
ΔS -0.5
Residual 0.1
GW
3BTOLEC
243.3
LS
3BTOLEC
294.5
GW
3BTOENP
0.4
LS
3BTOENP
46.5
S355s
1.8


EVERGLADES
NATIONAL PARK
Run Name: IORBL1
Run Date: June 03, 2013
1965-2005 ANN-AVG (KAC-FT)
OF
WBTOENP
562.5
GW
ENPTOWB
0.2
S12s
689.6
S333
143.3
GW
3ATOENP
3.6
GW
3BTOENP
0.4
LS
3BTOENP
46.5
S355s
1.8
S356
0.0
S334
44.2
LS
ENPTOLEC
691.8
NET
PUMPAGE
0.0
S332s
308.9
GW
ENPTOLEC
4.8
RF 4619.2
ET 4272.3
ΔS 2.5
Residual 0.1
S18C
149.8
S200
97.4
S199
33.5
S197
6.7
OF
LECTOENP
2.6
TIDAL
1631.5

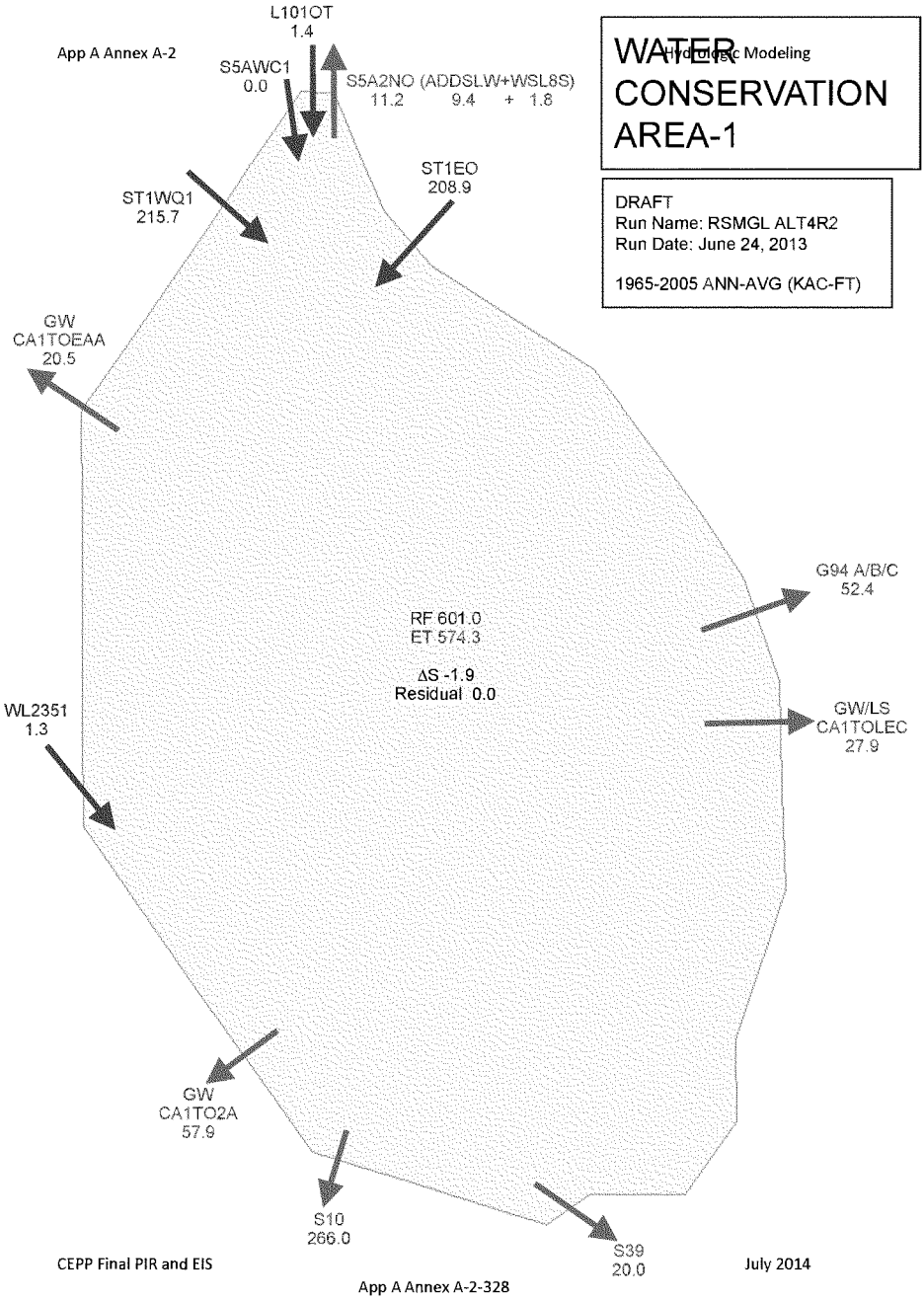
WESTERN BASINS

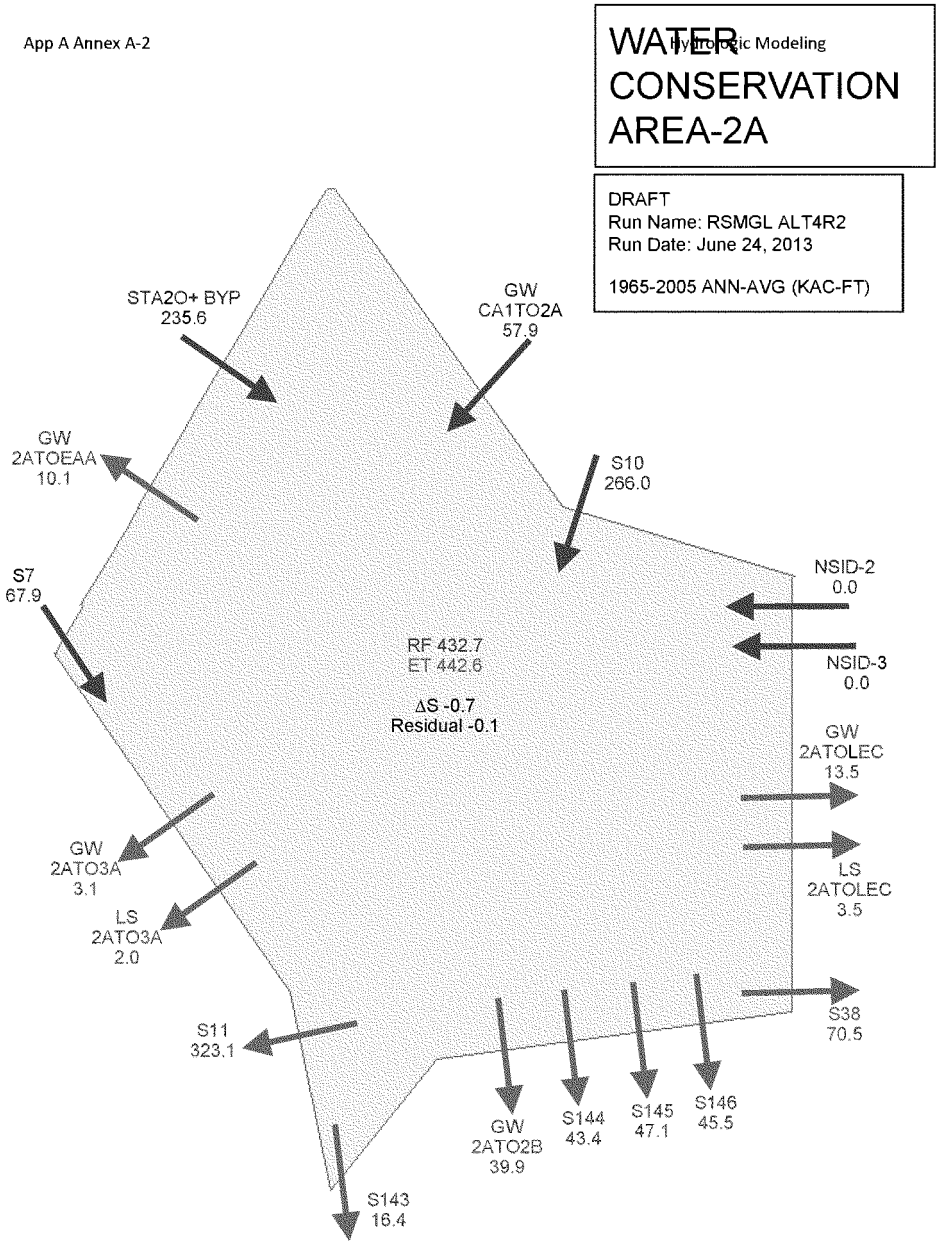
Run Name: IORBL1
Run Date: June 03, 2013

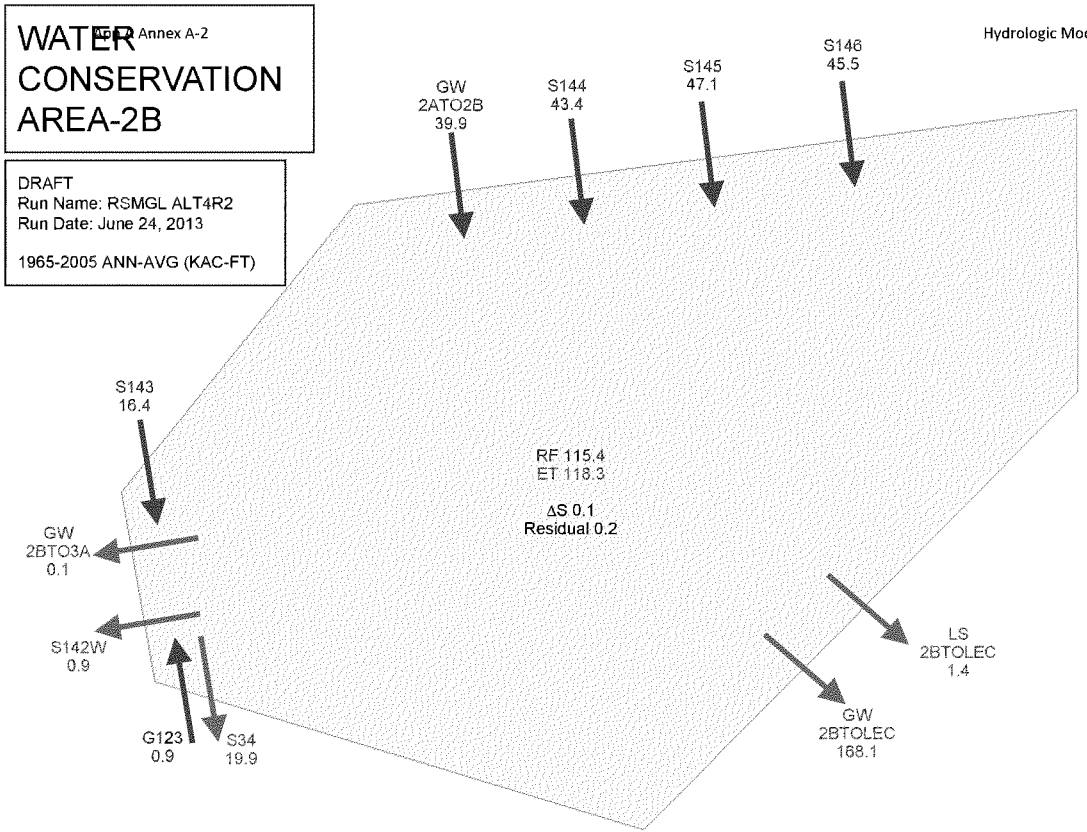
1965-2005 ANN-AVG (KAC-FT)



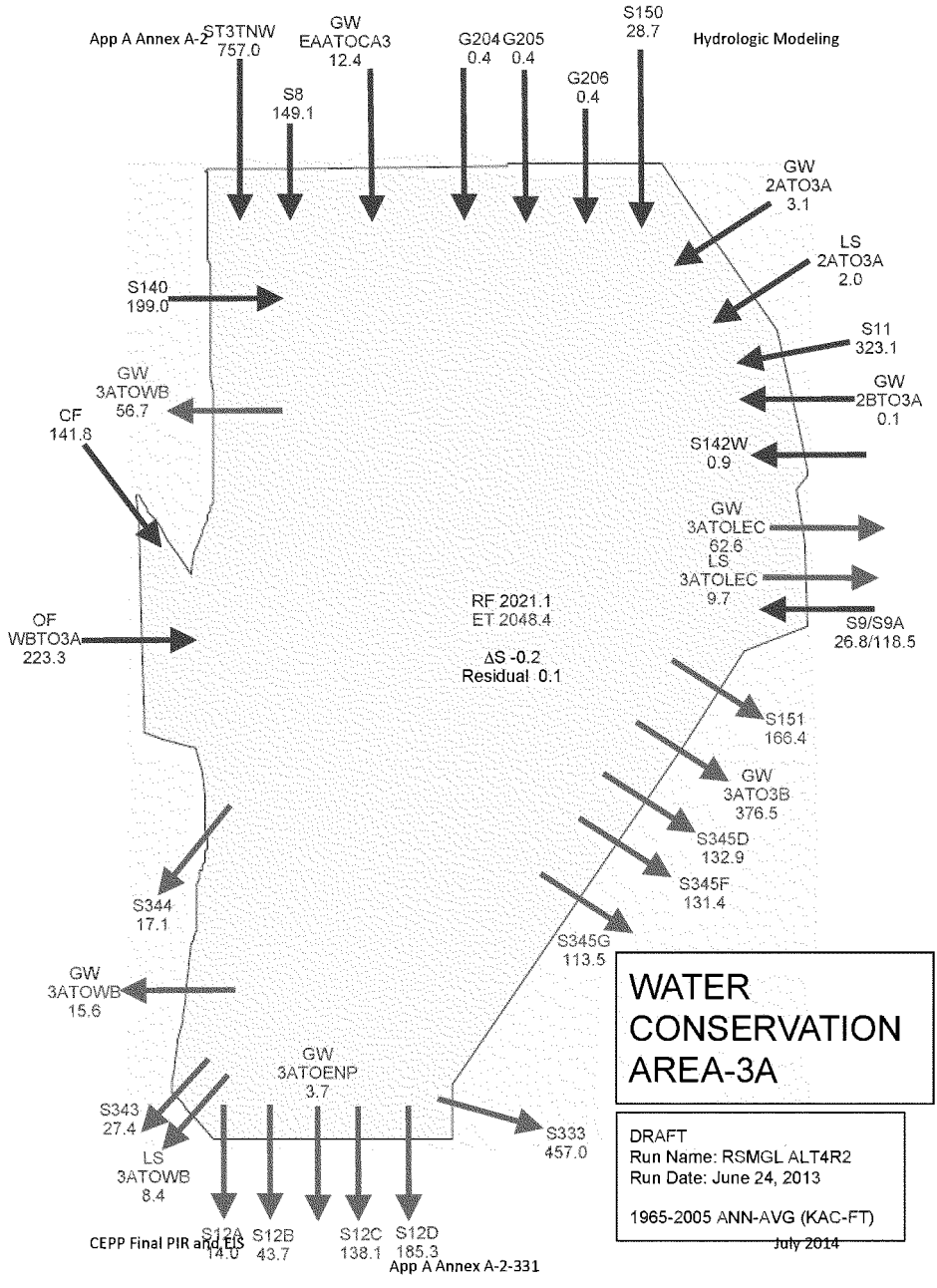
Note: Western Basins (WB) constitute L-28 Interceptor, Feeder Canal, L-28 Gap and East Collier Basins

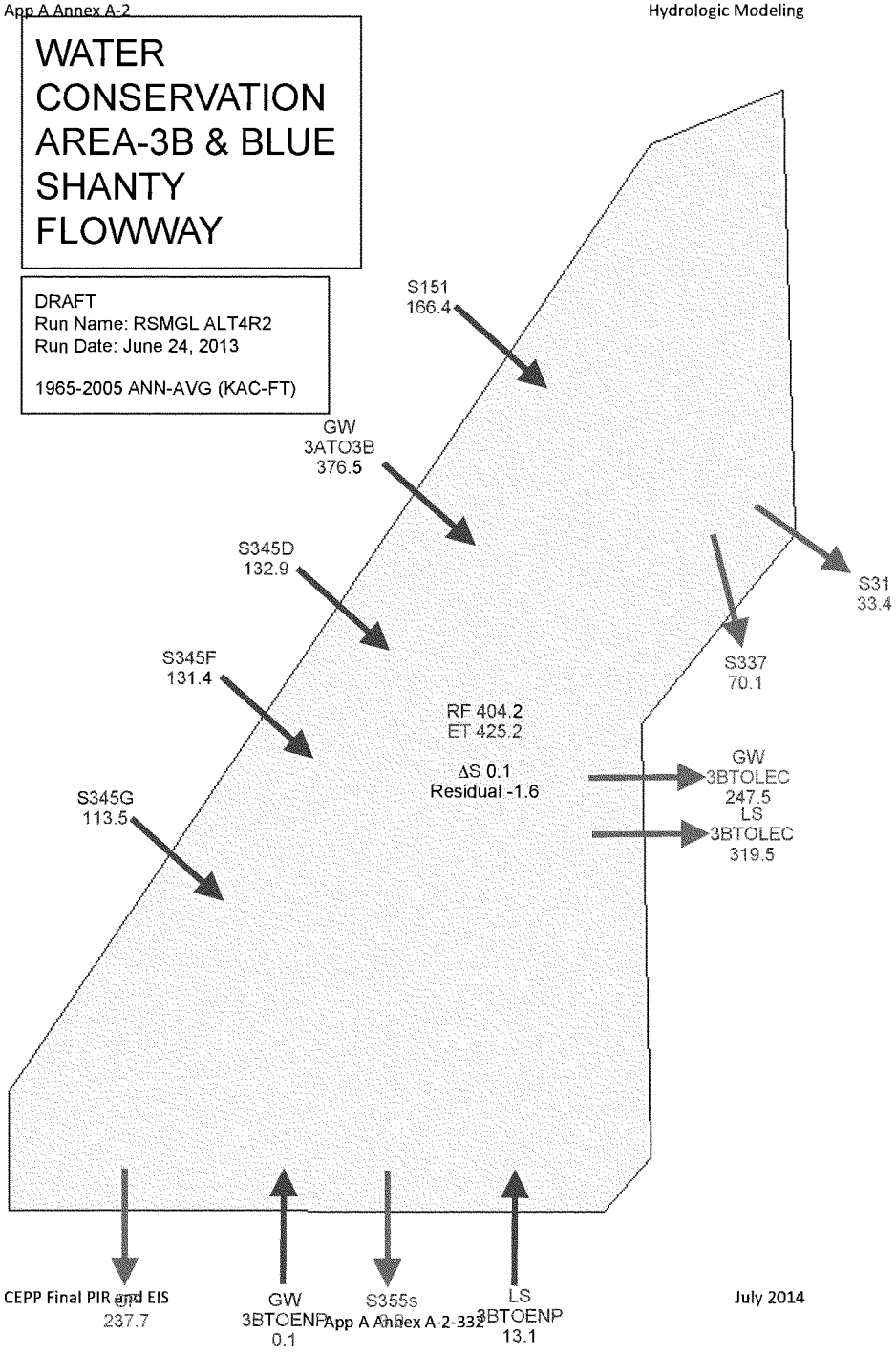

App A Annex A-2
L101OT
1.4
S5AWC1
0.0
S5A2NO (ADDSLW+WSL8S)
11.2 9.4 + 1.8
WATER CONSERVATION AREA-1
Hydrologic Modeling
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
ST1WQ1
215.7
ST1EO
208.9
GW
CA1TOEAA
20.5
G94 A/B/C
52.4
RF 601.0
ET 574.3
ΔS -1.9
Residual 0.0
WL2351
1.3
GW/LS
CA1TOLEC
27.9
GW
CA1TO2A
57.9
S10
266.0
S39
20.0
CEPP Final PIR and EIS
July 2014

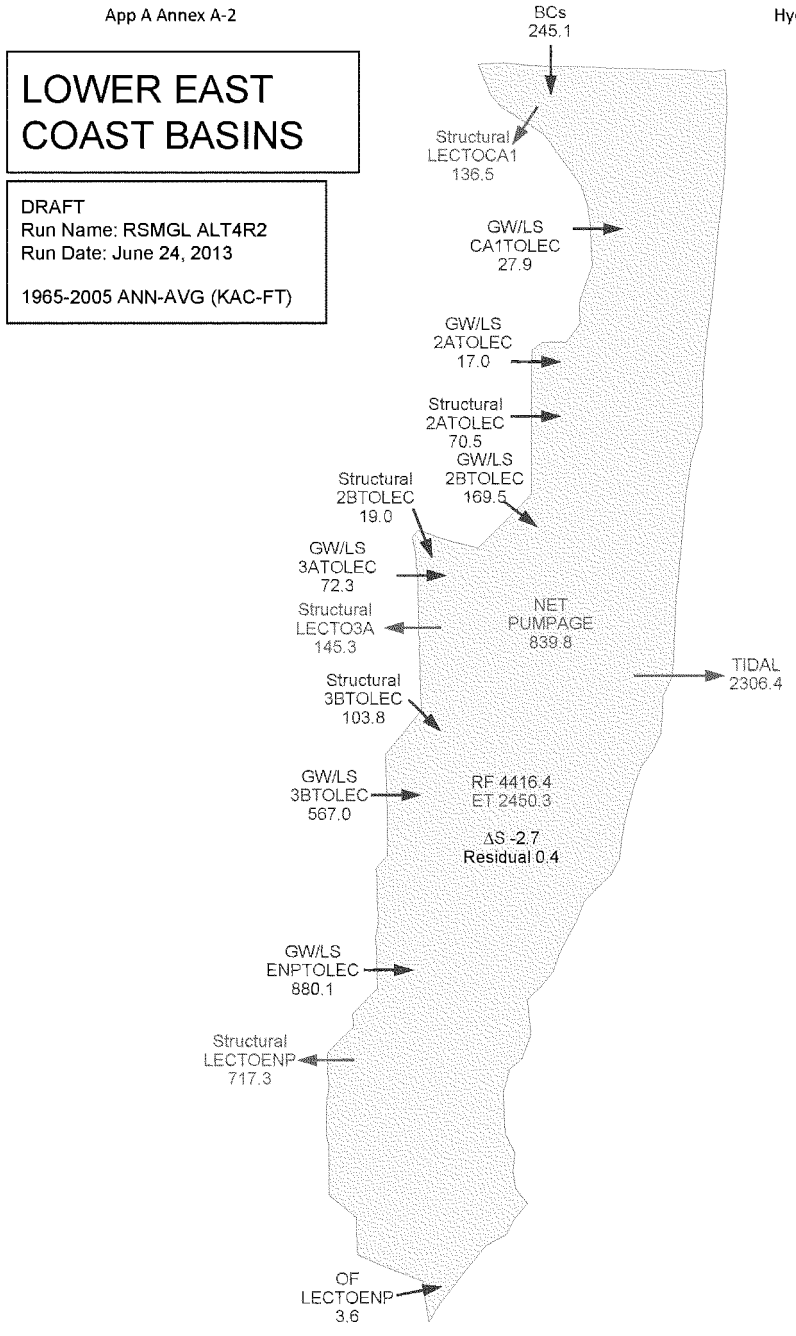

WATER CONSERVATION AREA-2A
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
STA2O+ BYP
235.6
GW
CA1TO2A
57.9
GW
2ATOEAA
10.1
S10
266.0
S7
67.9
NSID-2
0.0
NSID-3
0.0
RF 432.7
ET 442.6
ΔS -0.7
Residual -0.1
GW
2ATOLEC
13.5
LS
2ATOLEC
3.5
GW
2ATO3A
3.1
LS
2ATO3A
2.0
S11
323.1
S38
70.5
GW
2ATO2B
39.9
S144
43.4
S145
47.1
S146
45.5
S143
16.4

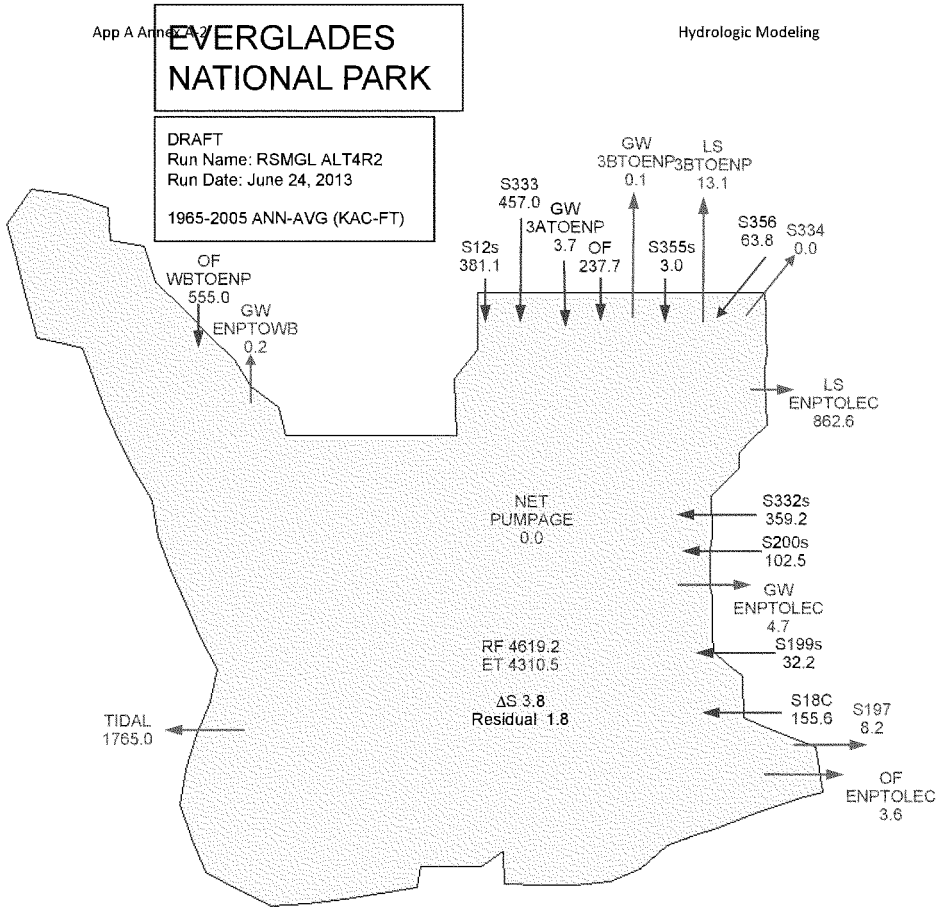

WATER CONSERVATION AREA-2B
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
GW 2ATO2B 39.9
S144 43.4
S145 47.1
S146 45.5
S143 16.4
GW 2BTO3A 0.1
S142W 0.9
G123 0.9
S34 19.9
RF 115.4
ET 118.3
ΔS 0.1
Residual 0.2
LS 2BTOLEC 1.4
GW 2BTOLEC 168.1

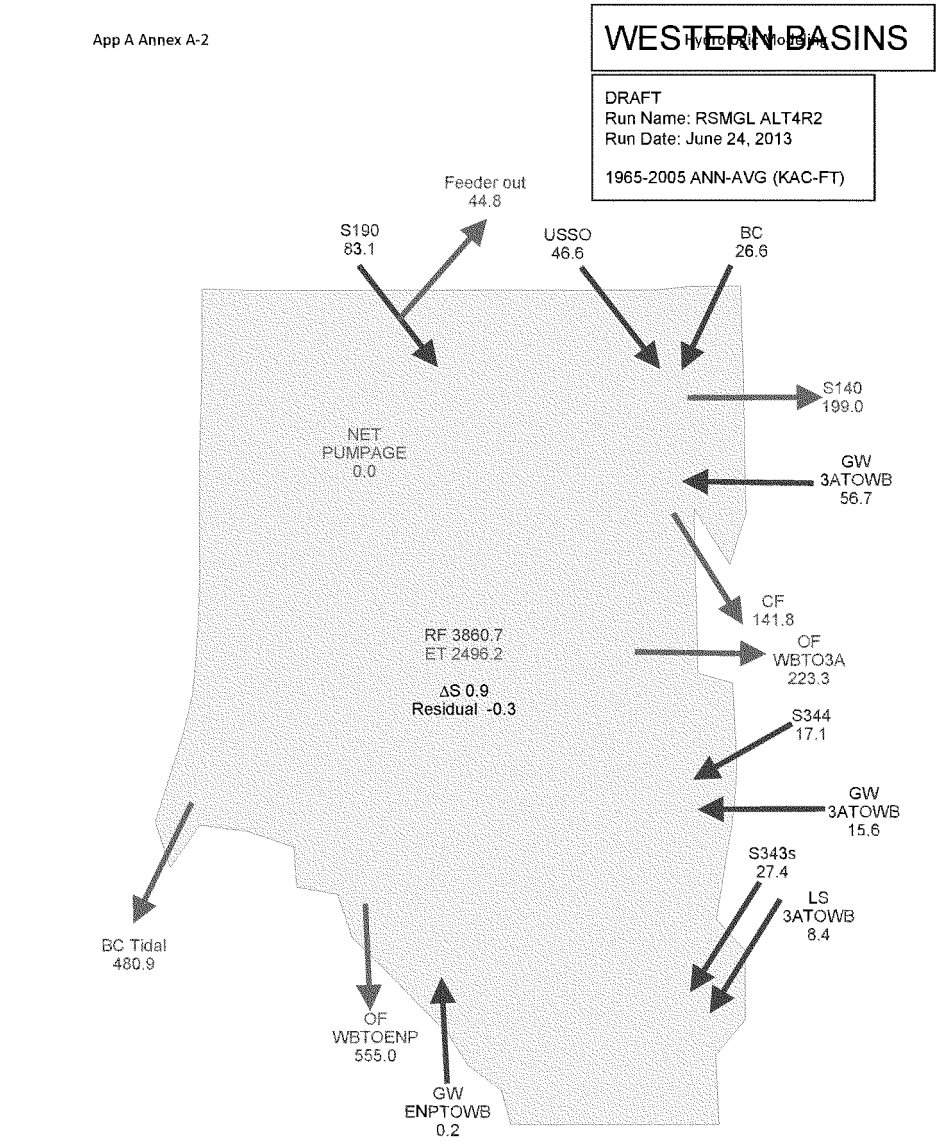
978


App A Annex A-2
ST3TNW 757.0
GW EAATOCA3 12.4
S8 149.1
G204 0.4
G205 0.4
G206 0.4
S150 28.7
Hydrologic Modeling
GW 2ATO3A 3.1
LS 2ATO3A 2.0
S11 323.1
GW 2BTO3A 0.1
S142W 0.9
GW 3ATOLEC 62.6
LS 3ATOLEC 9.7
S9/S9A 26.8/118.5
S140 199.0
GW 3ATOWB 56.7
CF 141.8
OF WBTO3A 223.3
RF 2021.1
ET 2048.4
ΔS -0.2
Residual 0.1
S151 166.4
GW 3ATO3B 376.5
S345D 132.9
S345F 131.4
S345G 113.5
S344 17.1
GW 3ATOWB 15.6
GW 3ATOENP 3.7
S343 27.4
LS 3ATOWB 8.4
S333 457.0
S12A 14.0
S12B 43.7
S12C 138.1
S12D 185.3
WATER CONSERVATION AREA-3A
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
July 2014


WATER CONSERVATION AREA-3B & BLUE SHANTY FLOWWAY
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
S151
166.4
GW
3ATO3B
376.5
S345D
132.9
S345F
131.4
S345G
113.5
S31
33.4
S337
70.1
RF 404.2
ET 425.2
ΔS 0.1
Residual -1.6
GW
3BTOLEC
247.5
LS
3BTOLEC
319.5
237.7
GW
3BTOENP
0.1
S355s
LS
3BTOENP
13.1


LOWER EAST COAST BASINS
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
BCs 245.1
Structural LECTOCA1 136.5
GW/LS CA1TOLEC 27.9
GW/LS 2ATOLEC 17.0
Structural 2ATOLEC 70.5
GW/LS 2BTOLEC 169.5
Structural 2BTOLEC 19.0
GW/LS 3ATOLEC 72.3
Structural LECTO3A 145.3
NET PUMPAGE 839.8
TIDAL 2306.4
Structural 3BTOLEC 103.8
GW/LS 3BTOLEC 567.0
RF 4416.4
ET 2450.3
ΔS -2.7
Residual 0.4
GW/LS ENPTOLEC 880.1
Structural LECTOENP 717.3
OF LECTOENP 3.6

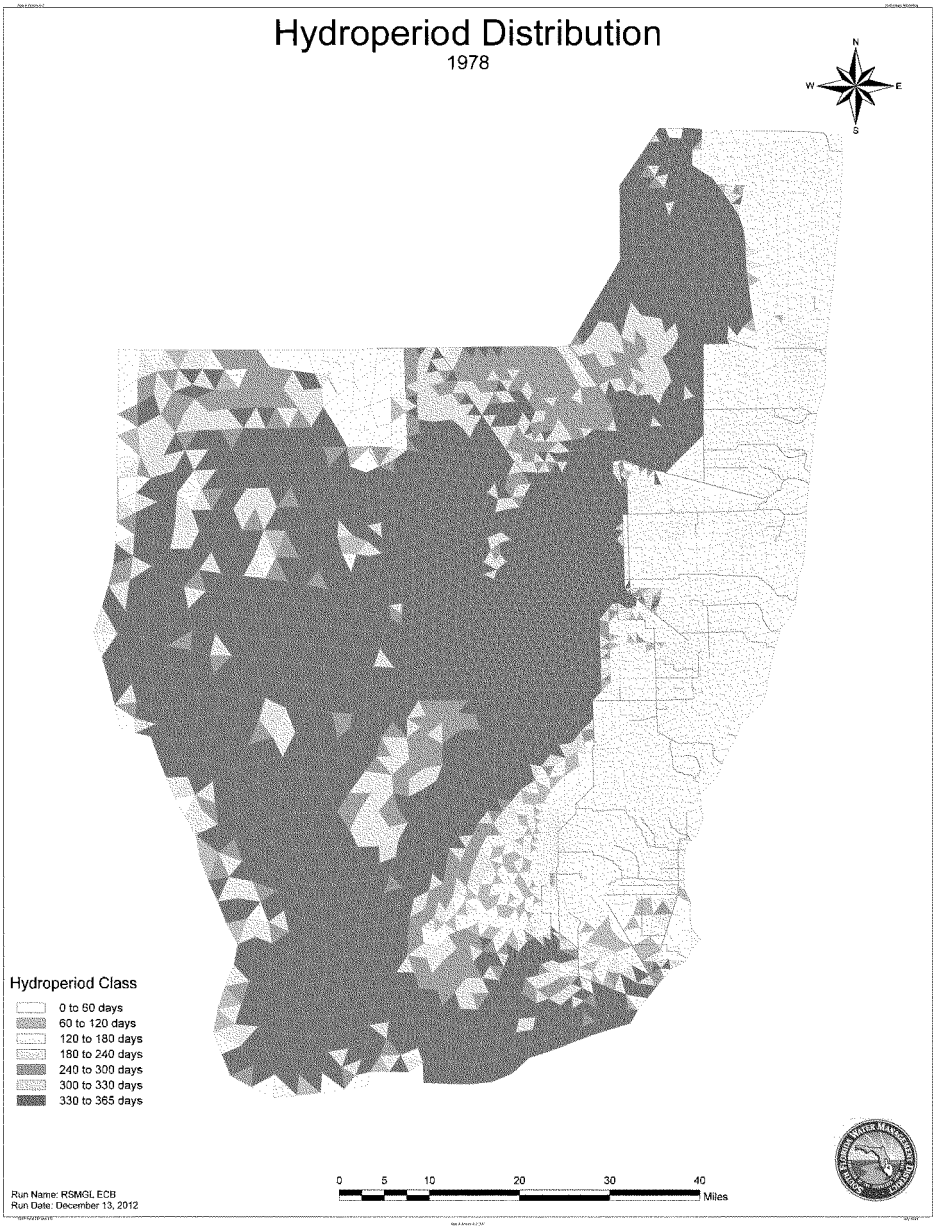

EVERGLADES
NATIONAL PARK
DRAFT
Run Name: RSMGL ALT4R2
Run Date: June 24, 2013
1965-2005 ANN-AVG (KAC-FT)
GW
3BTOENP
0.1
LS
3BTOENP
13.1
S333
457.0
GW
3ATOENP
3.7
S356
63.8
S334
0.0
S12s
381.1
OF
237.7
S355s
3.0
OF
WBTOENP
555.0
GW
ENPTOWB
0.2
LS
ENPTOLEC
862.6
NET
PUMPAGE
0.0
S332s
359.2
S200s
102.5
GW
ENPTOLEC
4.7
S199s
32.2
RF 4619.2
ET 4310.5
ΔS 3.8
Residual 1.8
S18C
155.6
S197
8.2
TIDAL
1765.0
OF
ENPTOLEC
3.6

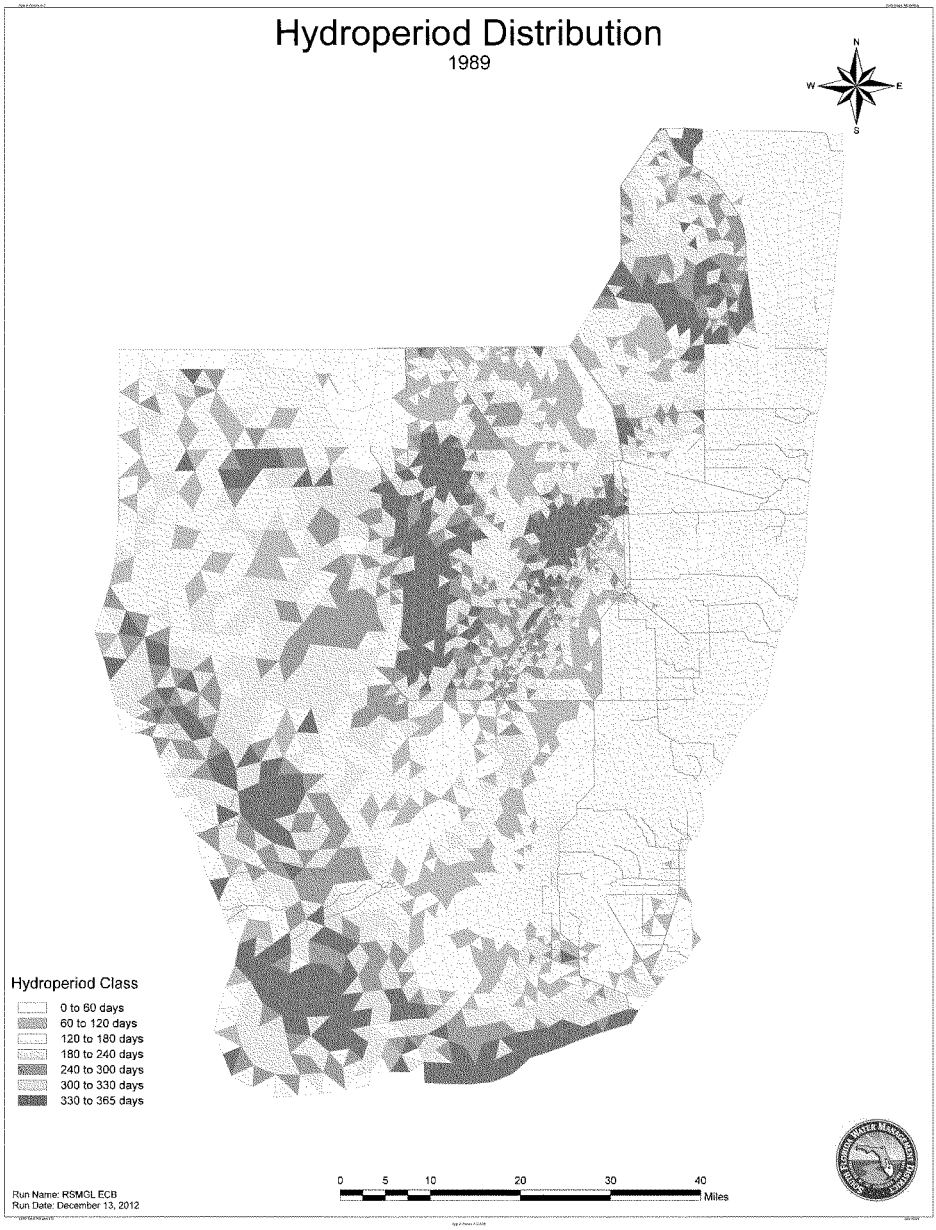


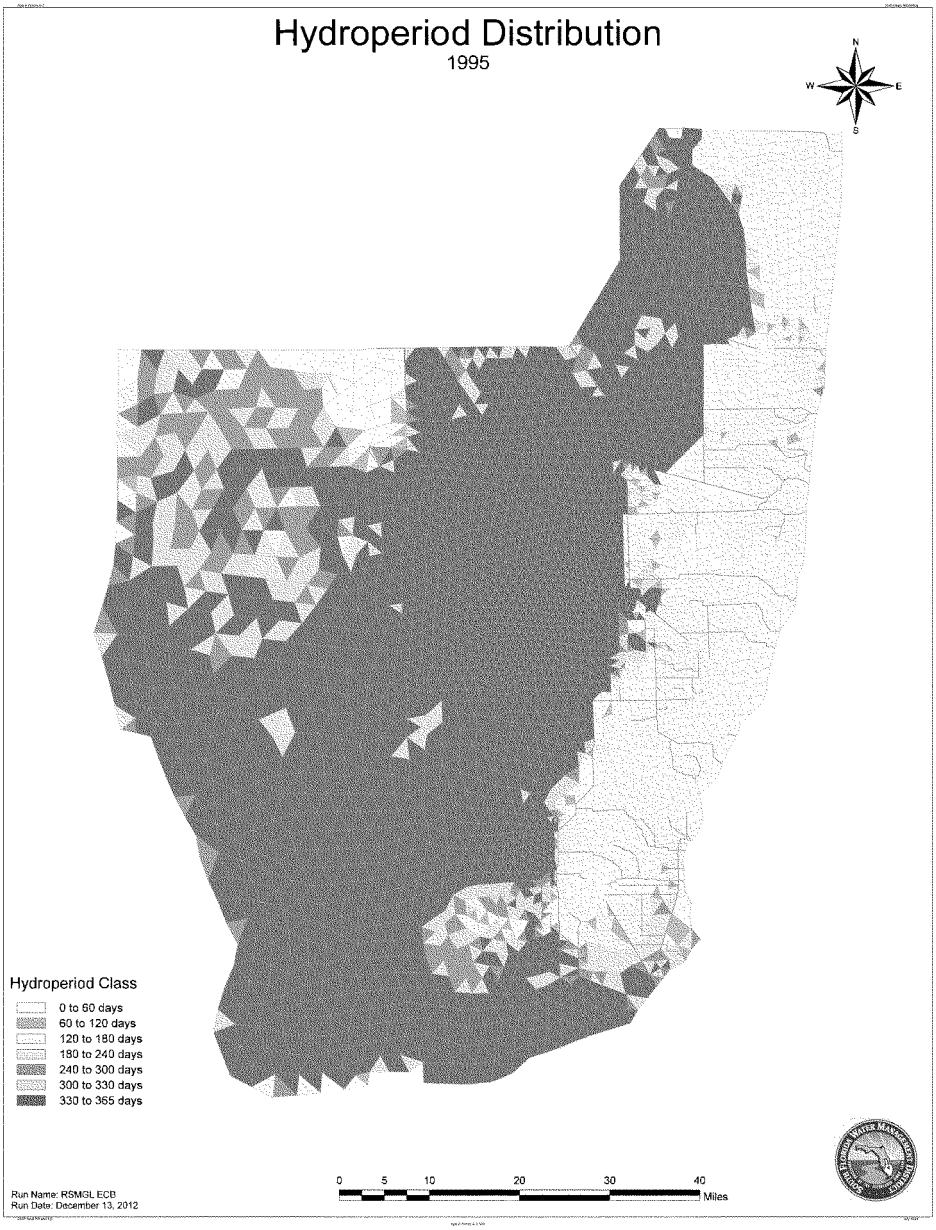
Note: Western Basins (WB) constitute L-28 Interceptor, Feeder Canal, L-28 Gap and East Collier Basins

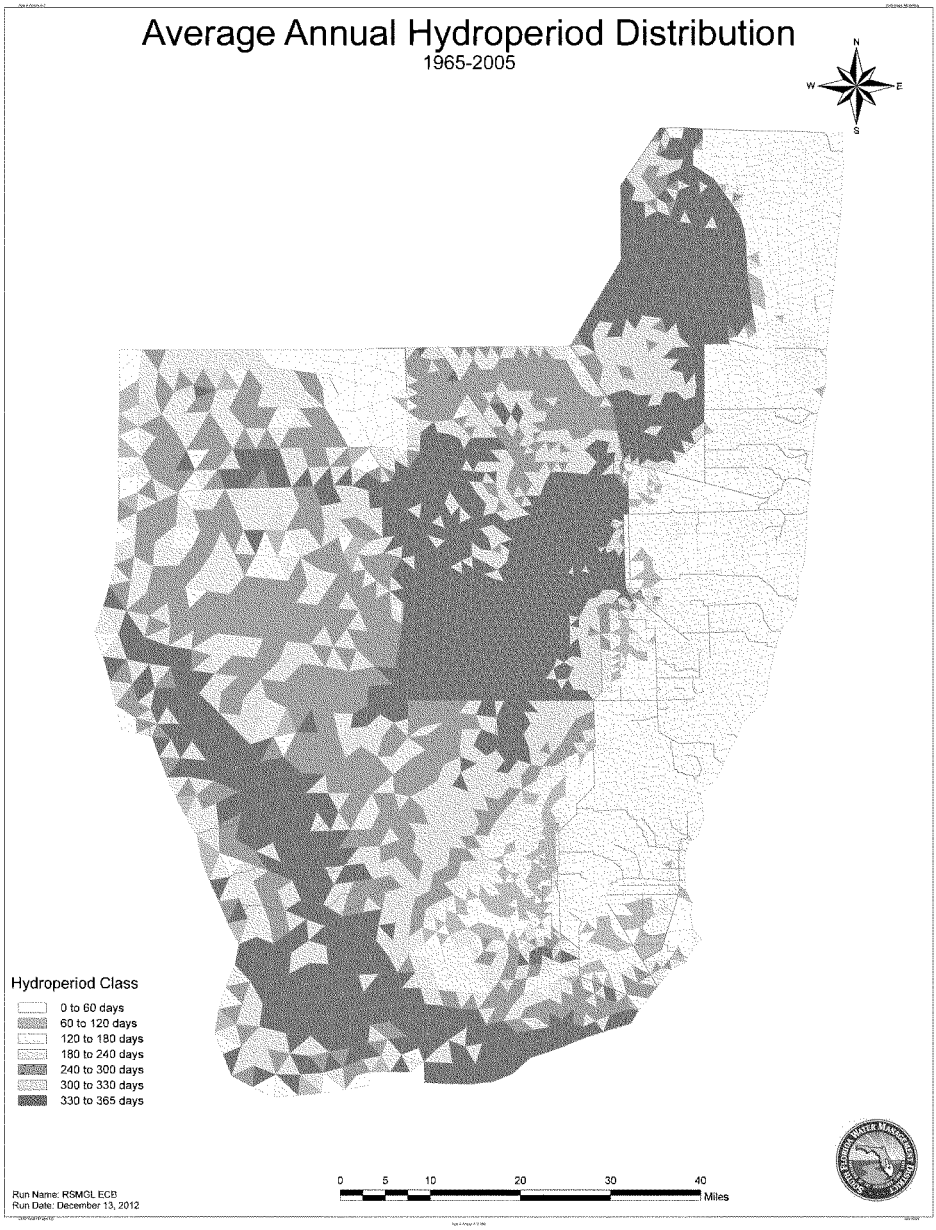
ANNEX A-2: REFERENCE 6

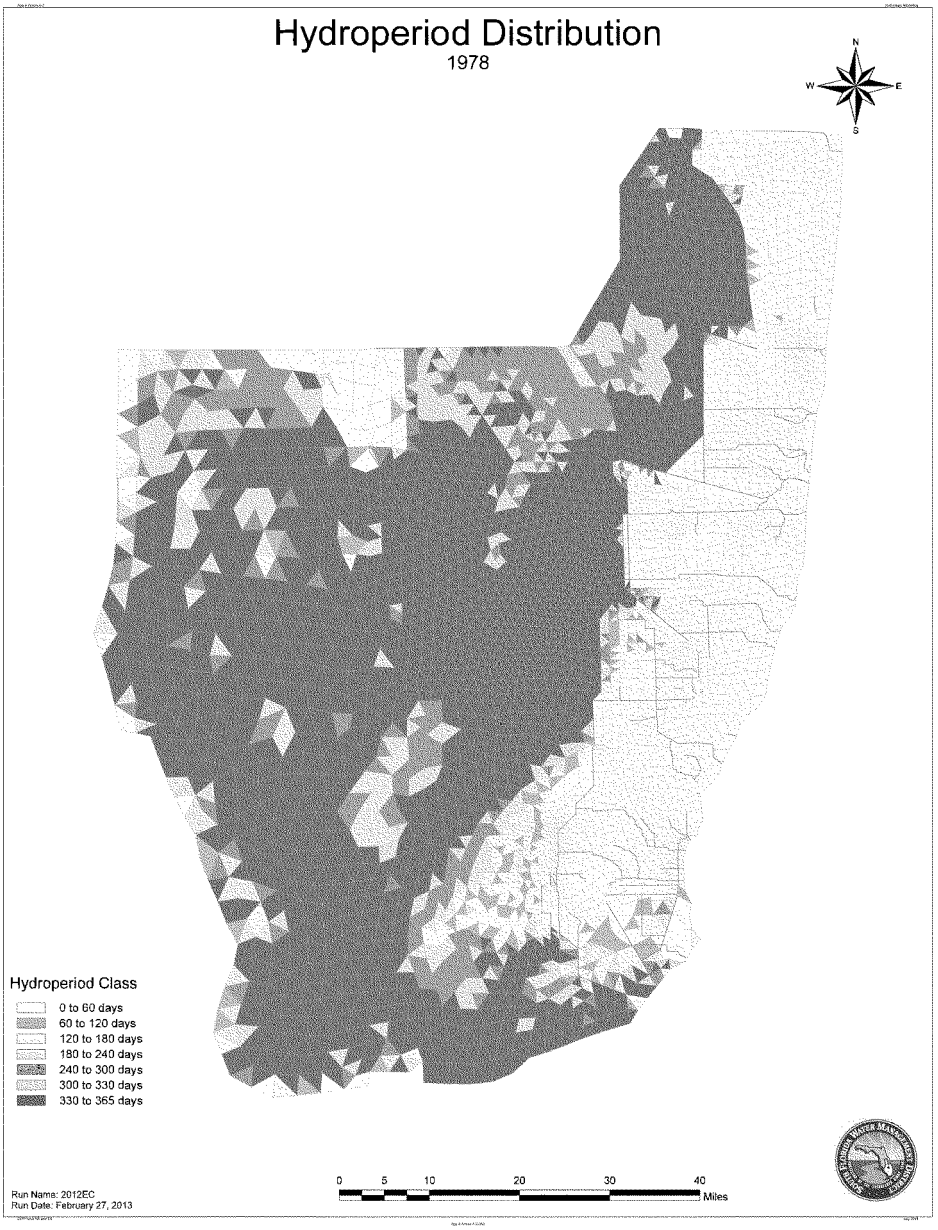
RSM-GL HYDROPERIOD, PONDING, AND DIFFERENCE MAPS FOR BASELINES AND ALT4R2

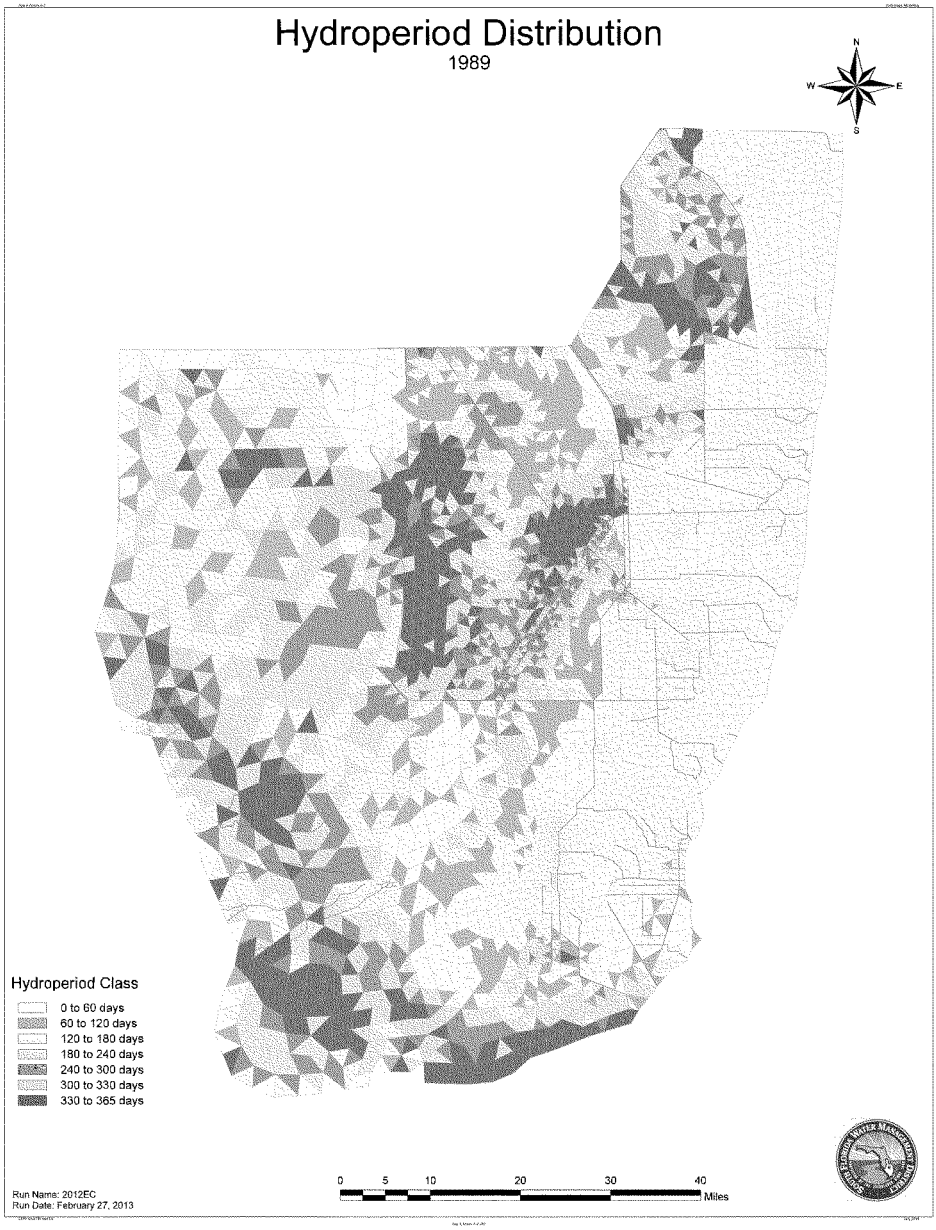

Hydroperiod Distribution
1978
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: RSMGL ECB
Run Date: December 13, 2012

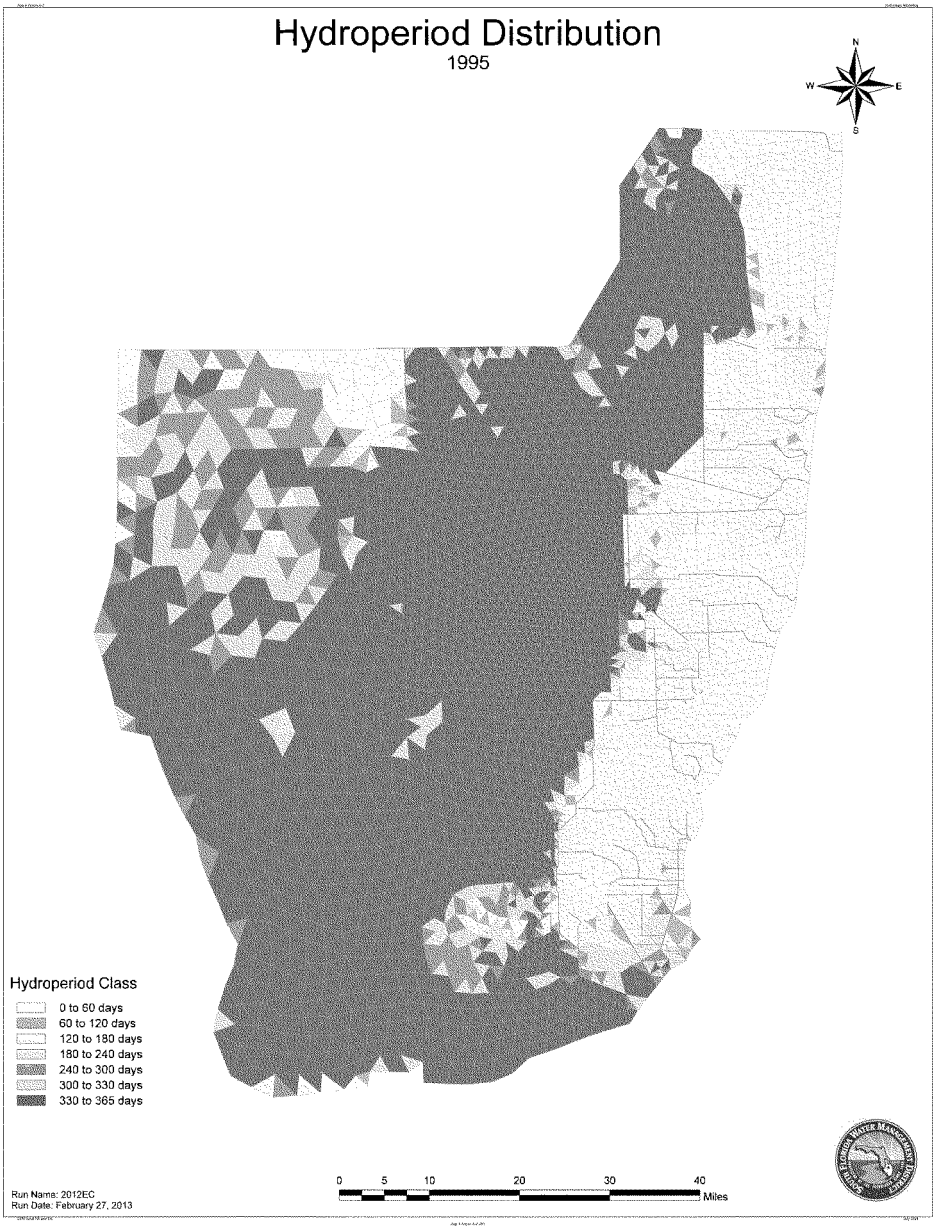

Hydroperiod Distribution
1989
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: RSMGL ECB
Run Date: December 13, 2012

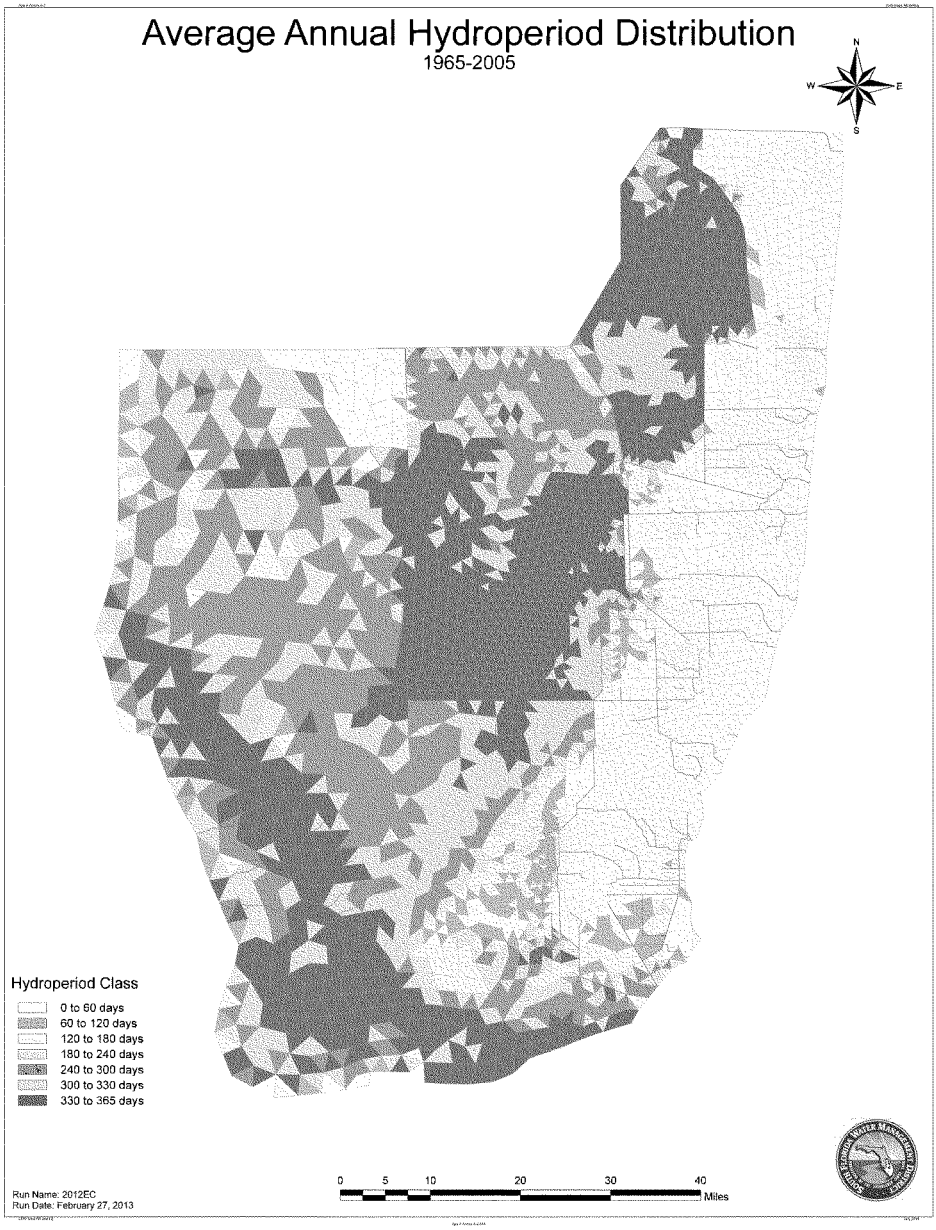

Hydroperiod Distribution
1995
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: RSMGL ECB
Run Date: December 13, 2012

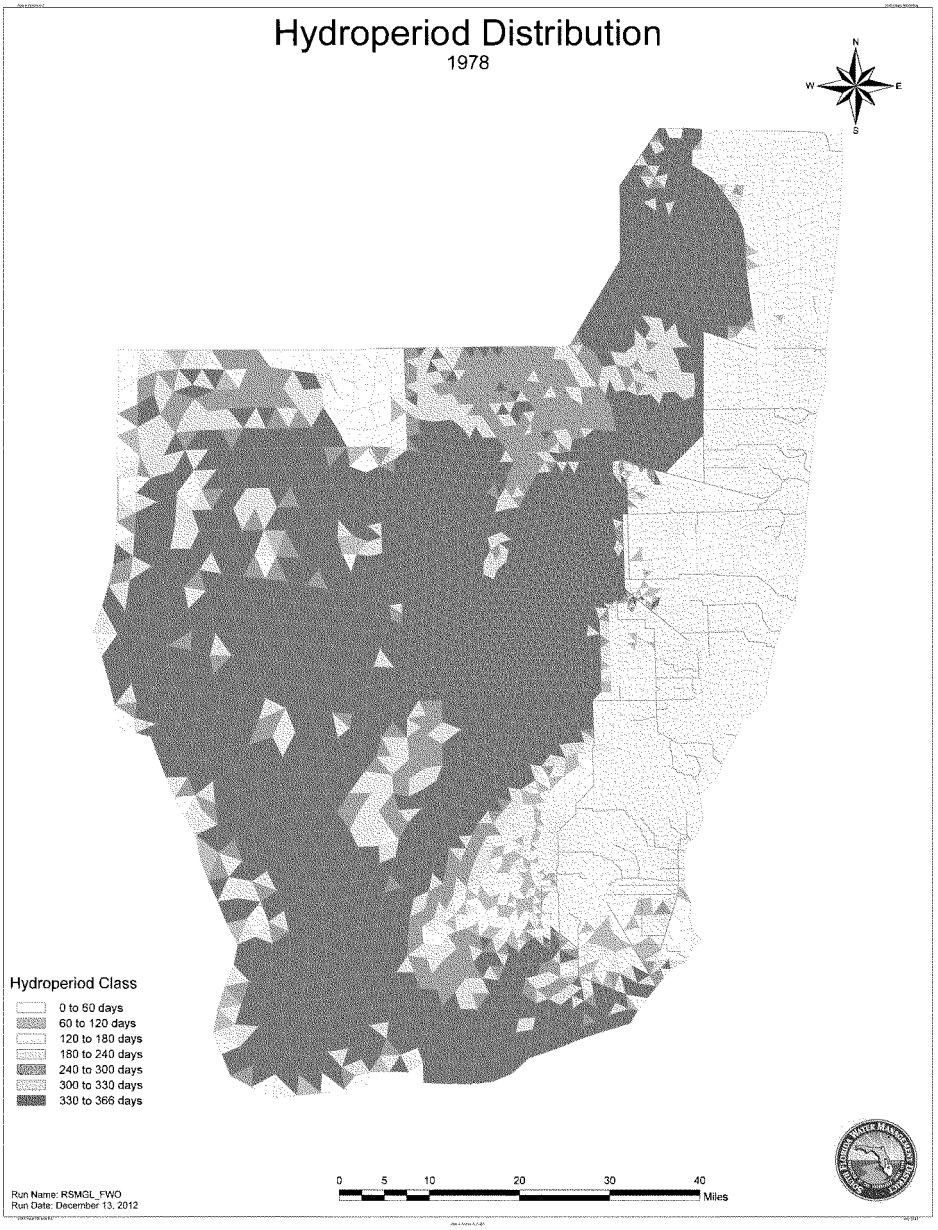

Average Annual Hydroperiod Distribution
1965-2005
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: RSMGL ECB
Run Date: December 13, 2012

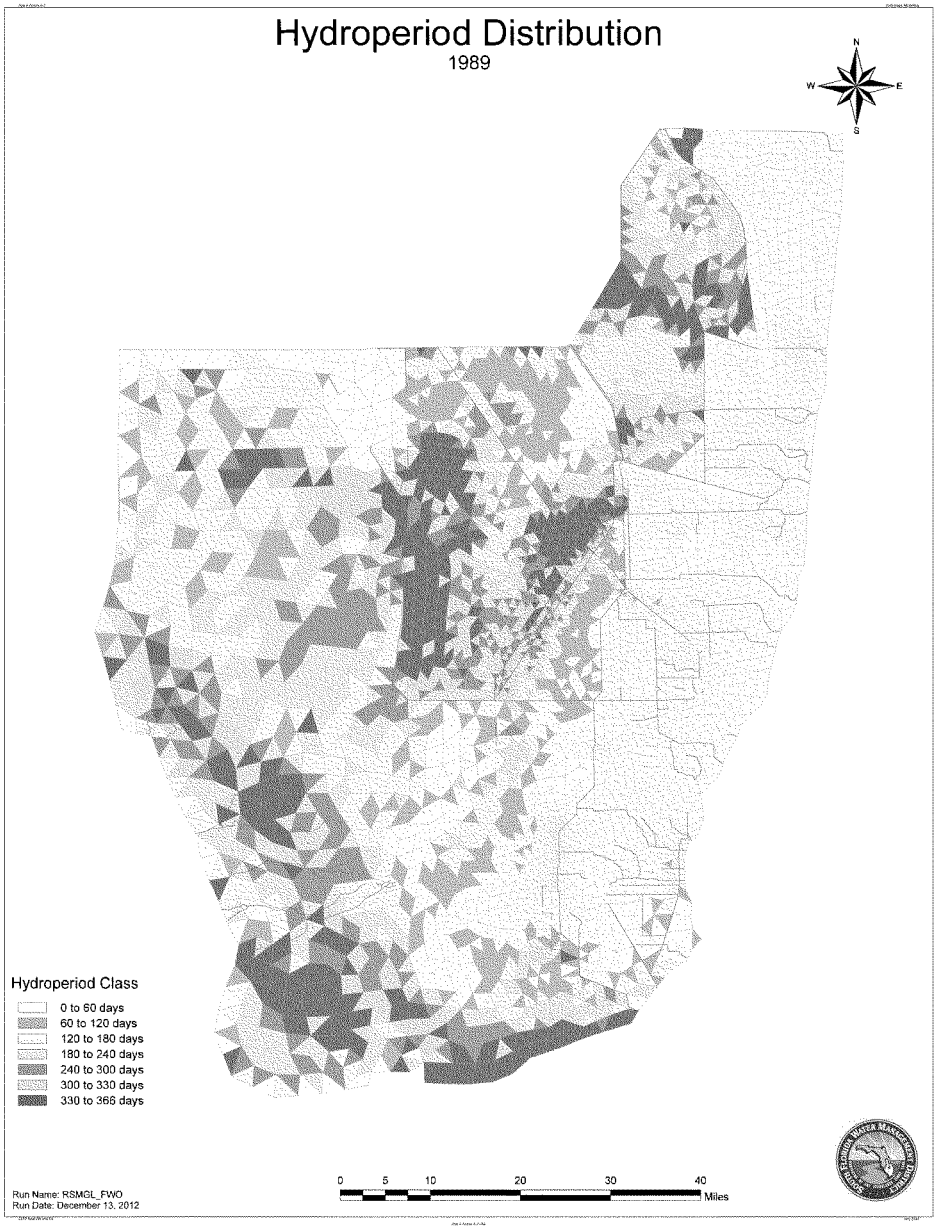

Hydroperiod Distribution
1978
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: 2012EC
Run Date: February 27, 2013

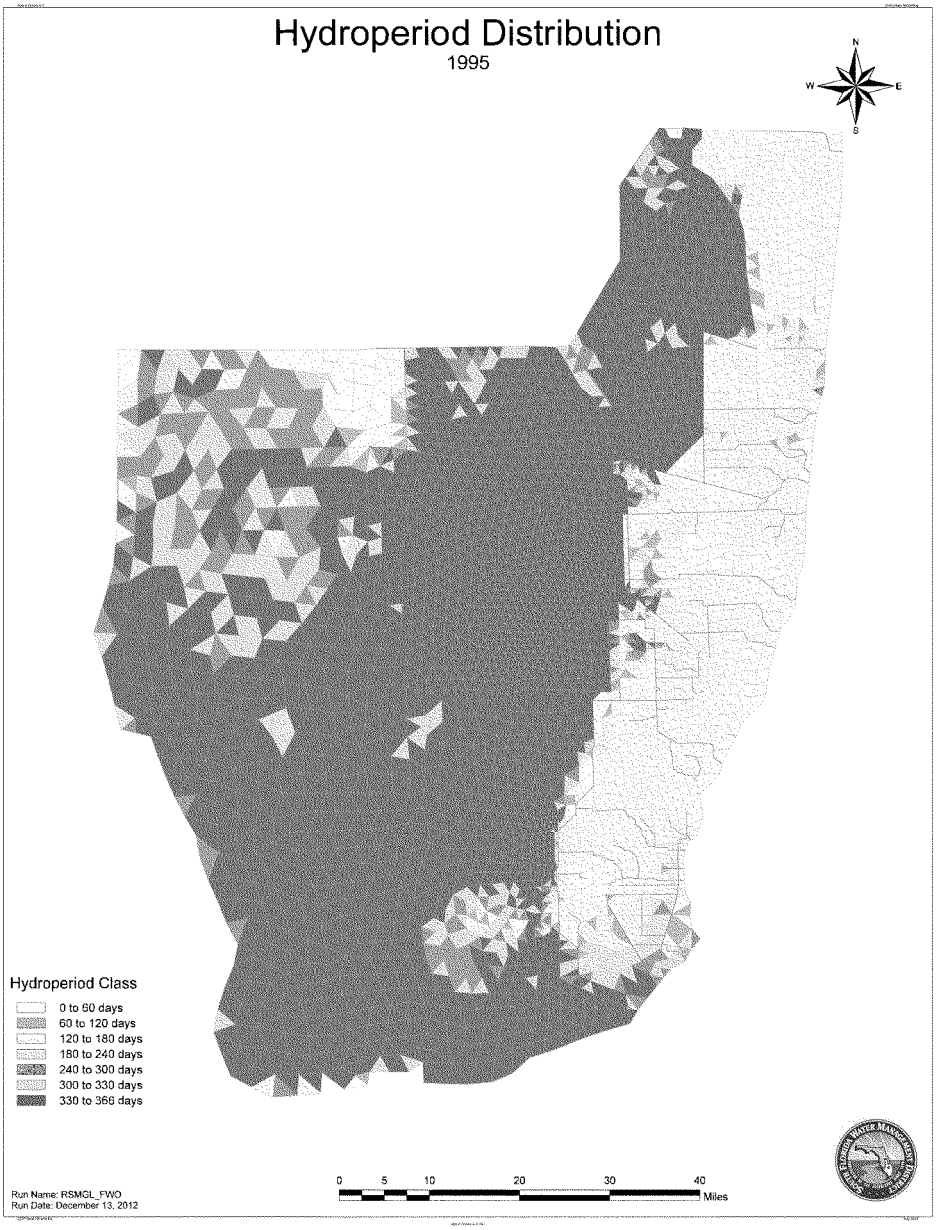

Hydroperiod Distribution
1989
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: 2012EC
Run Date: February 27, 2013

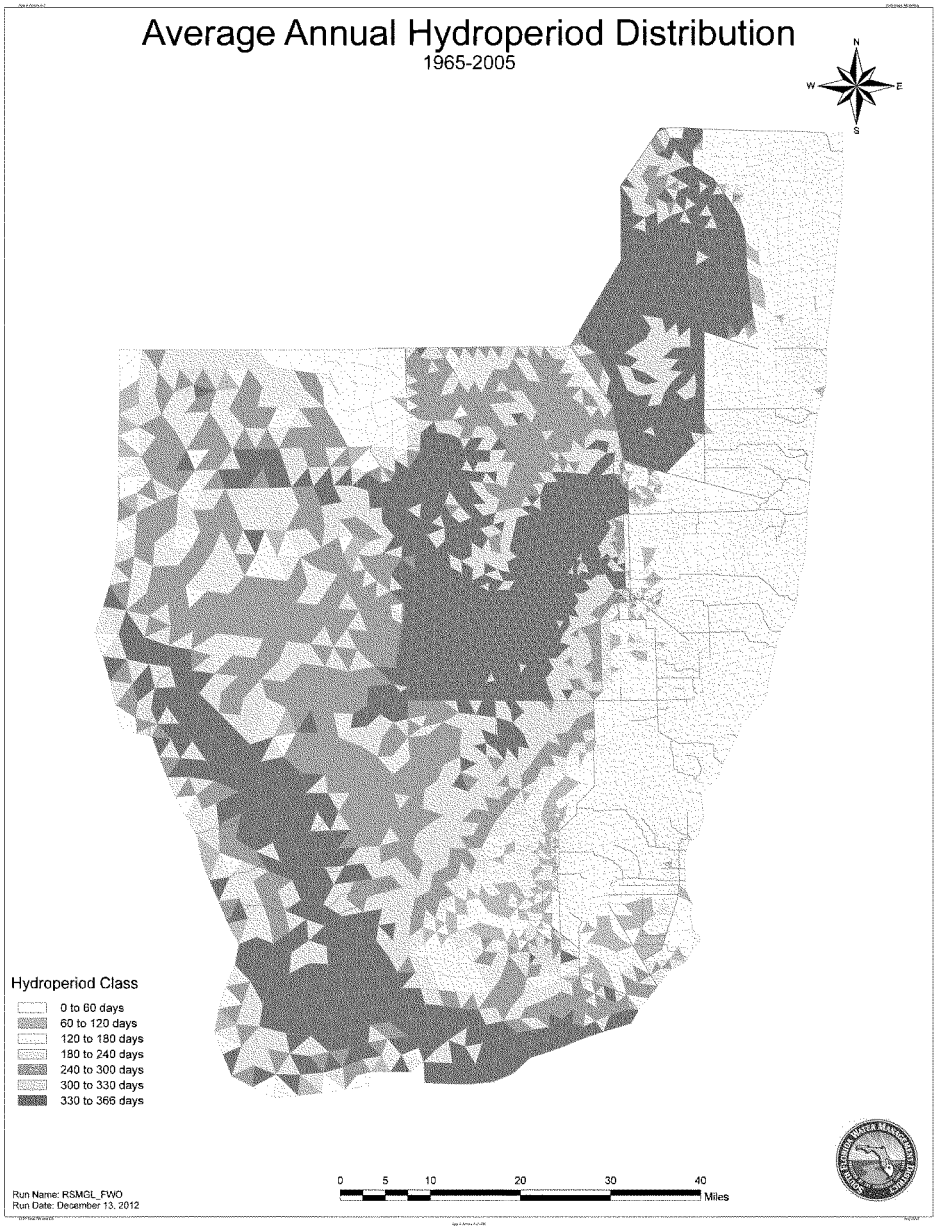

Hydroperiod Distribution
1995
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: 2012EC
Run Date: February 27, 2013


Average Annual Hydroperiod Distribution
1965-2005
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: 2012EC
Run Date: February 27, 2013


Hydroperiod Distribution
1978
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 366 days
0
5
10
20
30
40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

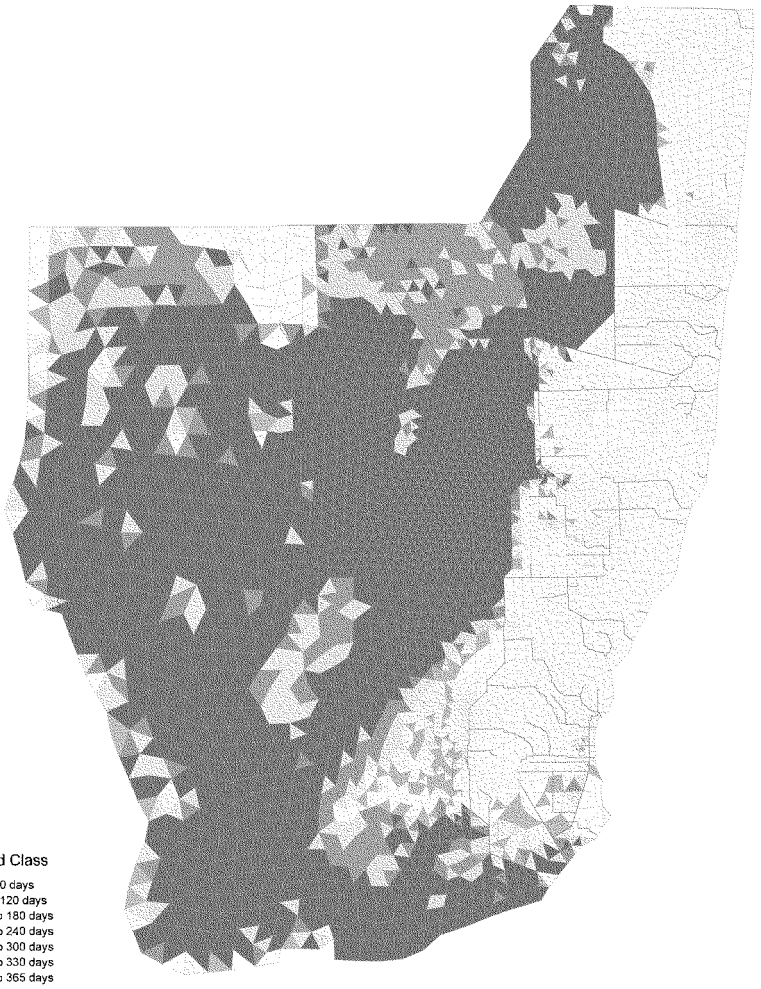

Hydroperiod Distribution
1989
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 366 days
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012


Hydroperiod Distribution
1995
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 366 days
0
5
10
20
30
40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012


Average Annual Hydroperiod Distribution
1965-2005
N
W
E
S
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 366 days
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

Hydroperiod Distribution

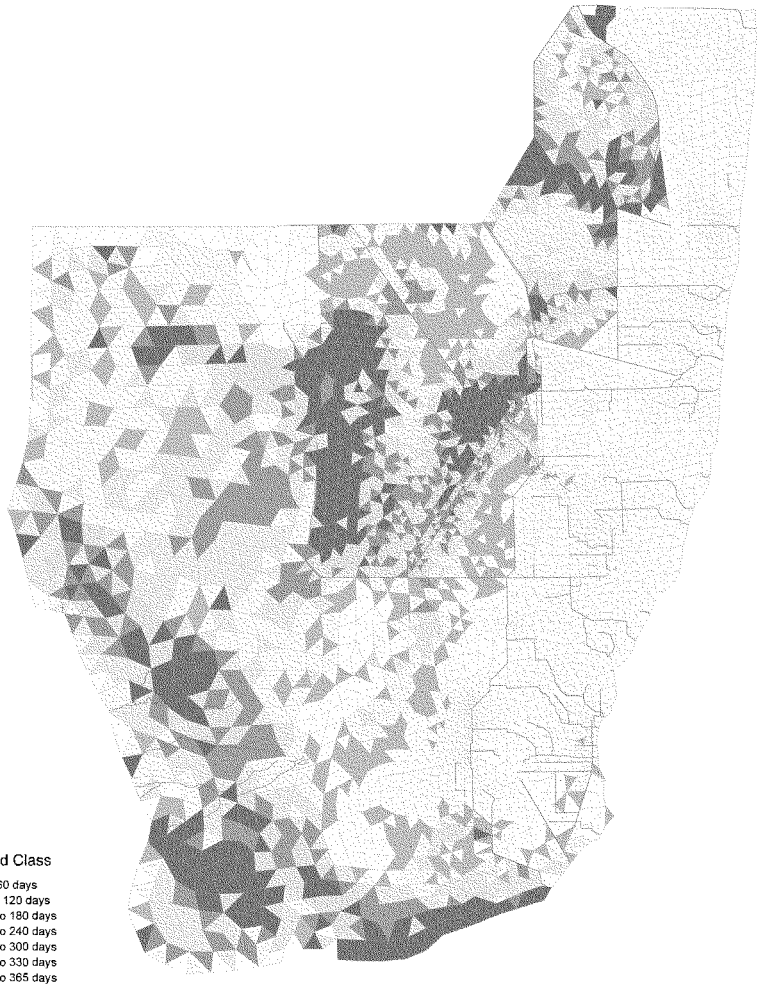
1978



Run Name: RSMGL IORSL1
Run Date: 03 June 2013

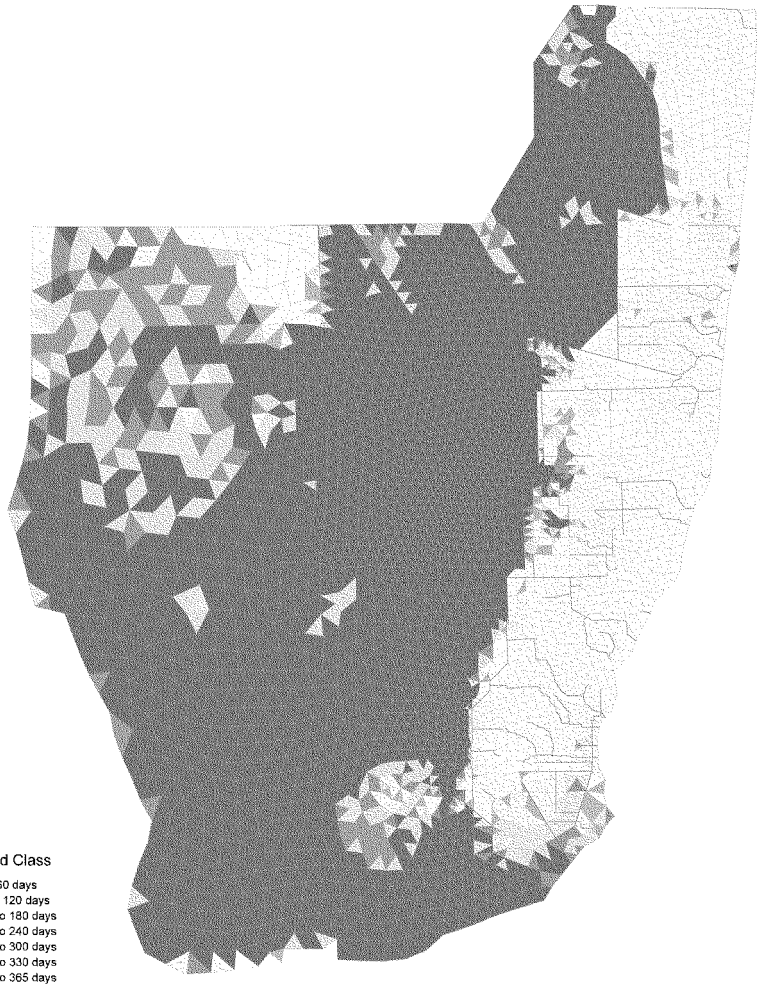
Hydroperiod Distribution

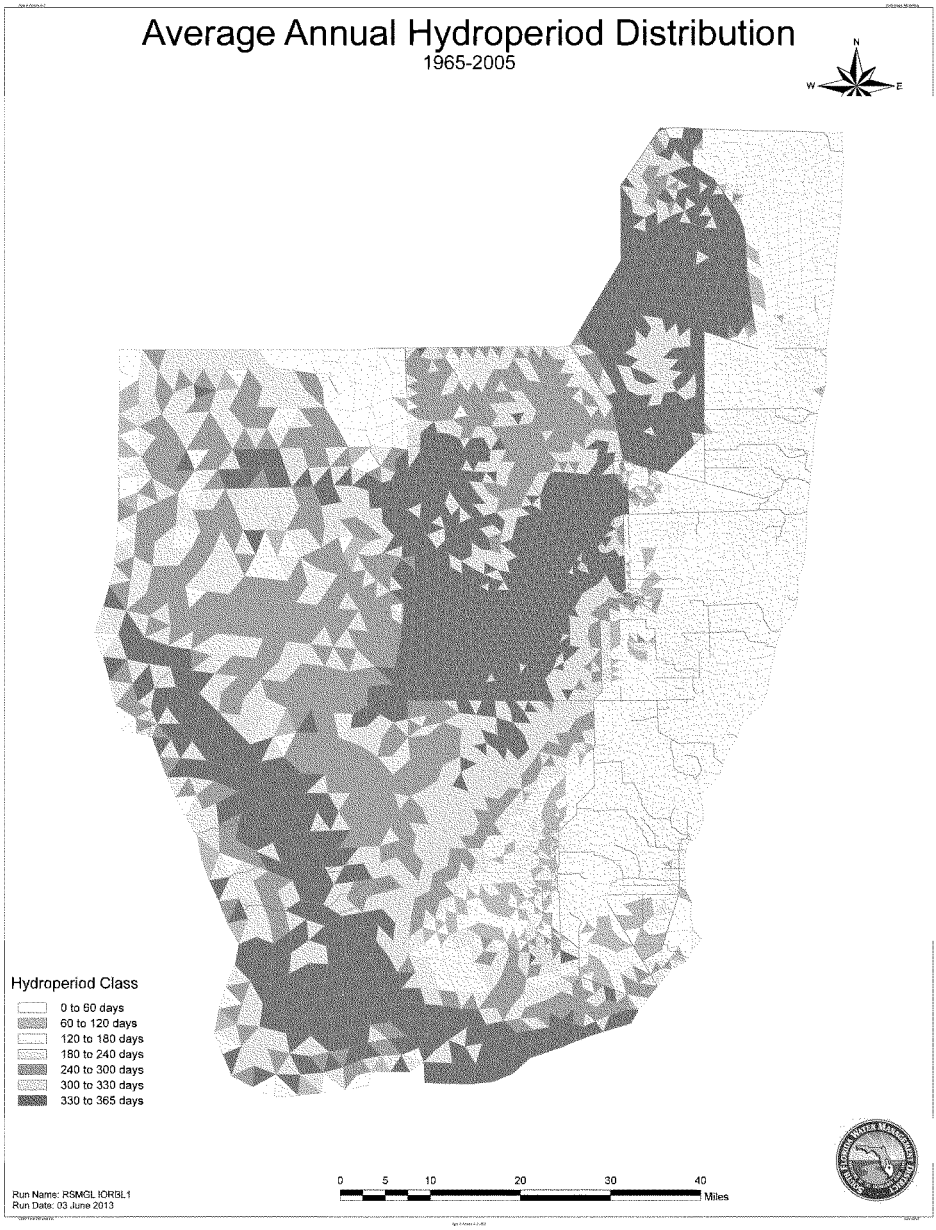
1989

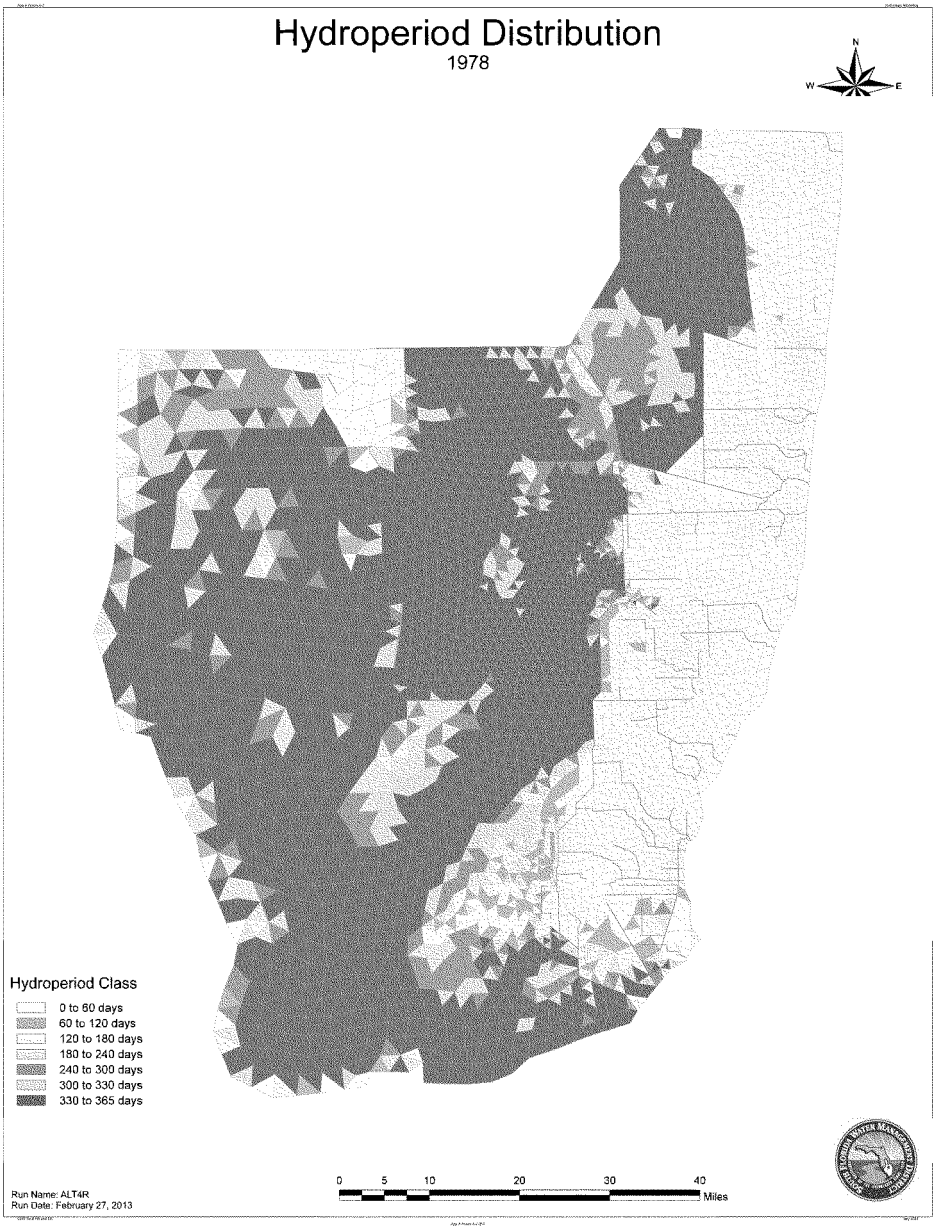


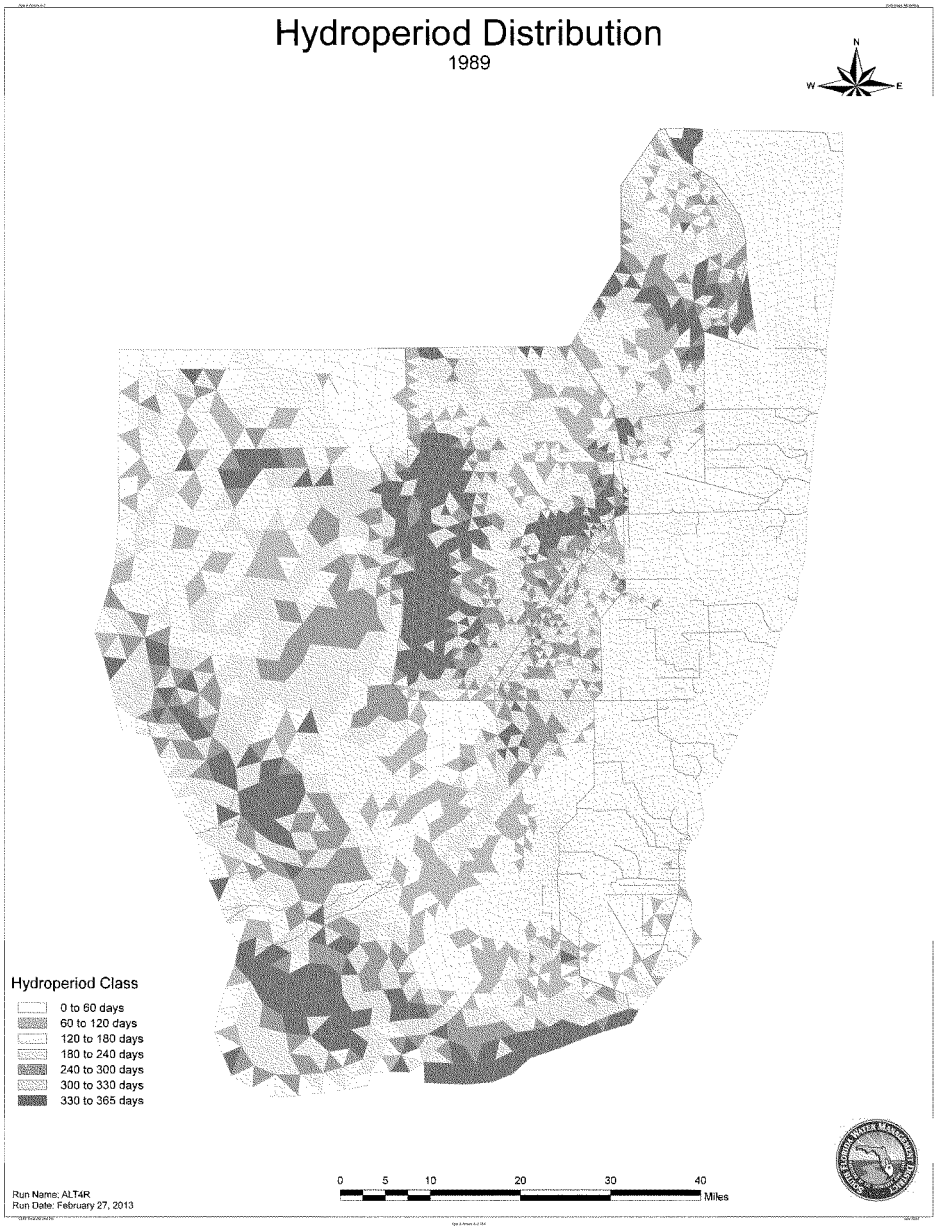
Hydroperiod Distribution

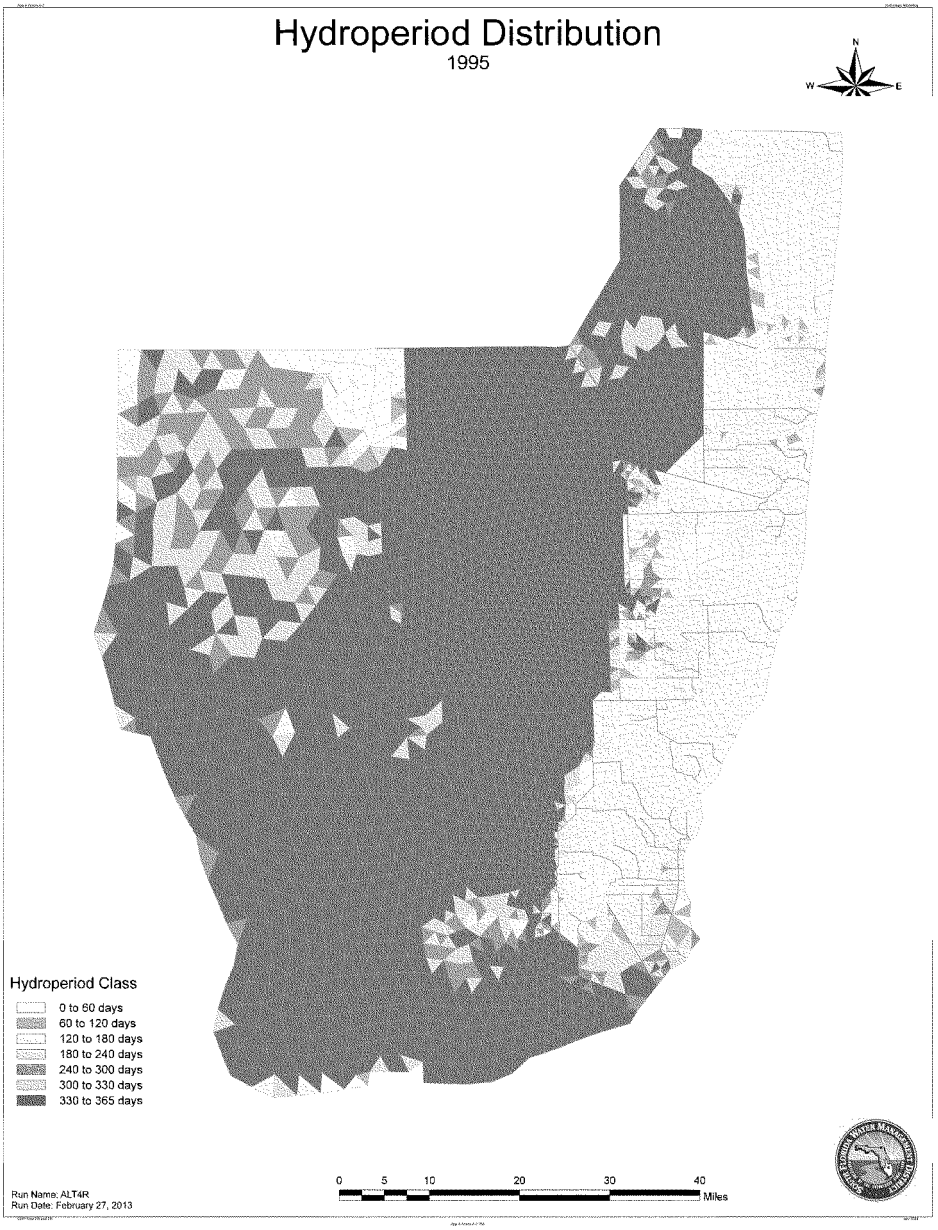
1995

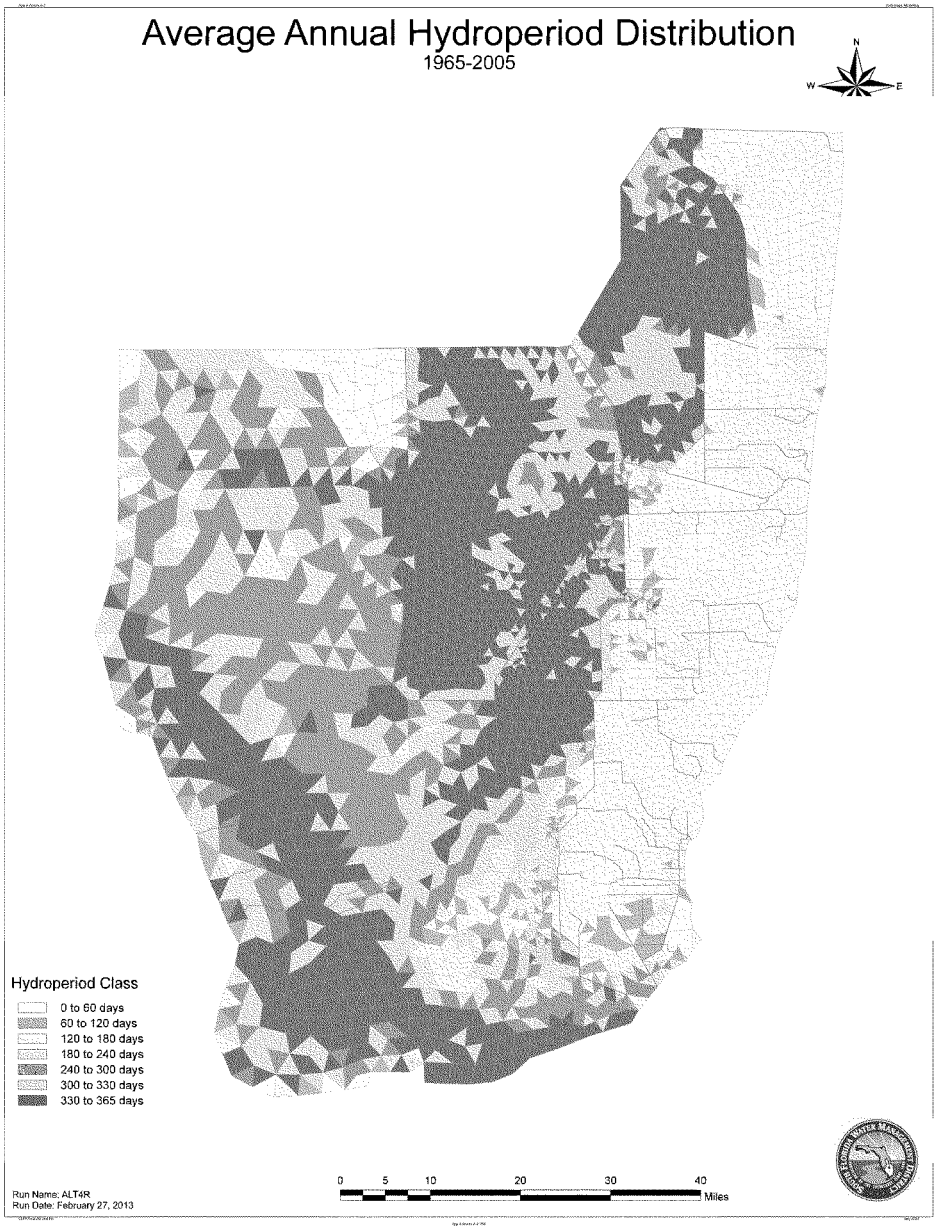


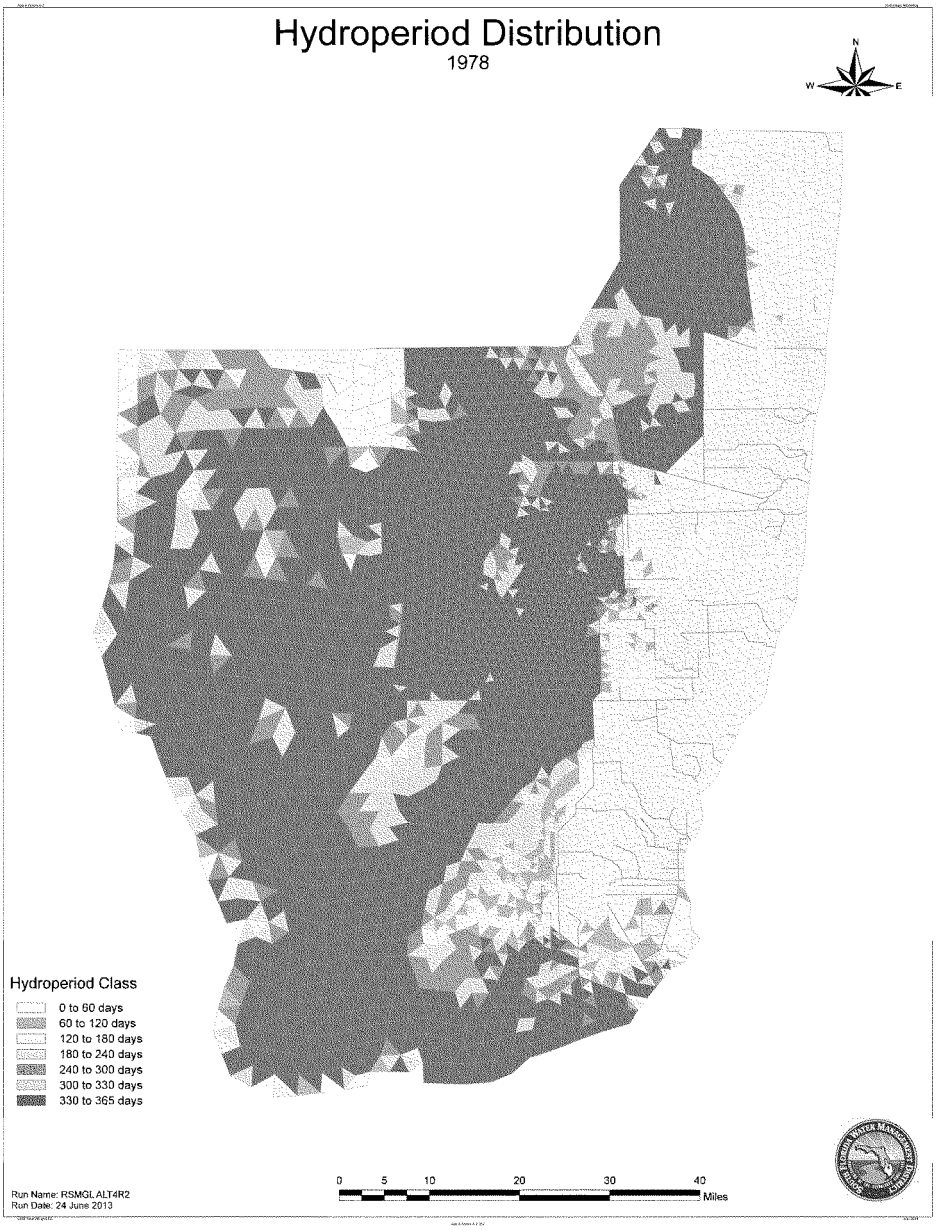

Average Annual Hydroperiod Distribution
1965-2005
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: RSMGLTORSL1
Run Date: 03 June 2013

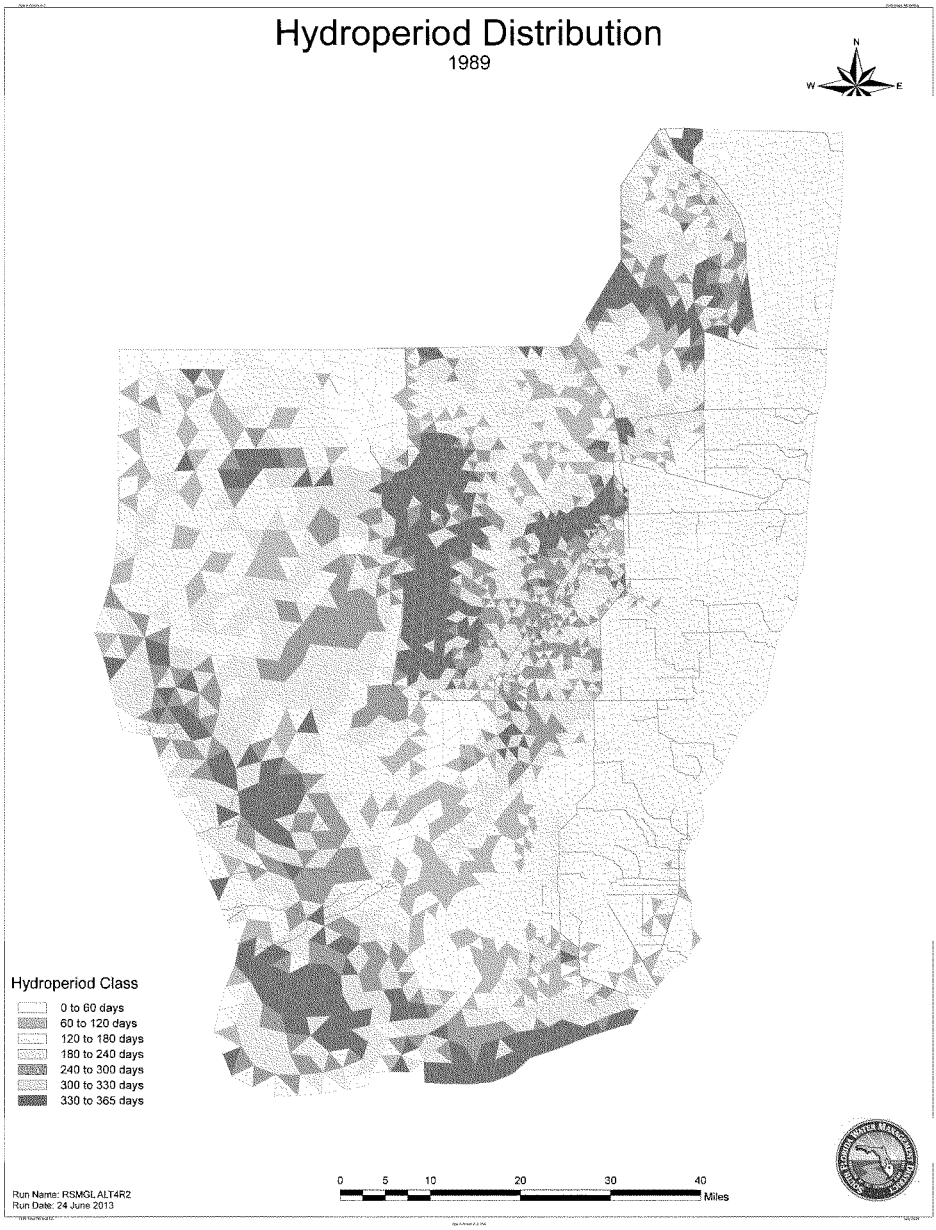

Hydroperiod Distribution
1978
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: ALT4R
Run Date: February 27, 2013

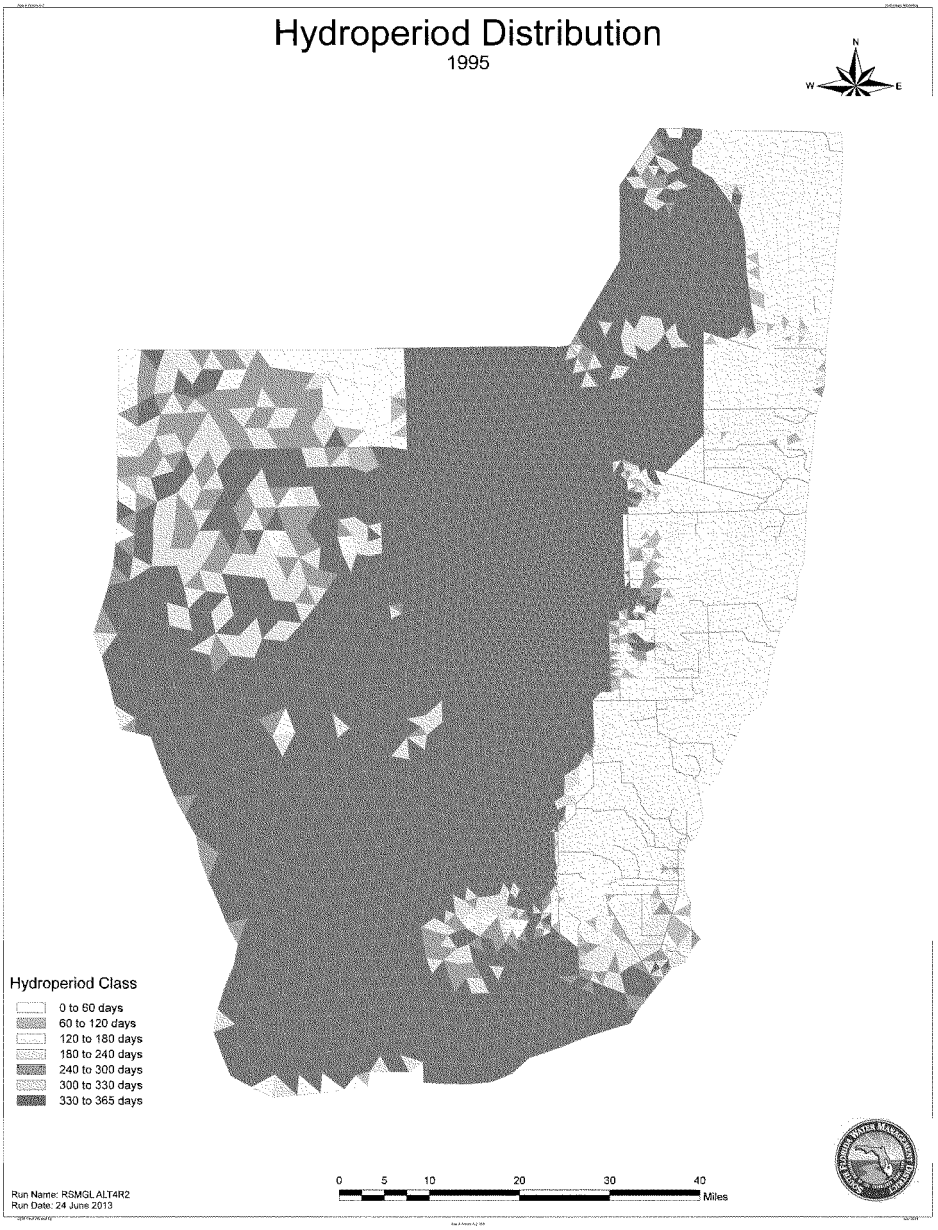

Hydroperiod Distribution
1989
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: ALT4R
Run Date: February 27, 2013

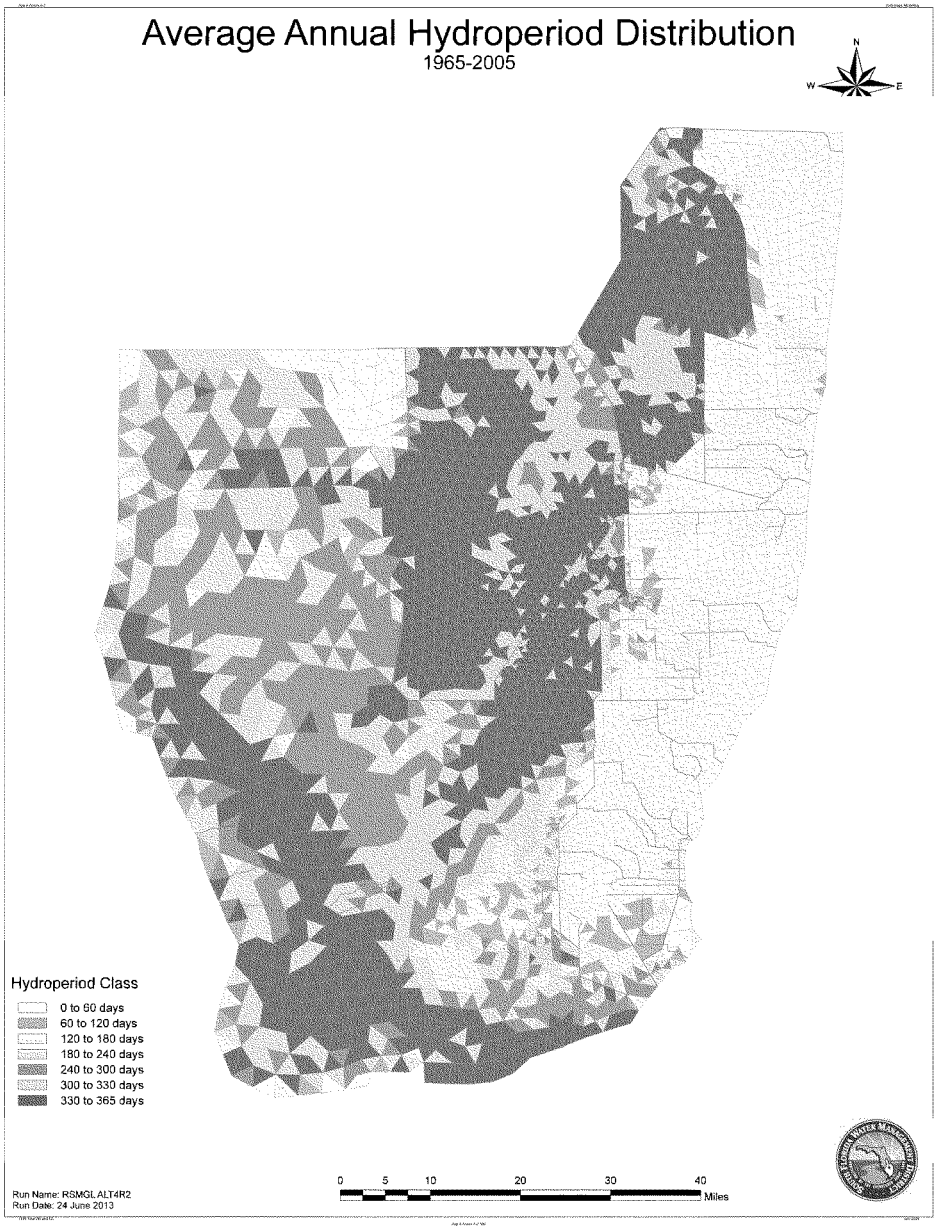

Hydroperiod Distribution
1995
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: ALT4R
Run Date: February 27, 2013


Average Annual Hydroperiod Distribution
1965-2005
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: ALT4R
Run Date: February 27, 2013


Hydroperiod Distribution
1978
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: RSMGL ALT4R2
Run Date: 24 June 2013

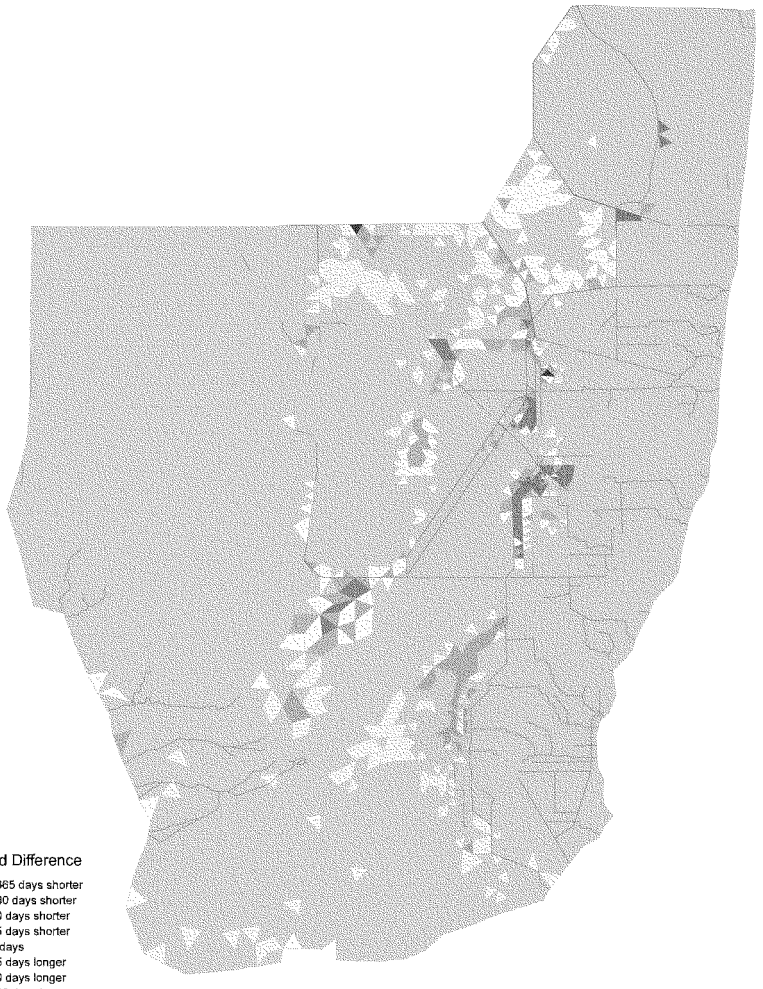

Hydroperiod Distribution
1989
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: RSMGLALT4R2
Run Date: 24 June 2013


Hydroperiod Distribution
1995
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0
5
10
20
30
40
Miles
Run Name: RSMGLALT4R2
Run Date: 24 June 2013


Average Annual Hydroperiod Distribution
1965-2005
N
W
E
Hydroperiod Class
0 to 60 days
60 to 120 days
120 to 180 days
180 to 240 days
240 to 300 days
300 to 330 days
330 to 365 days
0 5 10 20 30 40
Miles
Run Name: RSMGLALT4R2
Run Date: 24 June 2013

Hydroperiod Difference

1978

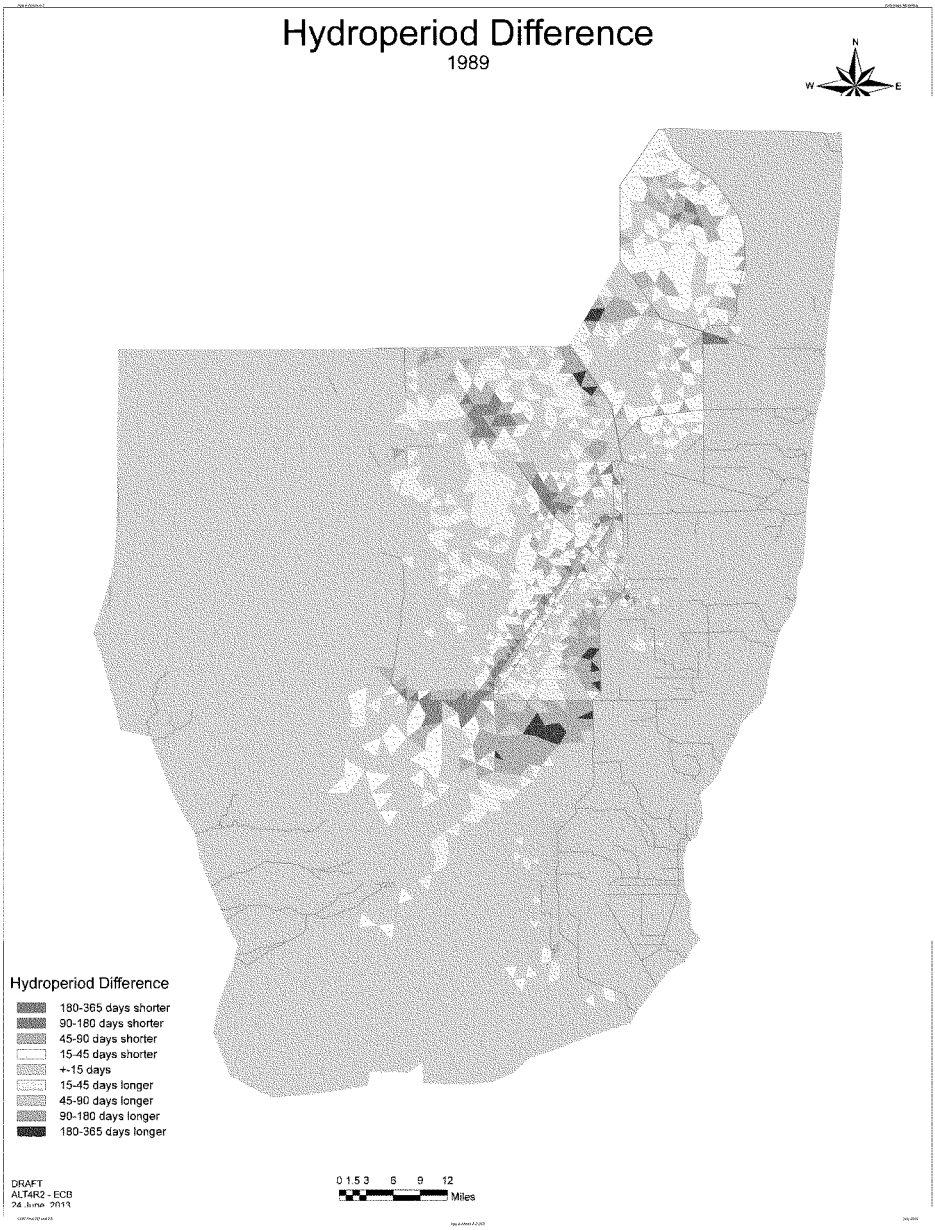


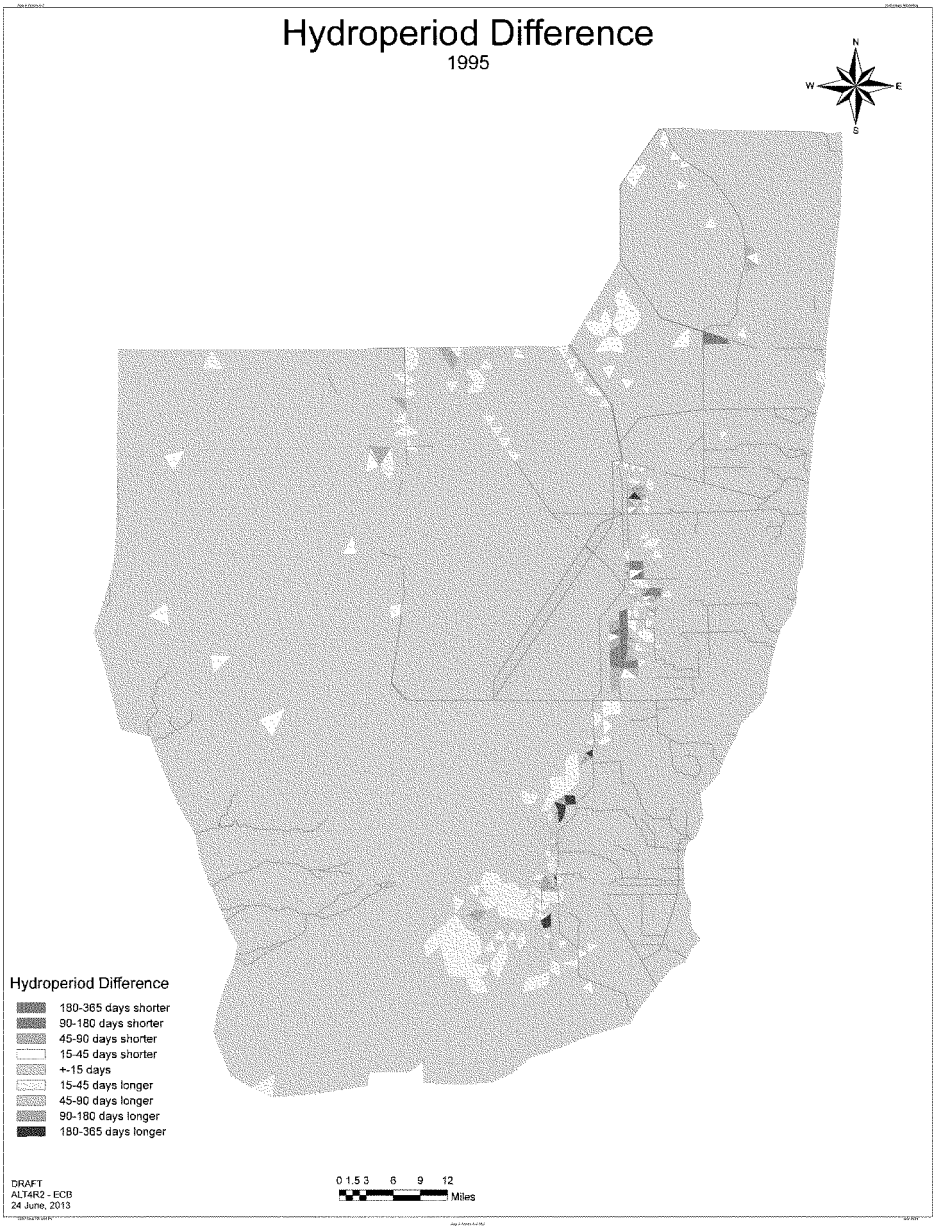
Hydroperiod Difference

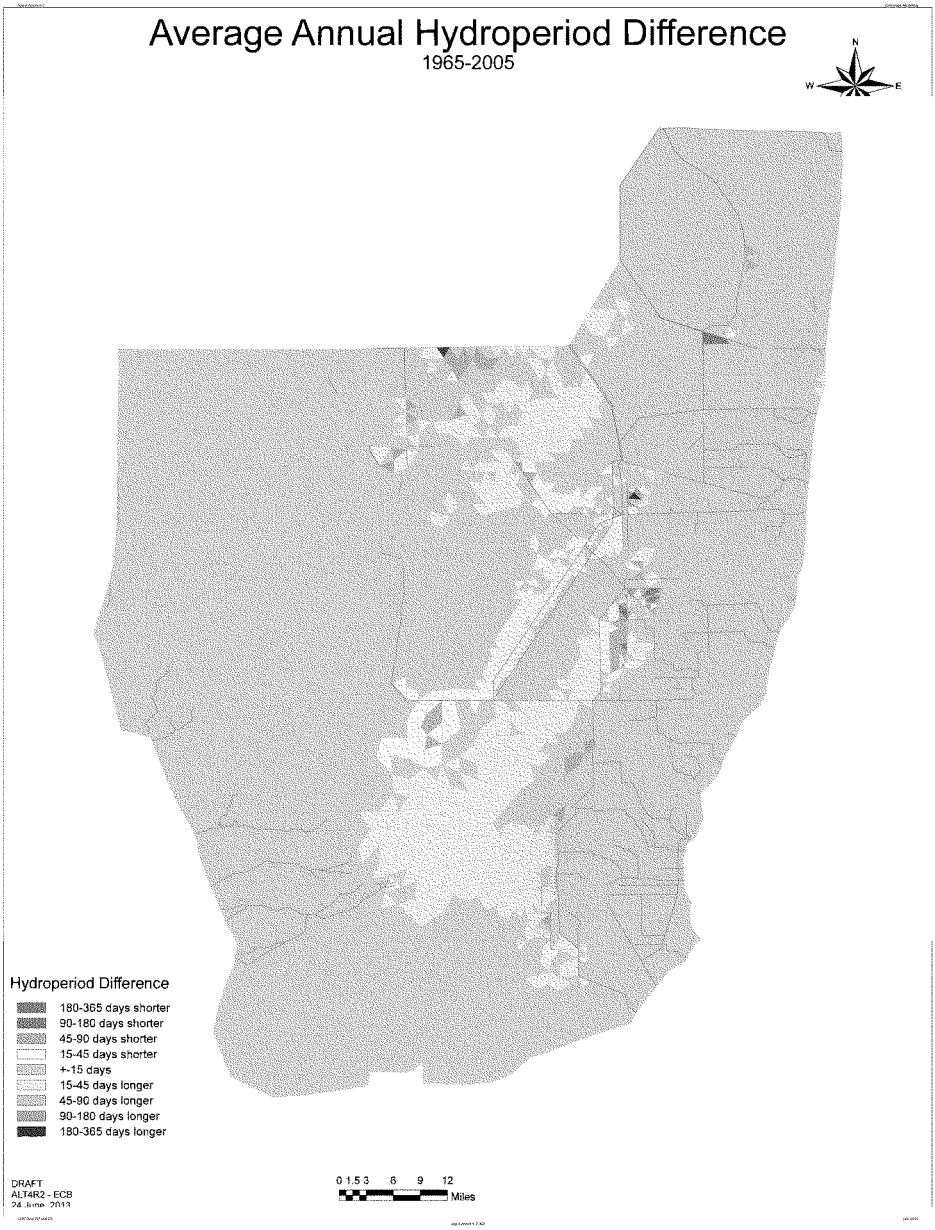
- 180-365 days shorter
- 90-180 days shorter
- 45-90 days shorter
- 15-45 days shorter
- +-15 days
- 15-45 days longer
- 45-90 days longer
- 90-180 days longer
- 180-365 days longer

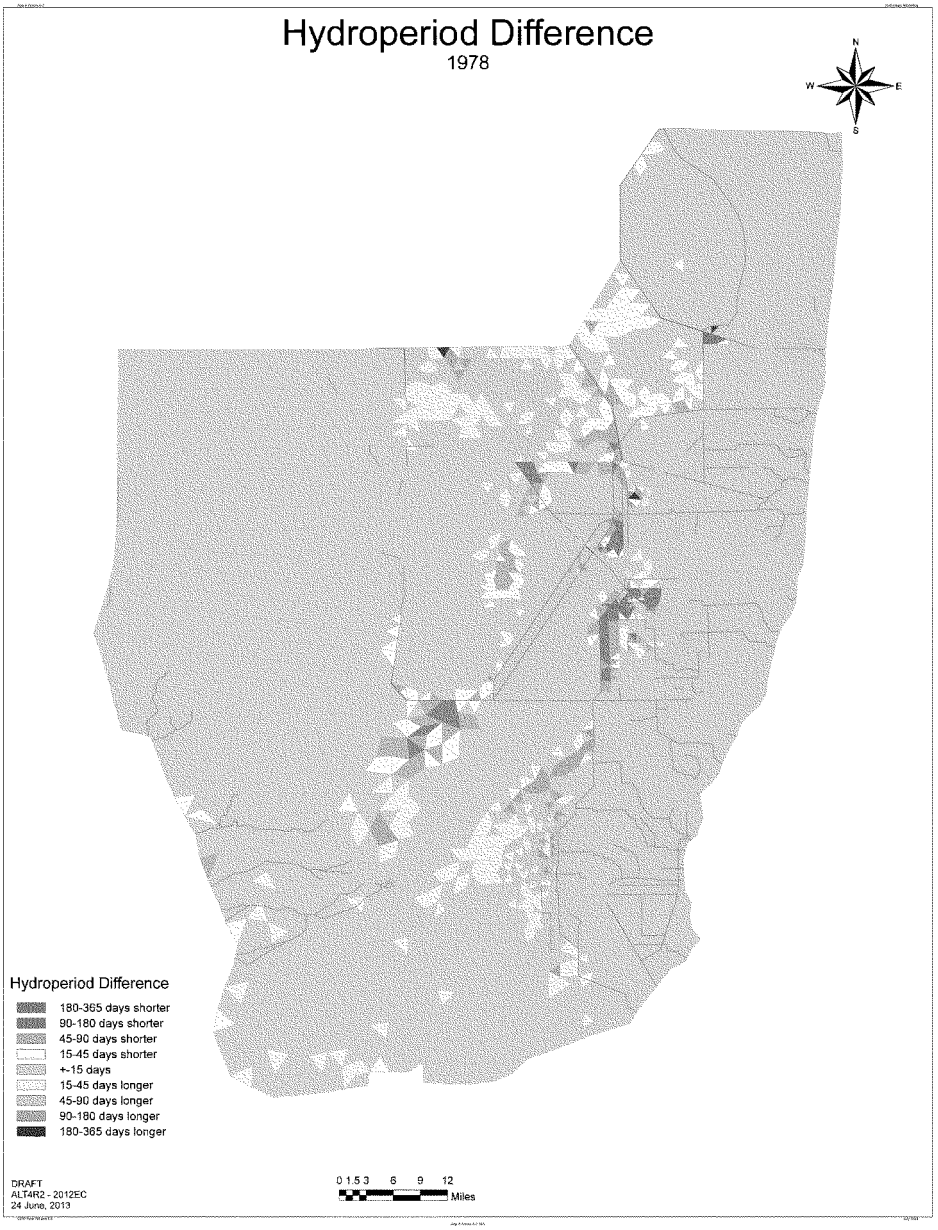
DRAFT
ALT4R2 - ECB
24 June 2013

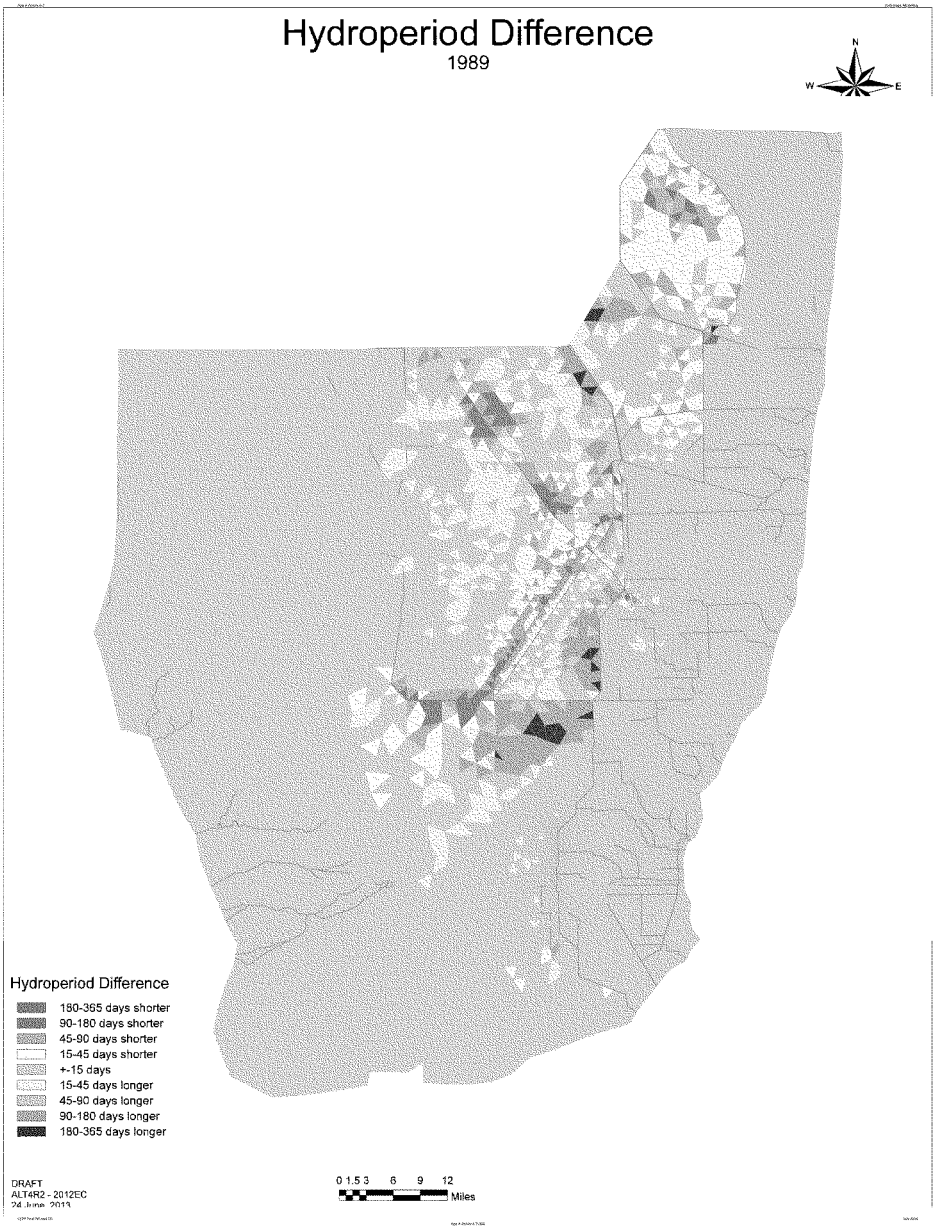
0 1.5 3 6 9 12
Miles

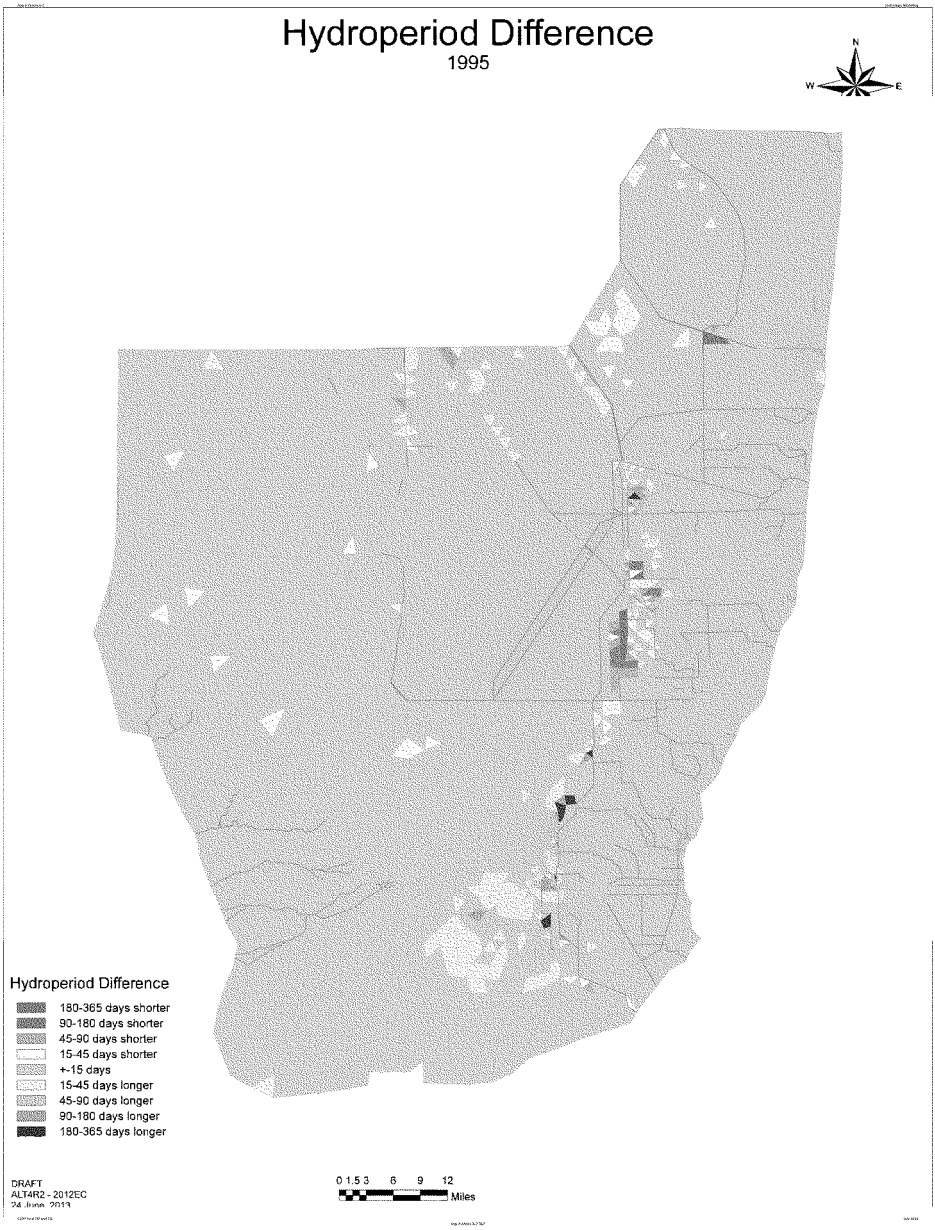

Hydroperiod Difference
1989
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - ECB
24 June 2013
0 1.5 3 6 9 12
Miles

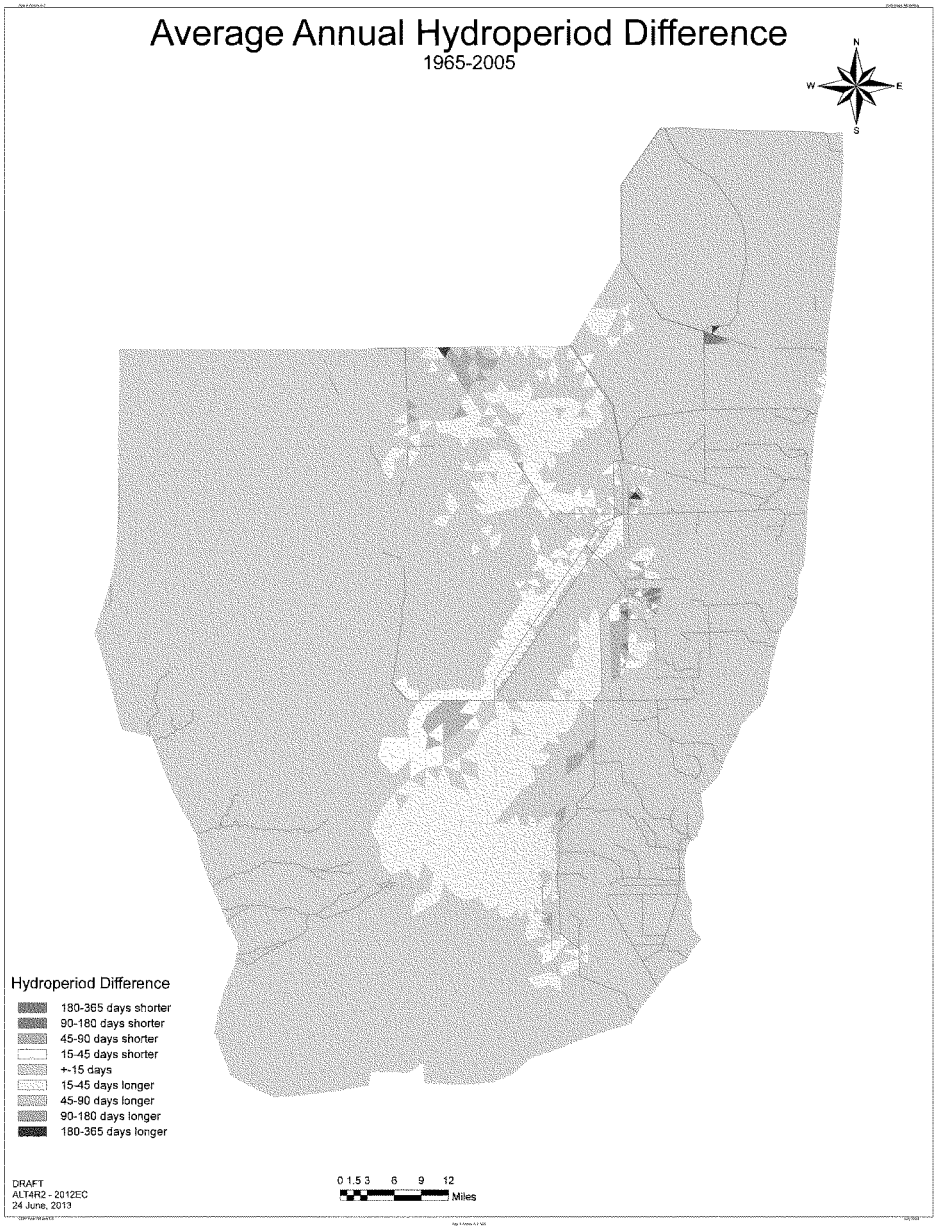

Hydroperiod Difference
1995
N
W
E
S
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - ECB
24 June, 2013
0 1.5 3 6 9 12
Miles

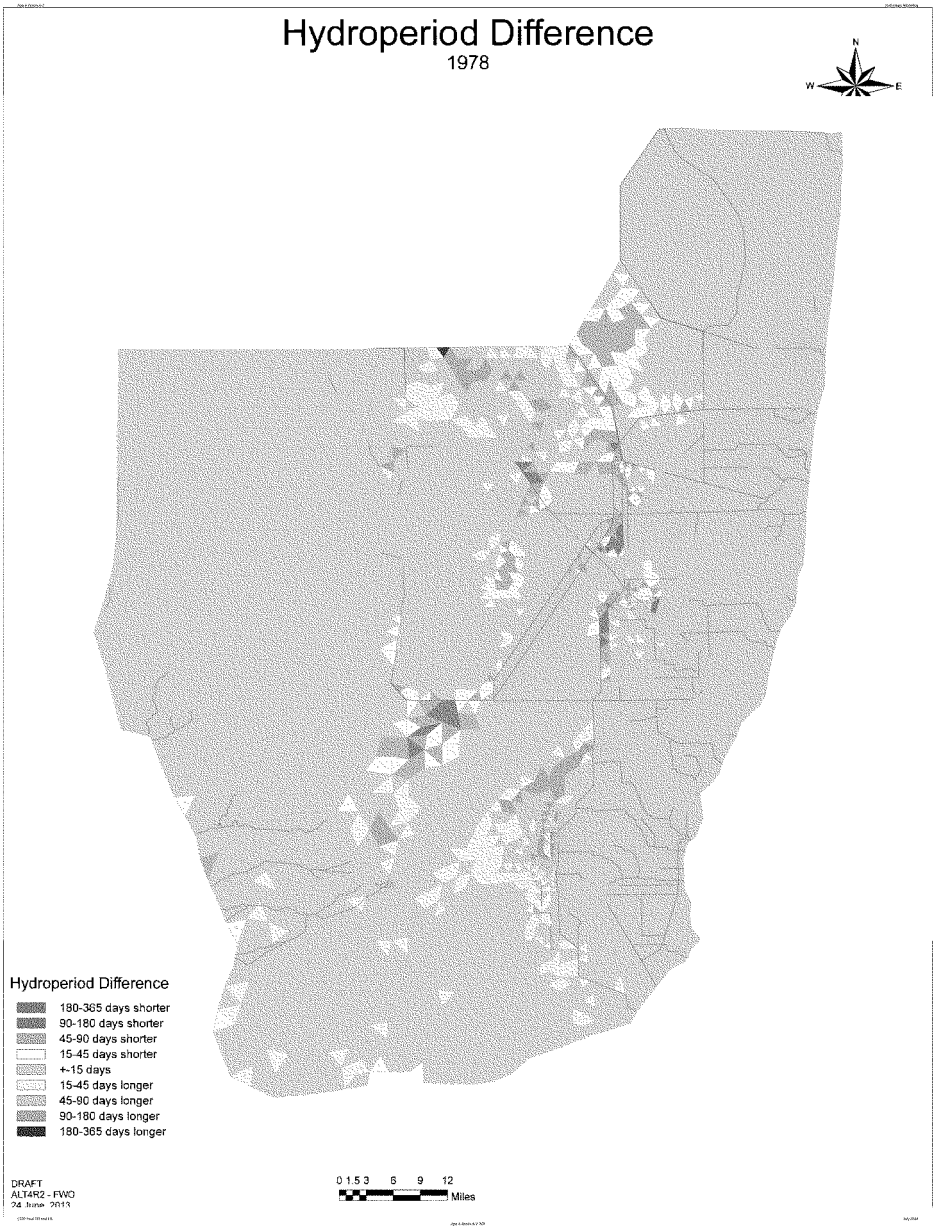

Average Annual Hydroperiod Difference
1965-2005
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - ECB
24 June 2013
0 1.5 3 6 9 12
Miles

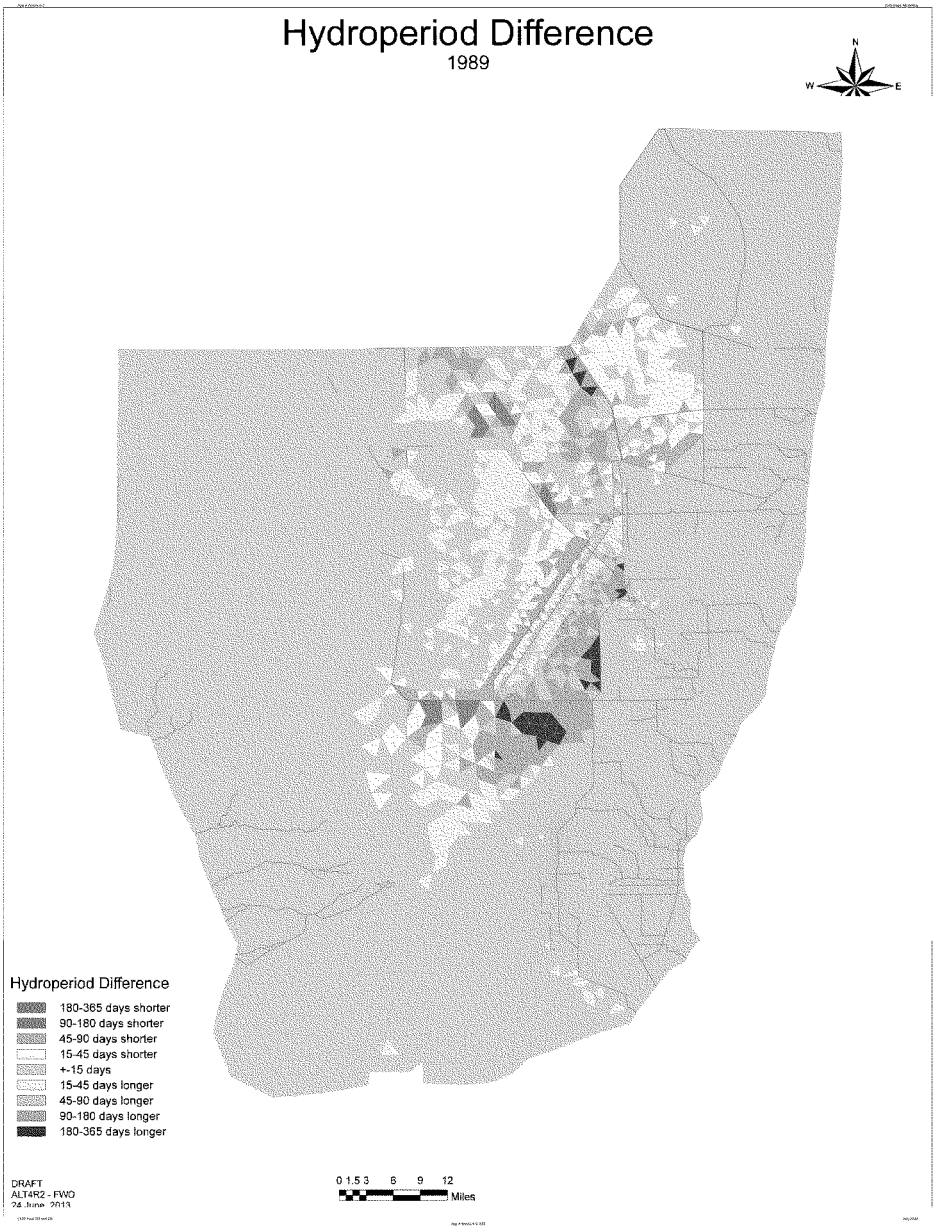

Hydroperiod Difference
1978
N
W
E
S
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - 2012EC
24 June, 2013
0 1.5 3 6 9 12
Miles

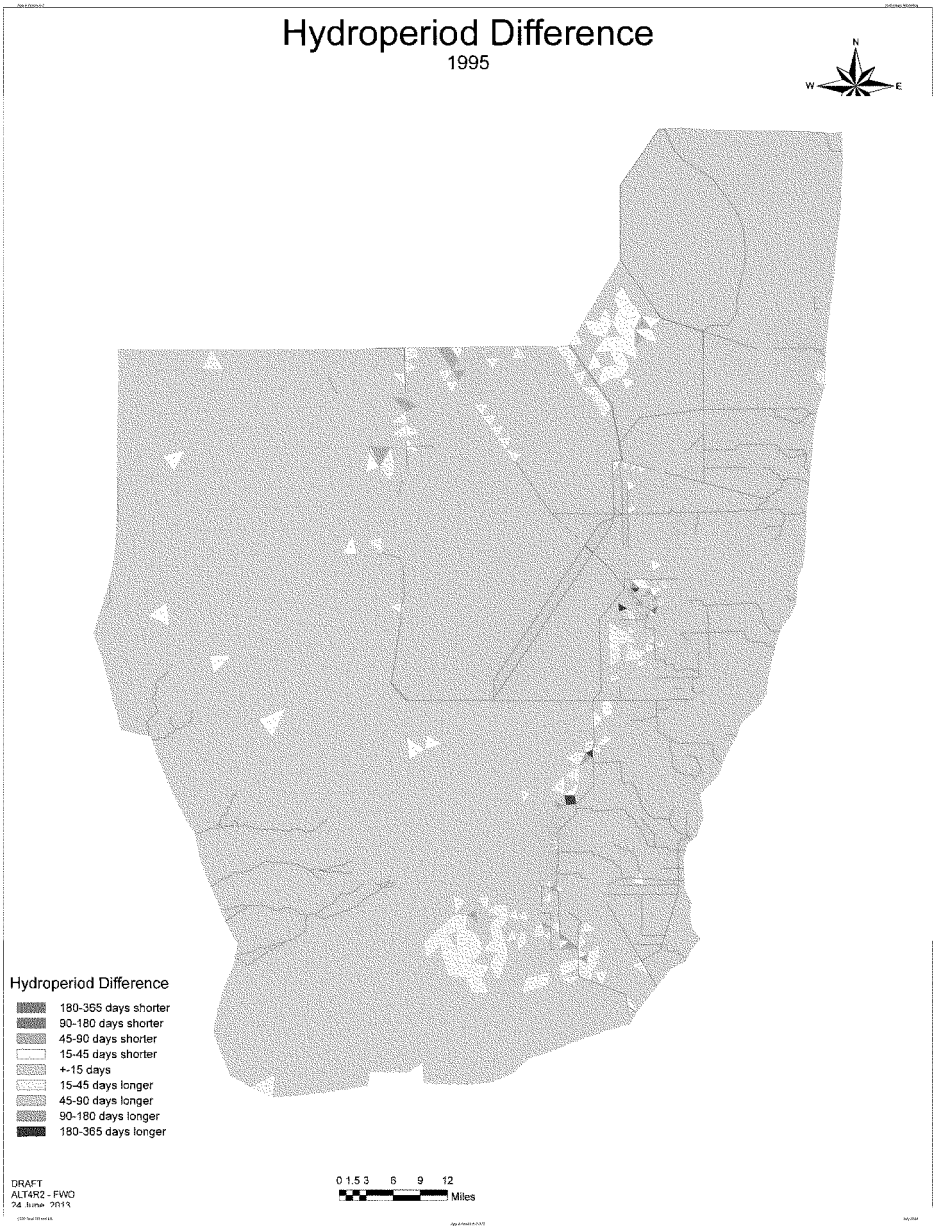

Hydroperiod Difference
1989
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - 2012EC
0 1.5 3 6 9 12
Miles

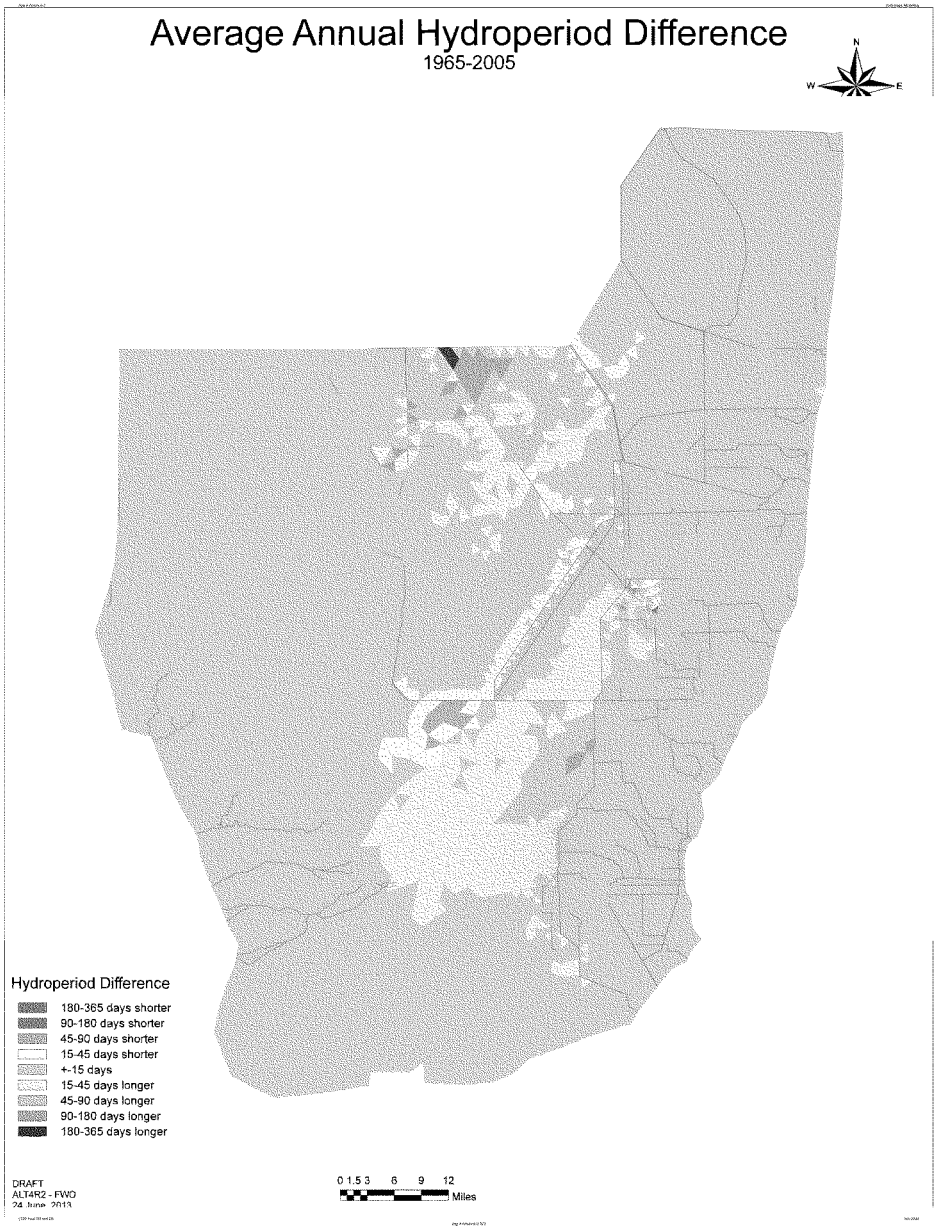

Hydroperiod Difference
1995
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - 2012EC
0 1.5 3 6 9 12
Miles

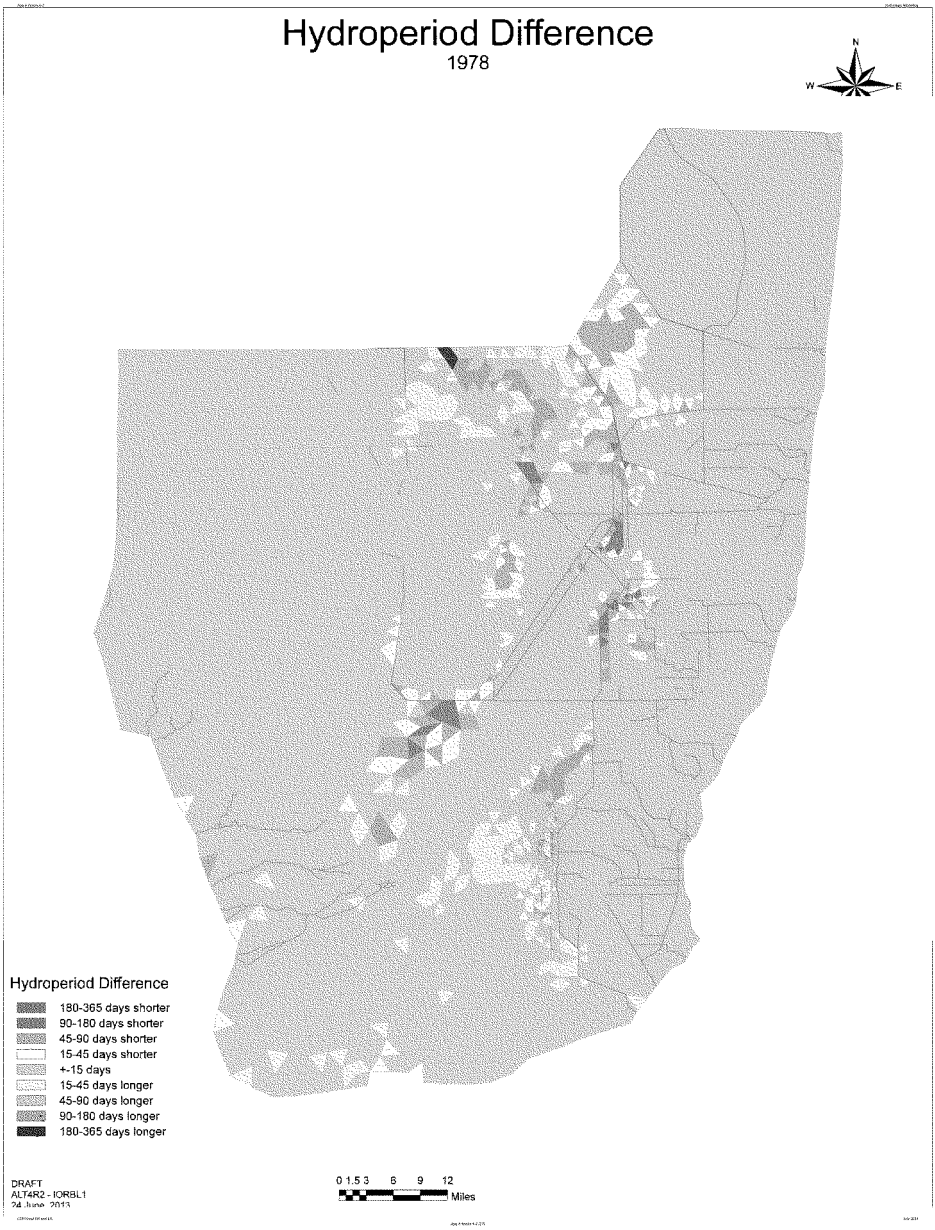

Average Annual Hydroperiod Difference
1965-2005
N
W
E
S
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - 2012EC
24 June, 2013
0 1.5 3 6 9 12
Miles

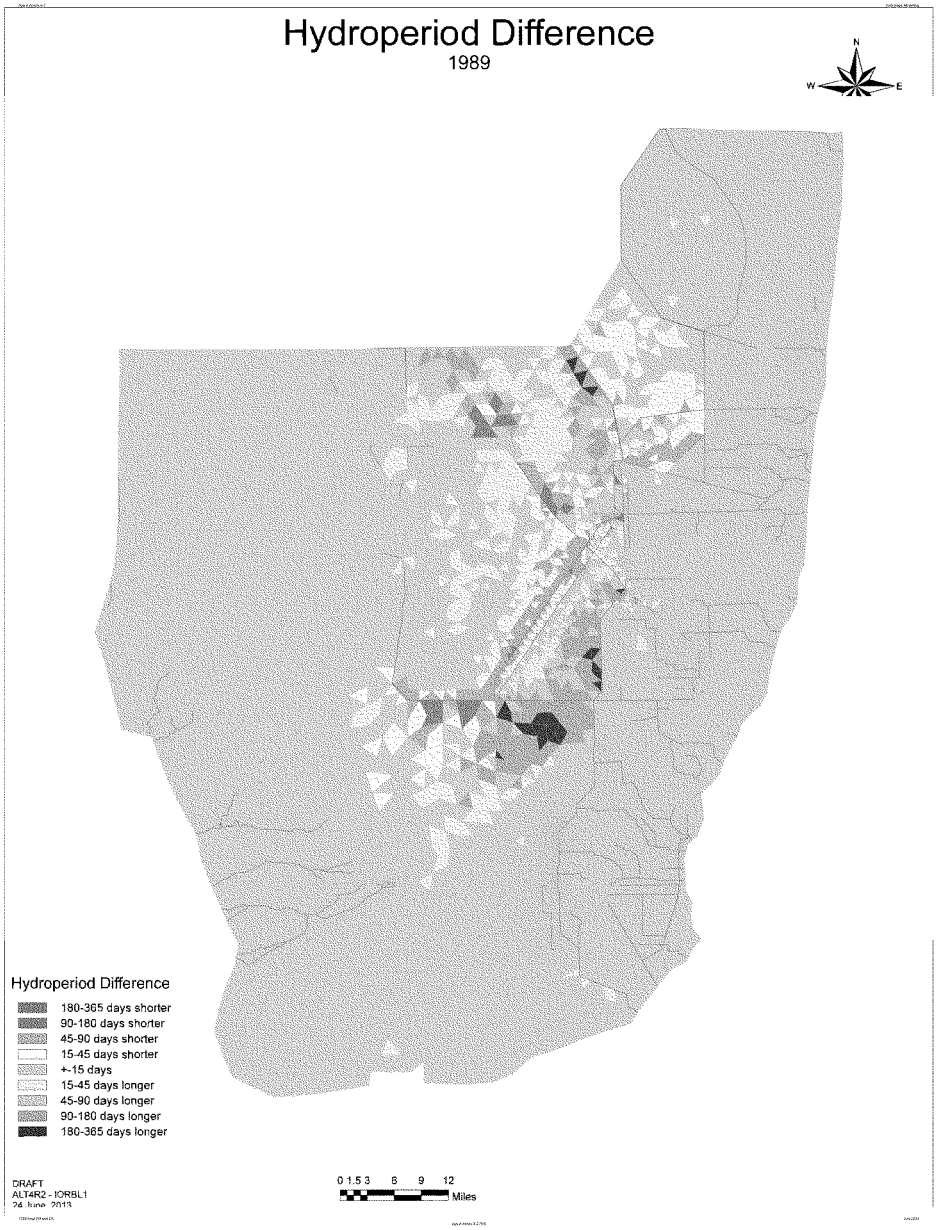

Hydroperiod Difference
1978
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - FWO
24 June 2013
0 1.5 3 6 9 12
Miles

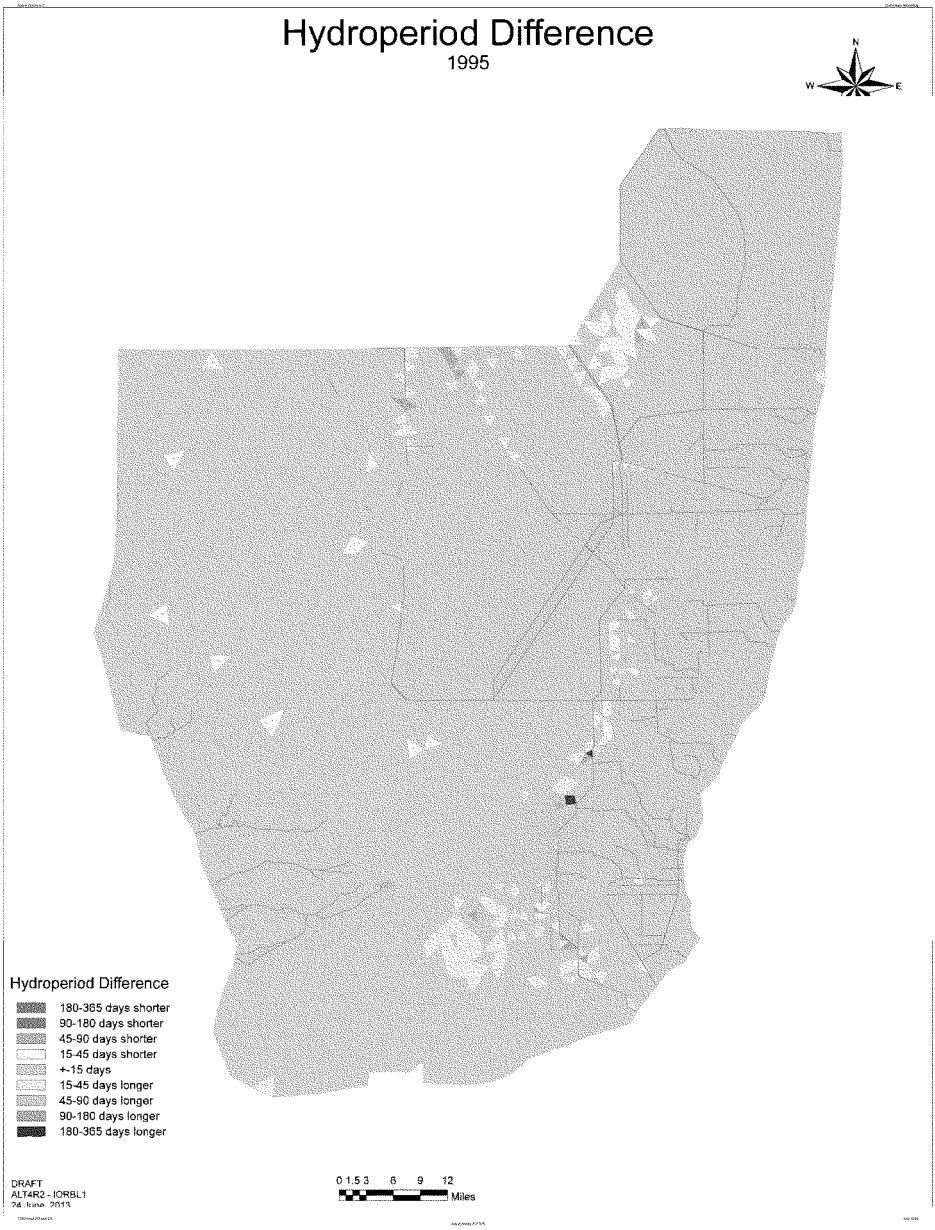

Hydroperiod Difference
1989
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - FWO
0 1.5 3 6 9 12
Miles

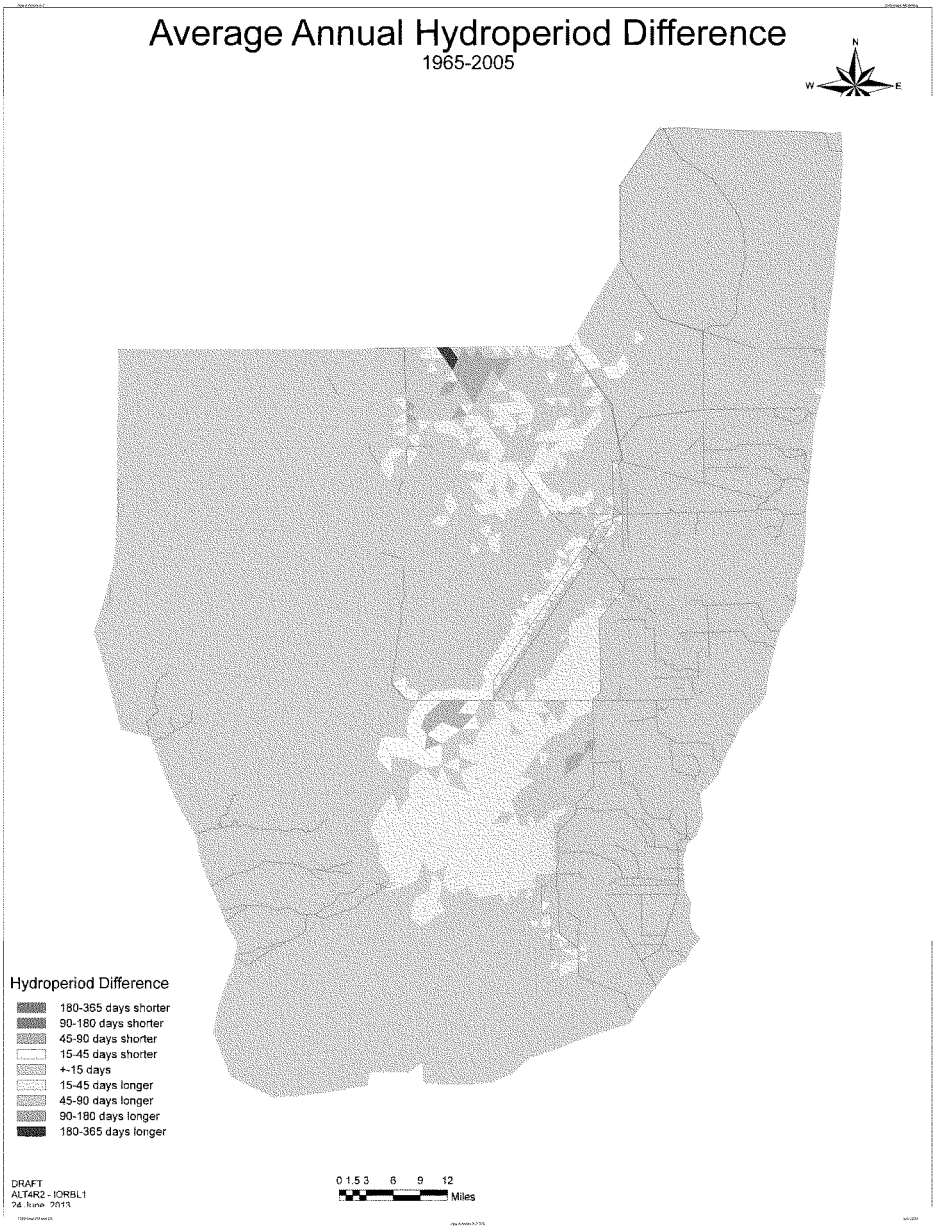

Hydroperiod Difference
1995
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - FWO
24 June 2013
0 1.5 3 6 9 12
Miles


Average Annual Hydroperiod Difference
1965-2005
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - FWO
24 June 2013
0 1.5 3 6 9 12
Miles


Hydroperiod Difference
1978
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - IORBL1
0 1.5 3 6 9 12
Miles

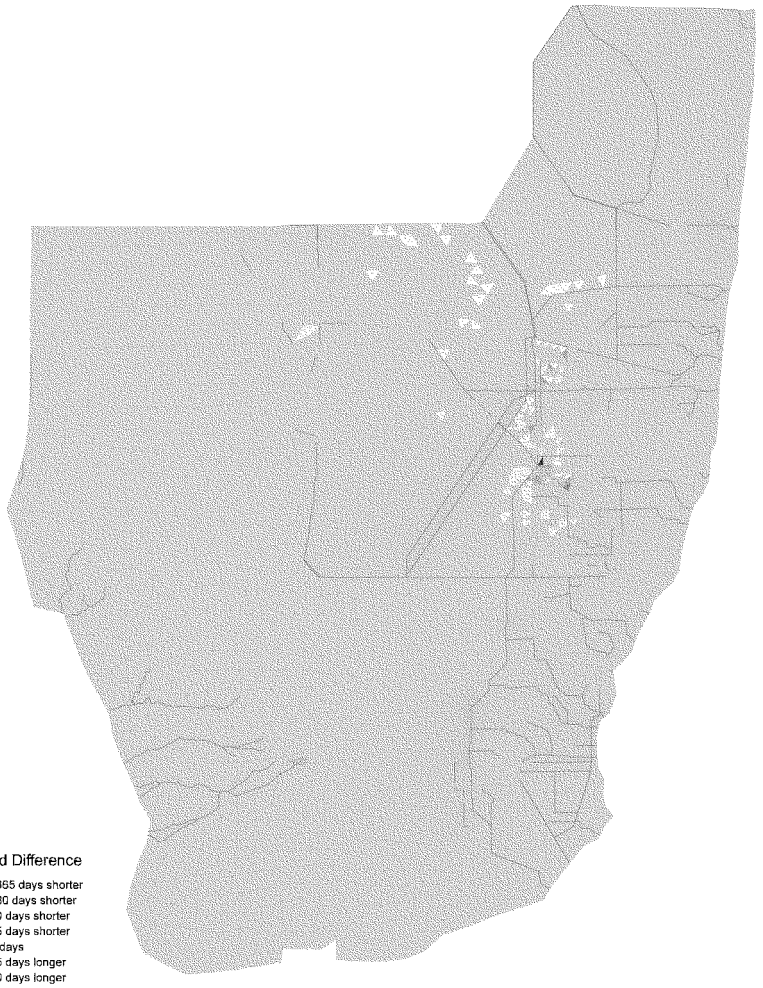

Hydroperiod Difference
1989
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - IORSL1
0 1.5 3 6 9 12
Miles


Hydroperiod Difference
1995
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - IORBL1
0 1.5 3 6 9 12
Miles

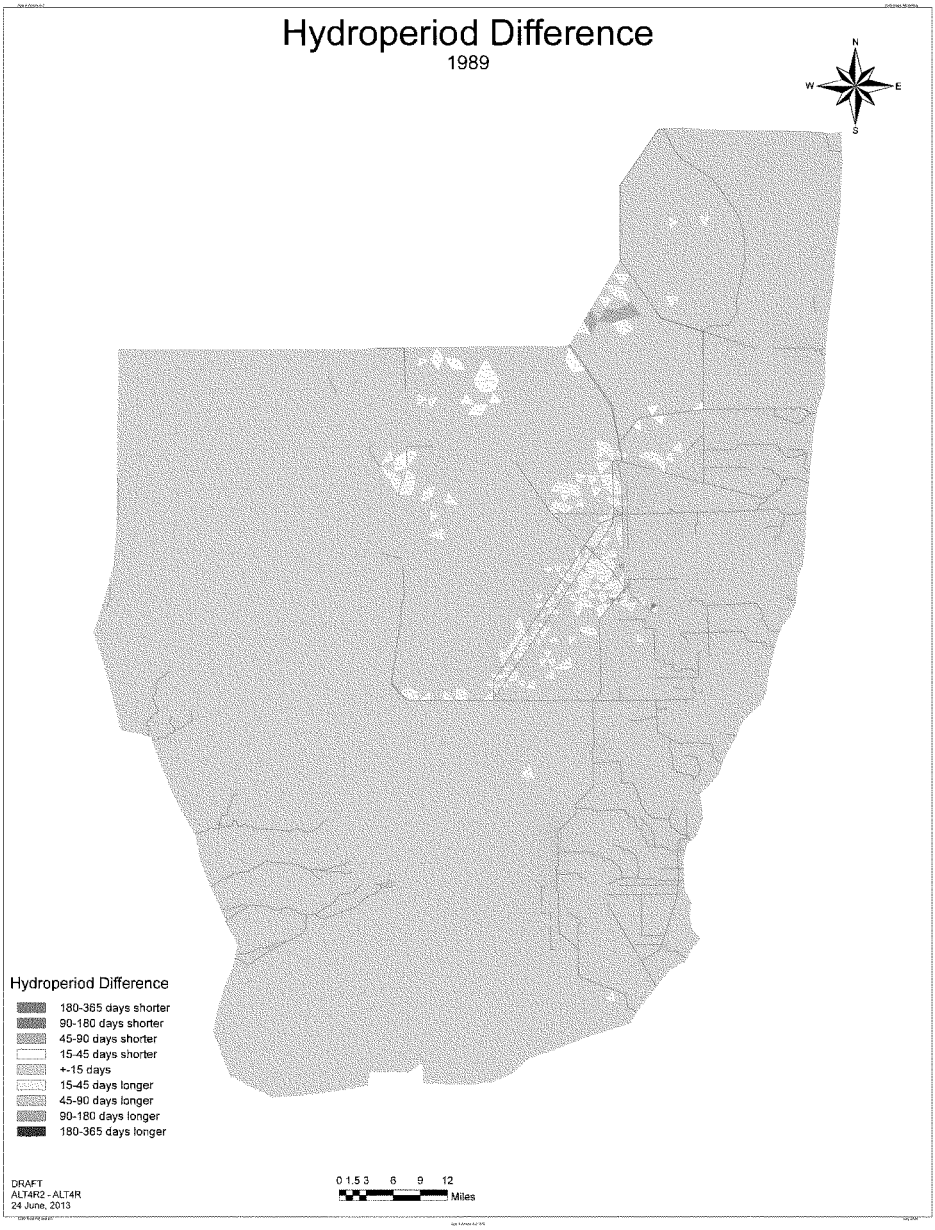

Average Annual Hydroperiod Difference
1965-2005
N
W
E
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - IORBL1
0 1.5 3 6 9 12
Miles

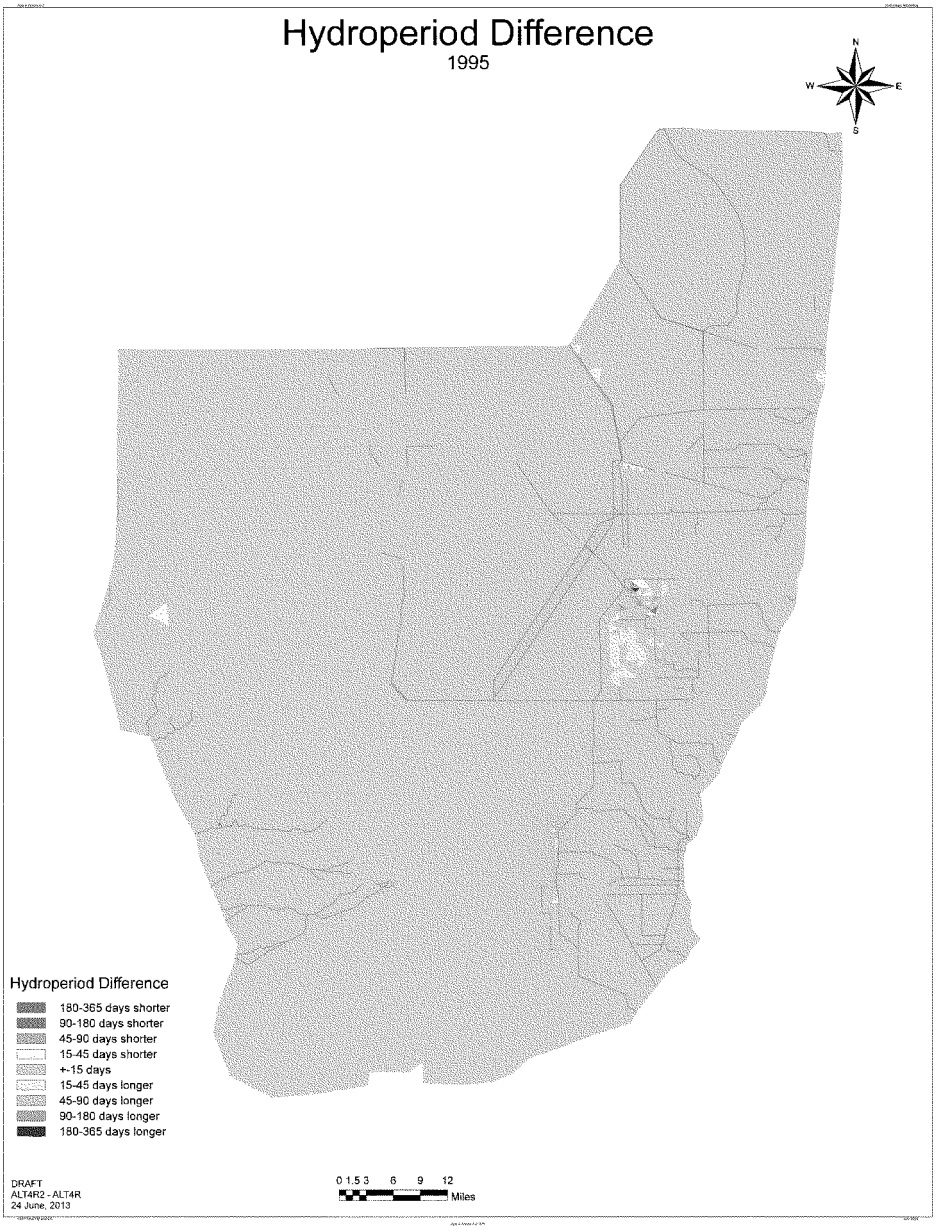
Hydroperiod Difference

1978



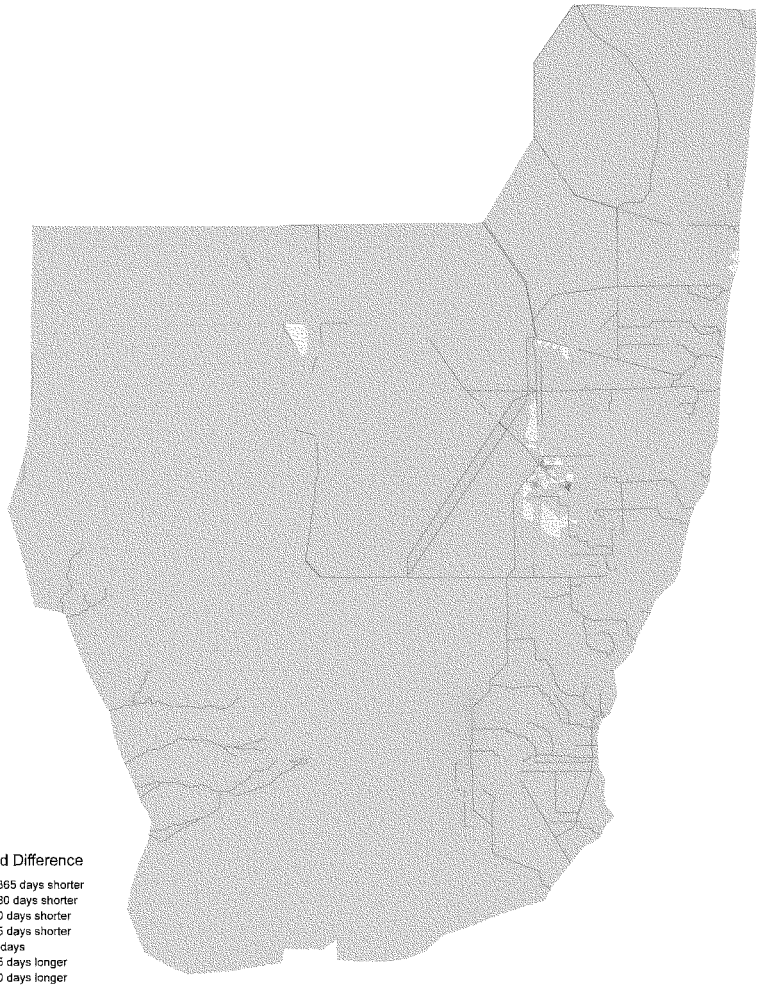
DRAFT
ALT4R2 - ALT4R
24 June 2013

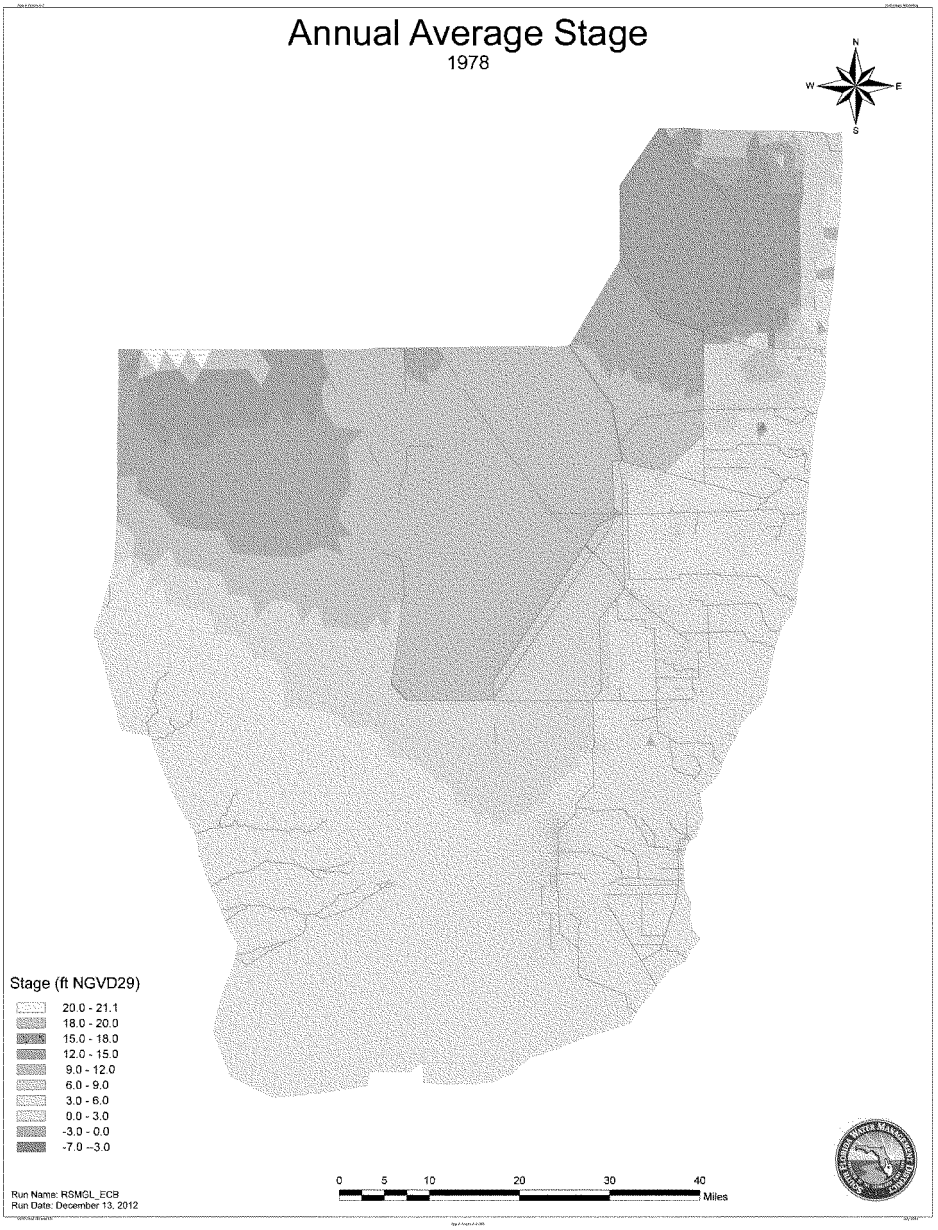

Hydroperiod Difference
1989
N
W
E
S
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - ALT4R
24 June, 2013
0 1.5 3 6 9 12
Miles

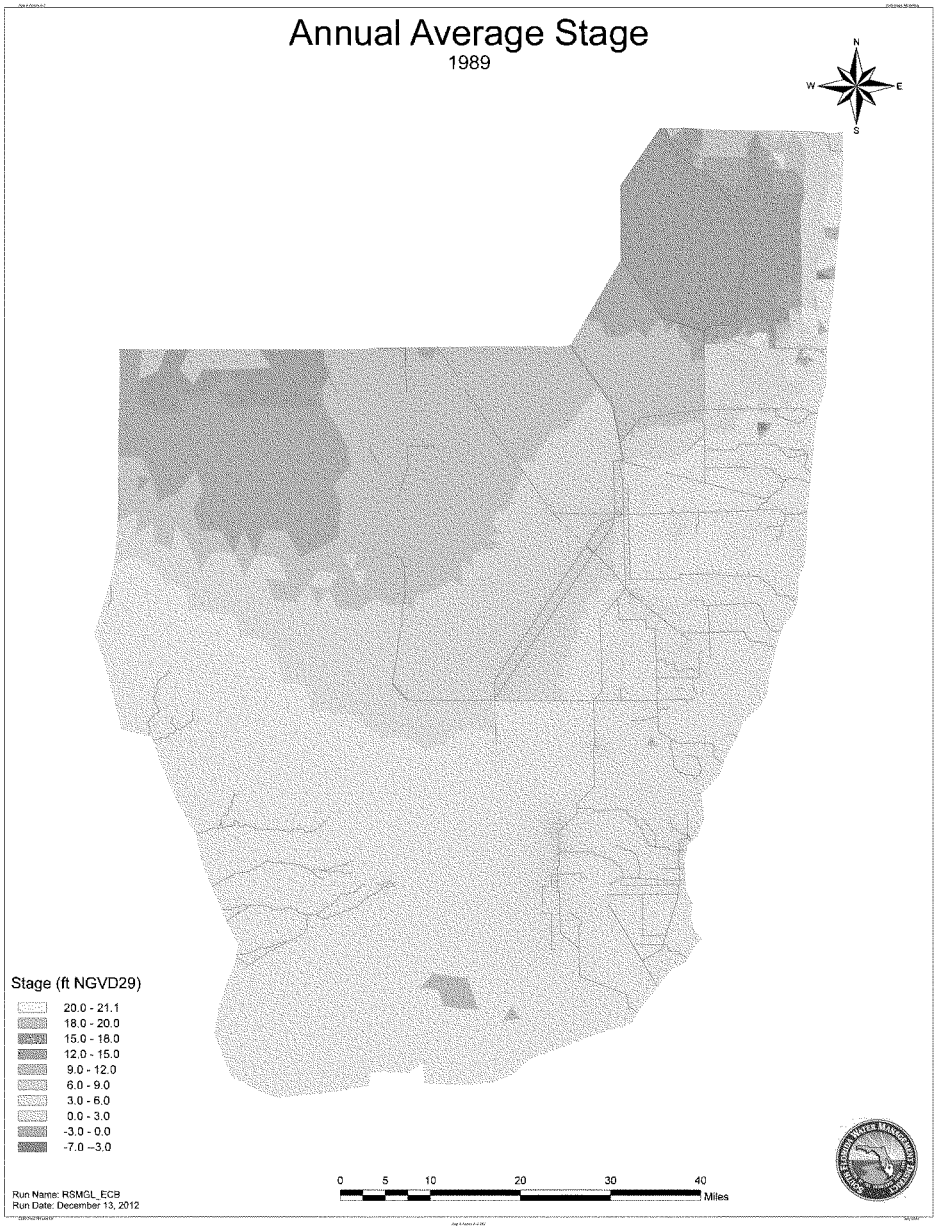

Hydroperiod Difference
1995
N
W
E
S
Hydroperiod Difference
180-365 days shorter
90-180 days shorter
45-90 days shorter
15-45 days shorter
+-15 days
15-45 days longer
45-90 days longer
90-180 days longer
180-365 days longer
DRAFT
ALT4R2 - ALT4R
24 June, 2013
0 1.5 3 6 9 12
Miles

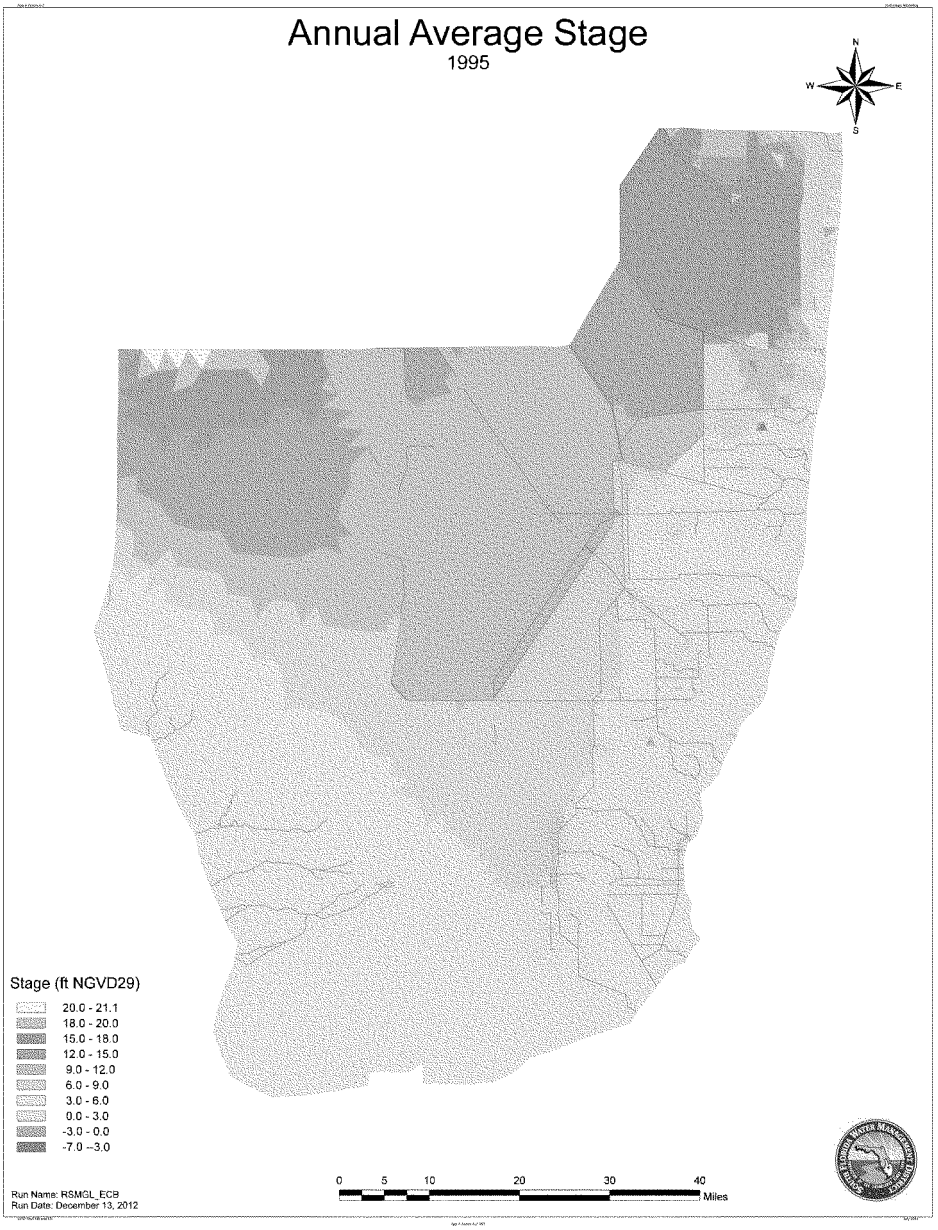
Average Annual Hydroperiod Difference

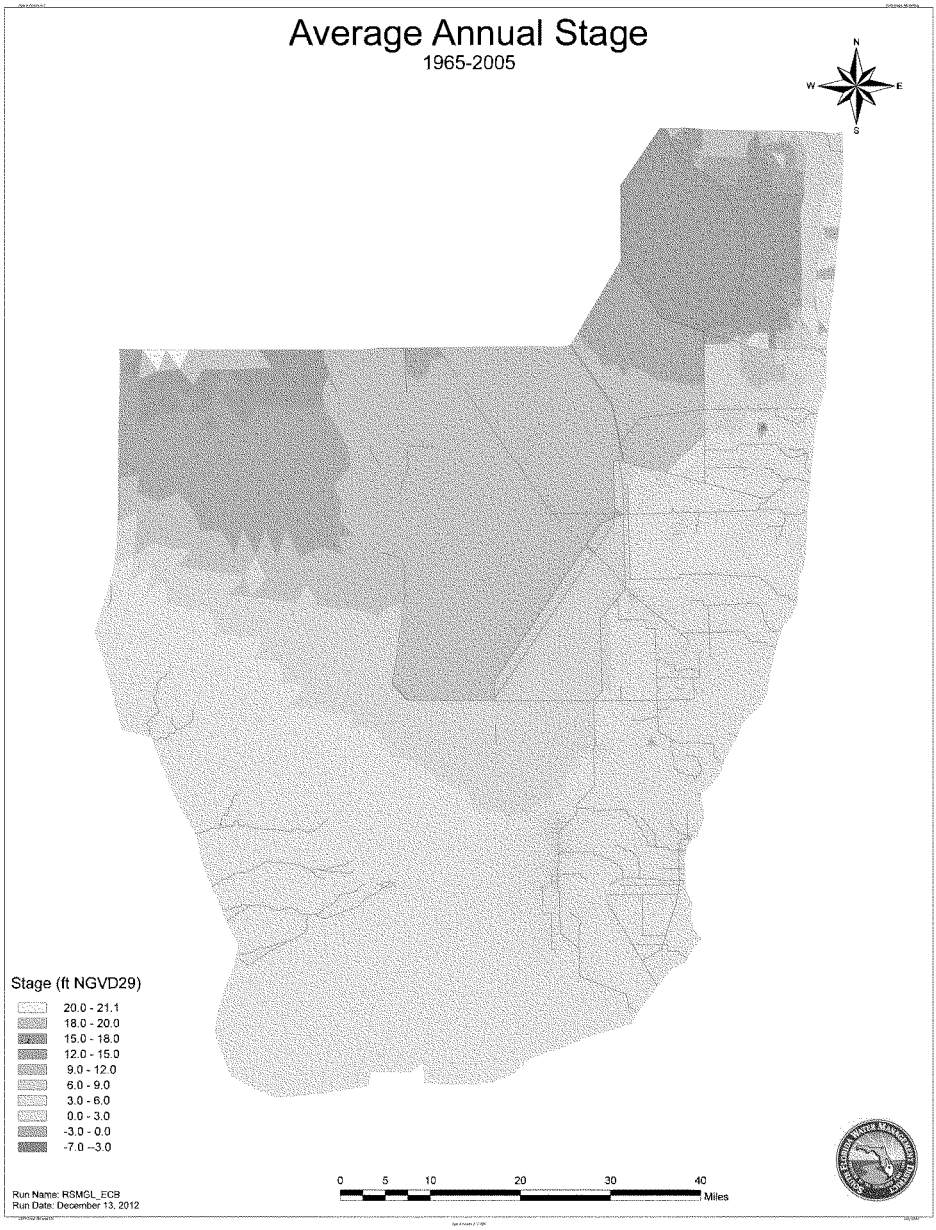
1965-2005

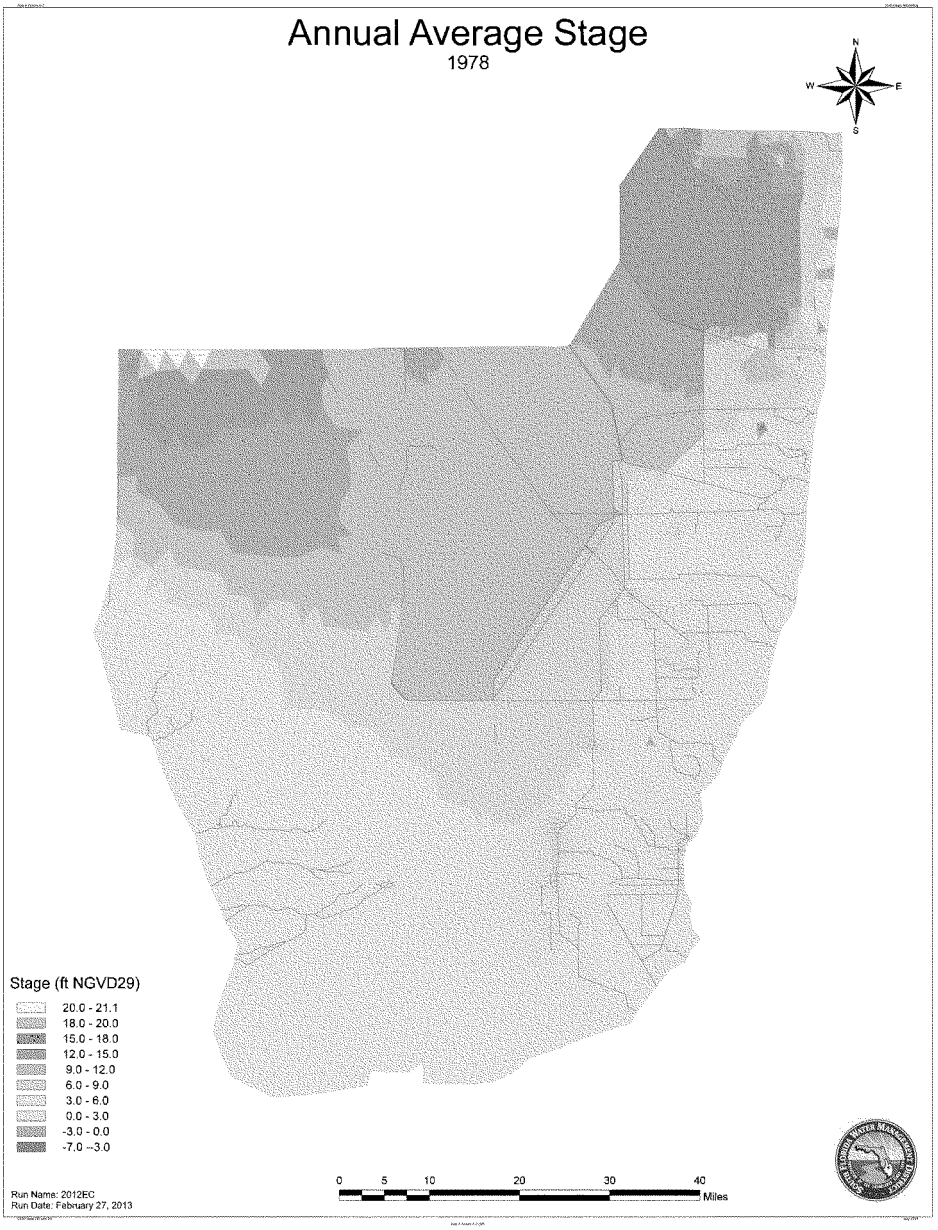


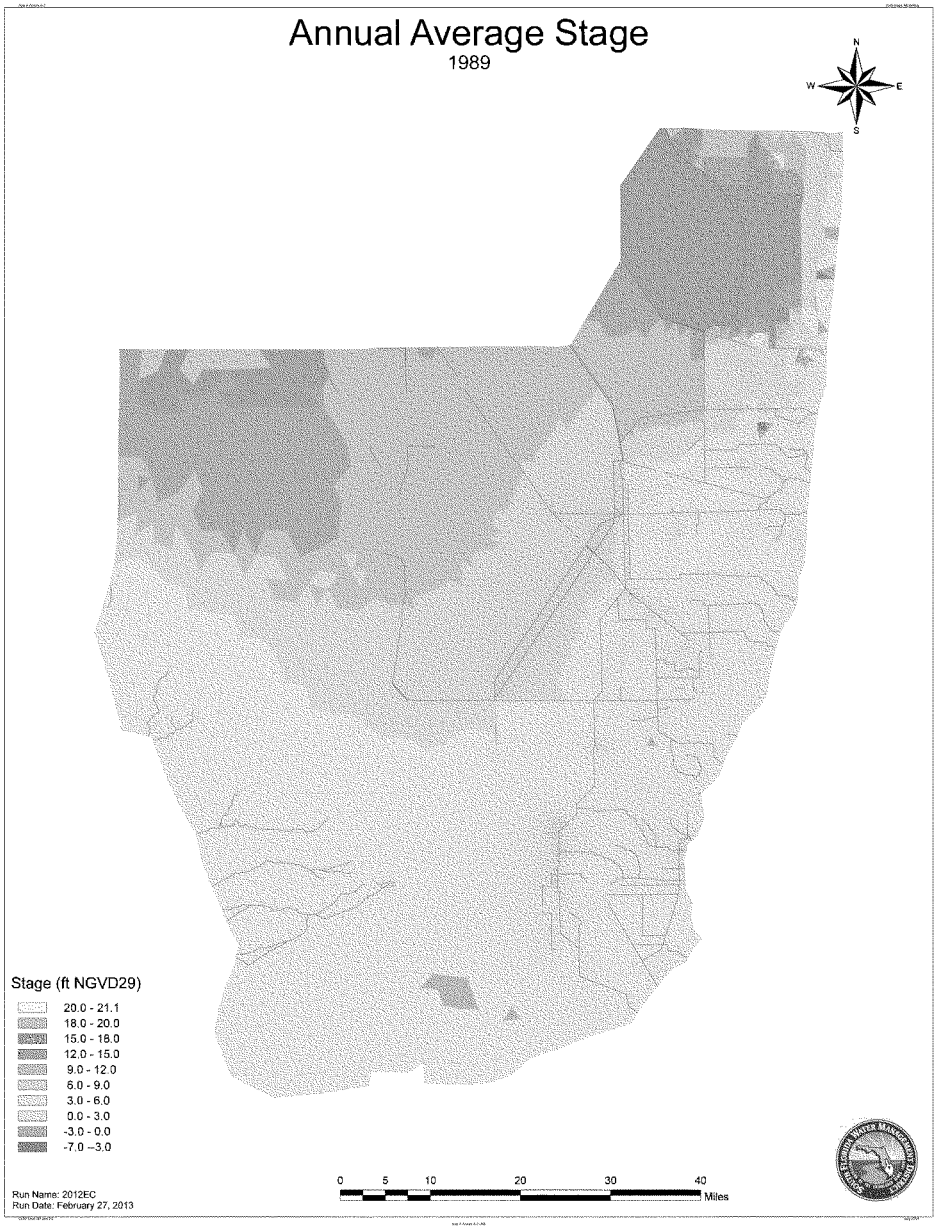

Annual Average Stage
1978
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_ECB
Run Date: December 13, 2012

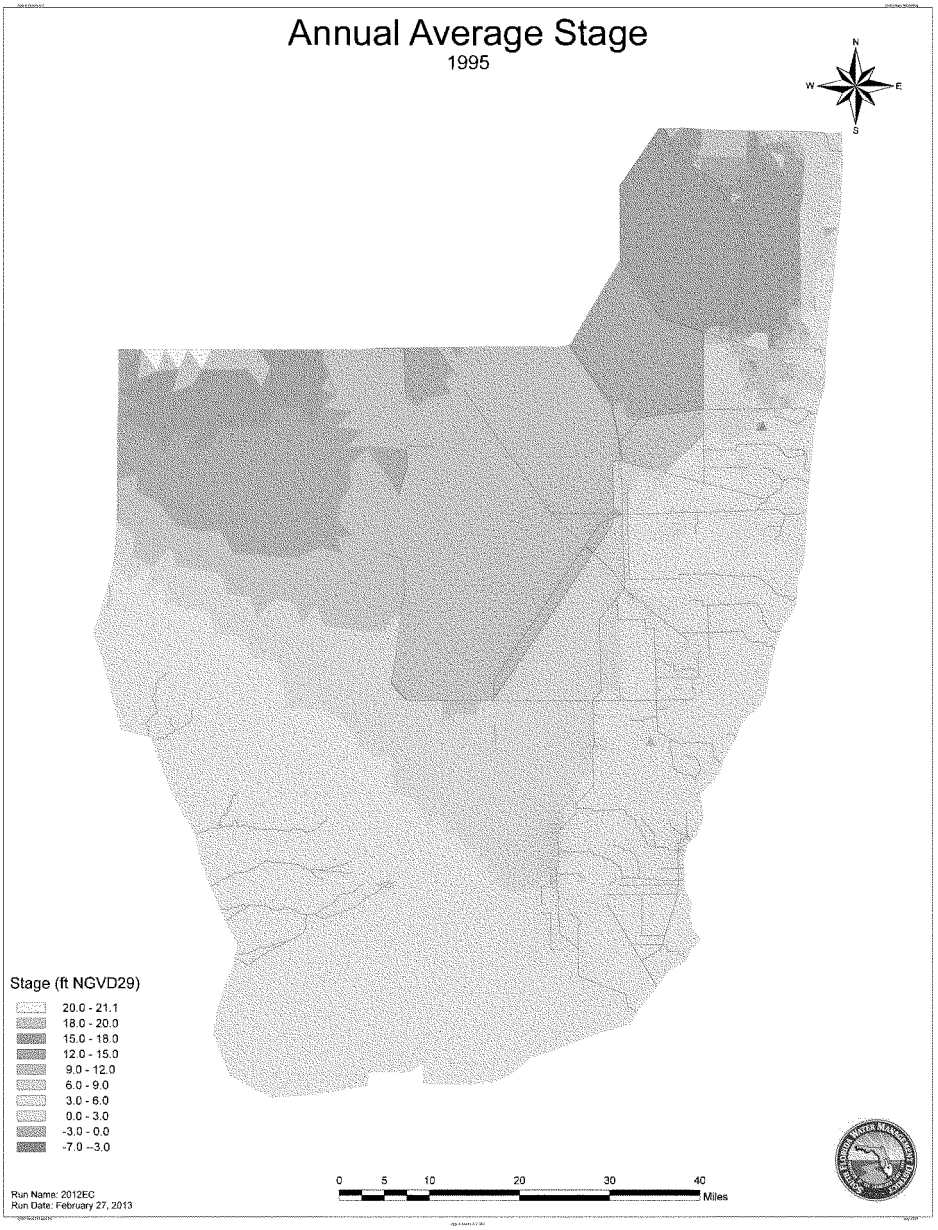

Annual Average Stage
1989
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGL_ECB
Run Date: December 13, 2012
0 5 10 20 30 40
Miles

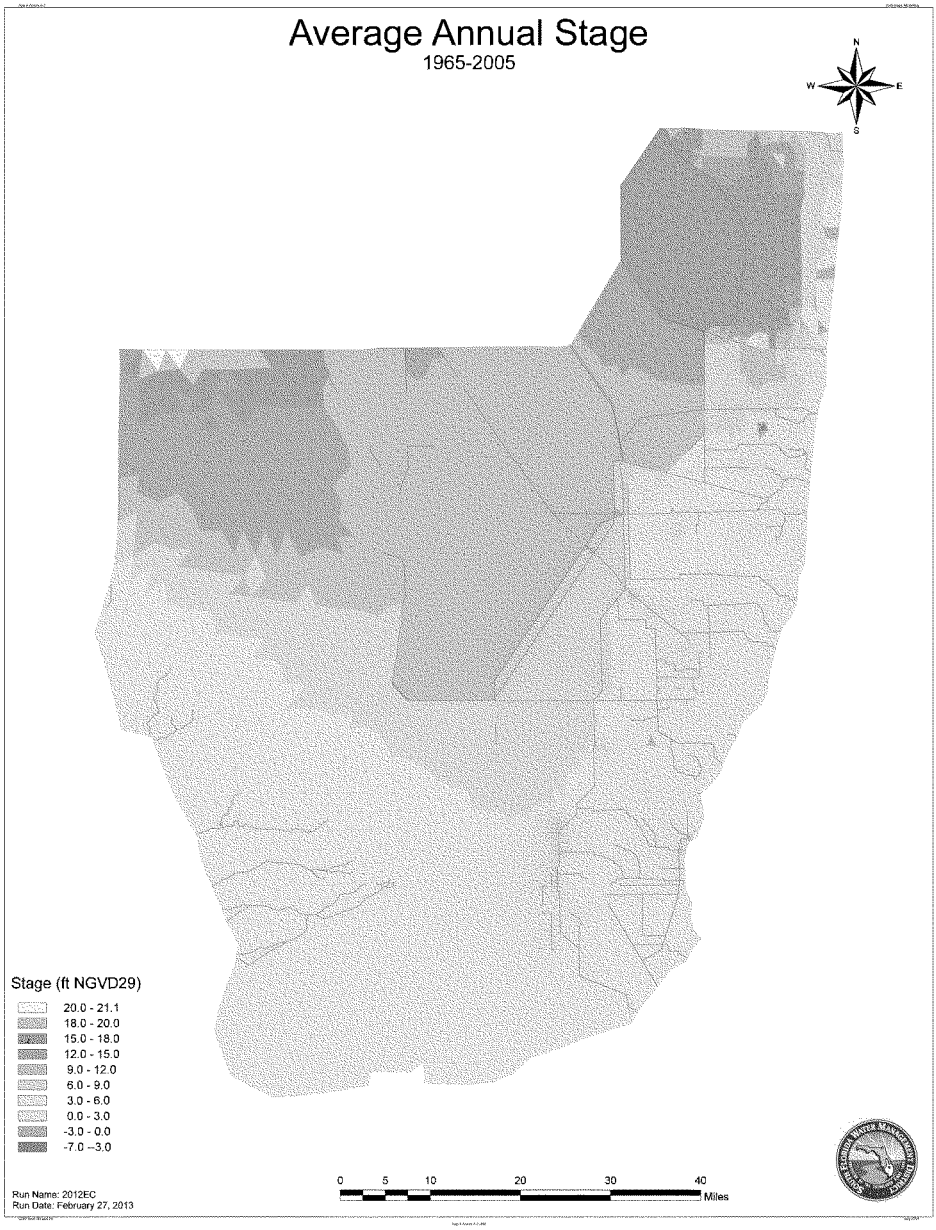

Annual Average Stage
1995
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_ECB
Run Date: December 13, 2012

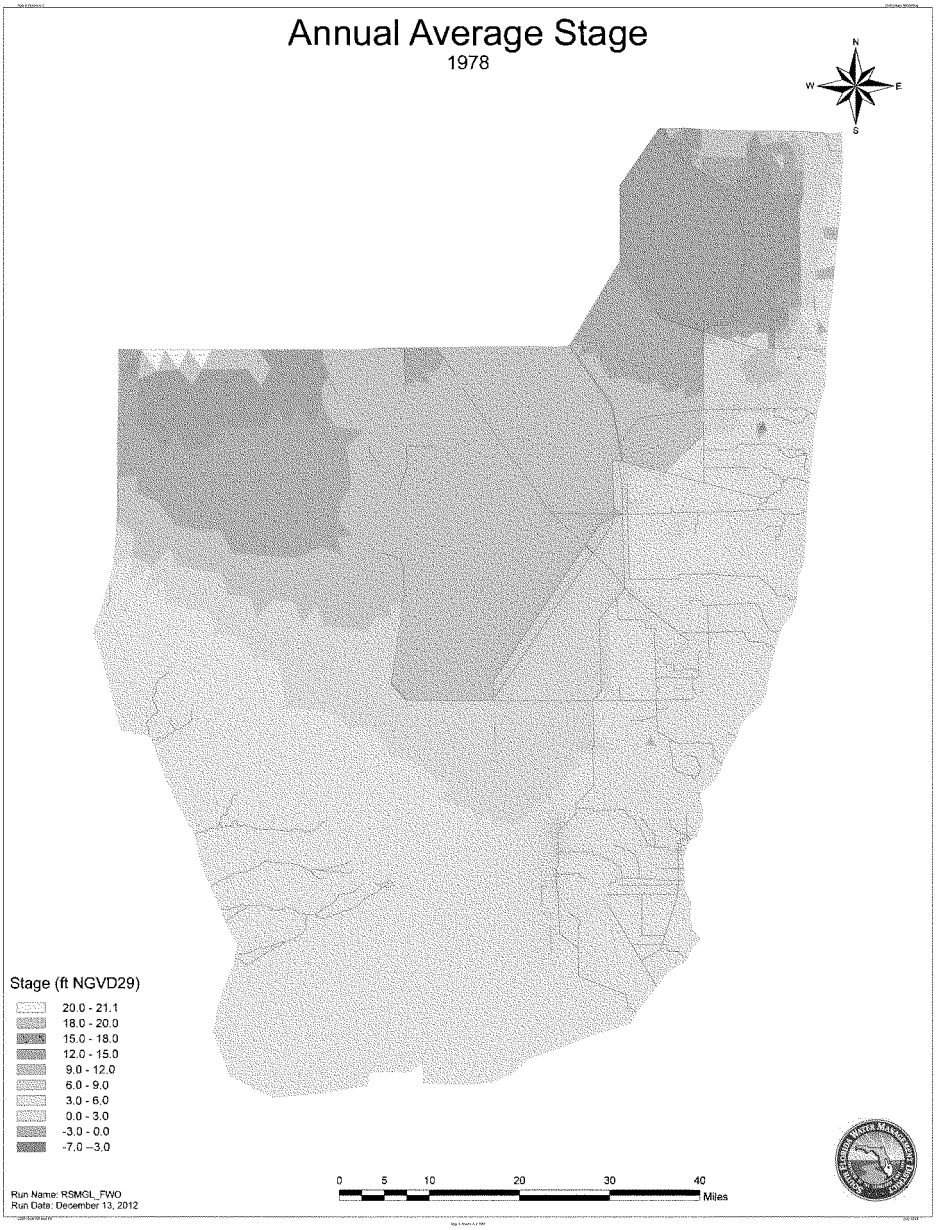

Average Annual Stage
1965-2005
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGL_ECB
Run Date: December 13, 2012
0 5 10 20 30 40
Miles

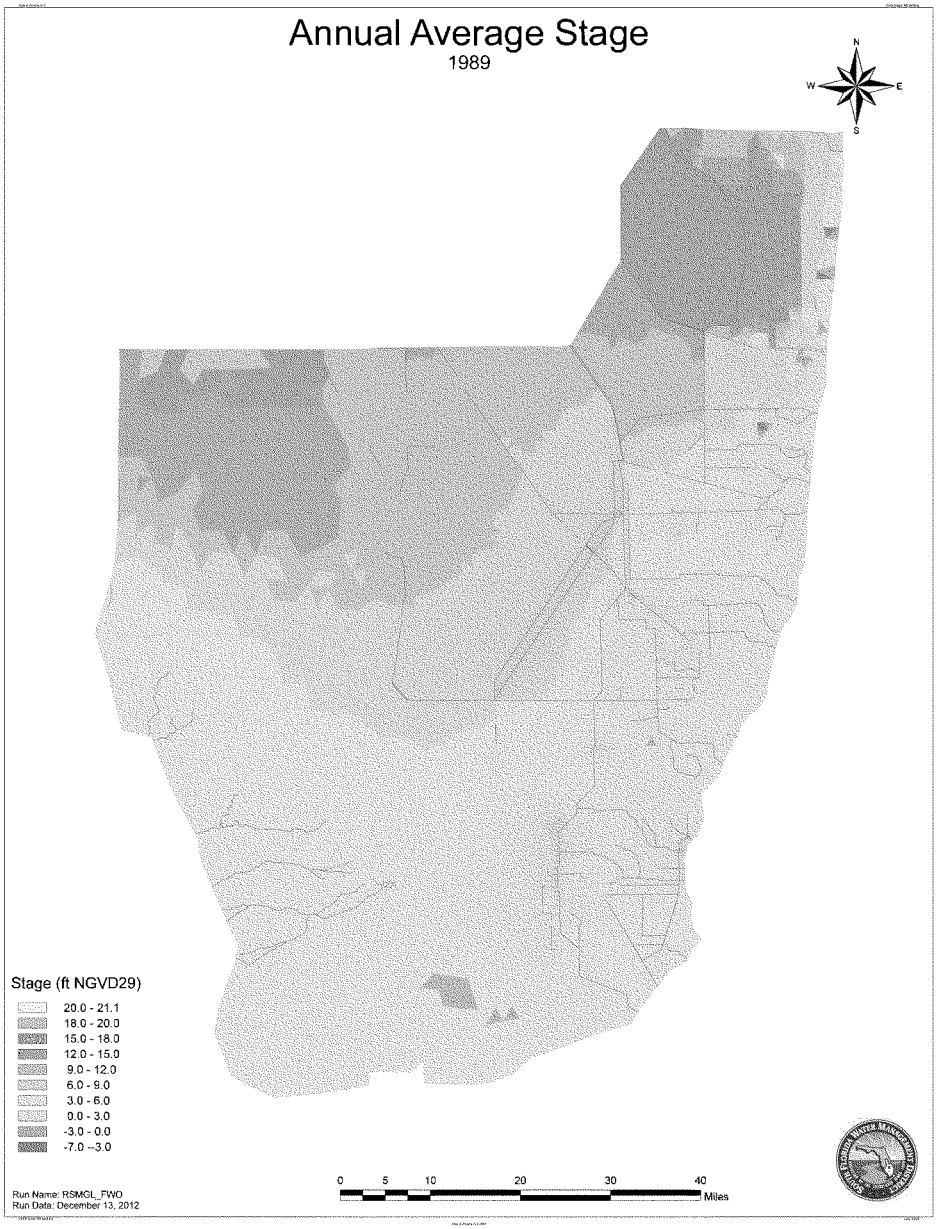

Annual Average Stage
1978
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: 2012EC
Run Date: February 27, 2013

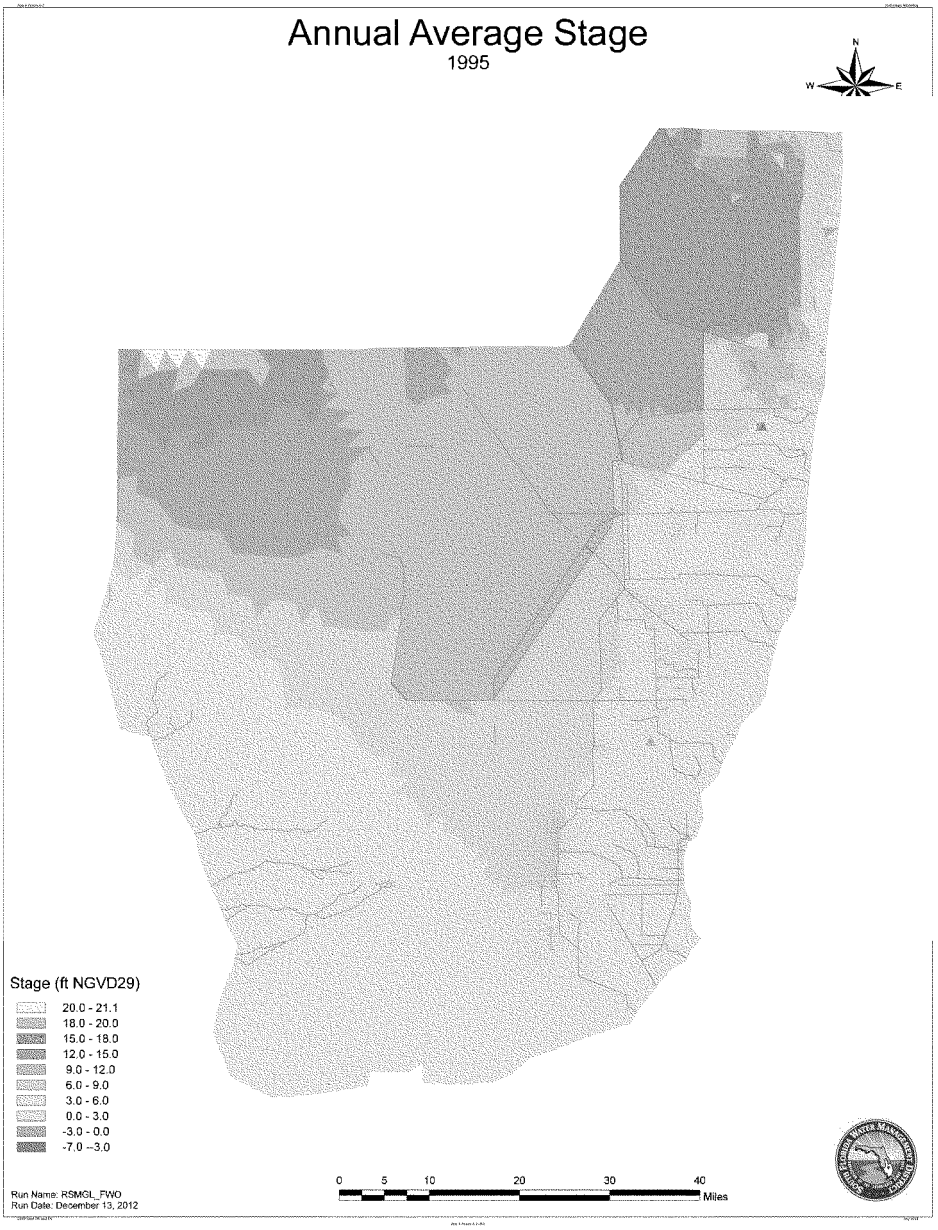

Annual Average Stage
1989
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: 2012EC
Run Date: February 27, 2013

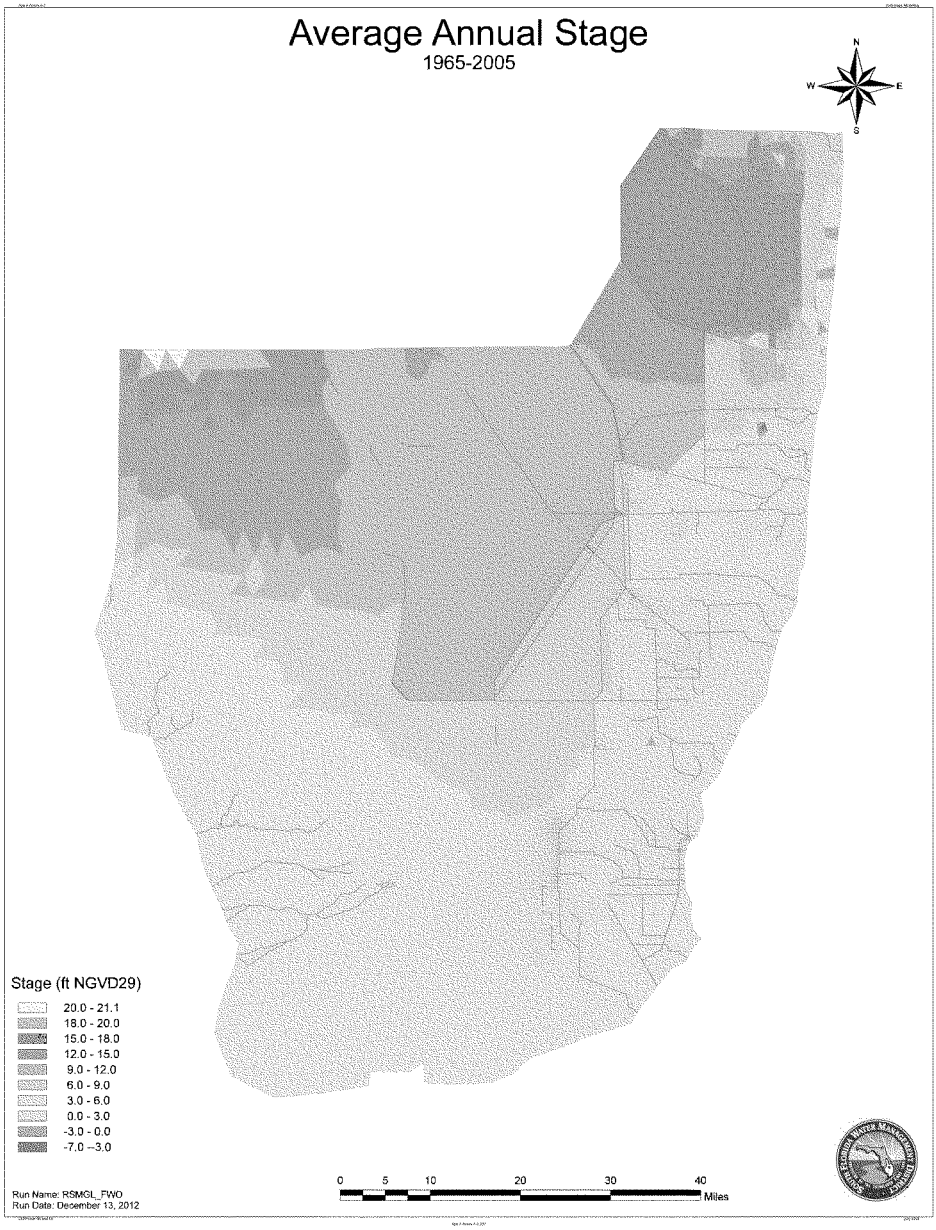

Annual Average Stage
1995
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: 2012EC
Run Date: February 27, 2013

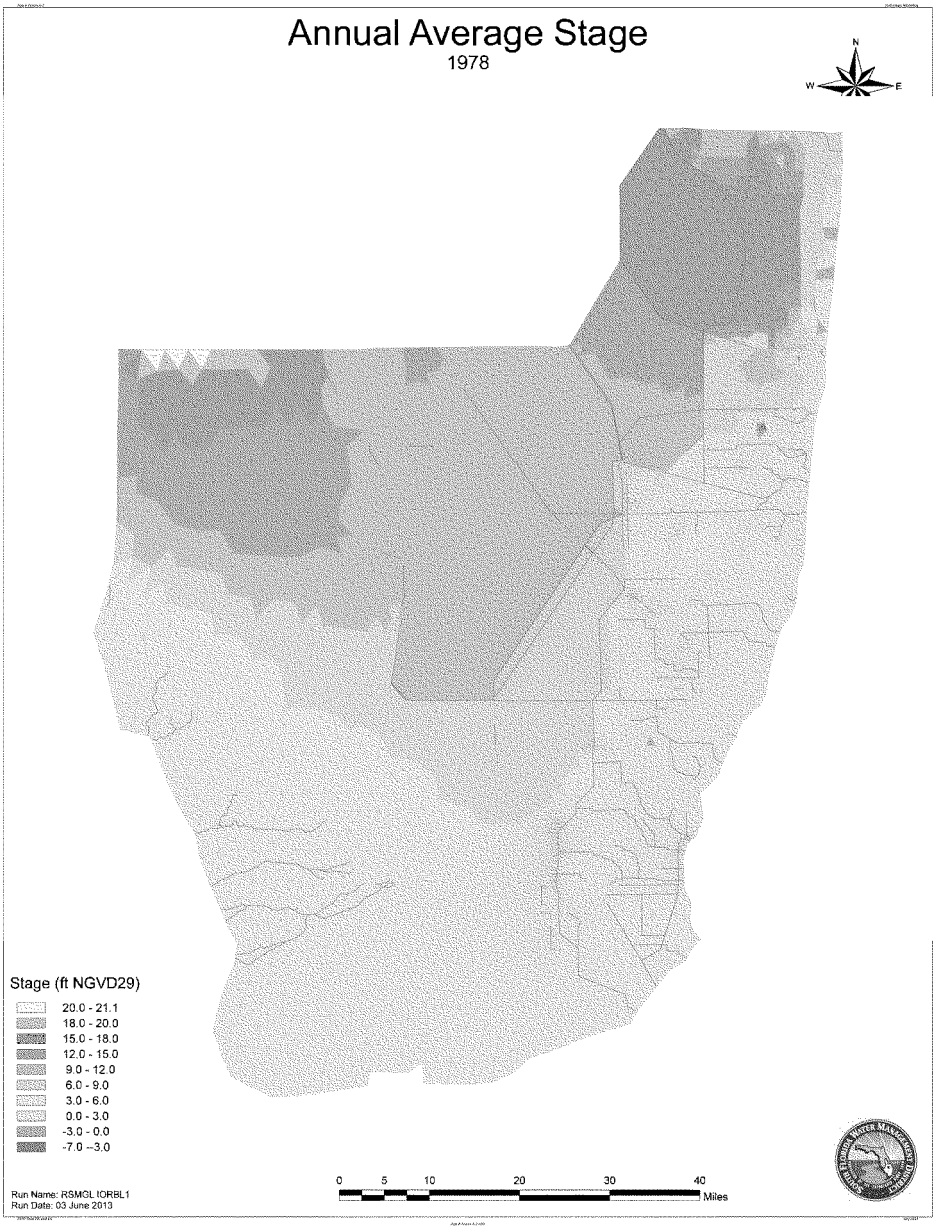

Average Annual Stage
1965-2005
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: 2012EC
Run Date: February 27, 2013
0 5 10 20 30 40
Miles

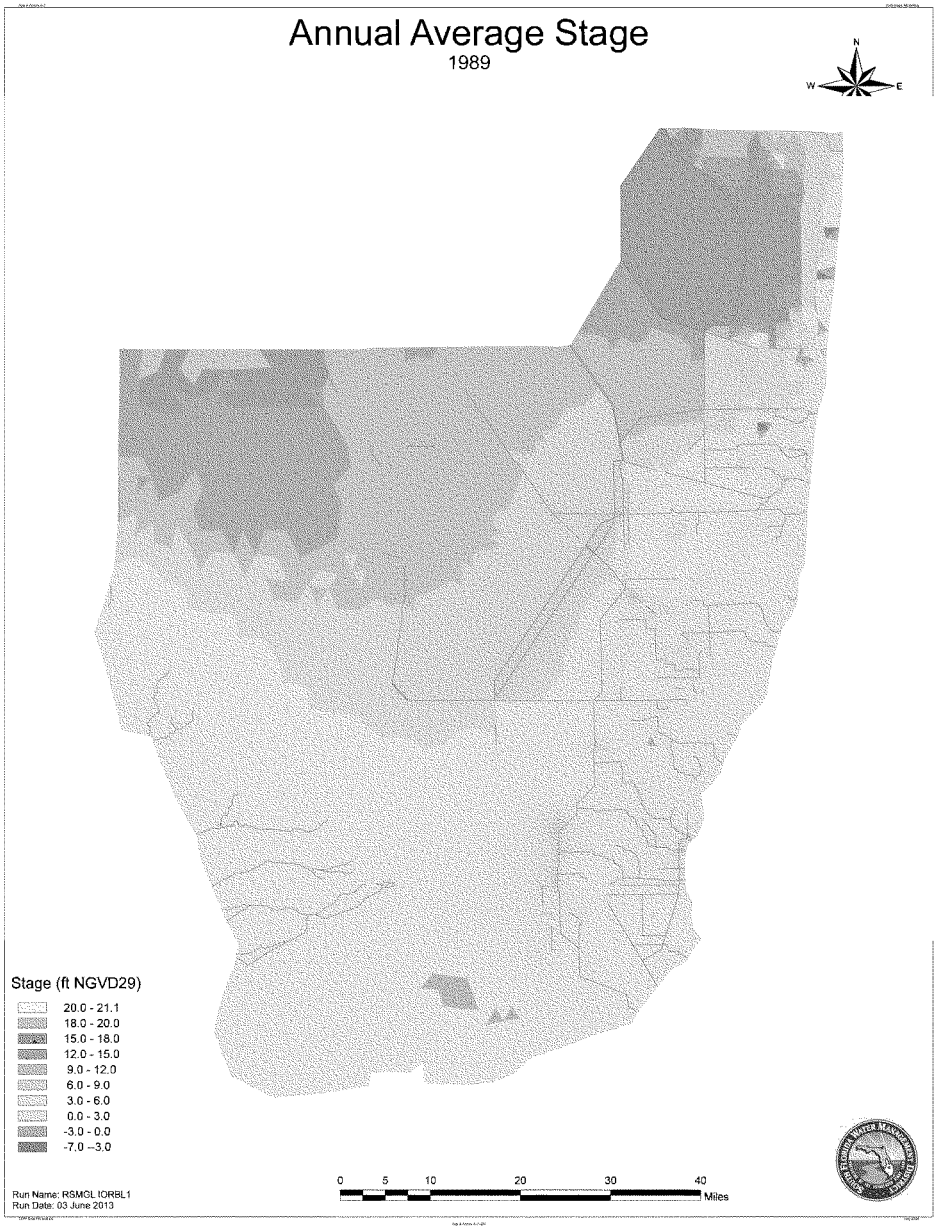

Annual Average Stage
1978
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

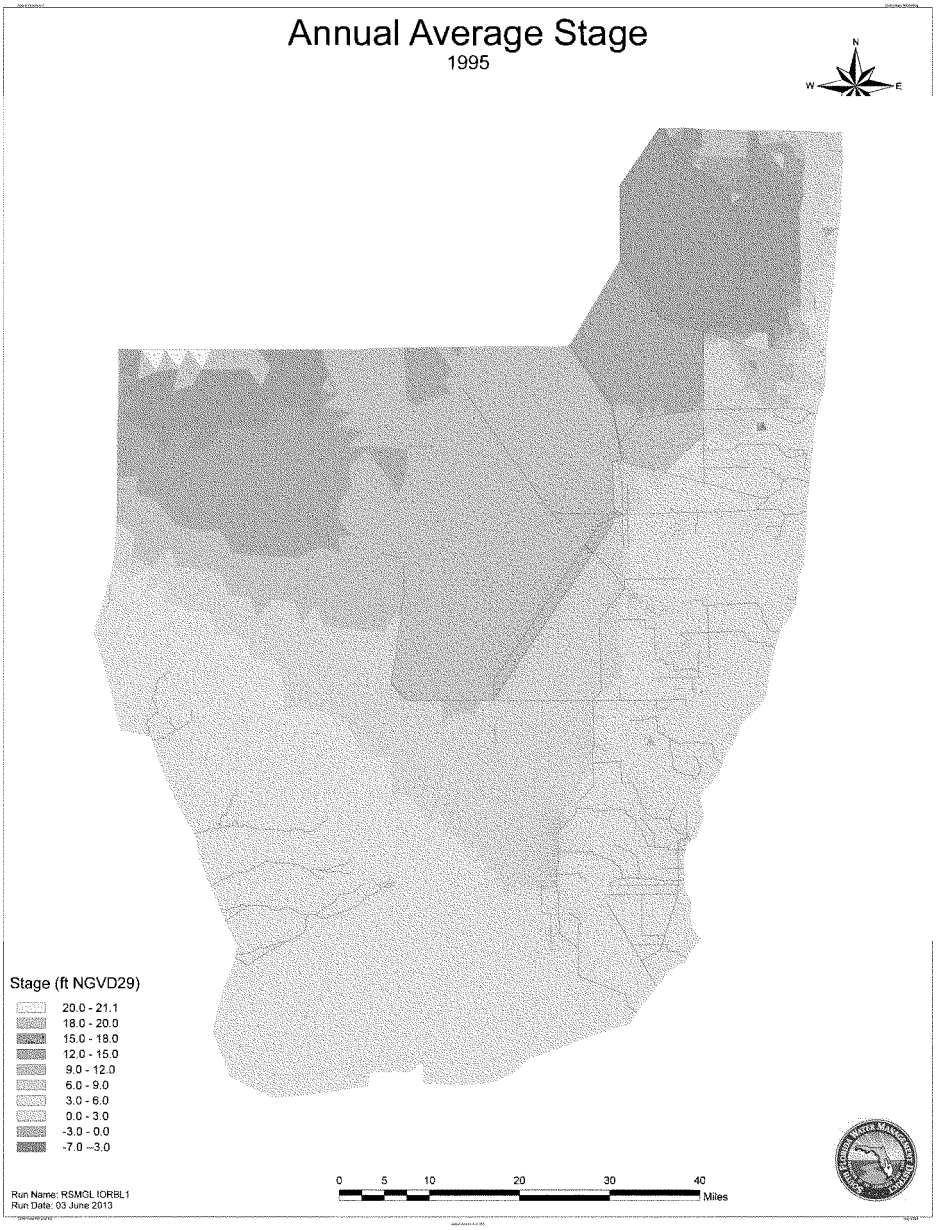

Annual Average Stage
1989
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

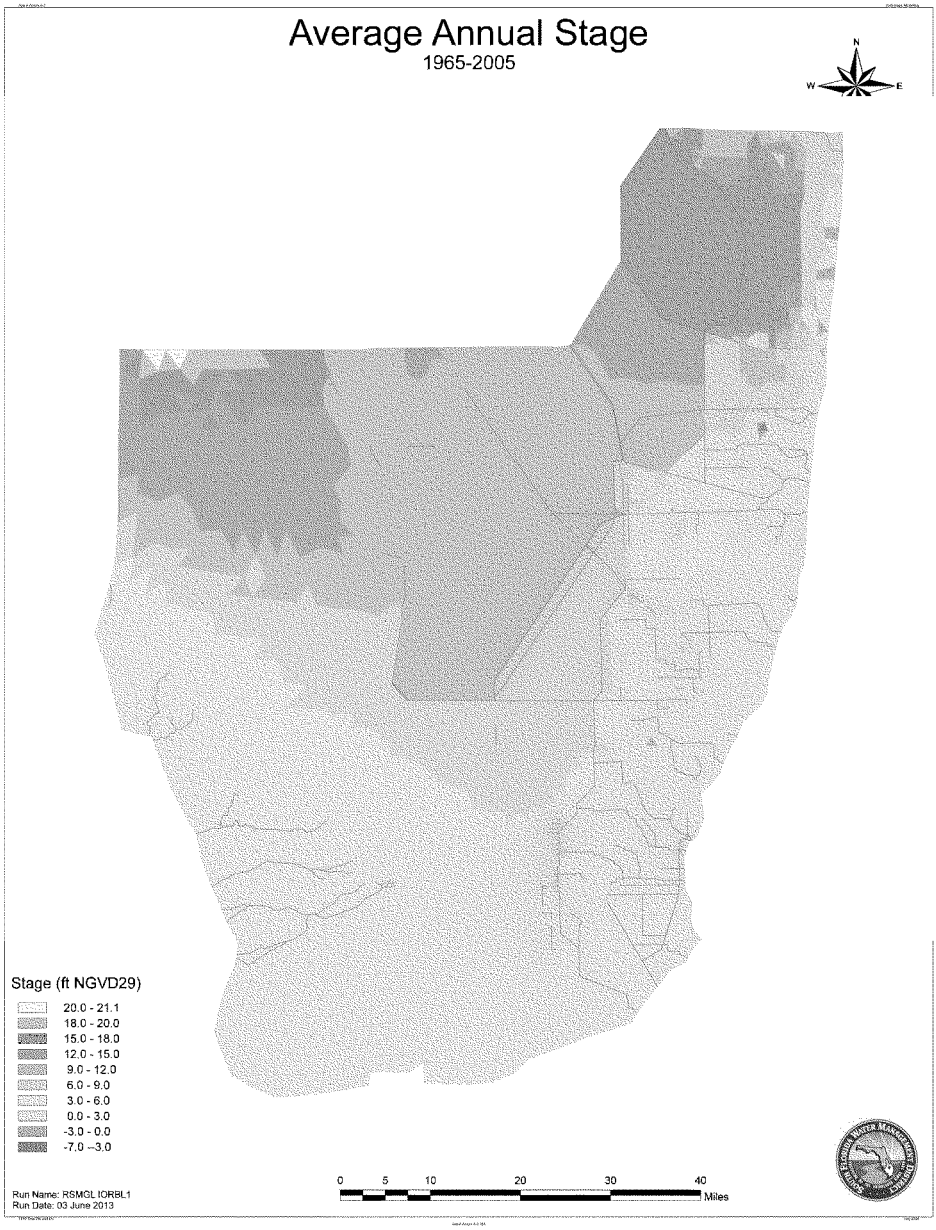

Annual Average Stage
1995
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

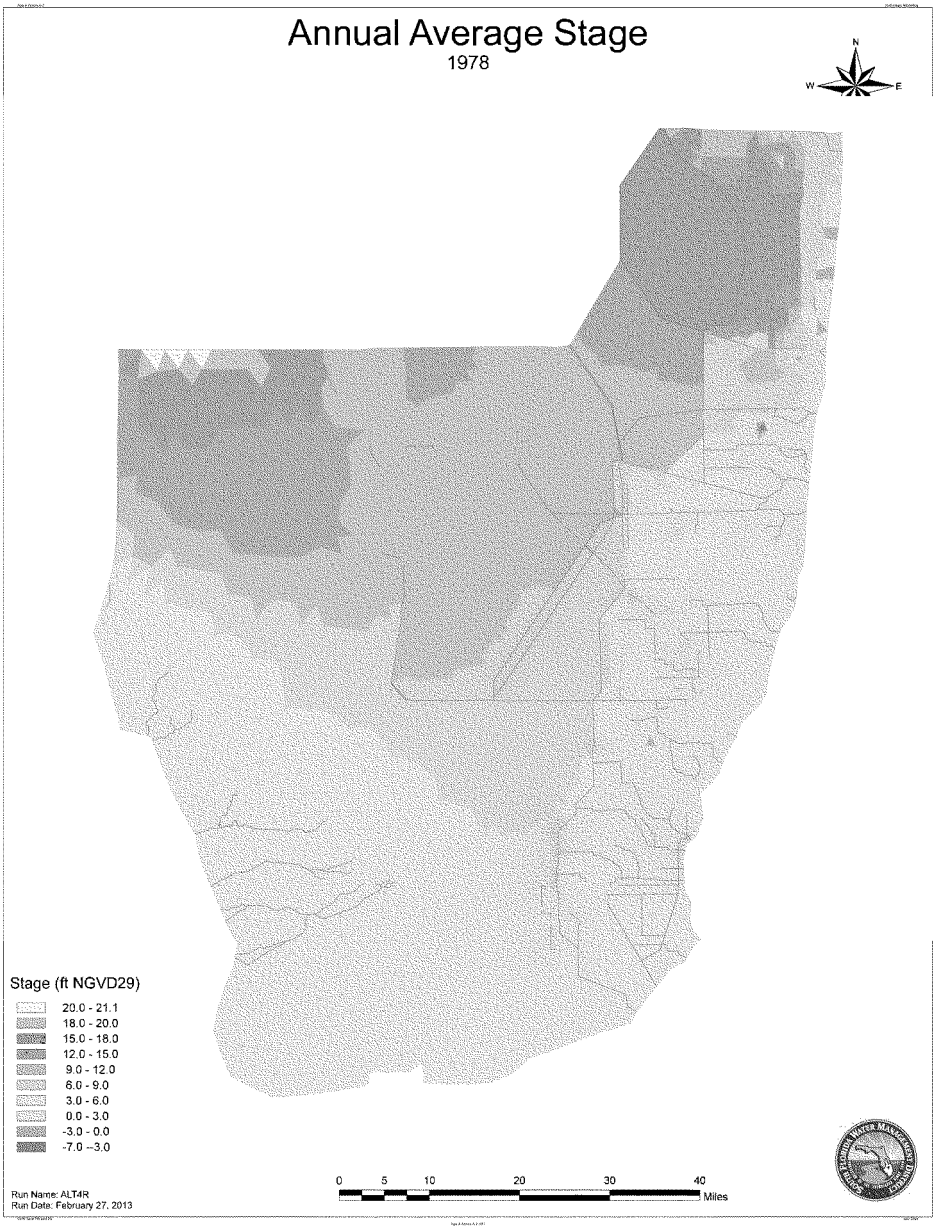

Average Annual Stage
1965-2005
N
W
E
S
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL_FWO
Run Date: December 13, 2012

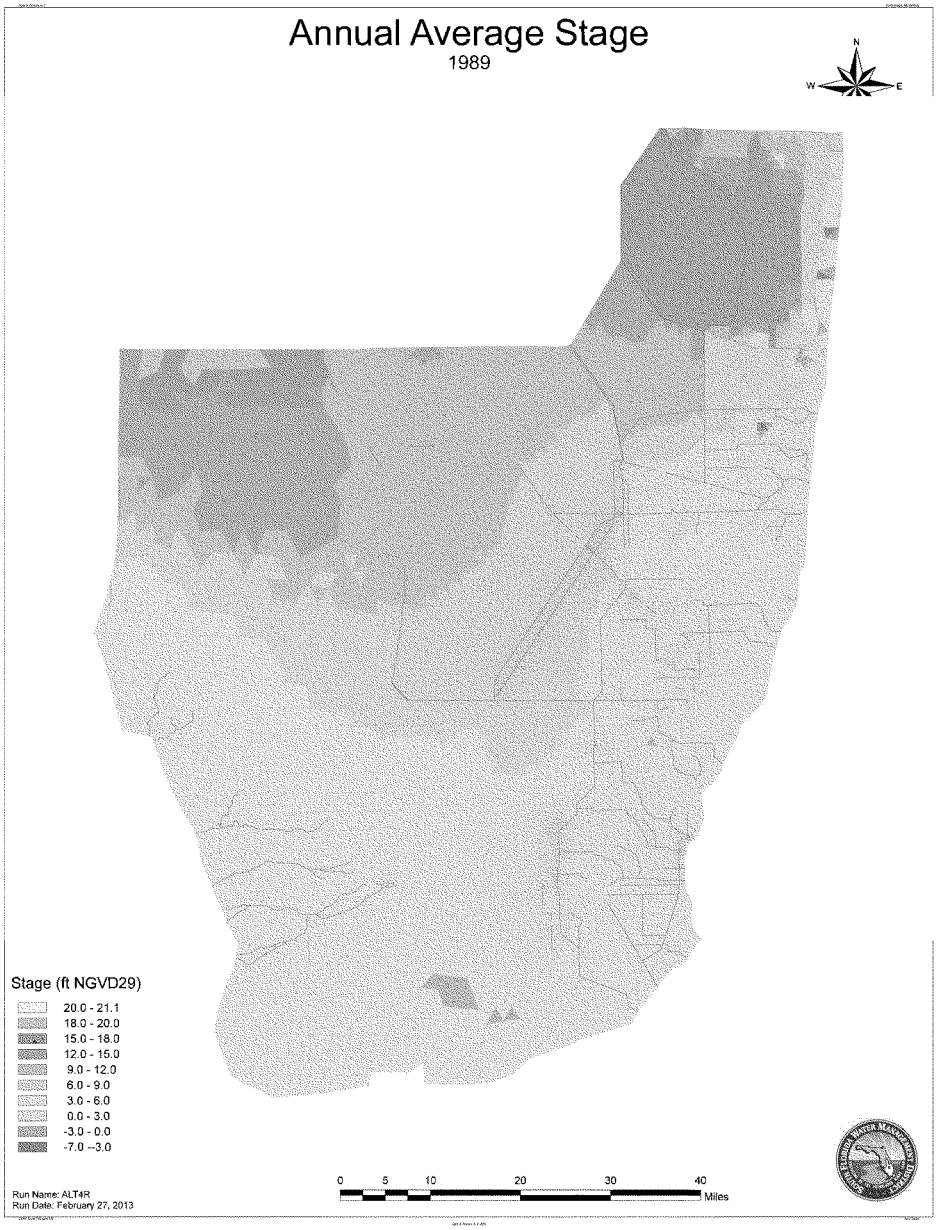

Annual Average Stage
1978
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL tORBL1
Run Date: 03 June 2013

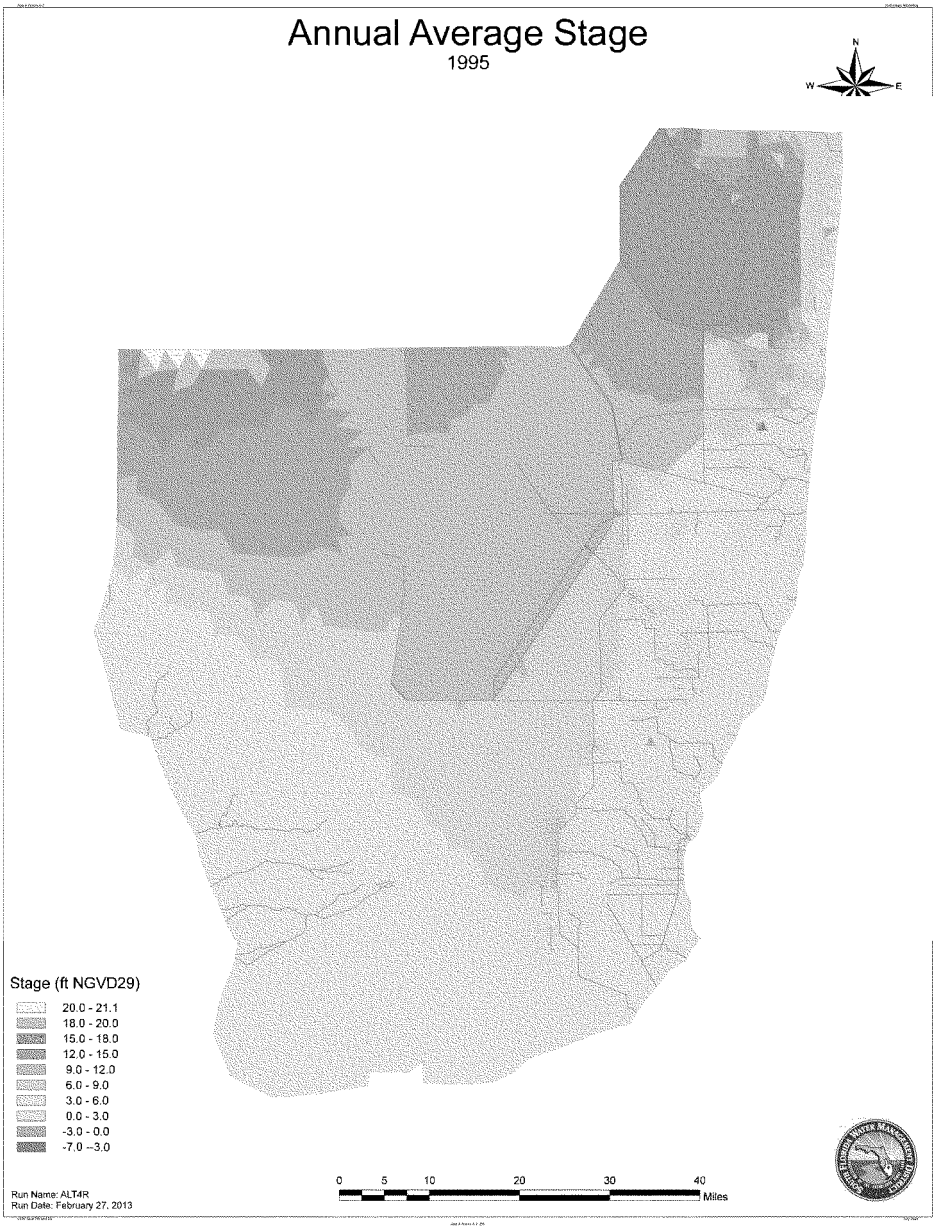

Annual Average Stage
1989
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGLTORBL1
Run Date: 03 June 2013
0 5 10 20 30 40
Miles

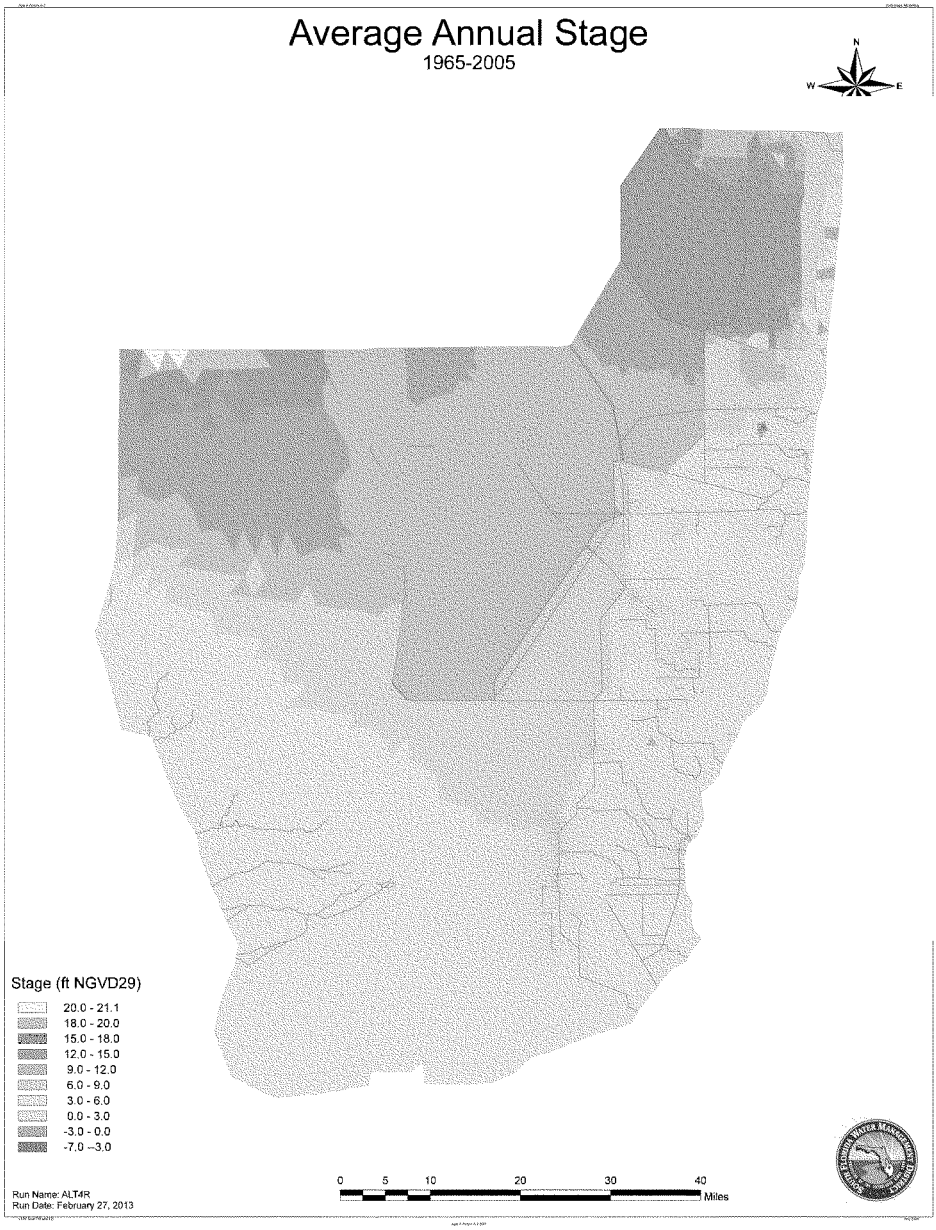

Annual Average Stage
1995
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGL tORBL1
Run Date: 03 June 2013

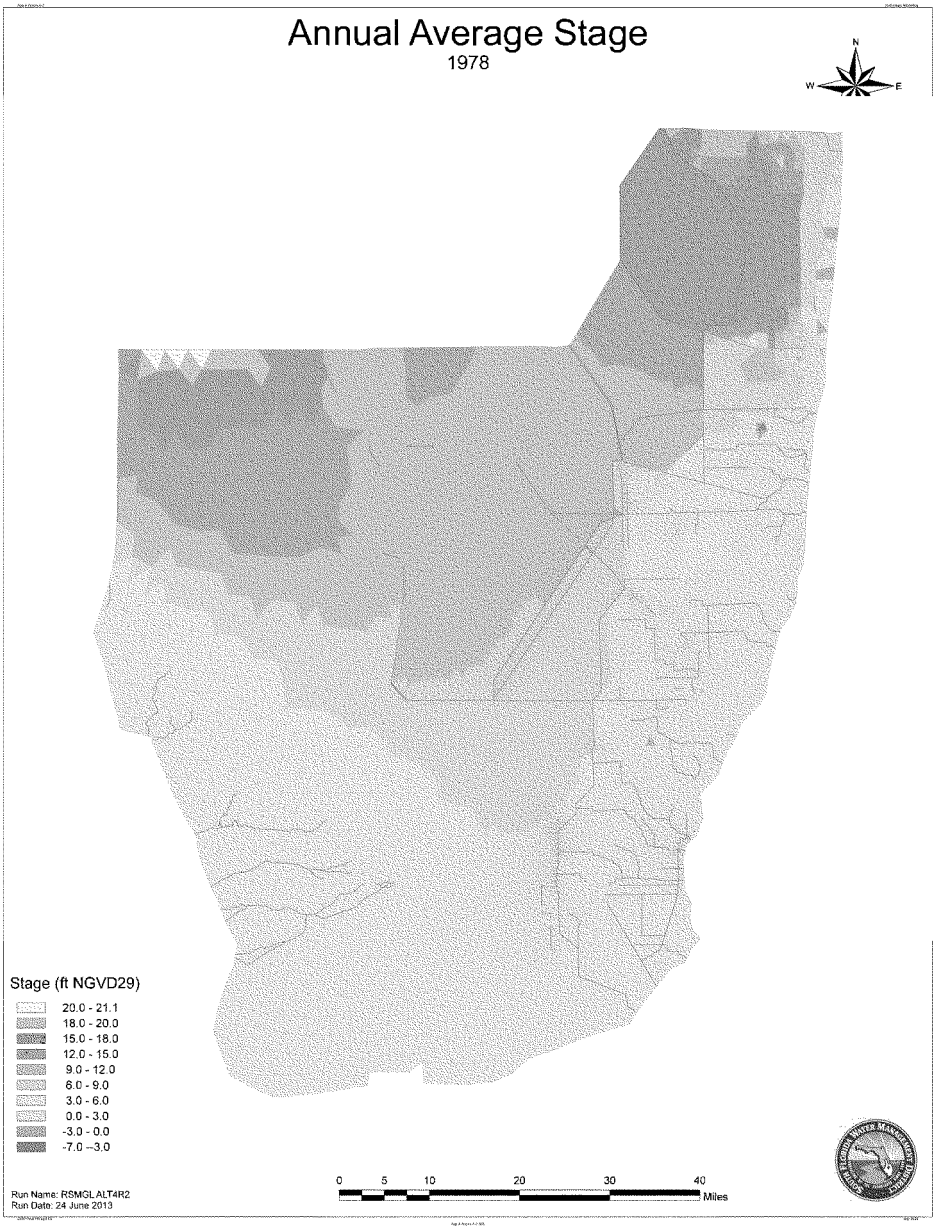

Average Annual Stage
1965-2005
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGLTORBL1
Run Date: 03 June 2013
0 5 10 20 30 40
Miles

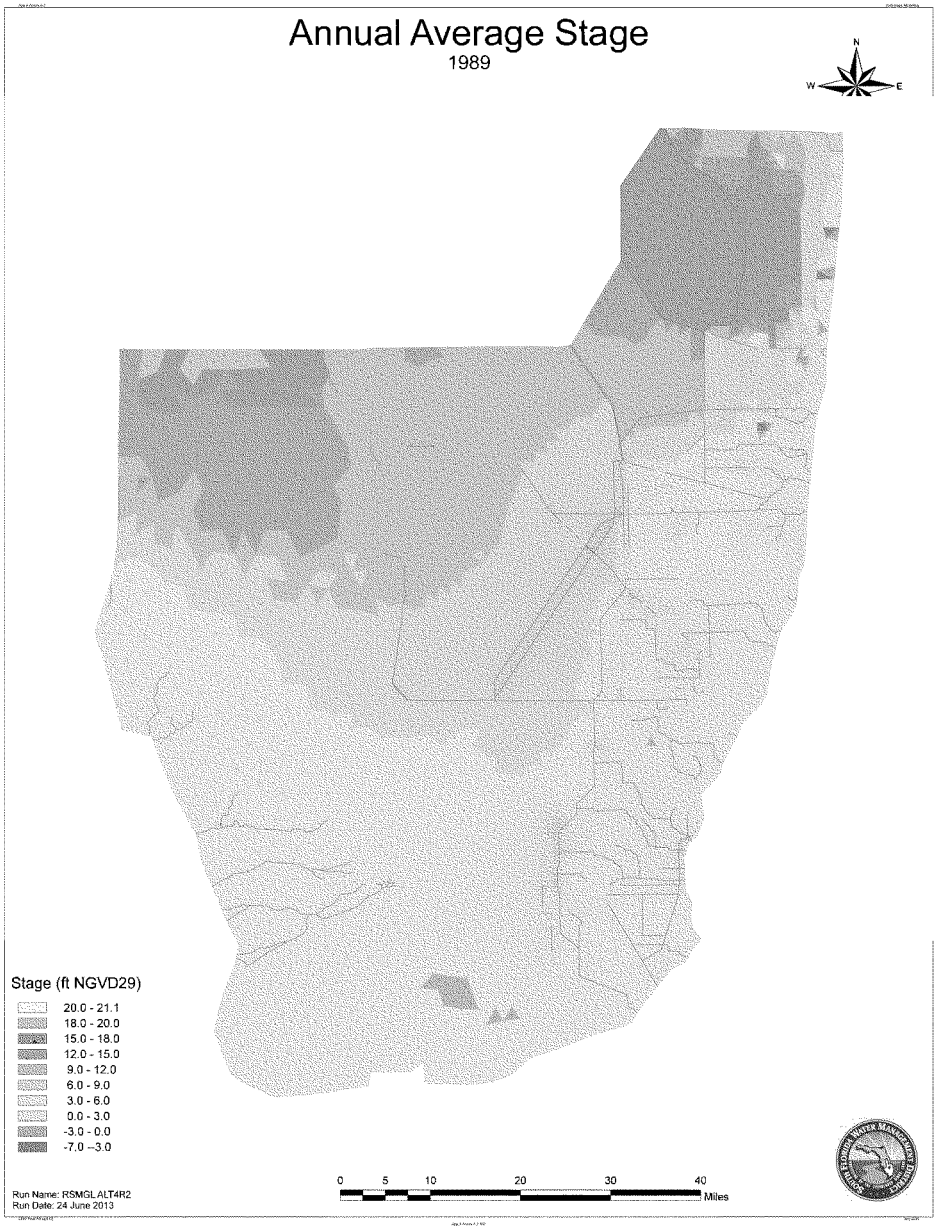

Annual Average Stage
1978
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: ALT4R
Run Date: February 27, 2013

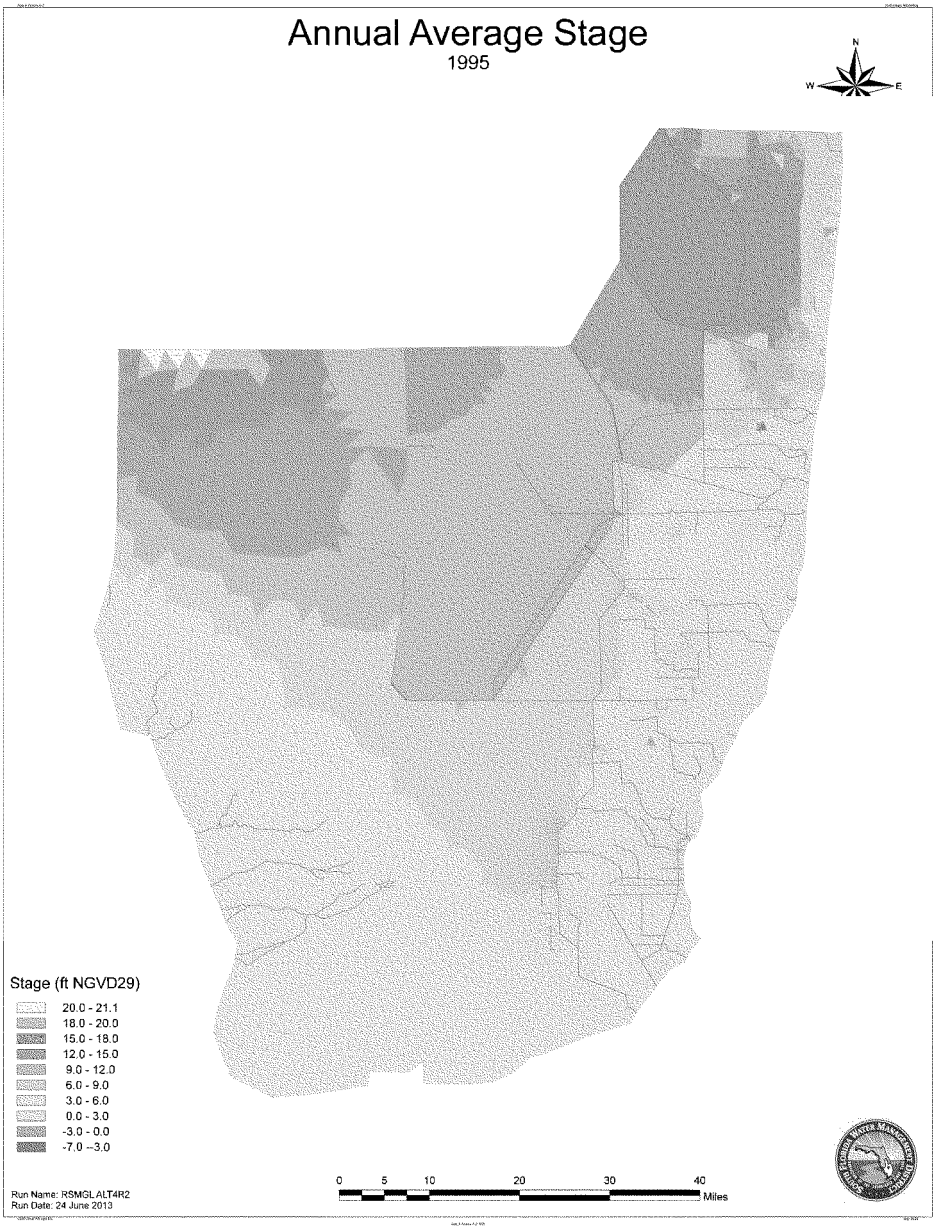

Annual Average Stage
1989
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: ALT4R
Run Date: February 27, 2013
0 5 10 20 30 40
Miles

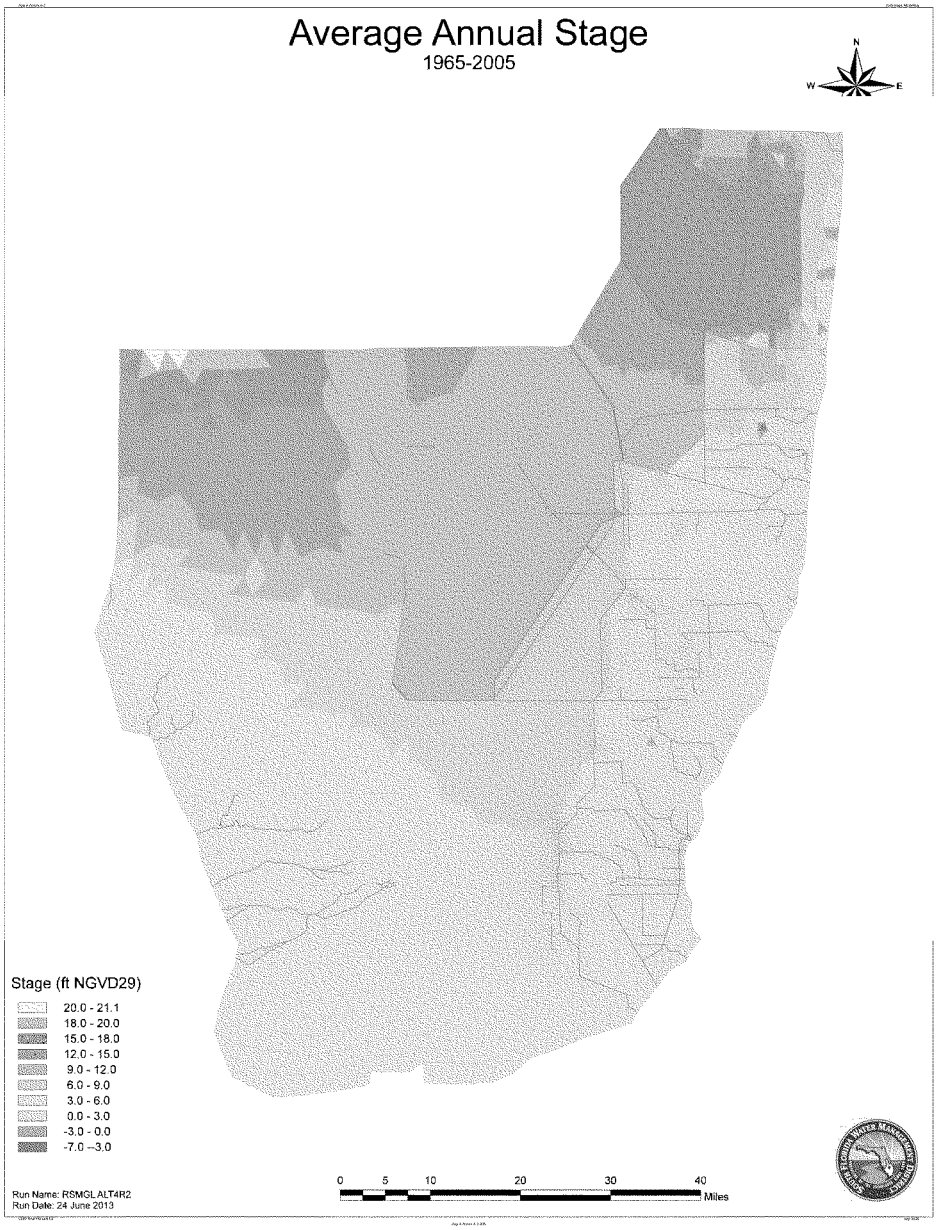

Annual Average Stage
1995
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: ALT4R
Run Date: February 27, 2013


Average Annual Stage
1965-2005
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: ALT4R
Run Date: February 27, 2013
0 5 10 20 30 40
Miles


Annual Average Stage
1978
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGLALT4R2
Run Date: 24 June 2013
0
5
10
20
30
40
Miles

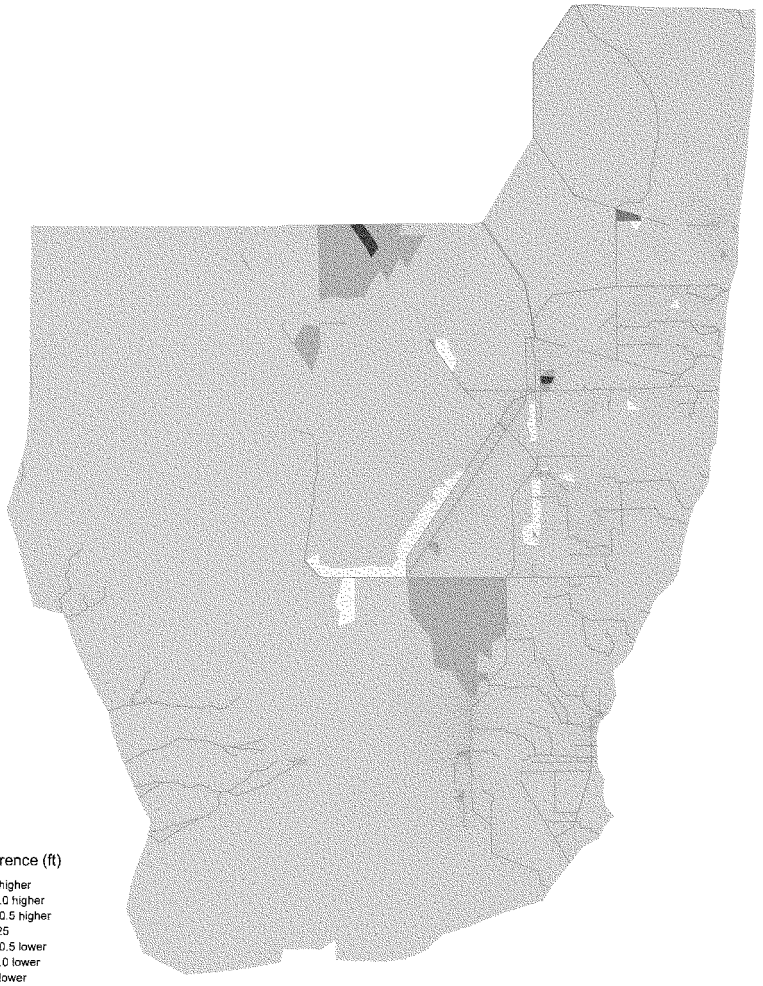

Annual Average Stage
1989
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGLALT4R2
Run Date: 24 June 2013
0 5 10 20 30 40
Miles


Annual Average Stage
1995
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
0 5 10 20 30 40
Miles
Run Name: RSMGLALT4R2
Run Date: 24 June 2013


Average Annual Stage
1965-2005
N
W
E
Stage (ft NGVD29)
20.0 - 21.1
18.0 - 20.0
15.0 - 18.0
12.0 - 15.0
9.0 - 12.0
6.0 - 9.0
3.0 - 6.0
0.0 - 3.0
-3.0 - 0.0
-7.0 --3.0
Run Name: RSMGLALT4R2
Run Date: 24 June 2013
0 5 10 20 30 40
Miles

Average Annual Stage Difference

1965-2005



Stage Difference (ft)

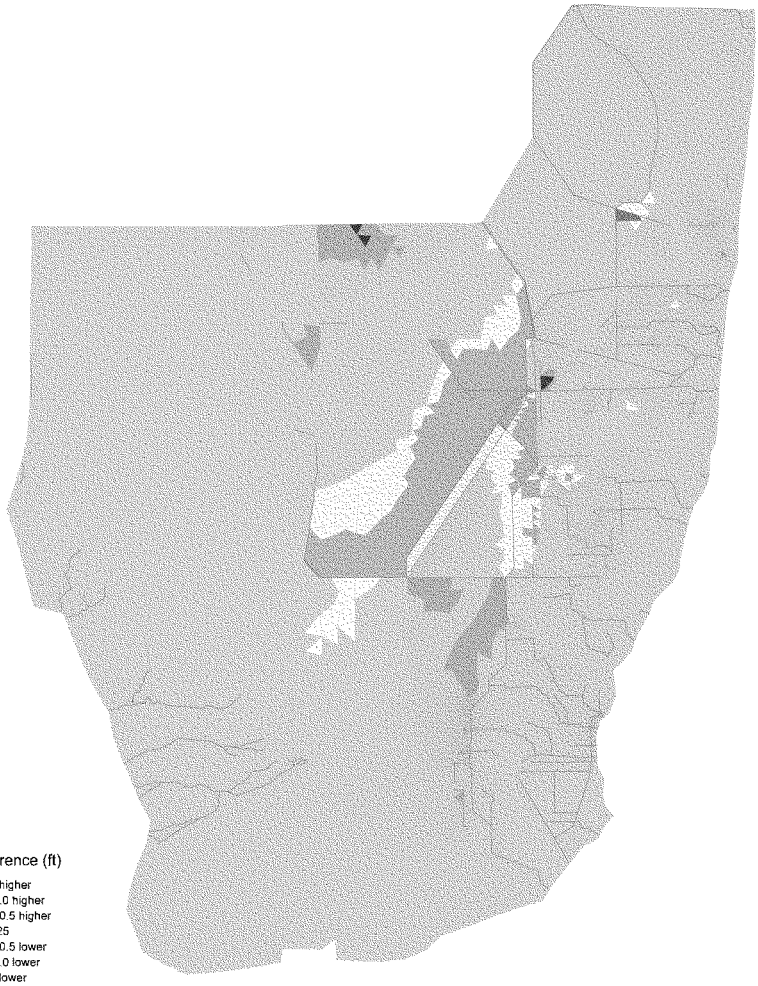
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - ECB
24 June 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

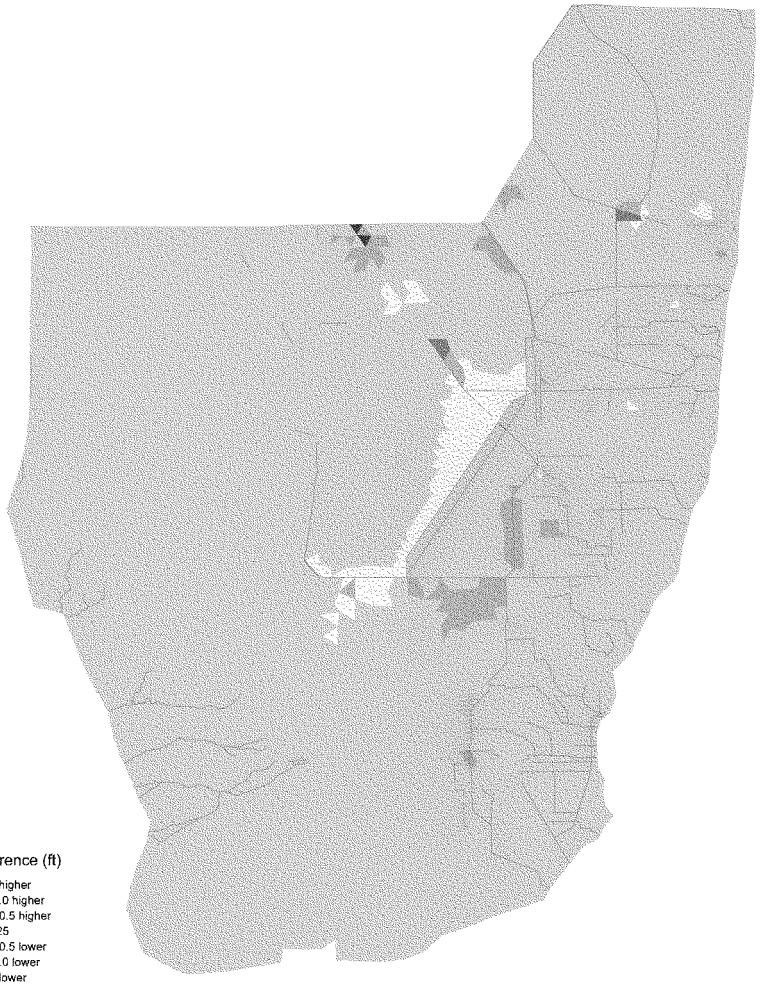
1978



DRAFT
ALT4R2 - ECB
24 June, 2013

Annual Average Stage Difference

1989



Stage Difference (ft)

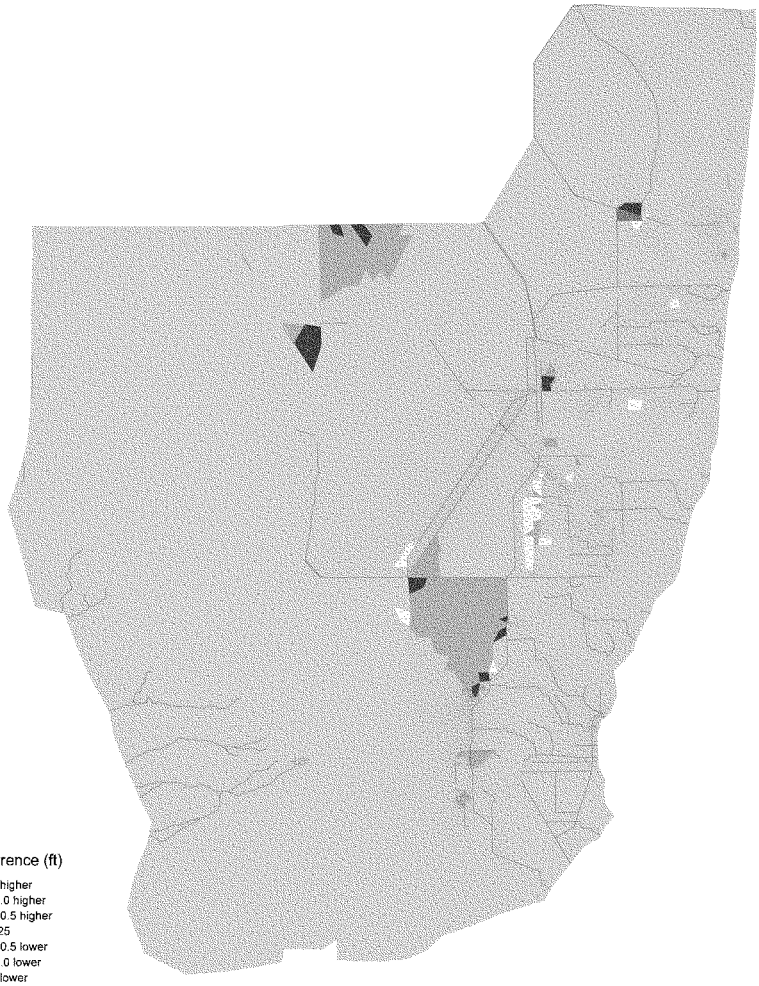
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - ECB
24 June, 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1995

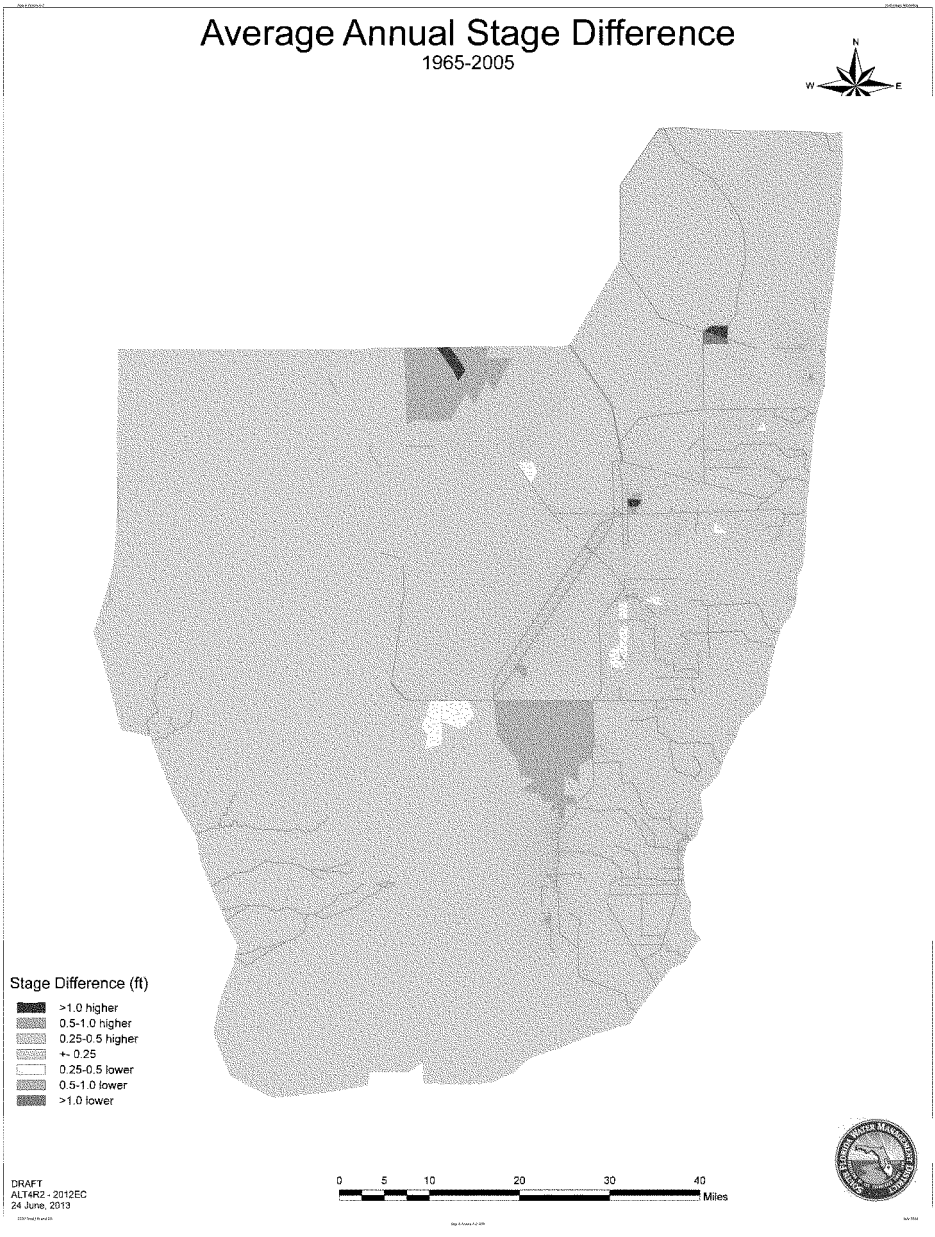


Stage Difference (ft)

- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

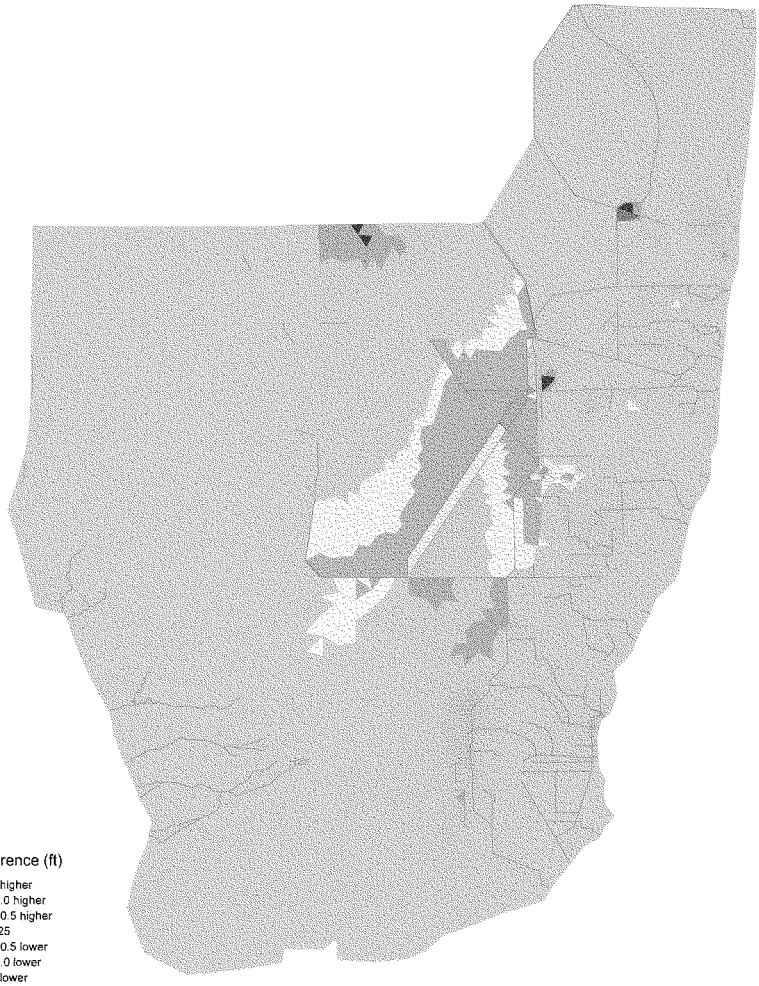
DRAFT
ALT4R2 - ECB
24 June, 2013

0 5 10 20 30 40 Miles


Average Annual Stage Difference
1965-2005
N
W
E
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - 2012EC
24 June, 2013
0 5 10 20 30 40
Miles

Annual Average Stage Difference

1978



Stage Difference (ft)

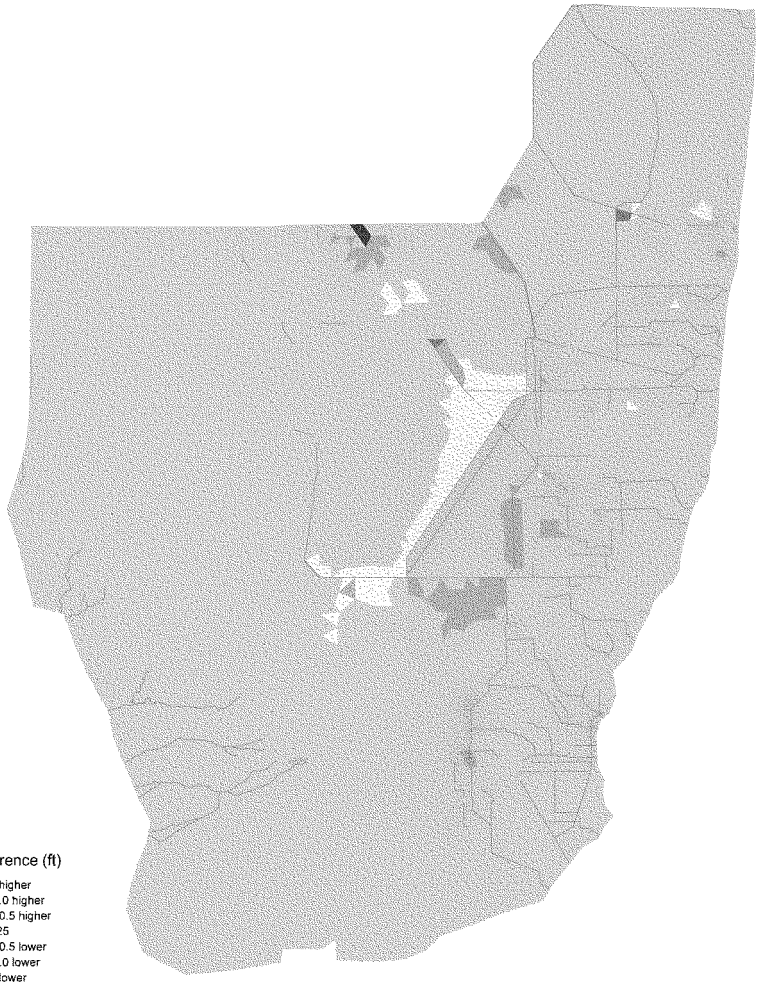
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - 2012EC
24 June, 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1989

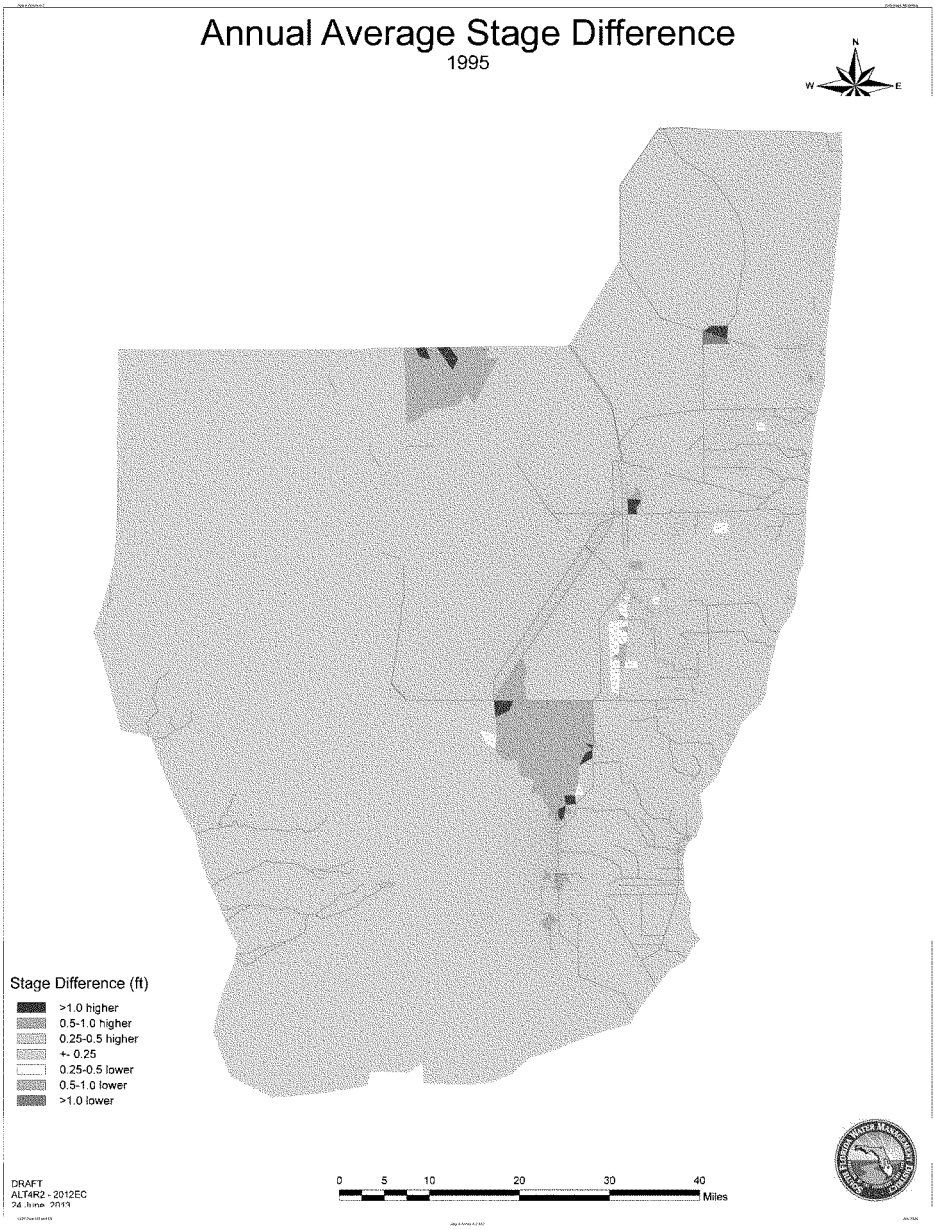


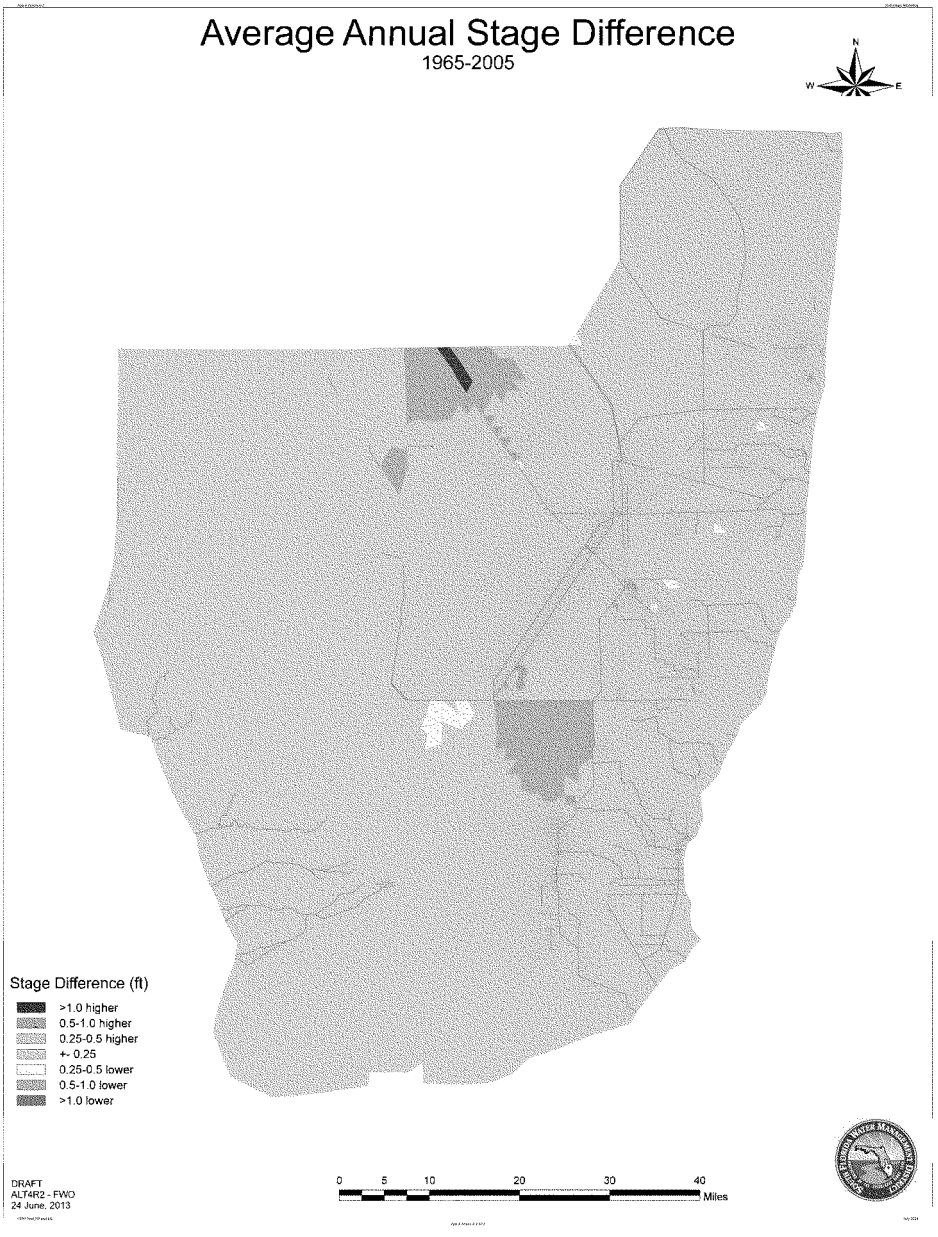
Stage Difference (ft)

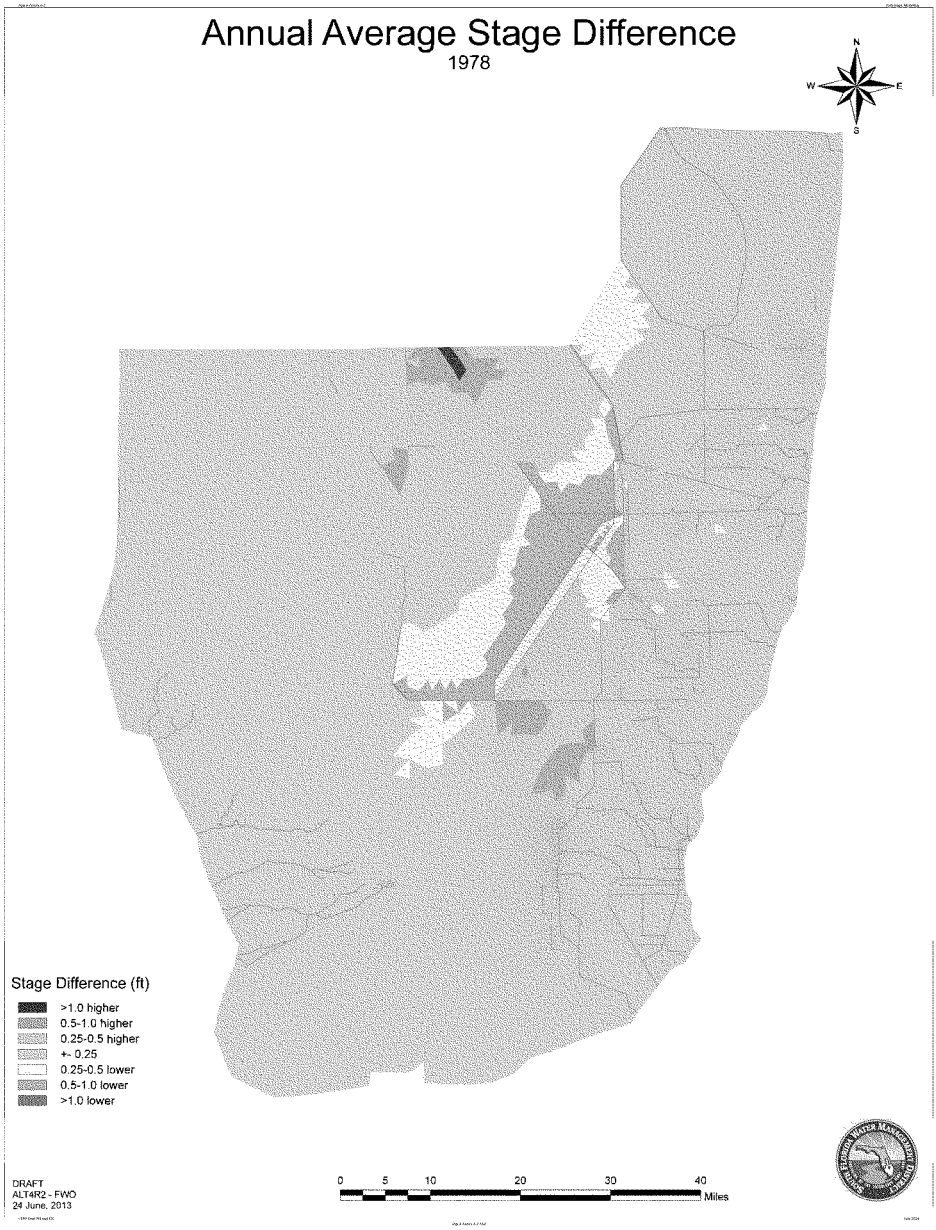
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

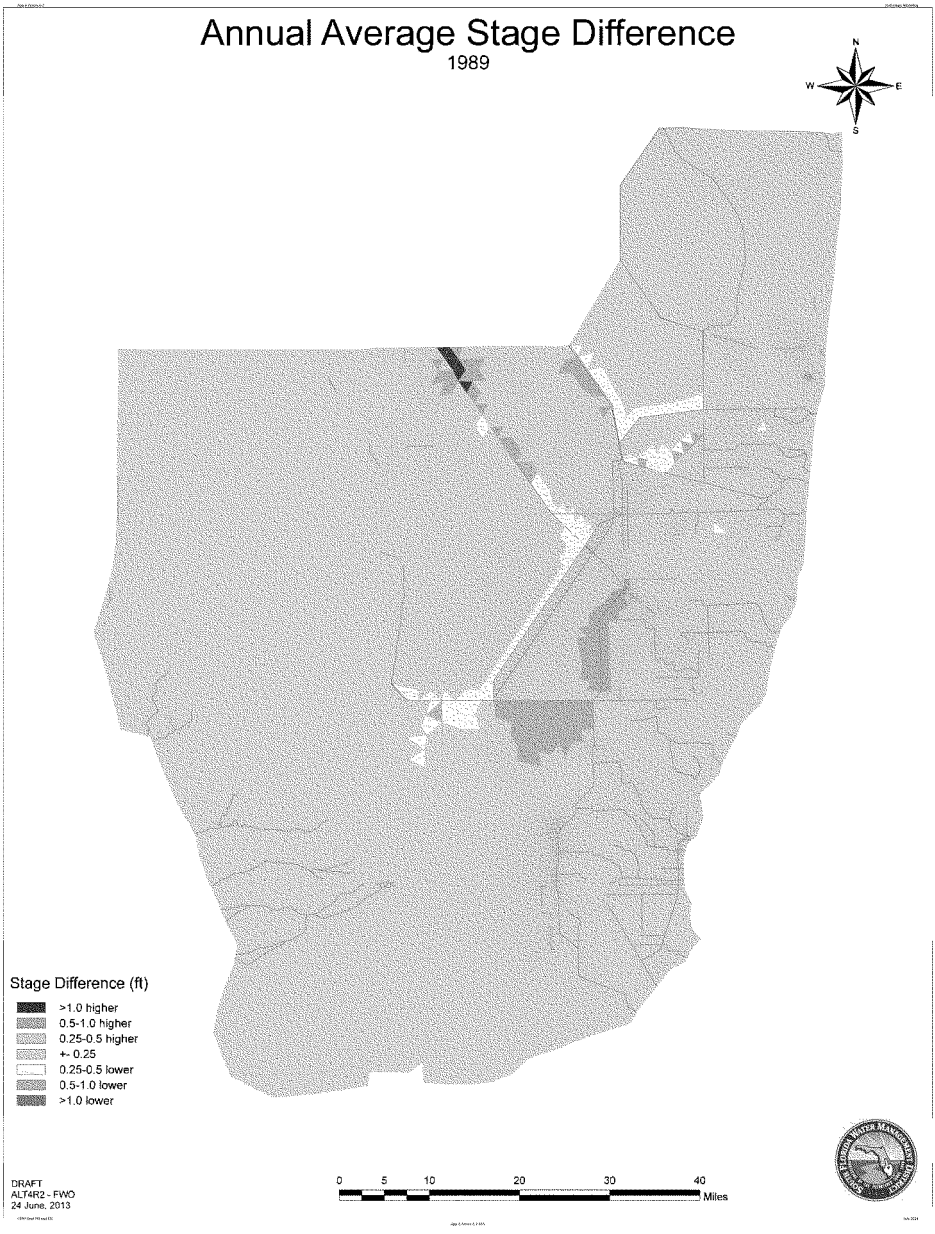
DRAFT
ALT4R2 - 2012EC
24 June 2013

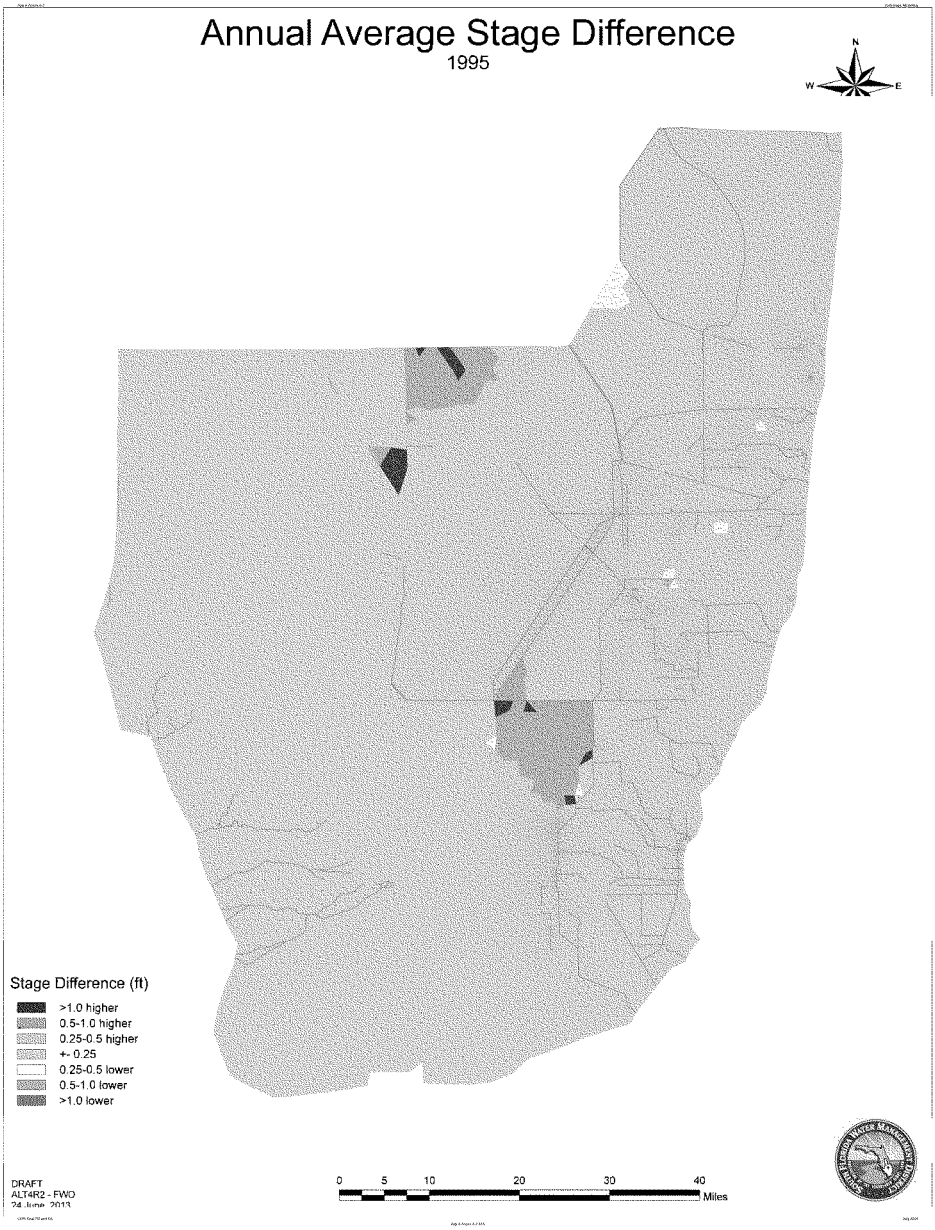
0 5 10 20 30 40 Miles


Annual Average Stage Difference
1995
N
W
E
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - 2012EC
24 June 2013
0 5 10 20 30 40
Miles


Average Annual Stage Difference
1965-2005
N
W
E
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - FWO
24 June, 2013
0
5
10
20
30
40
Miles

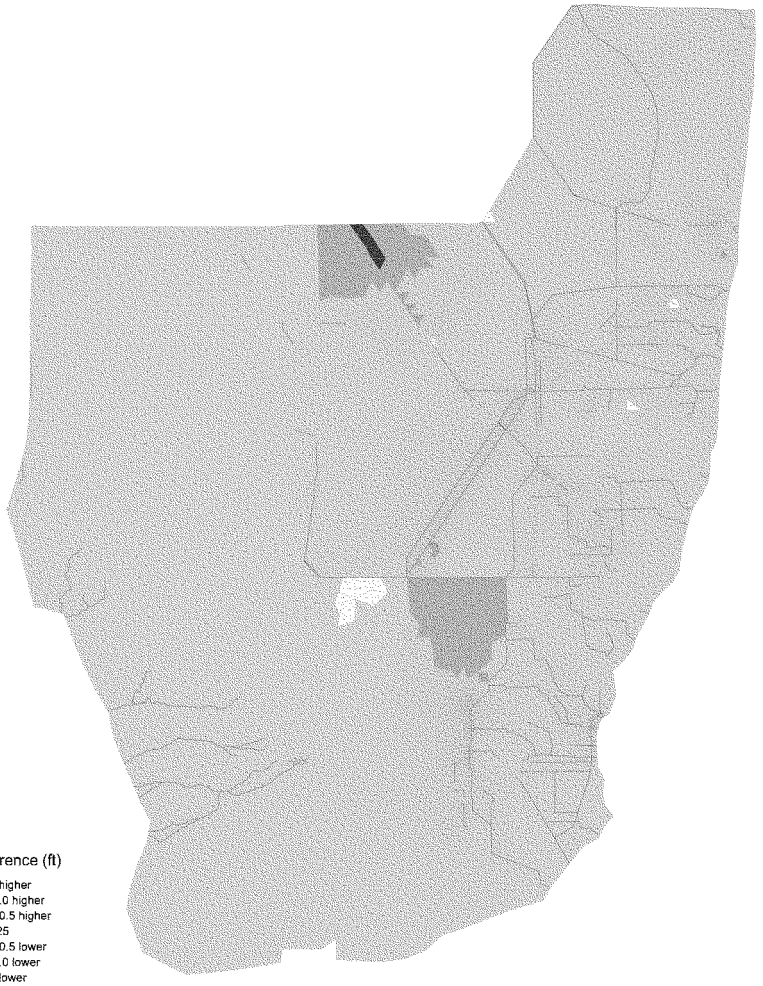

Annual Average Stage Difference
1978
N
W
E
S
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - FWO
24 June, 2013
0 5 10 20 30 40
Miles


Annual Average Stage Difference
1989
N
W
E
S
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - FWO
24 June, 2013
0 5 10 20 30 40
Miles


Annual Average Stage Difference
1995
N
W
E
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - FWO
0 5 10 20 30 40
Miles

Average Annual Stage Difference

1965-2005



Stage Difference (ft)

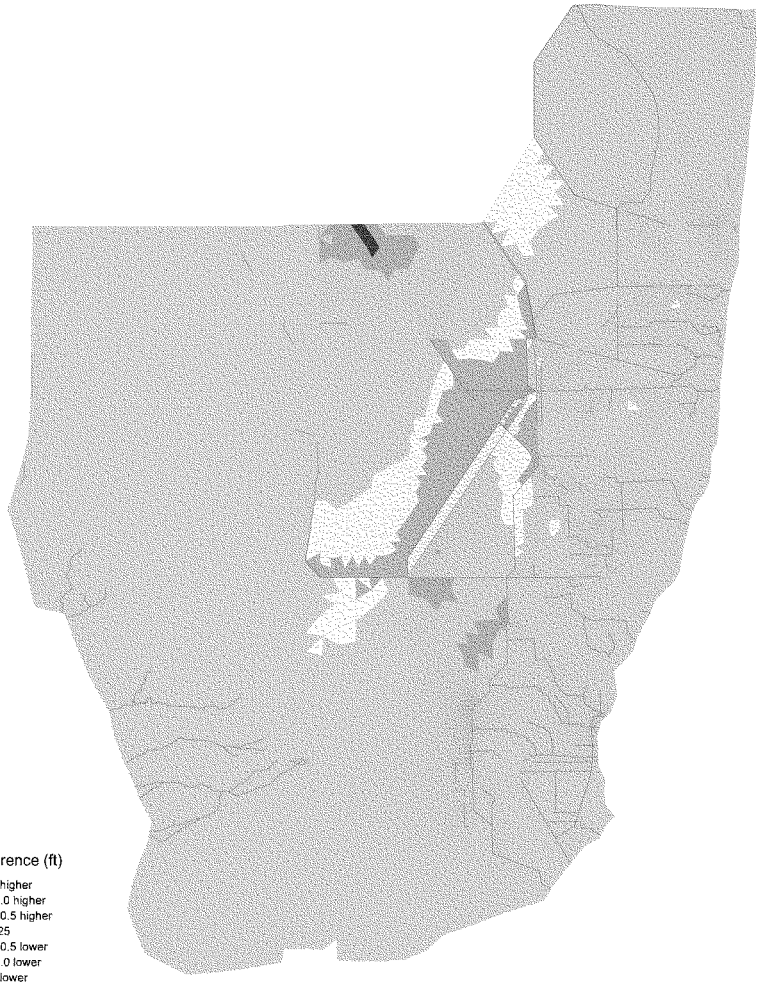
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - IORBL1
24 June, 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1978



Stage Difference (ft)

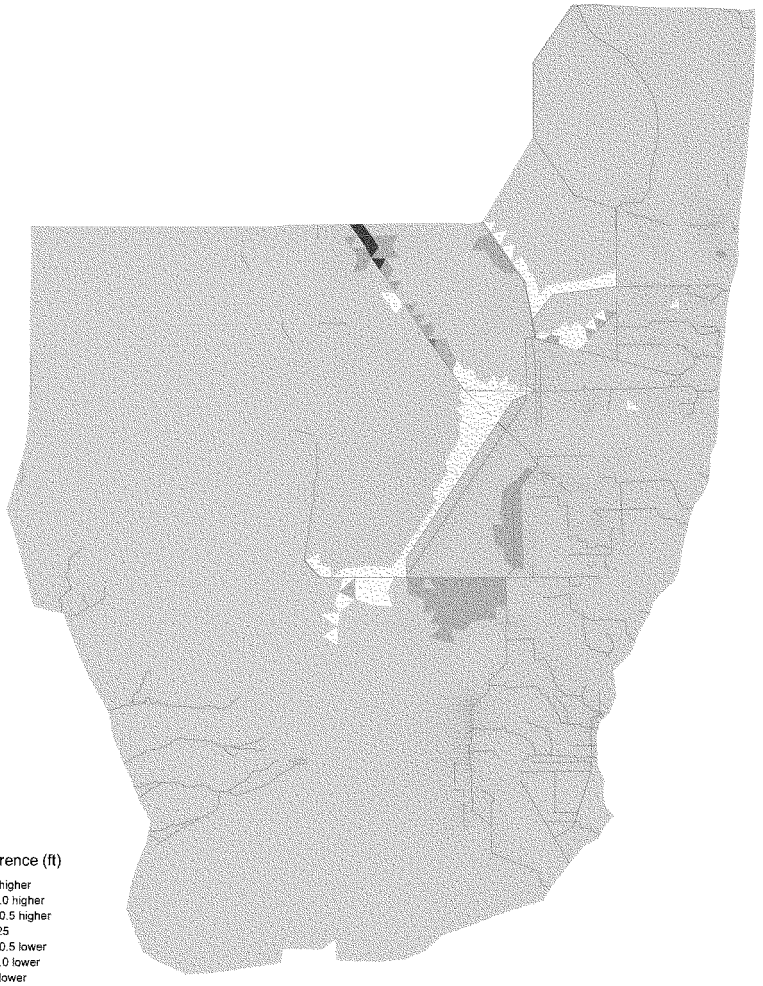
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - IORBL1
2d June 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1989



Stage Difference (ft)

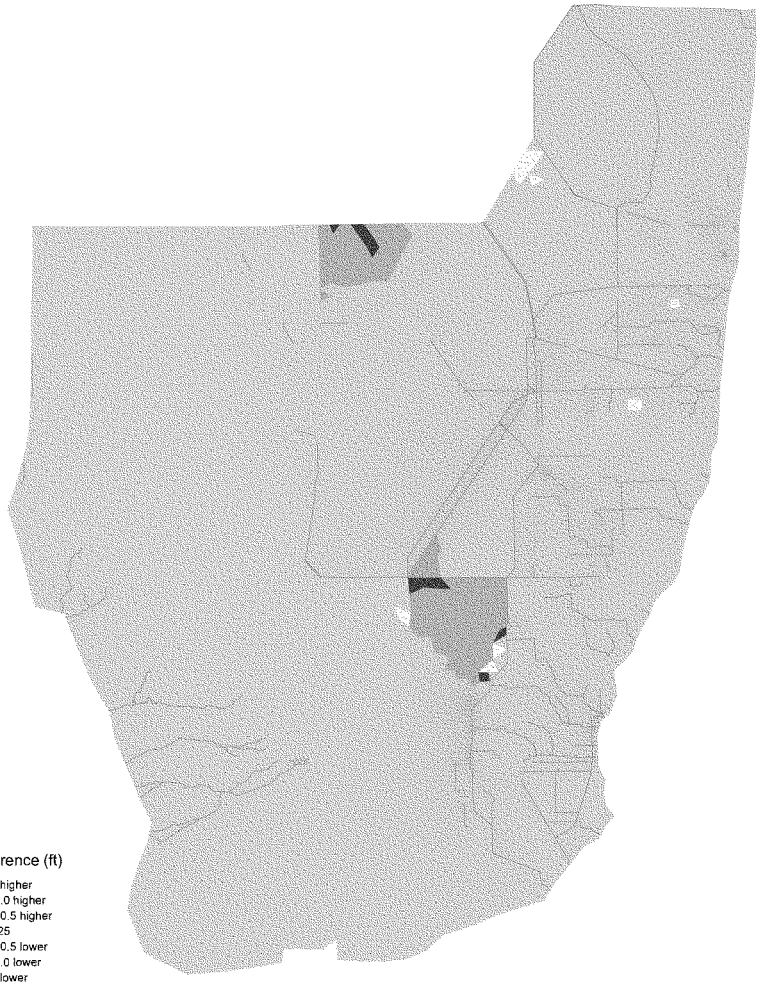
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - IORBL1
2d June 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1995



Stage Difference (ft)

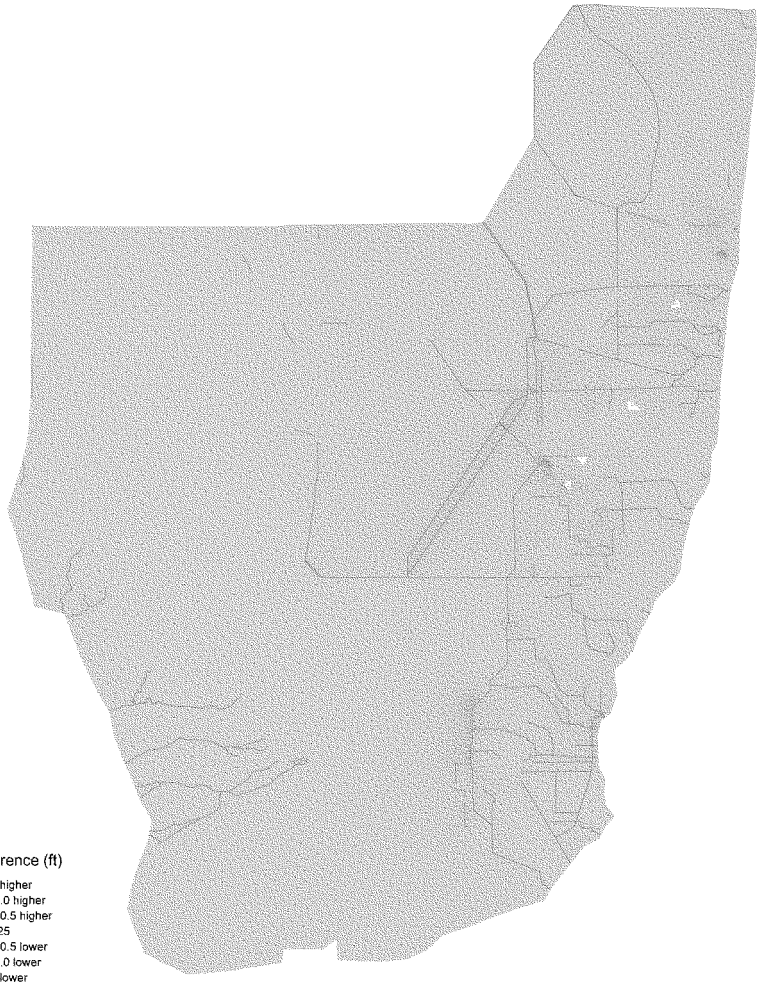
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - IORBL1
24 June 2013

0 5 10 20 30 40 Miles

Average Annual Stage Difference

1965-2005

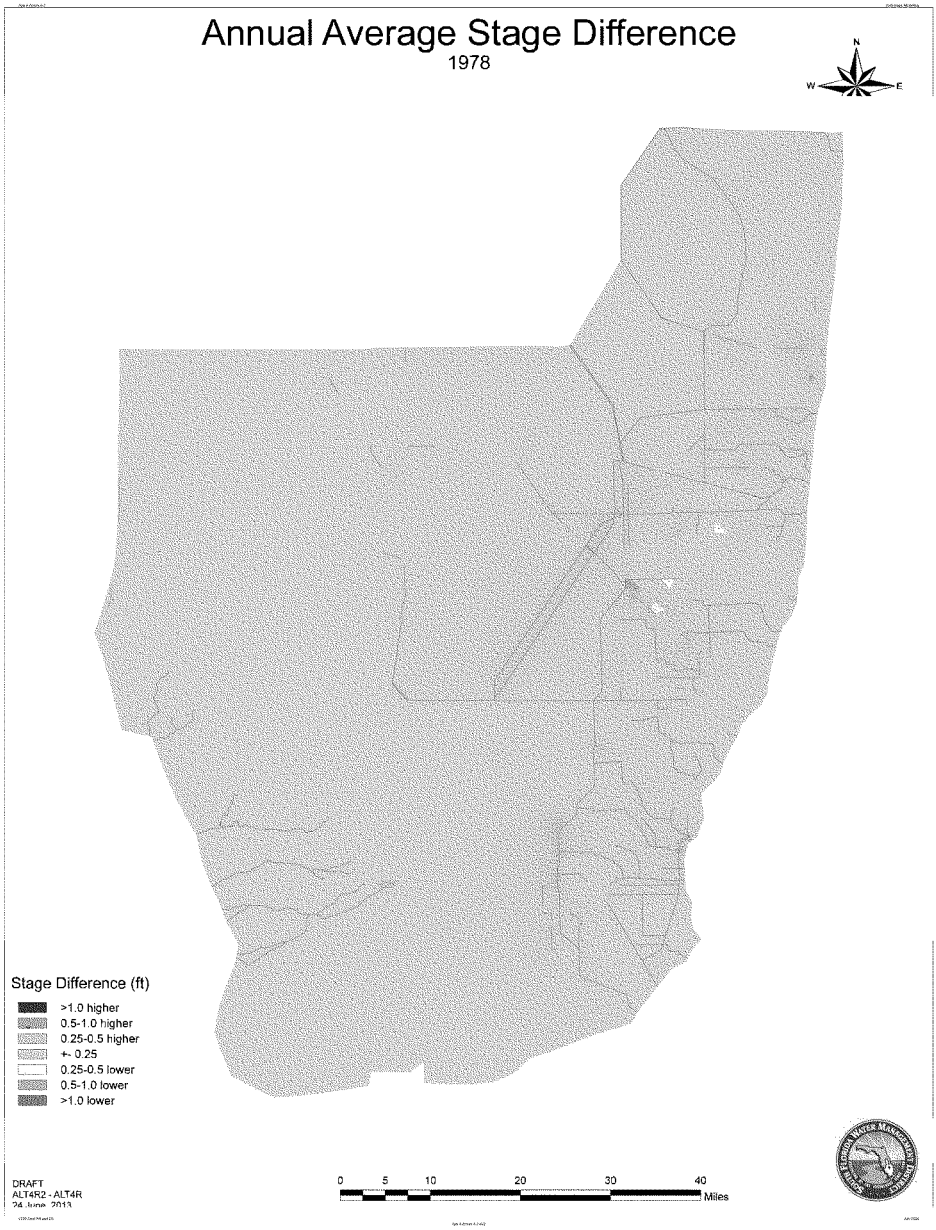


Stage Difference (ft)

- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

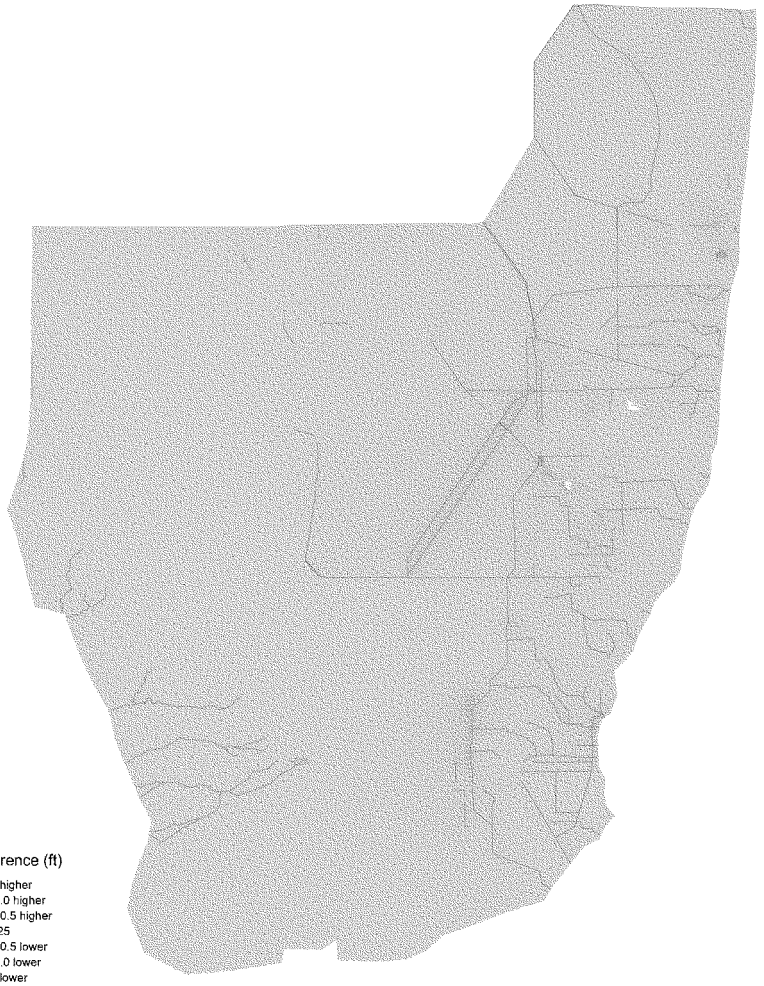
DRAFT
ALT4R2 - ALT4R
24 June 2019

0 5 10 20 30 40 Miles


Annual Average Stage Difference
1978
N
W
E
Stage Difference (ft)
>1.0 higher
0.5-1.0 higher
0.25-0.5 higher
+- 0.25
0.25-0.5 lower
0.5-1.0 lower
>1.0 lower
DRAFT
ALT4R2 - ALT4R
0 5 10 20 30 40
Miles

Annual Average Stage Difference

1989



Stage Difference (ft)

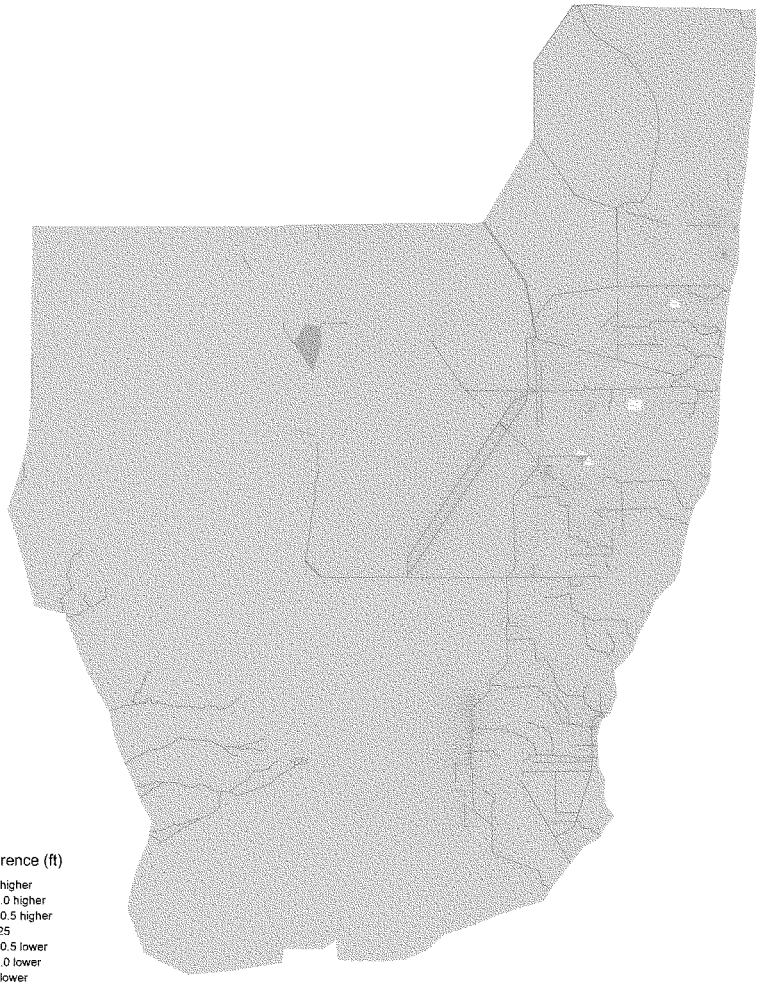
- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - ALT4R
24 June 2013

0 5 10 20 30 40 Miles

Annual Average Stage Difference

1995



Stage Difference (ft)

- >1.0 higher
- 0.5-1.0 higher
- 0.25-0.5 higher
- +- 0.25
- 0.25-0.5 lower
- 0.5-1.0 lower
- >1.0 lower

DRAFT
ALT4R2 - ALT4R
24 June 2013

0 5 10 20 30 40 Miles

ANNEX A-3: MODEL DOCUMENTATION REPORTS

SFWMD Hydrologic and Environmental Systems Modeling
USACE Jacksonville District, Interagency Modeling Center
February 2014

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Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Central Everglades Planning Project (CEPP) Screening Models Documentation Report

IMC MSR 368 **February 14, 2014**

1.0 Overview

Identification

The Central Everglades Planning Project (CEPP) is an expedited planning effort undertaken as part of the overall Comprehensive Everglades Restoration Plan (CERP), a program led by the United States Army Corps of Engineers (USACE) with the South Florida Water Management District (SFWMD) as local sponsor. The project worked throughout 2012 and 2013 to develop a Project Implementation Report (PIR) that combines planning and design activities for three primary areas of interest in the south Florida system as follows: 1) Storage & water treatment facilities in the Everglades Agricultural Area, 2) Decompartmentalization of levees within the Everglades Protection Area (EPA) and 3) Levee seepage management features along the Everglades / urban boundary in southeastern Florida. Modeling support to the CEPP effort was provided by a team comprised of modelers from the Hydrologic & Environmental Systems Modeling Section of the SFWMD and the Interagency Modeling Center (IMC), with direct support also provided by the USACE and Everglades National Park of the Department of the Interior (DOI). Modeling workflow and coordination were performed in a manner consistent with the procedures outlined in IMC Modeling Services Request (MSR) 368 and the CEPP Modeling Strategy (**SFWMD, 2012a**).

Scope and Objectives

Modeling support for CEPP focused on working with the larger project planning team and other interested parties to formulate and test project features leading to the ultimate identification and refinement of a tentatively selected plan (TSP). Modeling products were developed at the appropriate level of detail to support feature screening and detailed representation of project features and to provide information to all necessary evaluations required for plan development and documentation in the PIR. The project plan formulation framework is shown in **Figure 1.1** and illustrates a spatially determined workflow (moving north to south through the south Florida system) utilizing initial screening followed by detailed evaluation to identify final project planning alternatives and ultimately a TSP for the effort.

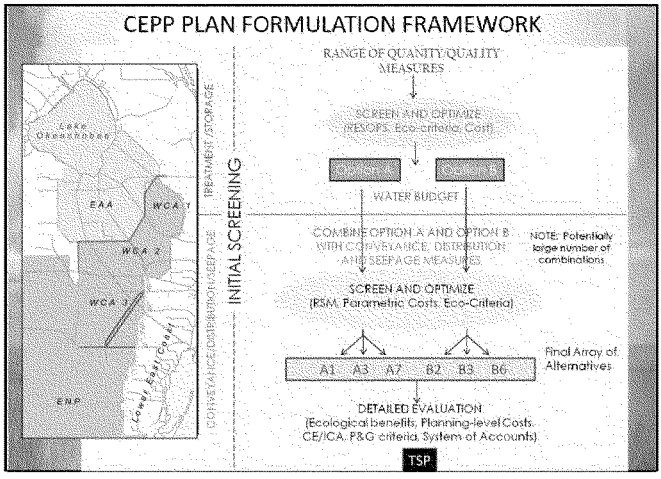


Figure 1.1. Central Everglades Planning Project Plan Formulation Framework

The CEPP Modeling Strategy document (**SFWMD, 2012a**) describes the modeling process and tools utilized, the associated rationale of the selection process and the means by which the tools could expediently support the project workflow. The primary model support tools utilized in CEPP are as follows:

Screening Tools:

- REservoir Sizing and OPerations Screening (RESOPS)
- Lake Okeechobee OPerations Screening (LOOPS)
- C-43 Spreadsheet Model
- iModel©

Detailed Planning Models:

- Regional Simulation Model Basins (RSMBN)
- Regional Simulation Model Glades-LECSA (RSMGL)
- Dynamic Model for Stormwater Treatment Areas (DMSTA)

From a modeling deliverable perspective, the entirety of the CEPP modeling support can be summarized by reviewing the following four Model Documentation Reports (MDRs):

1. CEPP Baseline Runs – Reviews the various non-CEPP model representations (e.g. current and future without project conditions) used in various aspects of the project planning (**SFWMD & IMC, 2014a**).
2. CEPP Final Array of Alternatives – Reviews four proposed with-CEPP project model representations examined during plan formation (**SFWMD & IMC, 2014b**).
3. CEPP Tentatively Selected Plan – Reviews the model representation of the CEPP TSP and subsequent refinements during final plan formulation and project assurance planning (**SFWMD & IMC, 2014c**).
4. CEPP Model Supported Screening Efforts – Reviews the various model-supported feature screening efforts undertaken at various points in the planning process (this document).

This screening models MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling representations of screening and sensitivity analysis performed in support of developing the CEPP final array of alternatives and TSP. Due to the broad nature of this MDR, the outline of this MDR differs from the standard used in the CEPP baselines, final array and TSP MDRs. This document will provide an overview of the CEPP screening modeling in Section 2 followed by individual model applications and outcomes organized by geographic area in Section 3. Section 4 will then summarize the final identification of all screening modeling products. These model runs were in support of plan formulation efforts; information on the use and rationale for the definition of these specific screening products is contained in the CEPP PIR Appendix E (**USACE, 2014**).

2.0 Screening Overview

Screening Methodology

As outlined in the CEPP Modeling Strategy document (**SFWMD, 2012a**), the CEPP modeling process utilized a modified approach to the traditional modeling workflow of narrowing and refining alternatives incrementally over longer periods of time. In CEPP, where possible, screening, rapid sensitivity assessment, batch processing of model information and/or inverse modeling techniques were performed up front in the planning process to identify to decision-makers key performance or tradeoff issues.

The benefit of performing screening is to quickly test the performance of management measures, components and potential alternative configurations; this

- Allows comparisons of the viability of management measures
- Identifies the feasible sizing ranges for further in-depth analysis
- Is not a replacement for the detailed regional models, but can reduce the burden on the more detailed regional models which helps to expedite the project schedule
- Optimization and inverse modeling techniques can be used to automatically evaluate thousands of operating rules and select the best performers
- Informs the discussion on what objectives are most critical to design

The project and modeling teams in CEPP proceeded within the plan formulation framework identified in Section 1 using a spatial approach as shown in **Figure 2.1.**

The screening products summarized in Section 3 will be organized in relation to this spatial perspective and each subsection will describe the assumptions and outcomes of the screening model applications in a given area. This document will focus on the modeling details and quality assurance steps taken in developing CEPP screening products, but it is important to note that these products were used by the project team in conjunction with other tools and multi-criteria decision analysis (MCDA) in determining project outcomes.

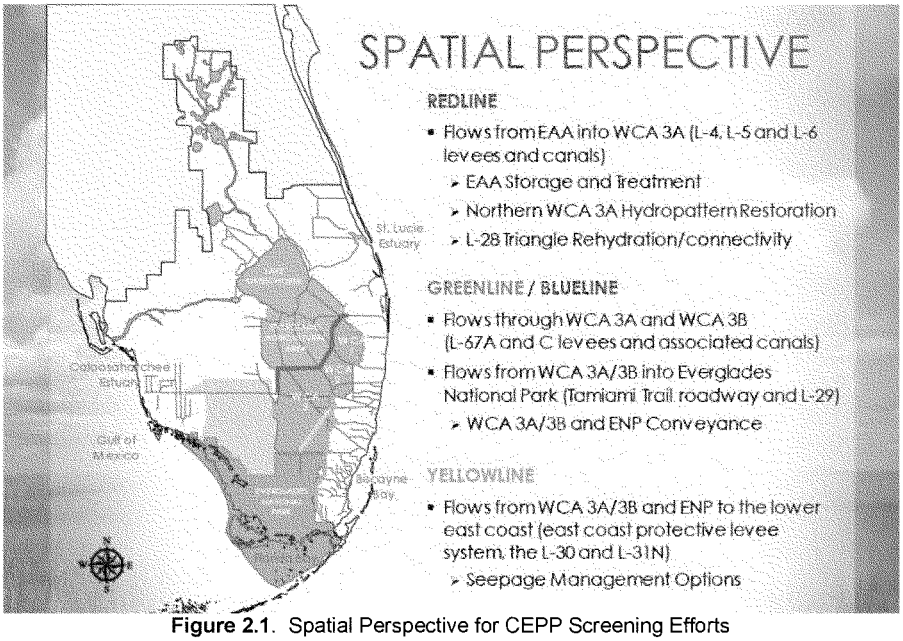


Figure 2.1. Spatial Perspective for CEPP Screening Efforts

Model Limitations and Intended Use of Results

The primary modeling products of CEPP 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, 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 RSMBN, RSMGL (**SFWMD, 2010** and **2011**), and DMSTA (**Walker & Kadlec, 2005**; **Wang, 2012**) models were reviewed through the USACE validation process for engineering software, as part of the CEPP project. The RSM and DMSTA models were classified as "allowed for use" for South Florida applications in August 2012 and January 2013, respectively. Additionally, the RESOPS (**SFWMD, 2009**), LOOPS (**Neidrauer et al, 2006**), and C-43 spreadsheet model (**Stames & Marlowe, 2007**) tools and the iModel optimization tool (**Ali, 2009**) used in CEPP underwent USACE Agency Technical Review (ATR). Approval of these modeling tools for CEPP application was completed in November, 2012.

3.0 Screening Modeling

North of Redline RESOPS Screening

The CEPP project team identified a series of project features (management measures) on available land north of the redline and used the RESOPS model (as described in the CEPP modeling strategy) to test the potential of these various features to achieve desired system performance objectives. The model was set up to run a discrete set of combinations of various management measures (e.g., 12 ft deep storage, 6 ft deep storage, shallow storage, stormwater treatment area, flow equalization basin) that could be located within the ~27,600 acre effective area of the Talisman property in the Everglades Agricultural Area. For each combination of assumed features, the RESOPS model was run numerous times using an optimization algorithm included in the model toolset that seeks to vary operational protocols within the assumed system with the following goals:

- Increase total flow to the downstream Everglades system
- Increase dry season flow to the downstream Everglades system
- Reduce high discharge months to the Northern Estuary systems
- Maintain performance for Lake Okeechobee and Lake Okeechobee Service Area (LOSA) users relative to the LORS08 baseline
- Attempt to meet water quality (phosphorous) objectives for discharge south using a simplified algorithm that mimics the behavior of the DMSTA model.

Once a database of optimally performing storage combinations was developed, various post processing graphics were produced and provided to the project team. Examples of these types of products are shown in **Figures 3.1** and **3.2**. A full list of screening products produced by RESOPS is provided in **Appendix A**. All RESOPS modeling utilized a period of simulation based on climate data from 1965-2005.

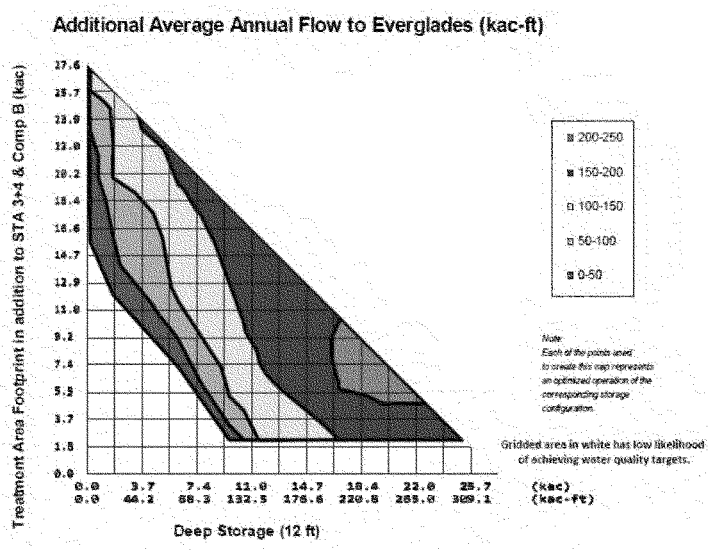


Figure 3.1. Example RESOPS output showing potential for increasing flow to the Everglades given multiple configurations of storage and treatment area expansion on the Talisman site in the EAA.

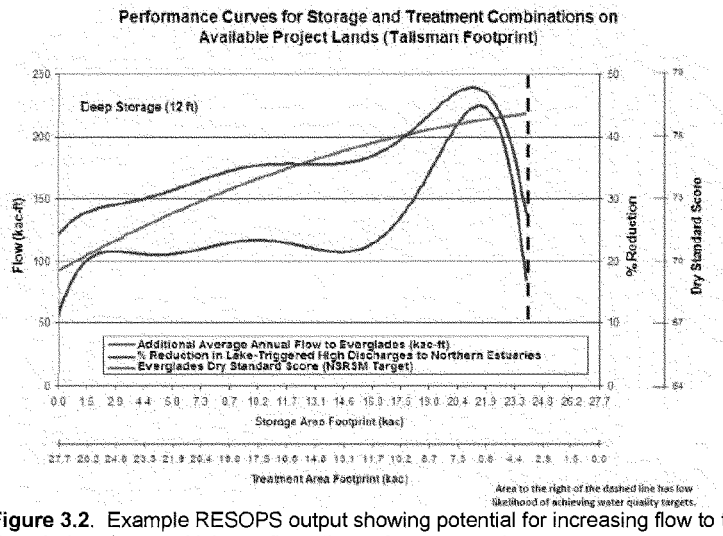


Figure 3.2. Example RESOPS output showing potential for increasing flow to the Everglades given multiple configurations of storage and treatment area expansion utilizing the full footprint of the Talisman site in the EAA

Following review of the initial RESOPS modeling results in combination with other factors, the project team identified a series of viable plan components for continued consideration. It was observed that these options could be generally categorized into three groupings based on their ability to achieve flow south to the Everglades system. These groupings were labeled "High", Medium" and "Low" and an additional three RESOPS scenarios were produced to represent these generalized conditions. Data from these RESOPS scenarios were then utilized as boundary conditions in subsequent LOOPS screening as described in the next section.

In all steps of the RESOPS screening process, results were reviewed by the modeling team to ensure correct execution of the model and reasonable and explainable predicted outcomes. Additionally, due to the highly interactive nature of the CEPP planning process, results were being reviewed and evaluated by regional experts immediately after release, providing an additional means for product QAQC.

North of Redline LOOPS / C43 Screening

Continued analysis of potential project features north of the redline utilized the LOOPS and C43 screening models (as described in the CEPP modeling strategy) to further refine the outcomes of the RESOPS screening and to explore a broader range of operational options for Lake Okeechobee. The objectives of this screening work built upon the outcomes of those gains identified in the RESOPS screening and additionally looked in more detail at Lake Okeechobee, LOSA and Northern Estuary performance trends. Several applications of the LOOPS model were set up to run with assumed downstream flow boundary conditions derived for the High, Medium and Low RESOPS scenarios. All LOOPS and C43 modeling utilized a period of simulation based on climate data from 1965-2005.

For a given assumed flow scenario, the LOOPS model was run numerous times using a batch-processing algorithm included in the model toolset that can apply changes to Lake Okeechobee operations based on parameters identified in a discrete user-specified matrix. Performance measure outcomes for each of these individual runs were saved and then, through coordination with the project team, minimum acceptable levels were identified. The resulting outcomes were summarized in figures such as **Figure 3.3**, in which all possible scenarios run are illustrated as black circles, but only those scenarios that meet minimum criteria are highlighted in red. Using these type of modeling products, the project team identified three unique operational scenarios for each of the High, Medium and Low RESOPS scenarios as follows:

- LOKOPT – maximum performance observed utilizing the Lake Okeechobee Standard Score performance measure
- WSOPT – maximum performance observed utilizing the average water supply cutback % for the eight worst cutback years in the simulation
- ESTOPT – maximum performance observed in minimizing the frequency of high discharge months to the Northern Estuaries

As a post processing step to the LOOPS outcomes, flows leaving Lake Okeechobee were imposed as a boundary condition to the C43 Spreadsheet model as a means of simulating the assumed project baseline feature of the C43 reservoir. Performance summaries provided to the project for S79 discharges into the Caloosahatchee Estuary came from the C43 model while all other summaries were derived directly from LOOPS. Examples of the performance measure

matrices for each geographic region are provided in **Tables 3.1 to 3.4.** Each table is organized in a hierarchical way such that the three LOOPS "OPT" scenarios are grouped with the assumed RESOPS High, Medium or Low boundary condition.

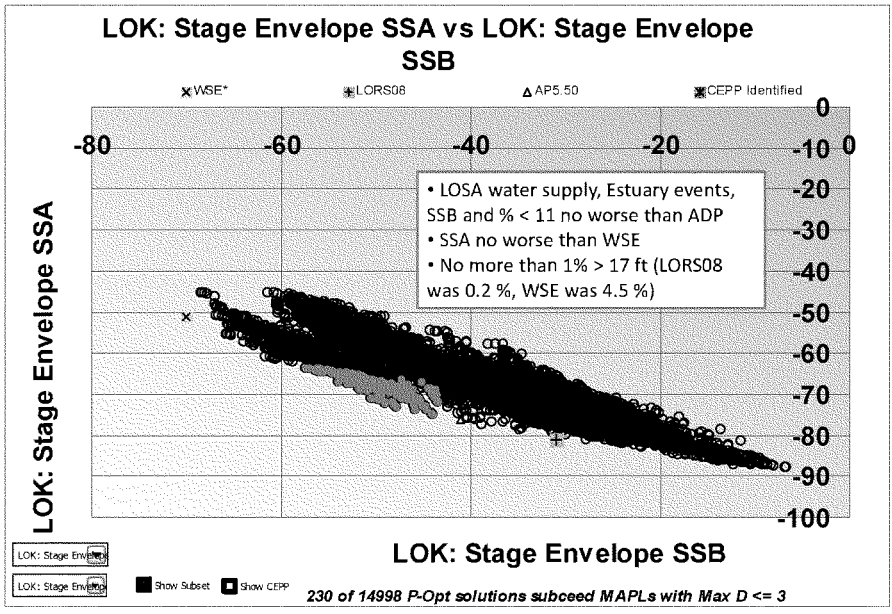


Figure 3.3. Example LOOPS output for multiple Lake Okeechobee (LOK) operating strategies

Table 3.1. Example LOOPS Output for Lake Okeechobee Performance

	Baselines		
Run	WSE	LORS08	AP5.50
Standard Score Above Envelope	51.3	81.0	76.3
Standard Score Below Envelope	70.0	30.7	41.4
Standard Score Above 17 feet	78.6	99.1	98.7
Standard Score Below 10 feet	95.7	86.1	90.3

	Low Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Standard Score Above Envelope	67.8	61.2	67.2
Standard Score Below Envelope	48.9	56.3	47.0
Standard Score Above 17 feet	97.5	95.7	96.1
Standard Score Below 10 feet	90.4	92.3	90.0

	Medium Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Standard Score Above Envelope	71.1	63.5	66.9
Standard Score Below Envelope	50.5	57.4	45.2
Standard Score Above 17 feet	97.6	95.9	95.6
Standard Score Below 10 feet	91.0	92.1	89.2

	High Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Standard Score Above Envelope	69.3	66.7	69.9
Standard Score Below Envelope	47.9	50.8	45.5
Standard Score Above 17 feet	97.3	96.6	96.2
Standard Score Below 10 feet	89.7	89.8	89.3

Table 3.2. Example LOOPS Output for Lake Okeechobee Service Area Performance

	Baselines		
Run	WSE	LORS08	AP5.50
Cutback %	15.50%	27.70%	24.90%
	Low Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Cutback %	23.30%	20.90%	24.20%
	Medium Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Cutback %	21.90%	20.50%	24.90%
	High Everglades Flow		
Run	LOKOPT	WSOPT	ESTOPT
Cutback %	24.10%	23.10%	24.90%

Table 3.3. Example LOOPS & C43 Model Output for Caloosahatchee Estuary Performance

Caloosahatchee (S79)					
MEAN MONTHLY FLOWS	**<450**	**450-2800**	**2801-4500**	**>2800**	**>4500**
WSE + C43 RES	68	340	39	84	45
LORS08 + C43 RES	38	375	38	79	41
ADP + C43 RES	24	382	39	86	47
LOW + LOKOPT + C43RES	75	344	30	73	43
LOW + WSOPT + C43RES	81	342	28	69	41
LOW + ESTOPT + C43 RES	66	352	37	74	37
MED + LOKOPT + C43RES	78	340	31	74	43
MED + WSOPT + C43RES	82	343	27	67	40
MED + ESTOPT + C43 RES	82	342	36	68	32
HIGH + LOKOPT + C43RES	86	335	32	71	39
HIGH+ WSOPT + C43RES	82	343	27	65	38
HIGH+ ESTOPT + C43 RES	74	348	36	70	34

Table 3.4. Example LOOPS Output for St Lucie Estuary Performance

St. Lucie (S80+SLETRIB)					
MEAN MONTHLY FLOWS	**<350**	**350-2000**	**2001 - 3000**	**>2000**	**>3000**
WSE + C43 RES	140	279	38	73	35
LORS08 + C43 RES	120	300	39	72	33
ADP + C43 RES	136	283	38	73	35
LOW + LOKOPT + C43RES	148	274	36	70	34
LOW + WSOPT + C43RES	148	276	32	68	36
LOW + ESTOPT + C43 RES	138	289	35	65	30
MED + LOKOPT + C43RES	150	272	37	70	33
MED + WSOPT + C43RES	149	277	31	66	35
MED + ESTOPT + C43 RES	149	280	39	63	24
HIGH + LOKOPT + C43RES	151	276	34	65	31
HIGH+ WSOPT + C43RES	150	277	34	65	31
HIGH+ ESTOPT + C43 RES	144	286	34	62	28

In all steps of the LOOPS and C43 screening process, results were reviewed by the modeling team to ensure correct execution of the model and reasonable and explainable predicted outcomes. Additionally, due to the highly interactive nature of the CEPP planning process, results were being reviewed and evaluated by regional experts immediately after release, providing an additional means for product QAQC.

Redline RSMGL Screening

Building upon the work performed by the WCA3A Decompartmentalization & Sheetflow Enhancement Project (**SFWMD, 2011**), additional scenarios were performed to analyze the potential effects of proposed CEPP project features in the vicinity of the Redline in northern WCA3A, as conceptually shown in **Figure 3.4**. This work was performed using the RSMGL model (as described in the CEPP modeling strategy), and specifically by modifying the RSMGL Alt A and Alt E scenarios developed during the WCA3A Decomp effort. This modeling utilized a period of simulation based on climate data from 1965-2000.

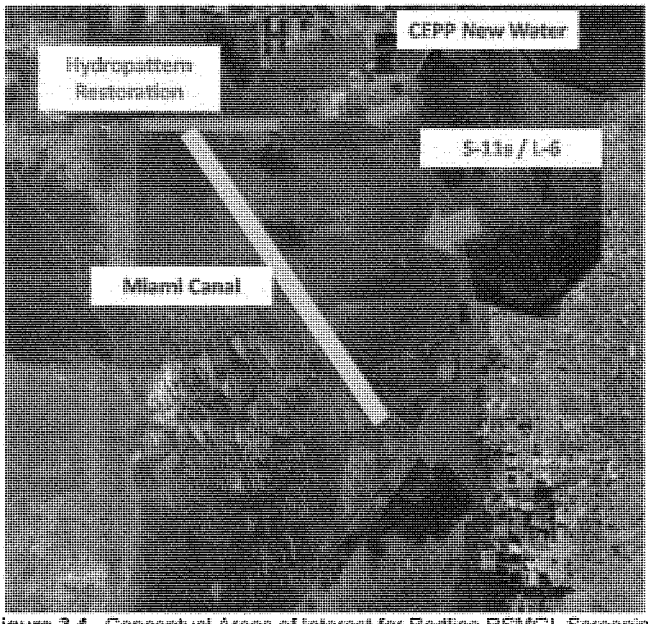


Figure 3.4. Conceptual Areas of Interest for Redline RSMGL Screening

Given consideration of additional "new water" being provided by the CEPP project as identified in the north of redline screening work, the project team identified four areas of primary interest for this screening work as follows:

- Configurations of a hydropattern restoration feature (HRF) in northern WCA3A
- Extent of Miami Canal backfill
- Potential gapping of the C-11 Extension spoil mounds
- Potential to divert STA2 outflows from the L6 to the L5 canal, thereby redirecting WCA2A inflow into WCA3A and reducing discharges at the S11 structures.

No screening hydrologic modeling work was performed on the C-11 Extension item since the scale of the RSMGL model was too large to meaningfully capture the localized effects of these modifications. Combinations of the other features were combined into four RSMGL scenarios as shown in **Table 3.5**.

Table 3.5. Assumptions for Redline RSMGL Scenarios

Model Run	HRF	Miami Canal	C-11 Ext	L-6 Deliveries
Redline Run1	West G-206	North I-75	Gapping (100')	Without
Redline Run2	West G-206	North I-75, Plug around S-340, Plug south of C-11	Removal of spoil north of C-11ext, Gapping South of C-11ext	Without
Redline Run3	Full	North I-75	Gapping (100')	Without
Redline Run4	Full	North I-75	Gapping (100')	With

For the four Redline scenarios modeled using RSMGL, northern boundary inflows were imposed as shown in **Table 3.6**. These flows were calculated using the Decomp model assumed boundary conditions plus additional "medium" flow from the RESOPS screening. Specific HRF canal (Central HRF) and Miami Canal configurations as modeled are shown in **Figures 3.5** to **3.7**. East HRF and West HRF features are not modeled as a canal within the model domain but with boundary inflows into the cells on the northern boundary in the vicinity of the proposed HRF features.

Table 3.6. Average Annual Inflows (ac-ft) assumed for Decomp (Alt A & Alt E)

Inflows	WCA2A	East HRF	West HRF	Central HRF	Sum
Alt A	336,925	64,755	223,044	233,193	857,916
Alt E	337,757	0	259,775	263,702	861,234
Run12	416,536	0	326,471	329,523	1,072,546
Run3	415,704	64,445	290,024	299,039	1,069,212
Run4	273,060	100,836	342,690	352,626	1,069,212

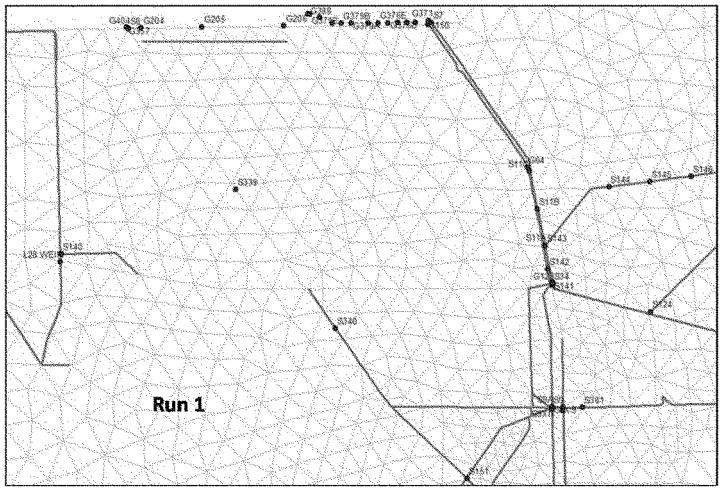


Figure 3.5. RSMGL Canal Configuration for Redline Run 1

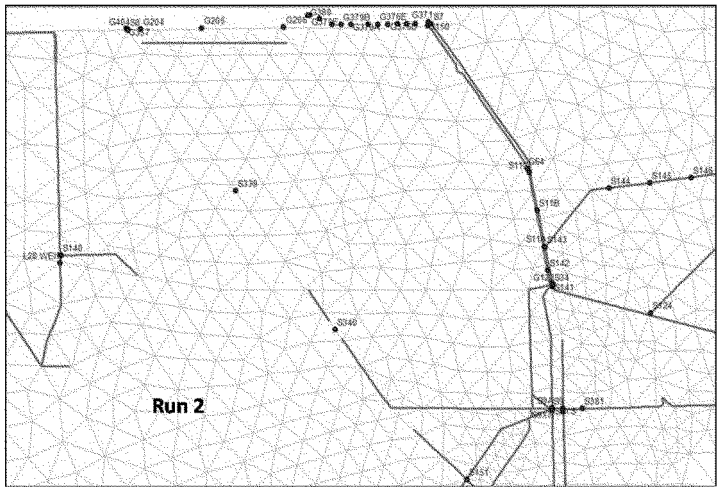


Figure 3.6. RSMGL Canal Configuration for Redline Run 2

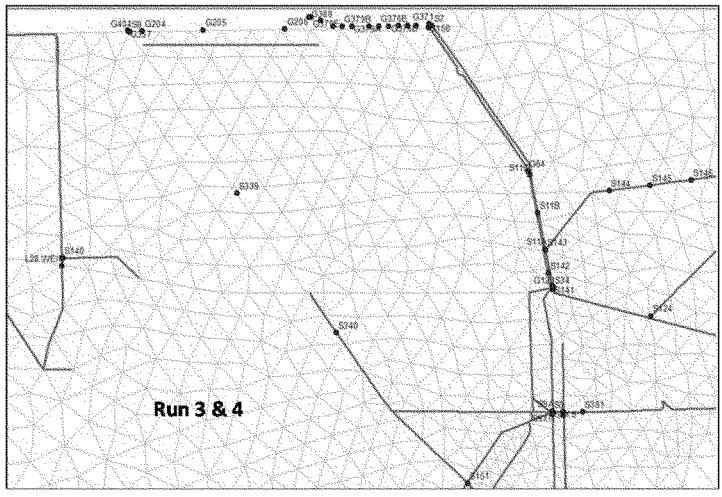


Figure 3.7. RSMGL Canal Configuration for Redline Run 3 & Run 4

The Redline Run 1, Run 2, Run 3 and Run 4 modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. While many performance indicators were provided to the project team (in particular maps showing hydroperiod and ponding conditions), only a subset of the results are shown in this document to illustrate that the various scenarios did indeed meet the modeling intent. Trends in WCA2A were as expected with Run 1, Run 2 and Run 3 experiencing higher flows / depths and Run 4 resulting in lower depths and average flows (**Figure 3.8** illustrates depth performance at gauge 2A-17 in WCA2A). In WCA3A, a range of outcomes were observed, with many differences being in the immediate vicinity of the differences in assumed canal configurations. **Figure 3.9** shows as an example that flows in eastern WCA3A have variability across the alternatives.

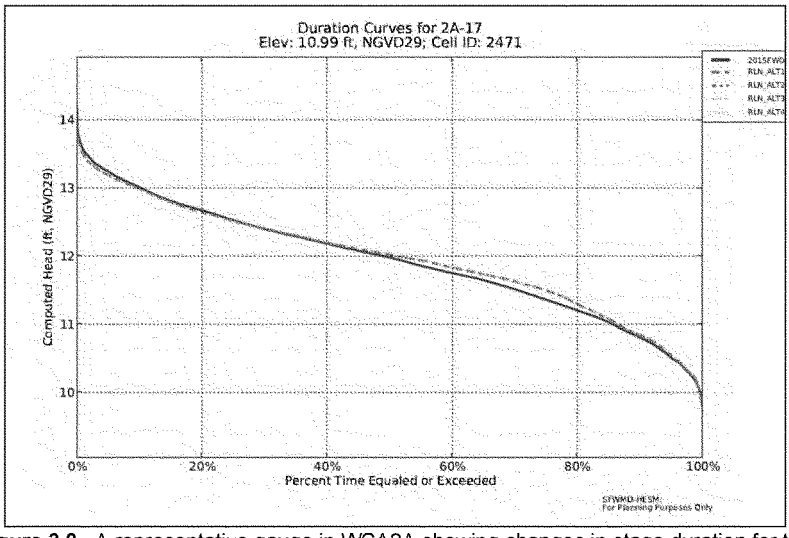


Figure 3.8. A representative gauge in WCA2A showing changes in stage duration for the Redline RSMGL scenarios

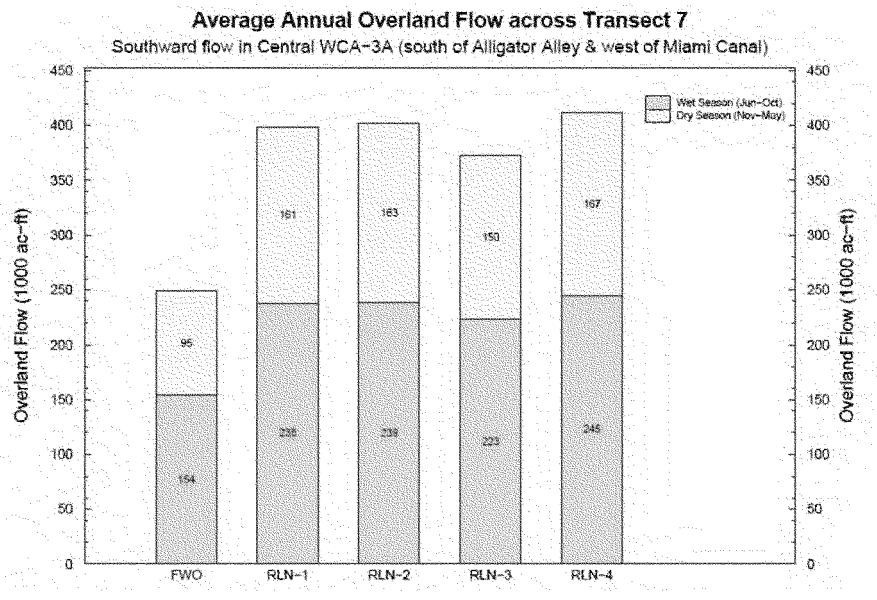


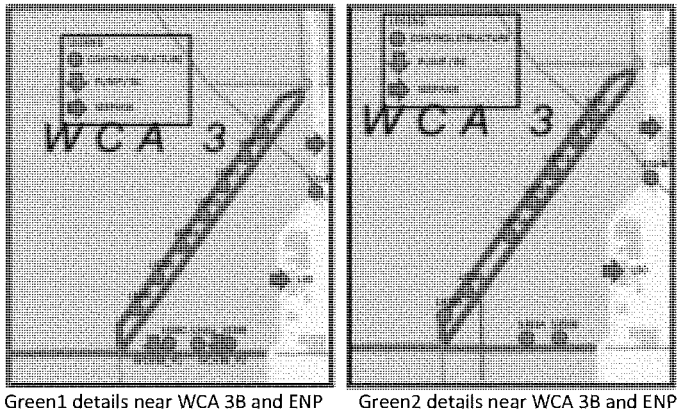
Figure 3.9. Flow differences between Redline RSMGL scenarios in central WCA3A

Greenline iModel Screening

As a result of Redline screening, it was determined that approximately 200 kac-ft of additional flow would be provided to the Everglades in CEPP. The CEPP project team held a series of public workshops to identify potential system infrastructure and operational changes that could be considered to help distribute the existing and new water in order to meet identified system objectives. The iModel (as described in the CEPP modeling strategy) was utilized to inform project screening during a series of planning steps as follows:

- Step 1: Identify conceptual configurations based on public input; perform initial analysis
- Step 2: Identify holistic system targets that were informed by ecological targets and system limitations (target contradictions, infrastructure limitations, water availability); identify causal relationships.
- Step 3: Test highly performing infrastructure options (observed in Steps 1 and 2) using operational targets defined in Step 2

Based on public input, two conceptual configurations were identified by the project team and run by the iModel as shown in **Figure 3.10**. The Green1 scenario focused on expanding a variety of infrastructure (spillways and pumps) in the L67 and L29 levees while Green2 included the "Blue Shanty" feature, a new levee aligned parallel with flow, in WCA3B. These two configurations were intentionally established with several infrastructure options, thereby allowing the iModel optimization to identify which potential features were most effective. For each configuration, a RSMGL model run was made with highly varied imposed flow boundaries (intended to encompass the range of potential physical outcomes associated with the structure operations), and then the iModel was trained on the RSMGL outputs. The features shown in **Figure 3.10** for southern WCA3A, WC3B and ENP were combined with other known south Florida infrastructure (e.g., structures in the WCA1 & WCA2 areas, inflows to northern WCA3A, seepage estimates & Lower East Coast Service Area (LEC) return seepage pumping) to create two system-wide implementations of iModel.



Green1 details near WCA 3B and ENP Green2 details near WCA 3B and ENP

Figure 3.10. Conceptual configurations for Step 1 Greenline iModel analysis

Following implementation of the iModel to the Green1 and Green2 scenarios, an iModel run was performed for both scenarios utilizing the available ecological targets for each area. These outcomes were analyzed as the results of the Step 1 planning process described above. The results of this analysis indicated that certain parts of the system were not performing as desired and that additional refinement to the operational targets was needed. Step 2 iModel work provided a series of investigations predicated from either the Green1 or Green2 scenario that examined the following areas:

- Reduced stage targets in northern WCA3A and using Gauge 3A-4 as a "pivot" point for refined operational targets.
- Ability to maintain stages within constraints of Zone A of the WCA3A regulation schedule
- Sensitivity to the L29 stage constraint (unconstrained, 8.5 ft, 8.0 ft)
- Optimization without L6 diversion operations
- Assumed impact of seepage management effects on Site 71 in WCA3B

From a modeling perspective, setup of these iModel scenarios focused on revisions to input target time series data and/or weights and on assuming limitations to structure capacity, if warranted (e.g., L6 diversion capacity set to 0 cfs). The findings from the above investigations were analyzed by the CEPP team (as described in Appendix E of the CEPP PIR) and decisions by the project team were consolidated into a consensus set of operational targets (modifications to the original ecological targets, such as scaling NSM targets to a revised percentage of the NSM depth), as shown in **Table 3.7**. Details of the data sources and rational for the consensus operational target selection can be found in the CEPP PIR. Based on review of Step 1 and Step 2 outcomes, the project team also identified a set of ten potentially highly performing alternatives. Step 3 iModel applications ran the ten options shown in **Table 3.8** using the modified operational targets identified in Step 2. Results of this screening were incorporated into a MCDA for ultimate identification of the features that would carry forward into the final array scenario modeling.

The Greenline iModel scenarios were reviewed from the perspective of ensuring that effects of project implementations were observed as expected and that optimized regional performance was considered reasonable. While many rounds of outputs were provided to the project team, only a subset of the results are shown in this document as examples of the ability to meet the modeling intent. Typical outputs from the iModel for the purposes of system performance evaluation are shown in **Figure 3.11** and **Table 3.9** which illustrate the ability of an iModel scenario to trend toward target from the assumed starting baselines. Another example of utilized iModel outputs is shown in **Figure 3.12** and **3.13**, which illustrates the difference in optimized utilization of two structures that are geographically nearby. These types of outcomes were used by the project team to identify highly efficient infrastructure to carry forward into subsequent analysis.

Table 3.7. Outcomes of Greenline Step2 Refined Operational Targets for iModel use in Step 3

Area	Gauge	Target
WCA1	1-7	Based on RSMGL Existing Condition Baseline (ECB)
WCA2A	2A-159	Based on RL4 Redline Screening Run
	2A-17	Based on RL4 Redline Screening Run
WCA2B	Eden-13	Based on RSMGL Existing Condition Baseline
WCA3A	3ANW	60% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3A11	30% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3ASW	50% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	W2	100% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3A3	65% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3A4	75% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3AS	70% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3ANE	50% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	3A28	100% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	E4	85% of NSM v4.6.2-based RECOVER Ridge & Slough Target
WCA3B	Site71	88% of NSM v4.6.2-based RECOVER Ridge & Slough Target
	Shanty_loc	100% of NSM v4.6.2-based RECOVER Ridge & Slough Target
ENP	NP205	Based on RSMGL ECB Depth at NP46 (both NP205 and NP46 are marl areas)
	NP46	Based on RSMGL ECB Depth at NP46
	P33	Based on Florida Bay RECOVER Paleological targets
	NE2	Based on Florida Bay RECOVER Paleological targets

Table 3.8. Ten scenarios identified for Step 3 Greenline iModel screening

Option	Title	S-333	3B/L-67A levee	L67C levee	L-29 levee	Blue Shanty levee, 3B	3B Seepage Management
1A	No - WCA 3B	2000					Constrained
3A1	Southerly Orientation 3B	2000	S4, S5, S6 @500cfs	Gaps at structures	355A,B,C		Unconstrained
3A2	Southerly Orientation 3B	2000	S4, S5, S6 @750cfs	Gaps at structures	355A,B,C		Unconstrained
3B2	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1		Unconstrained
3B3	Southerly Orientation 3B	2000	S 4, S5, S6 @750 cfs	Gaps at structures	355A,B,C Pump 1		Constrained
4A	Southwest 3B - Blue Shanty	Existing	S5, S6 and S1-4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Constrained
4B	Southwest 3B - Blue Shanty	Existing	S5, S6 and S4	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Constrained
4C	Southwest 3B - Blue Shanty	Existing	S5, S6	Degrade west of Blue Shanty levee	Degrade west of blue shanty levee	From L67A to L-29	Constrained
9A	Entire L-67A extent	2000	6 structures S(1-6)	Gaps at structures	more 355s; gravity		Unconstrained
10A	North/South	2000	S2,S3 S5,S6 @500cfs	Gaps at structures	355A,B,C 2 pumps @500cfs		Unconstrained

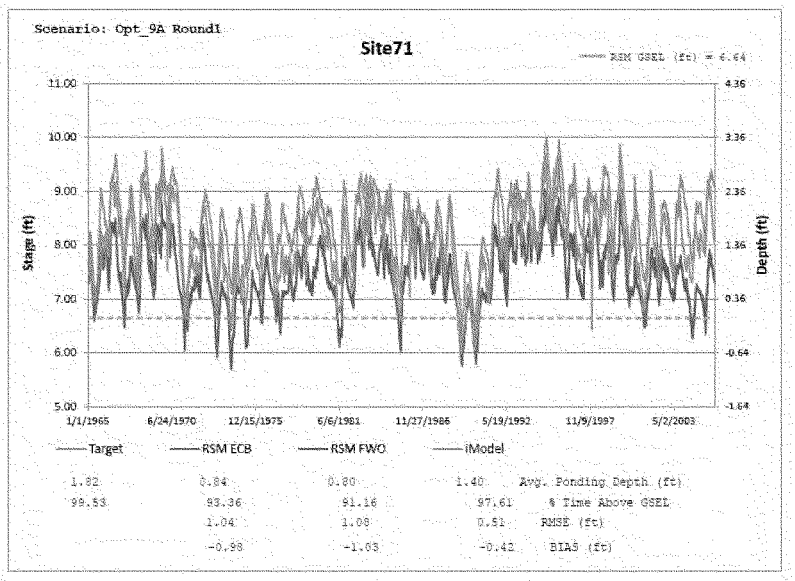


Figure 3.11. Example iModel graphic output comparing optimized outcomes to project baseline conditions and desired ecological targets at a specific location

Table 3.9. Example iModel tabular output comparing the statistics of optimized outcomes to project baseline conditions and desired ecological targets at multiple locations

Central Everglades Planning - Greenline Screening
Optimized iModel results, Stage Table 1 of 5
Scenario: Green2
Average % time above ground surface elevation (GSEL)

Location	Target	RSM ECB	RSM FWO	iModel
1-7	99.11	99.53	99.11	99.49
2A-159	90.74	91.96	93.97	92.38
2A-17	84.75	87.32	87.65	87.37
EDEN-13	97.29	95.00	97.29	99.02
3ANW	99.53	68.15	81.62	97.85
3A11	99.53	47.43	47.90	86.25
3ASW	99.53	83.82	81.95	91.39
W2	99.53	98.46	97.94	99.72
3A4	99.53	92.38	91.35	95.88
3AS	99.53	86.34	87.18	97.71
3ANE	99.53	69.27	66.18	93.12
3A28	99.53	99.25	98.97	99.77
EDEN-4	99.53	95.09	94.34	98.46
3A3	99.53	79.42	77.03	94.11
Site71	99.53	93.36	91.16	99.44
Shanty_loc	99.53	96.82	95.74	99.95
NP205	66.18	73.53	74.04	78.81
P33	98.78	89.34	89.10	99.39
NE2	99.53	87.75	87.28	97.75
NP46	66.18	63.05	64.27	73.48

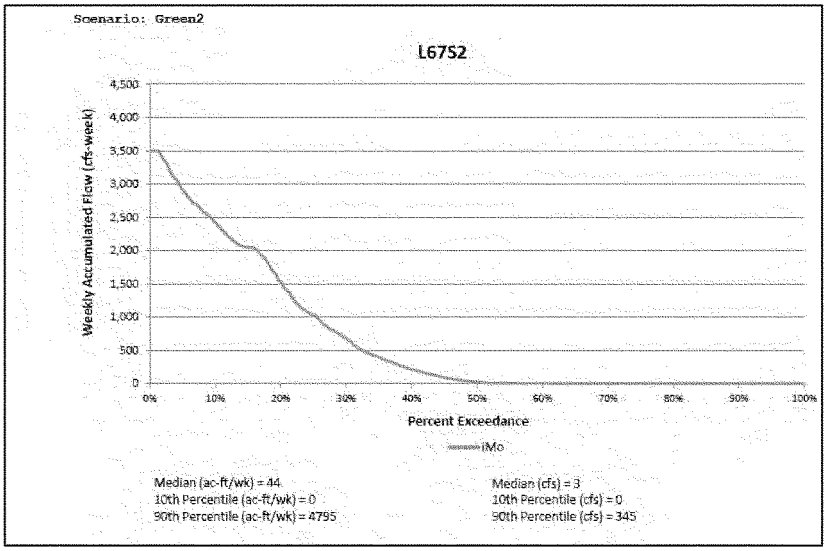


Figure 3.12. Example iModel output showing relative low utilization of structure L67 S2

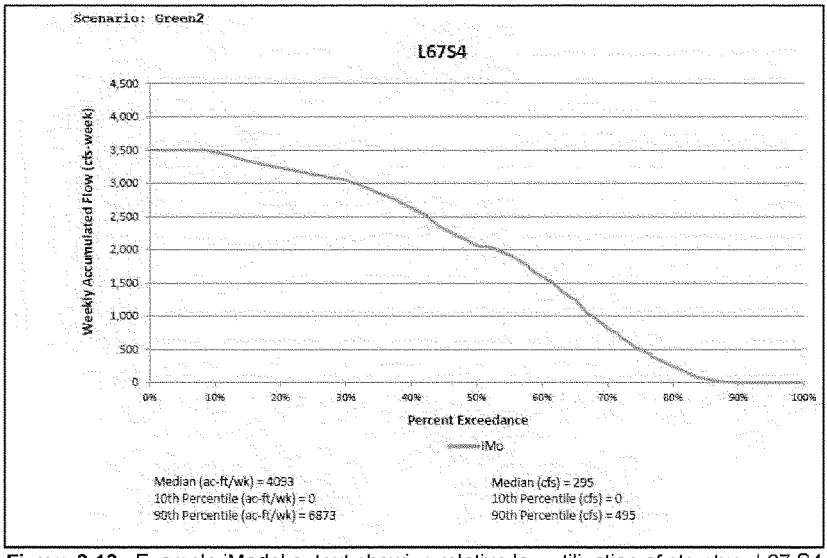


Figure 3.13. Example iModel output showing relative low utilization of structure L67 S4

Blueline and Yellowline Screening

Screening scenarios were performed to analyze the potential effects of proposed CEPP project features in the vicinity of the Blueline and Yellowline in WCA3B, ENP and the LEC, as conceptually shown in **Figure 3.14**. This work was performed using the RSMGL model (as described in the CEPP modeling strategy), and specifically by modifying the intermediate versions of RSMGL FWO baseline. This modeling utilized a period of simulation based on climate data from 1965-2000.

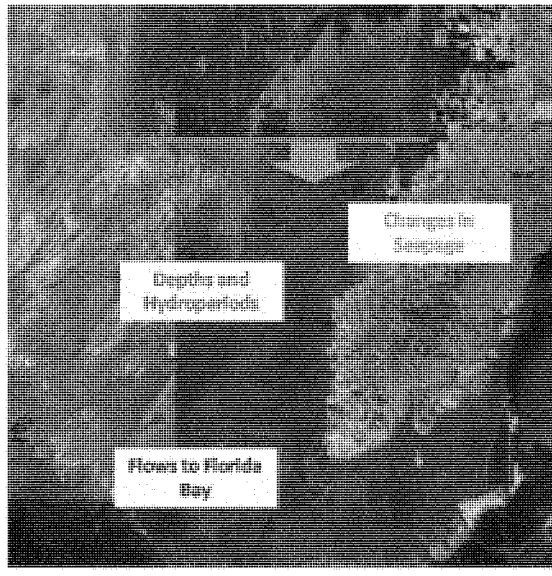


Figure 3.14. Conceptual Areas of Interest for Blueline and Yellowline RSMGL Screening; Changes in Seepage affect LEC canal and Southern Estuary Discharge Performance

The Blueline RSMGL sensitivity runs consist of five scenarios derived from a May 2012 version of the CEPP RSMGL FWO run and produced subsequent to North of Redline screening, concurrent with Redline RSMGL screening and prior to Greenline and Yellowline screening. These model runs were solely performed to assist with up-front screening and understanding of the model output and performance measure trends for Central Everglades planning prior to determination of a final array of alternatives. Given the expectation that CEPP would provide additional flow through the system in the vicinity of the Blueline (the magnitude of which was undetermined at the time of screening), the modeling strategy employed for the Blueline sensitivities focuses on imposing percentages of NSM Transect 18 (eastern ENP) volumes of water into the L-29 canal without specifying the source or conveyance route of this water. As

such, only RSMGL outputs at and downstream of L29 are valid for evaluation. Water deliveries to Everglades National Park are imposed as follows:

- S12s, S333 & S355s discharges imposed as internal boundary conditions per the CEPP 2050 FWO scenario (i.e., not simulated).
- S-356 is operated up to 500 cfs. L-29 stage constraint for operation of S-356 assumed to be 7.5 ft, NGVD. G-3273 constraint for operation of S-356 assumed to be 6.8 ft, NGVD.
- No S-334 flood control releases simulated.
- 6.7 miles of Tamiami Trail Bridge as approximated per Alternative 6E of the 2010 Tamiami Trail Modifications: Next Steps EIS Report are modeled as weirs. Located east of the L67 extension and west of the S334 structure.
- Volumes of water imposed as internal boundary conditions into the L-29 canal based on Transect 18 flow differences between NSM4.6.2 and CEPP 2050 FWO as follows:
    - NSM0 = No additional flow
    - NSM25 = Additional flow equal to 25% of difference between NSM4.6.2 and CEPP 2050 FWO at TR18.
    - NSM50 = Additional flow equal to 50% of difference between NSM4.6.2 and CEPP 2050 FWO at TR18.
    - NSM75 = Additional flow equal to 75% of difference between NSM4.6.2 and CEPP 2050 FWO at TR18.
    - NSM100 = Additional flow equal to 100% of difference between NSM4.6.2 and CEPP 2050 FWO at TR18.

The Blueline NSM0, NSM25, NSM50, NSM75 and NSM1000 modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. While many performance indicators were provided to the project team (in particular maps showing hydroperiod and ponding conditions), only a subset of the results are shown in this document to illustrate that the various scenarios did indeed meet the modeling intent. Trends in eastern inflow into ENP were as expected as shown in **Figure 3.15** and variability across the scenarios in other portions of the system were observed and trended as expected.

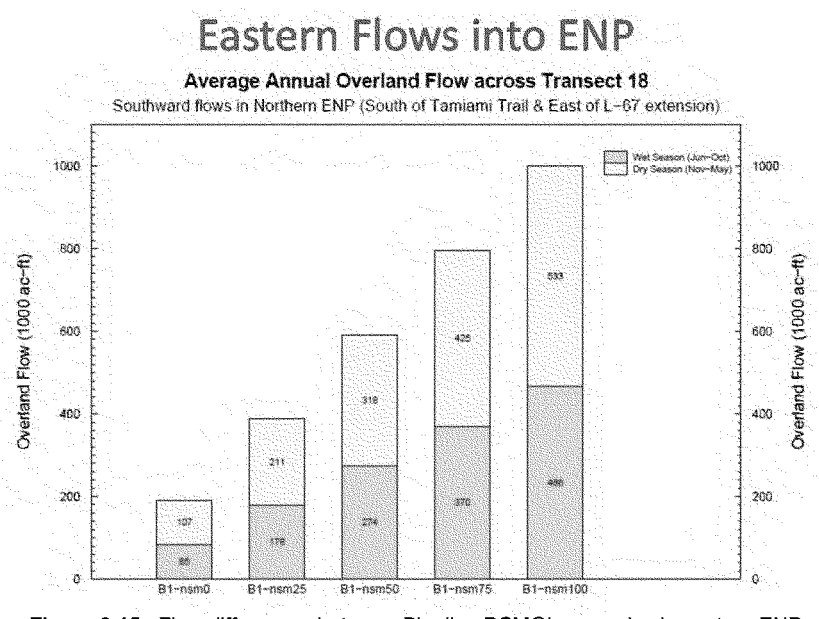


Figure 3.15. Flow differences between Blueline RSMGL scenarios in eastern ENP

The "Round 1" Yellowline RSMGL sensitivity runs consist of four scenarios derived from the Blueline NSM25 run and produced concurrent with Greenline screening. These model runs were performed to further examine the potential performance of the S356, S331 and S337 structures prior to determination of a final array of CEPP alternatives. The scenarios identified for the Round 1 Yellowline are as follows:

- BL_NSM25 = NSM25 Blueline sensitivity run (used as a baseline for comparison)
- WS2 = NSM25 run plus utilize the entire capacity of S-357 (500 cfs), restrict S-331 and G-211 for water supply use only and set L-29 canal stage constraint to 9.7 ft.
- WS3 = WS2 run plus increase S-356 capacity to 1000 cfs
- WS3.1 = WS3 run plus no "seepage constraint" operations for S356 pump and flood control open/close criteria for S356 set at the same levels as current G211 criteria.
- WS4 = WS2 run plus increase S-356 capacity to 1000 cfs and set L-29 canal stage constraint to 8.5 ft.

The Round 1 Yellowline modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. Changes in flows at the structures of interest were analyzed by the CEPP water supply sub team.

The "Round 2" Yellowline RSMGL sensitivity runs consist of six scenarios derived from the Yellowline Round 1 WS3.1 run and produced as a final screening step prior to identification of the final array of alternatives. These model runs were performed to further examine the potential performance of various proposed seepage management features. Using a similar technique as in the Blueline screening, the modeling strategy employed for the Yellowline Round 2 sensitivities imposed internal boundary conditions in the model based on information from the Greenline iModel work. Green1 flows were imposed along the L67 and at S-333 and the S12s in order to achieve higher stages in WCA3B and ENP for the purpose of testing seepage management features. As such, only RSMGL outputs at and downstream of L67 are valid for evaluation. The scenarios identified for the Round 2 Yellowline are as follows:

- YL0 = Revised S-356, S331 and S357 operations based on feedback from Round1 Yellowline work
- YL1 = YL0 plus fully penetrating seepage barrier (no groundwater flow and/or levee seepage) from S-335 to S-334 and extending ~ 1 mile south of Tamiami Trail adjacent to L-31N; S356 capacity to 1000 cfs
- YL2 = YL0 plus Partially penetrating seepage barrier (still allows reduced groundwater flow and/or levee seepage) from the northern Pennsuco to G-211; S356 capacity to 1000 cfs
- YL3 = YL0 plus convey discharges south more aggressively; utilize G-211 and S-331 to convey water supply and flood releases south; convey water through C-1W @ S-338, C-102 @ S-194, C-103 @ S-196 during dry season; convey water toward 332s during wet season
- YL4 = YL0 plus distributed pumping: series of 100 cfs pumps along L-30, L-31N (S-356 remains 500 cfs); conceptually shown in **Figure 3.16**
- YL5 = YL0 plus ~ 1/2 mile wide impoundment area in ENP; inflows S356 @500 cfs and new pump @500 cfs; allow Pennsuco to be higher, but maintain an improved DBLEV canal by adding pump near south end of Pennsuco; conceptually shown in **Figure 3.16**

Specific operational criteria may be referenced in **Appendix B** for the South Dade area.

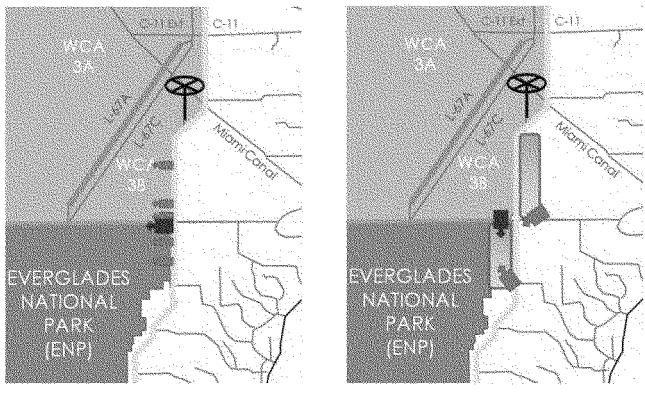


Figure 3.16. Conceptual configurations of YL4 (left) and YL5 (right) scenarios

The Yellowline Round 2 YL0, YL1, YL2, YL3, YL4 and YL5 modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. While many performance indicators were provided to the project team (in particular measurements of seepage and LEC canal/groundwater conditions graphics), only a subset of the results are shown in this document to illustrate that the various scenarios did indeed meet the modeling intent. Variability in seepage across the scenarios were as expected as shown in **Table 3.10.** Expected structural flow changes or feature utilization were observed in YL3, YL4 and YL5 as shown in **Figures 3.18**, **3.19 and 3.20**. Variability across the scenarios in other portions of the system were observed and trended as expected.

Table 3.10. Average annual seepage (kac-ft) from Everglades marsh cells into adjacent LEC canals for selected Yellowline scenarios and baselines. Geographic locations for the identified reaches are shown in **Figure 3.17**.

	Levee Seepage from Marsh Cell				
	ECB	FWO	YL0	YL1	YL2
L-30 between S-335 and the bridge	129	124	176	197	67
L-30 south of S-335	92	83	101	0	0
L-31N north of G-211	150	164	344	289	94

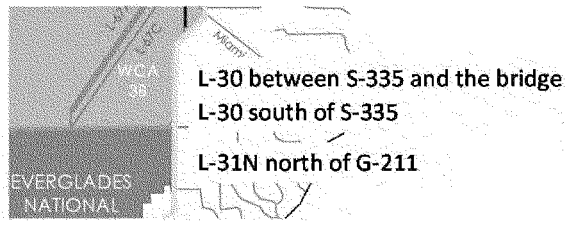


Figure 3.17. Geographic locations for the reaches identified in **Table 3.10**.

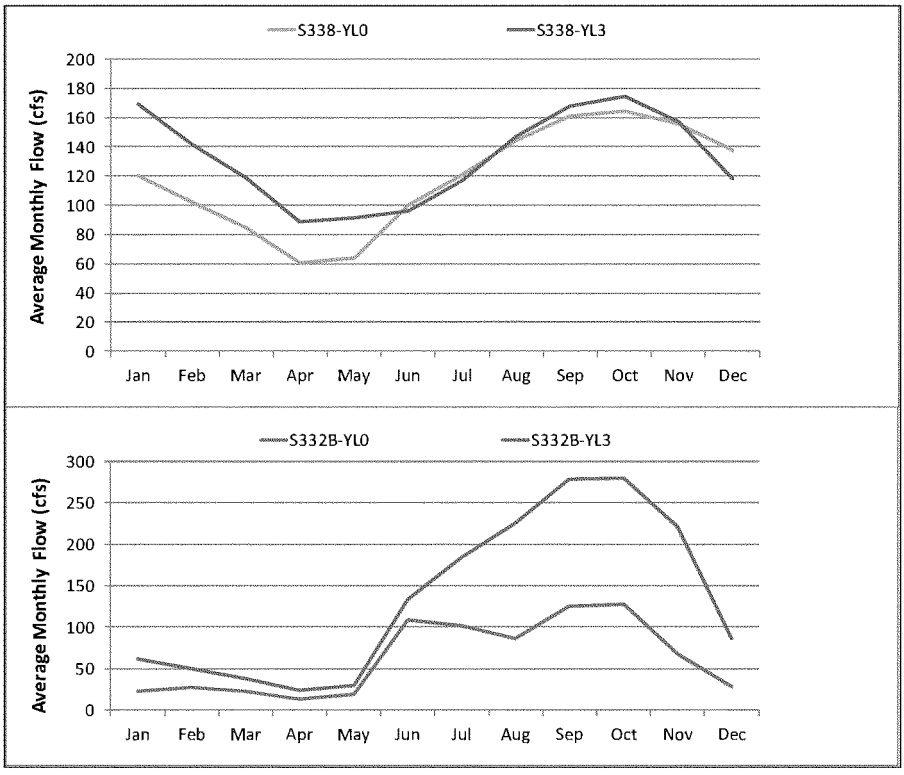


Figure 3.18. Example increases in seasonal flow volumes in YL3 relative to YL0 for dry season discharges toward coastal areas (top) and wet season discharges into the ENP buffer reservoirs (bottom)

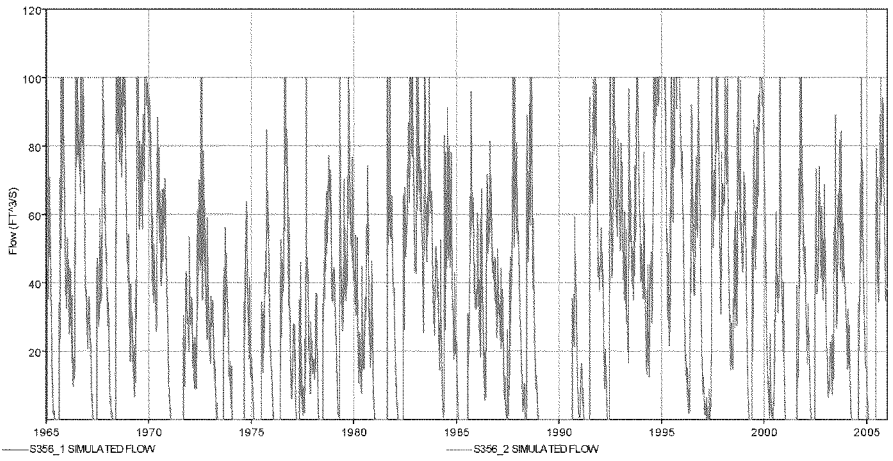


Figure 3.19. Utilization of the assumed L31N seepage return pumps in YL4.

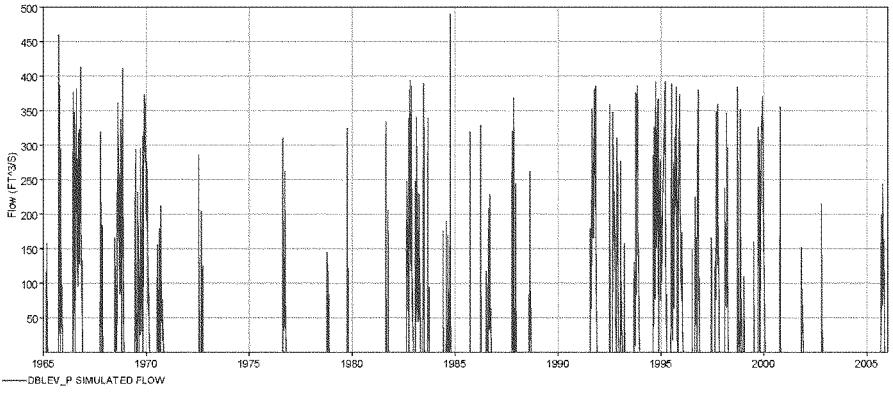


Figure 3.20. Seepage return from east of Pennsuco in YL5.

4.0 Identification of Screening Products

Final CEPP modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. This system can be accessed at http://www.evergladesplan.org/pm/progr_mms.aspx. CEPP modeling products in MMS can be accessed directly at the project page:

http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

Due to the large size of many of the CEPP modeling files, the majority of the modeling output has been archived in the Data Access Storage and Retrieval (DASR) application of CERPzone at www.cerpzone.org. CEPP modeling products in DASR can be accessed within the project modeling folder:

P:\IMC_Final_Modeling_Results\PROJ 51 - Central Everglades Planning

While the modeling products have been archived in the above systems, **Table 4.1** lists more specific information including model version, inputs used and detailed DASR archival location. Version numbers and "svnroot" paths refer to a model version control system found on the SFWMD network that is not generally accessible, but inputs, model executables and source code have been copied into the MMS system for ease of access.

In summary, the suite of screening modeling products identified in **Table 4.1** and as reviewed in Section 3 were deemed to adequately represent the intended project features assessed in screening and when used in the overall context of CEPP plan formulation (initial screening followed by more detailed modeling assessment as summarized in the other CEPP MDRs), were deemed to be suitable for use in various stages of project decision making.

Table 4.1. Version information and model file locations

Area	Model	Date	Simulation(s)	Notes	Input/Output
North of Redline	RESOPS V3.6	5/31/2012	Screening	DR6, DR12, etc...	Input: svnroot/trunk/CentEver/resops/Feature_Screening/
	RESOPS V3.6	5/31/2012	HML Flows	Screening_HML.xls	Input: svnroot/trunk/CentEver/resops/HML_Flows/RESOPS(V3.6)_Screening_HML.xls
	LOOPS v6.01beta	5/11/2012	HML Flows	high-scenarios, med-scenarios, low-scenarios	Input: svnroot/trunk/CentEver/loops/LOOPS_*.xlsm
	C43 Model v2.0	5/11/2012	HML Flows	HighEvg, MedEvg, LowEvg	Input: svnroot/trunk/CentEver/loops/C43_*.xlsm
Redline	RSMGL	7/31/2012	RLN_ALT1		Input: svnroot/trunk/CentEver/rsmgl/redline/RLN_ALT1, RLN_ALT2, RLN_ALT3, RLN_ALT4 Output (DASR): .../2PlanFormulation/3ConveyanceSeepage/Screening/redline/rsmgl_sensitivities/073112/rsmgl_model_output/RLN1,RLN2,RLN3,RLN4
		7/31/2012	RLN_ALT2		
		7/31/2012	RLN_ALT3		
		7/31/2012	RLN_ALT4		
Greenline	iModel	10/13/2012	Step 1	Green 1,Green2	Input: svnroot/trunk/CentEver/iModel/Step1_EqualWeights/
		10/19/2012	Step 2	3A-4, 3A-ZoneA, ENP_Marl, L29_8.0, L29_8.5, NO_L6, Site71_3BSeep,etc...	Input: svnroot/trunk/CentEver/iModel/Step2_TargetRefinement/
		10/25/2012	Step 3	10 options	Input: svnroot/trunk/CentEver/iModel/Step3_IdentifyInfrastructure/Round1
Blueline	RSMGL	07/27/2012	BL1_nsm0		Input: svnroot/trunk/CentEver/rsmgl/blueline/072712/BL1_nsm0, BL1_nsm25, BL1_nsm50, BL1_nsm75, BL1_nsm100 Output (DASR): .../2PlanFormulation/3ConveyanceSeepage/Screening/blueline/rsmgl_sensitivities_072712/rsmgl_model_output/NSM0, NSM25, NSM50, NSM75, NSM100
			BL1_nsm25		
			BL1_nsm50		
			BL1_nsm75		
			BL1_nsm100		
Yellowline	RSMGL	11/05/2012 Round1	BL1_nsm25_WS		Input: svnroot/trunk/CentEver/rsmgl/yellowline/Round1/BL1_nsm25, BL1_nsm25_WS2, BL1_nsm25_WS3, BL1_nsm25_WS3.1, BL1_nsm25_WS4 Output (DASR): .../2PlanFormulation/3ConveyanceSeepage/Screening/yellowline/rsmgl_sensitivities_110512/rsmgl_model_output/WS2, WS3, WS4
			BL1_nsm25_WS2		
			BL1_nsm25_WS3		
			BL1_nsm25_WS3.1		
			BL1_nsm25_WS4		
		11/13/2012 Round2	YL0		Input: svnroot/trunk/CentEver/rsmgl/yellowline/Round2/YL0, YL1, YL2, YL3, YL4, YL5 Output (DASR): .../2PlanFormulation/3ConveyanceSeepage/Screening/yellowline/rsmgl_sensitivities_111312/rsmgl_model_output/YL0, YL1, YL2, YL3, YL4, YL5
			YL1		
			YL2		
			YL3		
			YL4		
			YL5		

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Appendix A
Screening Products from North of Redline RESOPS Screening

Table A.1. CEPP RESOPS Screening Products.

Graph ID #*	General Vicinity	Tier	Horizontal Axis	Vertical Axis	Performance Surface (Optional)	Eco - Logic (Optional)	Notes
1	Red Line	1	Shallow Reservoir (4 ft)	STA in addition to 3+4 and Comp B.	Total Flows to Everglades		Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
2	Red Line	1	Shallow Reservoir (4 ft)	STA in addition to 3+4 and Comp B.	Everglades Dry Standard Score	Muck Fire Index / Soil Oxidation	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
3	Red Line	1	Shallow Reservoir (4 ft)	STA in addition to 3+4 and Comp B.	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
4	Red Line	1	Deep Reservoir (12 ft)	STA in addition to 3+4 and Comp B.	Total Flows to Everglades		Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
5	Red Line	1	Deep Reservoir (12 ft)	STA in addition to 3+4 and Comp B.	Everglades Dry Standard Score	Muck Fire Index / Soil Oxidation	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
6	Red Line	1	Deep Reservoir (12 ft)	STA in addition to 3+4 and Comp B.	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
7	Red Line	1	Deep Reservoir (6 ft)	STA in addition to 3+4 and Comp B.	Total Flows to Everglades		Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
8	Red Line	1	Deep Reservoir (6 ft)	STA in addition to 3+4 and Comp B.	Everglades Dry Standard Score	Muck Fire Index / Soil Oxidation	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
9	Red Line	1	Deep Reservoir (6 ft)	STA in addition to 3+4 and Comp B.	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
10	Red Line	1	Flow-Through Wetland	STA in addition to 3+4 and Comp B.	Total Flows to Everglades		Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
11	Red Line	1	Flow-Through Wetland	STA in addition to 3+4 and Comp B.	Everglades Dry Standard Score	Muck Fire Index / Soil Oxidation	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs
12	Red Line	1	Flow-Through Wetland	STA in addition to 3+4 and Comp B.	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Constrained to Maintain Lake O. Performance and meet WQBEL; Limit axis ranges to Talisman footprint; Display costs

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Graph ID #*	General Vicinity	Tier	Horizontal Axis	Vertical Axis	Performance Surface (Optional)	Eco - Logic (Optional)	Notes
~~13~~	~~Red Line~~	~~1~~	~~Total Flows to Everglades~~	~~"Pulse Flow" Measure of Everglades Inflow Variability~~		~~Hydrologic Surrogate for Flow Velocity~~	~~Constrained to meet WQBEL. Assumes no "Clean" storage.~~ Note: Tier 1 outcomes indicate relatively small changes in performance when "pulse" operations of monthly duration are attempted. Non-modeling sources of information should be considered (e.g., STA vegetation viability, engineering considerations, etc....) in assessing the feasibility of "pulse" discharges.
~~14~~	~~Red Line~~	~~1~~	~~STA in addition to 3+4 and Comp B.~~	~~Shallow Reservoir (4 ft)~~	~~STA Supplemental Water Supply from Lake~~		~~Constrained to Maintain Lake O. Performance and meet WQBEL;~~ ~~Limit axis ranges to Talisman footprint~~ Note: Tier 1 outcomes indicate relatively small water supply need in STAs due to Lake environmental release operations; this will be further examined during detailed modeling.
~~15~~	~~Red Line~~	~~1~~	~~Strategic ASR~~	~~STA Supplemental Water Supply from Lake~~			~~Illustrate for multiple STA sizing configurations.~~ Note: Tier 1 outcomes indicate relatively small water supply need in STAs due to Lake environmental release operations; this will be further examined during detailed modeling.
16	Red Line	2	Storage & STA Components	Total Flows to Everglades			Constrained to Maintain Lake O. Performance and meet WQBEL; Illustrate for different types of storage (shallow, deep, flow-through wetland)
17	Red Line	2	Storage & STA Components	Everglades Dry Standard Score			Constrained to Maintain Lake O. Performance and meet WQBEL; Illustrate for different types of storage (shallow, deep, flow-through wetland)
18	Red Line	2	Storage & STA Components	% Reduction in Damaging Northern Estuary Discharges			Constrained to Maintain Lake O. Performance and meet WQBEL; Illustrate for different types of storage (shallow, deep, flow-through wetland)
19	Red Line	2	High Lake O. Performance	Low Lake O. Performance			Used to identify operational flexibilities in Lake Okeechobee; Will assume feasible flows south from Tier 1 outputs.
20	Red Line	2	High Lake O. Performance	Low Lake O. Performance	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Used to identify operational flexibilities in Lake Okeechobee; Will assume feasible flows south from Tier 1 outputs.
21	Red Line	2	High Lake O. Performance	LOSA Water Supply Performance			Used to identify operational flexibilities in Lake Okeechobee; Will assume feasible flows south from Tier 1 outputs.
22	Red Line	2	High Lake O. Performance	Low flows to Caloosahatchee Estuary			Used to identify operational flexibilities in Lake Okeechobee; Will assume feasible flows south from Tier 1 outputs.

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Graph ID #*	General Vicinity	Tier	Horizontal Axis	Vertical Axis	Performance Surface (Optional)	Eco - Logic (Optional)	Notes
23	Red Line	2	% Reduction in Damaging Northern Estuary Discharges	Low flows to Caloosahatchee Estuary		Hydrologic Surrogate for Flow Velocity	Constrained to meet WQBEL. Assumes availability of "Clean" storage.
~~24~~	~~Red Line~~	~~3~~	~~Total Flows to Everglades~~	~~"Pulse Flow" Measure of Everglades Inflow Variability~~		~~Hydrologic Surrogate for Flow Velocity~~	~~Constrained to meet WQBEL. Assumes availability of "Clean" storage~~. Note: Tier 1 outcomes indicate relatively small changes in performance when "pulse" operations of monthly duration are attempted. Non-modeling sources of information should be considered (e.g., STA vegetation viability, engineering considerations, etc...) in assessing the feasibility of "pulse" discharges.
25	Red Line	2	Flows to Holeyland (from STA34)	Everglades Dry Standard Score			Constrained to meet WQBEL & Holeyland inflow water quality standards.
26	Red Line	2	Flows to Holeyland (from STA34)	Total Flows to Everglades			Constrained to meet WQBEL & Holeyland inflow water quality standards.
27	Red Line	2	Flows to Holeyland (from Talisman)	Everglades Dry Standard Score			Constrained to meet WQBEL & Holeyland inflow water quality standards.
28	Red Line	2	Flows to Holeyland (from Talisman)	Total Flows to Everglades			Constrained to meet WQBEL & Holeyland inflow water quality standards.
29	Red Line	1	Storage & STA Components	Trend Lines for Everglades and Estuary Performance			Shallow Reservoir (4 ft); Display Multiple Axes
30	Red Line	1	Storage & STA Components	Trend Lines for Everglades and Estuary Performance			Deep Reservoir (12 ft); Display Multiple Axes
31	Red Line	1	Storage & STA Components	Trend Lines for Everglades and Estuary Performance			Deep Reservoir (6 ft); Display Multiple Axes
32	Red Line	1	Storage & STA Components	Trend Lines for Everglades and Estuary Performance			Flow-Through Wetland; Display Multiple Axes
33	Red Line	1	Deep Reservoir (12 ft)	STA in addition to 3+4 and Comp B.	Total Flows to Everglades		Constrained to Maintain Lake O.Performance and meet WQBEL; Display axis ranges beyond Talisman footprint; Display costs
34	Red Line	1	Shallow Reservoir (4 ft)	STA in addition to 3+4 and Comp B.	% Reduction in Damaging Northern Estuary Discharges	Oyster Viability	Constrained to Maintain Lake O.Performance and meet WQBEL; Display axis ranges beyond Talisman footprint; Display costs

*Graph ID #s refer to PDT #6 presentation graphics (in DASR under Project 51-Central Everglades Planning, Model_Documentation)

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Appendix B
Structure Operations in South Miami-Dade County for CEPP Yellowline Round 2 Runs

In **Table B.1**, the list of structures is color-coded in three groupings:

green	Structures on the L-67, L-28, and L-29 canals. Structures included are S-345, S-349, S-344, S-343A-B, S-12A-D, S-333, S-334, S-355, and S-356
blue	Structures on the L-30 and part of the L-31 canals Structures included are S-337, S-151, S-335, S-338, G-211, S-173 & S-331P (COMBQ), S-176 and S-174
yellow	Structures on part of the L-31 canal and L-31W and C-111 canals Structures included are S-332A-D, S-357, S-332, S-175, S-200, S-199, S-177, S-18C, S-197 and S-332E

Table B.1 includes the six Yellowline Round 2 runs (YL0, YL1, YL2, YL3, YL4 and YL5).

Table B.1 Yellowline Round 2 Alternatives (YL0, YL1, YL2, YL3, YL4, YL5)

Canal	Structure	YL0 (RSMGL)	YL1 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	Non-existent	Non-existent
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only	Special code 1) Closed Nov 1- Jul15 2) flood control only
L-29	S-12A-D*	Not operated, flows are imposed	Not operated, flows are imposed
	S-333*	Not operated, flows are imposed	Not operated, flows are imposed
	S-334	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs
	S-355*	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.
	S-356*	Special code 1) Pumping limited to the amount of seepage into L-31N 2) Flood control 3) Pumped into L-29 4) L-29 constraint 9.7, G3273 constraint 6.8. 5) S356 = 1000 cfs.	Special code 1) Pumping limited to the amount of seepage into L-31N 2) Flood control 3) Pumped into L-29 4) L-29 constraint 9.7, G3273 constraint 6.8. 5) S356 = 1000 cfs.

Canal	Structure	YL2 (RSMGL)	YL3 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	Non-existent	Non-existent
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only	Special code 1) Closed Nov 1- Jul15 2) flood control only
L-29	S-12A-D*	Not operated, flows are imposed	Not operated, flows are imposed
	S-333*	Not operated, flows are imposed	Not operated, flows are imposed
	S-334	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs
	S-355*	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.
	S-356*	Special code 1) Pumping limited to the amount of seepage into L-31N 2) Flood control 3) Pumped into L-29 4) L-29 constraint 9.7, G3273 constraint 6.8. 5) S356 = 1000 cfs.	Flood Control, Pumpedinto L29. S356 dischar=500; Rule Curve s356 SeepFC designCap 01jan-31may = 0 cfs; 01jun-15jul=500 cfs; 16jul-30nov=0 cfs; 01dec-31dec=500cfs: Rule curve s356 Seep designCap 01jan-31may=500cfs; 01jun-15jul=0 cfs; 16jul-30nov=500 cfs; 01dec-31dec=0: S cfs. Special code s356 Open=6.0 ft; s356 Close=5.5 ft; L29 constr=9.7 ft; G3273=9.5 ft.

Canal	Structure	YL4 (RSMGL)	YL5 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	Non-existent	Non-existent
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only	Special code 1) Closed Nov 1- Jul15 2) flood control only
L-29	S-12A-D*	Not operated, flows are imposed	Not operated, flows are imposed
	S-333*	Not operated, flows are imposed	Not operated, flows are imposed
	S-334	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs
	S-355*	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.	1) S355 A and B Modeled Design Q = 1000 cfs each, 2) Flood control only 3) Not operated per special code (FC). Any available water u/s is passed thru the structure under gravity.
	S-356*	Special code 1) Pumping limited to the amount of seepage into L-31N 2) Flood control 3) Pumped into L-29 4) L-29 constraint 9.7, G3273 constraint 6.8. 5) S356 designCap=500 cfs,dischar = 500 cfs, s356_1 designCap=100 cfs, dischar=100 cfs, open/close=6.0/5.5; s356_2 designCap=100 cfs dischar=100 cfs open/close=6.0/5.5.	Special code 1) Pumping limited to the amount of seepage into L-31N 2) Flood control 3) Pumped into L-29 4) L-29 constraint 9.7, G3273 constraint 6.8. 5) S356 = 500 cfs.

Canal	Structure	YL0 (RSMGL)	YL1 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Not operated, flows are imposed	Not operated, flows are imposed
	S-335	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=2.5926E-05; Kms=1.474070E-02; Mash cell id=2983	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=0.0000000E-00; Kms=0.0000000E-00; Marsh cell id=2983

Canal	Structure	YL2 (RSMGL)	YL3 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Not operated, flows are imposed	Not operated, flows are imposed
	S-335	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=2.5926E-05; Kms=1.474070E-02; Mash cell id=2983	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=2.5926E-05; Kms=1.474070E-02; Mash cell id=2983

Canal	Structure	YL4 (RSMGL)	YL5 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		Water Supply & Flood Control designCap=1100 cfs; mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Not operated, flows are imposed	Not operated, flows are imposed
	S-335	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0; s335_1 flood control designCap=100 cfs dischar=100 cfs open/close=7.5/7.2 ft; s335_2 flood control designCap=100 cfs, dischar=100 cfs, open/close=7.5/7.2 ft; s335_3 flood control designCap=100 cfs, dischar=100 cfs, open/close=7.5/7.2 cfs. mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=2.5926E-05; Kms=1.474070E-02; Mash cell id=2983	**7.5/ 7.2** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd=2.5926E-05; Kms=1.474070E-02; Mash cell id=2983

Canal	Structure	YL0 (RSMGL)	YL1 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve; Seepage across L31N north of G211 Kmd=2.6041670E-03; Kms=6.7778771E-03; Marsh cell id=7542	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N;L31N localLevel=99.0 no rulecurve; Seepage across L31N north of G211 Kmd=0.0000000E-00; Kms=0.0000000E-00; Marsh cell id=7542
	S-173 & S-331P (COMBQ) *	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	YL2 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	YL3 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0 Seepage across L30 south of S335 Kmd and Kms values changed at several marsh cell id relative to those at YL0. Marsh cell ids are 3208, 3437, 3663, 3664, 3666, 3672, 2983.	Rule Curve s338 Open 01jan = 5.6 ft; 31may=5.6 ft; 01jun=5.8 ft; 31dec=5.8 ft: Rule curve s338 Close 01jan=5.4s; 31may=5.4 ft; 01jun=5.5 ft; 31dec=5.5 ft.
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve; Seepage across L31N. Kmd and Kms values changed relative to YL0 at 7542, 7540, 7551, 7550, 2972, 2971, 3186, 2966.	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N;L31N localLevel=99.0 no rulecurve.
	S-173 & S-331P (COMBQ) *	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	YL4 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	YL5 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve; Seepage across L31N north of G211 Kmd=2.6041670E-03; Kms=6.7778771E-03; Marsh cell id=7542	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply only 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N;L31N localLevel=99.0 no rulecurve.
	S-173 & S-331P (COMBQ) *	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply only 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	YL0 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	YL1 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	YL2 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	YL3 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	YL4 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	YL5 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	YL0 (RSMGL)		YL1 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65
		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:		**6.2 / 5.7** open/closed wet & dry season s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:	
L-31W	S-332 (pumps)*	s332BN 5.0/4.7 ft twHeadLimit 8.789 ft; s332B 5.0/4.7 ft twHeadLimit 7.866 ft; s332C 5.0/4.7 ft twHeadLimit 7.866 ft		s332BN 5.0/4.7 ft twHeadLimit 8.789 ft; s332B 5.0/4.7 ft twHeadLimit 7.866 ft; s332C 5.0/4.7 ft twHeadLimit 7.866 ft	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Canal	Structure	YL2(RSMGL)		YL3 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65
		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	**6.2 / 5.7** open/closed wet & dry season s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:		**6.2 / 5.7** open/closed wet & dry season s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:	
L-31W	S-332 (pumps)*	s332BN 5.0/4.7 ft twHeadLimit 8.789 ft; s332B 5.0/4.7 ft twHeadLimit 7.866 ft; s332C 5.0/4.7 twHeadLimit 7.866 ft		s332BN 5.0/4.7 ft twHeadLimit 8.789 ft; s332B 5.0/4.7 ft twHeadLimit 7.866 ft; s332C 5.0/4.7 ft twHeadLimit 7.866 ft	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Canal	Structure	YL4 (RSMGL)		YL5 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65
		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	**6.2 / 5.7** open/closed wet & dry season s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:		**6.2 / 5.7** open/closed wet & dry season s357A flood control designCap=250 cfs. twHeadLimit=12.17 ft; rule curve s357A Open 01nov-31may 5.7 ft 01jun-31oct=5.2 ft; rule curve s357A Close 01nov-31may 5.4 ft 01jun-31oct 4.9 ft; s357B flood control designCaop=250 cfs, twHeadLimit=12.17 ft rule curve s357B Open 01nov-31may=6.0 ft 01jun-31oct=5.5 ft; rule curve s357B Close 01nov-31may=5.7 01jun-310ct=5.2 ft:	
L-31W	S-332 (pumps)*	s332BN 5.0/4.7 ft twHeadLimit 8.789 ft; s332B 5.0/4.7 ft twHeadLimit 7.866 ft; s332C 5.0/4.7 twHeadLimit 7.866 ft		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Central Everglades Planning Project (CEPP) Baseline Runs Model Documentation Report

IMC MSR 368 **February 14, 2014**

1.0 Overview

Identification

The Central Everglades Planning Project (CEPP) is an expedited planning effort undertaken as part of the overall Comprehensive Everglades Restoration Plan (CERP), a program led by the United States Army Corps of Engineers (USACE) with the South Florida Water Management District (SFWMD) as local sponsor. The project worked throughout 2012 and 2013 to develop a Project Implementation Report (PIR) that combines planning and design activities for three primary areas of interest in the south Florida system as follows: 1) Storage & water treatment facilities in the Everglades Agricultural Area, 2) Decompartmentalization of levees within the Everglades Protection Area (EPA) and 3) Levee seepage management features along the Everglades / urban boundary in southeastern Florida. Modeling support to the CEPP effort was provided by a team comprised of modelers from the Hydrologic & Environmental Systems Modeling Section of the SFWMD and the Interagency Modeling Center (IMC), with direct support also provided by the USACE and Everglades National Park of the Department of the Interior (DOI). Modeling workflow and coordination were performed in a manner consistent with the procedures outlined in IMC Modeling Services Request (MSR) 368 and the CEPP Modeling Strategy (**SFWMD, 2012a**).

Scope and Objectives

Modeling support for CEPP focused on working with the larger project planning team and other interested parties to formulate and test project features leading to the ultimate identification and refinement of a tentatively selected plan (TSP). Modeling products were developed at the appropriate level of detail to support feature screening and detailed representation of project features and to provide information to all necessary evaluations required for plan development and documentation in the PIR. The project plan formulation framework is shown in **Figure 1.1** and illustrates a spatially determined workflow (moving north to south through the south Florida system) utilizing initial screening followed by detailed evaluation to identify final project planning alternatives and ultimately a TSP for the effort.

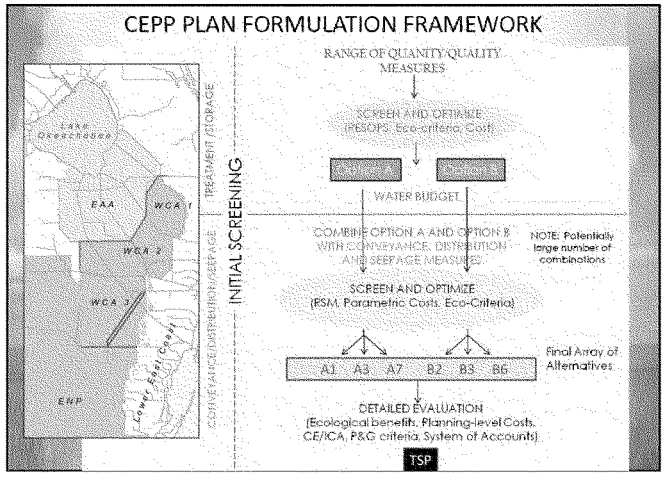


Figure 1.1. Central Everglades Planning Project Plan Formulation Framework

The CEPP Modeling Strategy document (**SFWMD, 2012a**) describes the modeling process and tools utilized, the associated rationale of the selection process and the means by which the tools could expediently support the project workflow. The primary model support tools utilized in CEPP are as follows:

Screening Tools:

- REservoir Sizing and OPerations Screening (RESOPS)
- Lake Okeechobee OPerations Screening (LOOPS)
- C-43 Spreadsheet Model
- iModel©

Detailed Planning Models:

- Regional Simulation Model Basins (RSMBN)
- Regional Simulation Model Glades-LECSA (RSMGL)
- Dynamic Model for Stormwater Treatment Areas (DMSTA)

From a modeling deliverable perspective, the entirety of the CEPP modeling support can be summarized by reviewing the following four Model Documentation Reports (MDRs):

1. CEPP Baseline Runs – Reviews the various non-CEPP model representations (e.g. current and future without project conditions) used in various aspects of the project planning (this document).
2. CEPP Final Array of Alternatives – Reviews four proposed with-CEPP project model representations examined during plan formation (**SFWMD & IMC, 2014b**).
3. CEPP Tentatively Selected Plan – Reviews the model representation of the CEPP TSP and subsequent refinements during final plan formulation and project assurance planning (**SFWMD & IMC, 2014c**).
4. CEPP Model Supported Screening Efforts – Reviews the various model-supported feature screening efforts undertaken at various points in the planning process (**SFWMD & IMC, 2014d**).

This Baseline Runs MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling representations of the current and future without project condition model scenarios. These model runs were predominantly used as a basis of comparison for many of the evaluations performed in support of plan formulation or project assurances assessment. This document will focus on the modeling details of these scenarios; information on the use and rationale for the definition of these conditions is contained in the CEPP PIR (**USACE, 2013b**).

2.0 Basis

Project Assumptions

This Baseline Runs MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling the following scenarios:

CEPP Final Plan Formulation Baselines - released 12/13/2012
- 2010 / 2011 Existing Condition Baseline (ECB)
- 2050 Future Without Project Baseline (FWO)

CEPP Final Project Assurances Baselines - released 6/3/2013
- 2012 Existing Condition Baseline (2012EC)
- 2050 Initial Operating Regime Baseline (IORBL1)

In general, the existing conditions baseline scenarios attempt to model assumed hydrologic conditions circa a defined date (e.g. November 2011 at CEPP project initiation for the ECB scenario) and include current system infrastructure assumptions and current operational practices. In general, the future projected 2050 conditions include, relative to existing conditions, additional representations of planned future project activities, including state, federal and CERP projects. It is important to note that since various parts of the CEPP planning effort initiated at different times (e.g. assurances work was subsequent to plan formulation work), the information available for any particular baseline may be slightly different as current system or future planned project activities evolve with time.

Detailed project assumption tables for each scenario are provided in **Appendix A** and key elements of model implementation are described in Section 3.

Model Limitations and Intended Use of Results

The primary modeling products of CEPP 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, 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 RSMBN, RSMGL (**SFWMD, 2010** and **2011**), and DMSTA (**Walker & Kadlec, 2005**; **Wang, 2012**) models were reviewed through the USACE validation process for engineering software,

as part of the CEPP project. The RSM and DMSTA models were classified as "allowed for use" for South Florida applications in August 2012 and January 2013, respectively. Additionally, the RESOPS (**SFWMD, 2009**), LOOPS (**Neidrauer et al, 2006**), and C-43 spreadsheet model (**Starnes & Marlowe, 2007**) tools and the iModel optimization tool (**Ali, 2009**) used in CEPP underwent USACE Agency Technical Review (ATR). Approval of these modeling tools for CEPP application was completed in November, 2012.

3.0 Simulation

Modeling Tools Used

RSM version 2.3.5 was used to run both the RSMBN and RSMGL models.
Release date 12/6/2012, SVN Version #4730.

Model Set Up

The CEPP baseline scenarios were developed using the decoupled RSMBN and RSMGL models. Collectively, these two models cover the spatial extent of the project planning area as shown in **Figure 3.1**. The RSMBN modeling for CEPP was built as an extension of the Northern Everglades RSM (**SFWMD et al, 2009a** and **2009b**) with expanded capabilities in the areas generally south of Lake Okeechobee while the RSMGL modeling for CEPP was built from the baseline scenarios developed for the DECOMP project (**SFWMD, 2010; SFWMD, 2011**). The period of simulation for both models utilizes a climate record from 1965 to 2005.

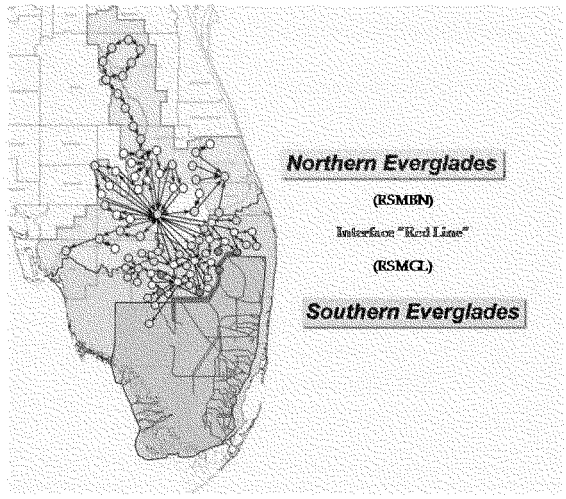


Figure 3.1. Decoupled CEPP Modeling Approach using RSMBN and RSMGL models.

Relative to the previous versions of the RSMBN and RSMGL models referenced, the following changes in model structure, extent or parameterization were made prior to or coincident with the development of the baseline scenarios:

- RSMBN simulation period was extended to a 1965-2005 period of simulation (NERSM modeling used 1970-2005); no additional verification was completed for the 1965-1969 period for CEPP application of RSMBN.
- The RSMBN was spatially expanded into areas south of Lake Okechobee, including the Everglades Agricultural Area (EAA) and the Western Basins.
- For the RSMBN Major EAA Basins (Miami, North New River-Hillsboro, West Palm Beach) the following modeling approach was implemented:
    - Major EAA and other, smaller basins (e.g. 298 districts) were delineated using GIS and stage-storage-surface area relationships were derived for each basin.
    - Three parameters (Kcalib for evapotranspiration, FcLevel & MaintLevel) were manually adjusted to match monthly simulated runoff and demand => total of 36 parameters
    - Matching of EAA runoff and demand based on long-term (1965-2005) monthly averages with the goal of close correspondence to the estimation produced by the South Florida Water Management Model (refrence to SFWMM primer), which is calibrated to historical data.
    - Example results are shown in **Figures 3.1 and 3.2** and **Table 3.1**.

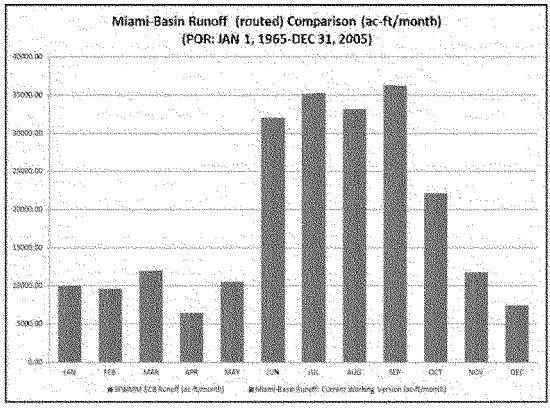


Figure 3.2. Validation of RSMBN Seasonal Runoff Variability for the Miami Canal Basin

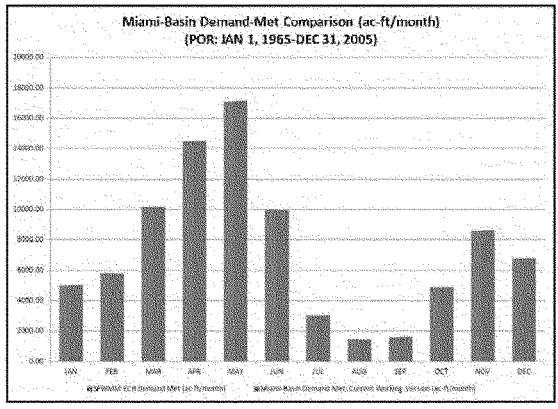


Figure 3.3. Validation of RSMBN Seasonal Supplemental Demand Variability for the Miami Canal Basin

Table 3.1. Long Term Average Validation of RSMBN Supplemental Demand and Runoff for Major EAA Basins

1965-2005 Annual Average Simulated EAA Runoff/Demand (kac-ft)						
	Runoff			Demand		
	SFWMM	RSMBN	%DIFF	SFWMM	RSMBN	%DIFF
MIAMI BASIN	226.5	226.6	0.01	88.8	88.9	0.04
NNR-HILLS BASIN	484.3	484.7	0.07	141.1	141.0	0.06
WPB BASIN	283.8	283.8	0.01	87.4	87.4	0.01

- For RSMBN Stormwater Treatment Areas (STA1, STA2, STA3/4, STA5 & STA6), the following modeling approach was implemented:
  - Flow within each STA was approximated using overland flow equation (weir outflow equation) used in the DMSTA model
  - "Soft" calibration was performed on standalone STA model applications
    - Rainfall reference evapotranspiration and total inflows were imposed
    - Stages, seepage and total outflows were simulated
    - Historical stages and flows (period-of-simulation varies by STA depending on available historical data) were matched by adjusting DMSTA flow coefficient

- In RSMBN application, these derived physical parameters were utilized and all rainfall, evapotranspiration and flows were once again simulated.

- For 298 Districts (South Florida Conservancy District, South Shore Drainage District, 715 Farms, East Shore Drainage District, East Beach Drainage District), the following modeling approach was implemented:
  - Evaportranspirtastion characteristics were assumed to be similar to adjacent primary EAA basins such that FcLevel and MaintLevel were the only parameters used in matching historical runoff
  - Validation of flows was performed for runoff data available from 1994-2005
  - Example results are shown in **Figure 3.3** and **Table 3.2.**

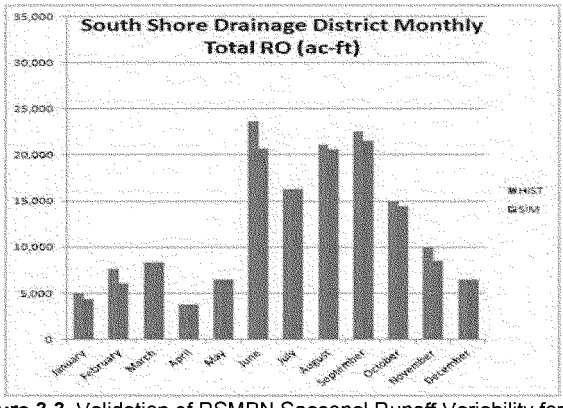


Figure 3.3. Validation of RSMBN Seasonal Runoff Variability for the South Shore Drainage 298 District

Table 3.2. Long Term Average Validation of RSMBN Runoff for 298 Districts

TOTAL RUNOFF FROM 298 DISTRICTS (May 1, 1994-Dec. 31, 2005)		
	WET SEASON (kac-ft)	DRY SEASON (kac-ft)
HISTORICAL	61.02	30.58
RSMBN	59.00	27.74
% DIFF	-3.31	-9.29

- For the Western Basins, the C139RSM implementation described by Flaig (2011a, 2011b), was coupled to the RSMBN model.
- RSMGL simulation period was extended to a 1965-2005 period of simulation (Decomp modeling used 1965-2000); no additional verification was completed for the 2001-2005 period for CEPP application of RSMGL.

- RSMGL parameters effecting the dynamics of levee seepage and regional groundwater flux (as described in the RSMGL calibration report) along the L31N reach in northern Miami-Dade county were revised based on provisional information obtained from field work being performed in that locality at the time of project initiation. Initial calibration of RSMGL was updated using application of an Analytic Element Model to refine the cross sectional hydrogeological representation in the model. This exercise resulted in a change in the relative ratio of flow into the L31N canal vs flow in the groundwater column of the surficial aquifer, moving from a previously assumed ~90/10 ratio to an updated ~70/30 ratio. It was verified that resulting changes to a re-run RSMGL calibration sensitivity did not significantly alter RSMGL calibration statistics or model goodness of fit measures.

The remainder of this section will focus on the project plan formation baselines of the ECB and FWO scenarios to describe model implementation. A short description near the end of the section will explain the relatively minor modifications included in the project assurances scenarios of 2012EC and IORBL1.

In general, the assumed modeled data sets (e.g. topography, water control districts, etc...) and/or system features (structure operations, etc...) are consistent with the previous planning exercises, unless identified as changed in this section or the assumptions tables in Appendix A. The CEPP project team identified the following primary datasets for use across all the baseline scenarios:

- Lake Okeechobee Service Area permit information as of 2/21/12 (**Figure 3.5**)
- LEC Public Water Supply: 2010 consumptive use permit information as documented in the C-51 Reservoir project (**Figure 3.6**)
- Industrial pumpage and Residential Self-Supplied using 2030 projected by SFWMD Water Supply Bureau (LECWSP)
- LEC Land Use: 2008-2009 coverage; consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information.

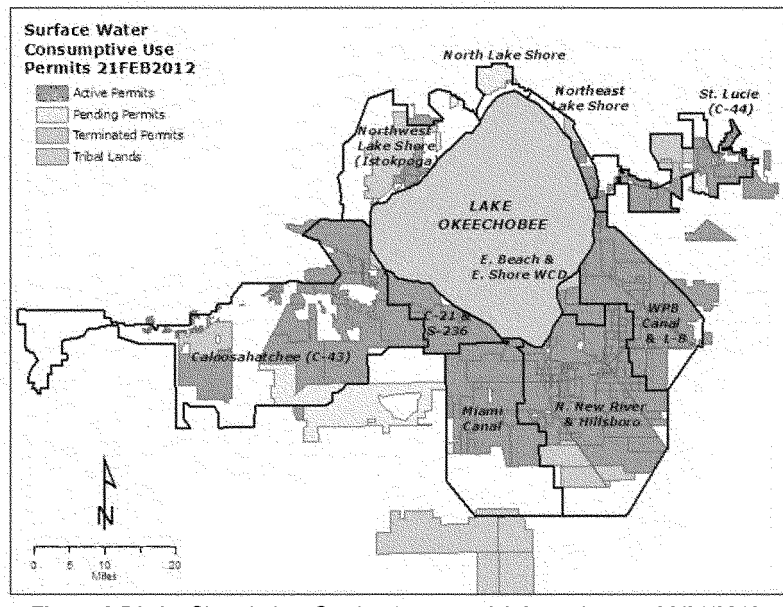


Figure 3.5 Lake Okeechobee Service Area permit information as of 2/21/2012.

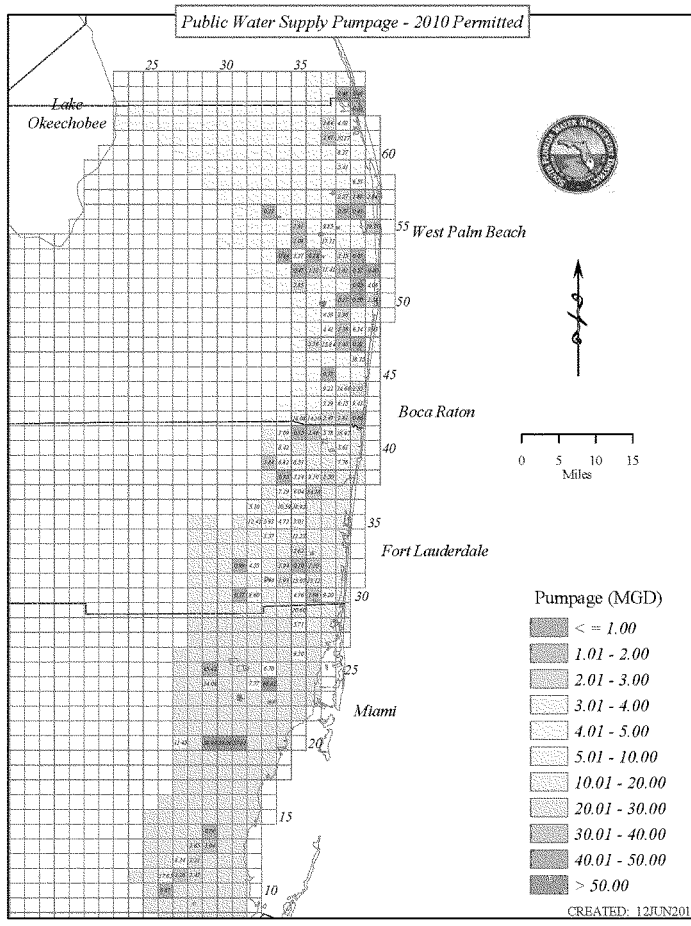


Figure 3.6. Lower East Coast Public Water Supply 2010 Consumptive Use permit information (Source: C-51 Reservoir Project)

The LORS08 schedule is used for operation of Lake Okeechobee in all CEPP baselines. Details of the model implementation of the schedule can be found in **Appendix B**.

A number of key model updates to assumed FWO projects were undertaken in CEPP as shown in **Figure 3.7**. The subsequent sub-sections will explain the modeling setup for each area as assumed in the ECB and FWO scenarios. Details about project intent can be found in the associated project reports for each effort.

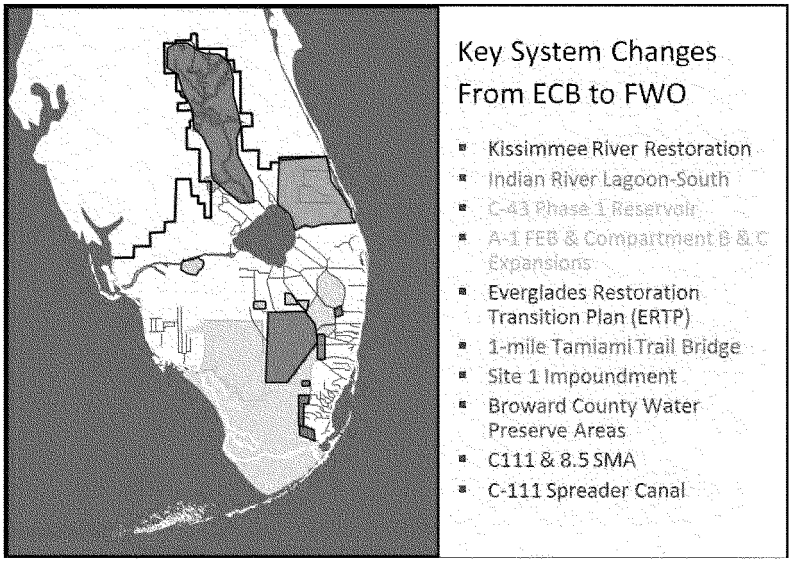


Figure 3.7. Key system updates differentiating the ECB (existing condition baseline) and FWO (future condition without project baseline) model runs.

Kissimmee River Restoration

Several projects seek to improve the water resource management and ecosystem performance for the Kissimmee River and the Upper Chain of Lakes (**SFWMD, 2007**). As considered in the RSMBN model, the following assumptions are made for operations at S65 and state of Kissimmee River restoration moving from ECB to FWO:

- Modification to the Lake Kissimmee regulation schedule for releases at S65 as seen in **Figures 3.8** and **3.9**.
- Physical alterations in the Lower Kissimmee River and flood plain representation as seen in **Figure 3.10**.

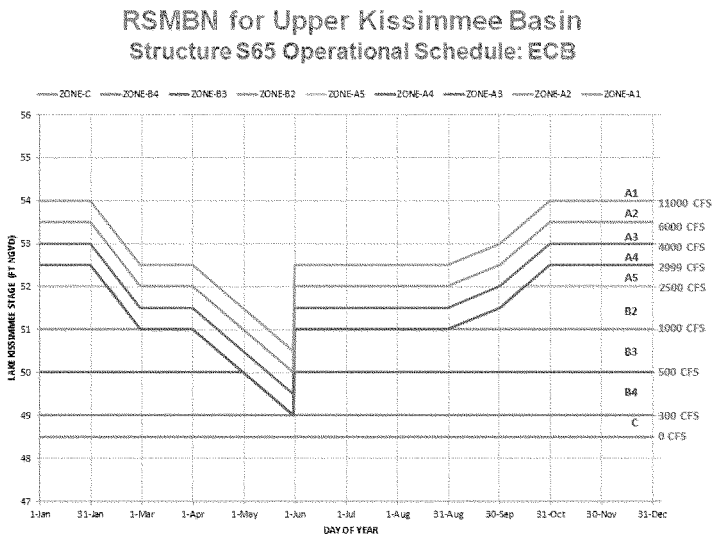


Figure 3.8. Lake Kissimmee Regulation Schedule for releases at S65 structure for the ECB run.

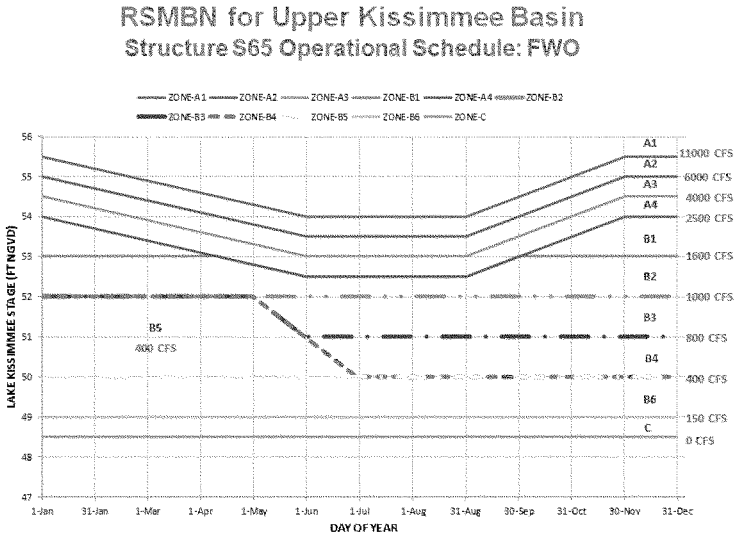


Figure 3.9. Lake Kissimmee Regulation Schedule for releases at S65 structure for the FWO run.

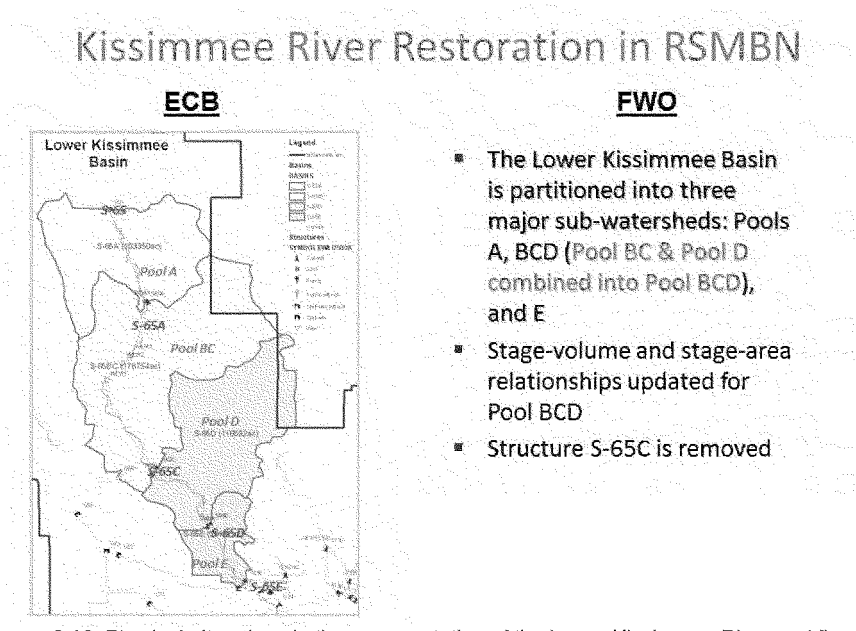


Figure 3.10. Physical alterations in the representation of the Lower Kissimmee River and flood plain between baseline runs ECB and FWO.

Indian River Lagoon-South

The purpose of the IRL South and Ten Mile Creek projects is to improve surface-water management in the C-23/C-24, C-25, and C-44 basins for habitat improvement in the Saint Lucie River Estuary and southern portions of the Indian River Lagoon. **Figures 3.11 and 3.12** show the model configuration for the RSMBN ECB and FWO run, respectively:

General FWO Project Features

- Consistent with latest CERP Indian River Lagoon – South DDRs that update the authorized 2004 PIR.
- Includes operational intent (Opti6) per St Lucie River Watershed Protection Plan (January 2009) to meet St. Lucie estuary environmental targets.
- Basin demands can be met by project features.

C44 Reservoir and STA

- Storage capacity: 50,246 acre-feet
- Footprint: 12,125 acres (assumed 9700 effective acres / 80%)
- Inlet: 1060 cfs capacity, modeled as pump; source: C44 Basin
- Inlet: 250 cfs capacity, modeled as pump; source: C23 Basin
- Outlet: 550 cfs capacity, modeled as pump; destination: C44 Basin
- Cannot divert Lake Okeechobee regulatory releases into storage

C23/24 Reservoir

- Storage capacity: 92,094 acre-feet
- Footprint: 8675 acres (assumed 6940 effective acres / 80%)
- Inlet: 900 cfs capacity, modeled as pump; source: C23 Bas
- Inlet: 900 cfs capacity, modeled as pump; source: C24 Basin
- Outlet: 300 cfs capacity, modeled as pump; destination: C23 Basin
- Outlet: 300 cfs capacity, modeled as pump; destination: C24 Basin
- Outlet: 200 cfs capacity, modeled as pump; destination: C23/C24 STA

C23/C24 STA

- Storage capacity: 3852 acre-feet
- Footprint: 3323 acres (assumed 2568 effective acres / 80%)
- Inlet: 200 cfs capacity, modeled as pump; source: C23/C24 Reservoir
- Outlet: 200 cfs capacity, modeled as pump; destination: TMC Basin

Ten Mile Creek Reservoir and STA

- Storage capacity: 7078 acre-feet
- Footprint: 820 acres (assumed 656 effective acres / 80%)
- Inlet: 360 cfs capacity, modeled as pump; source: TMC Basin
- Outlet: 200 cfs capacity, modeled as pump; destination: TMC Basin

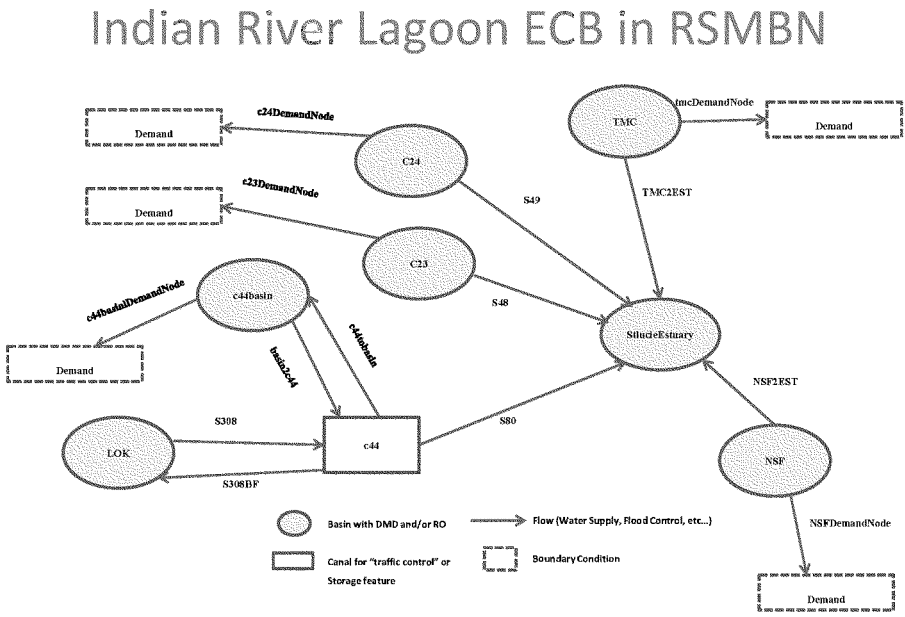


Figure 3.11. Indian River Lagoon-South routing in RSMBN for ECB run.

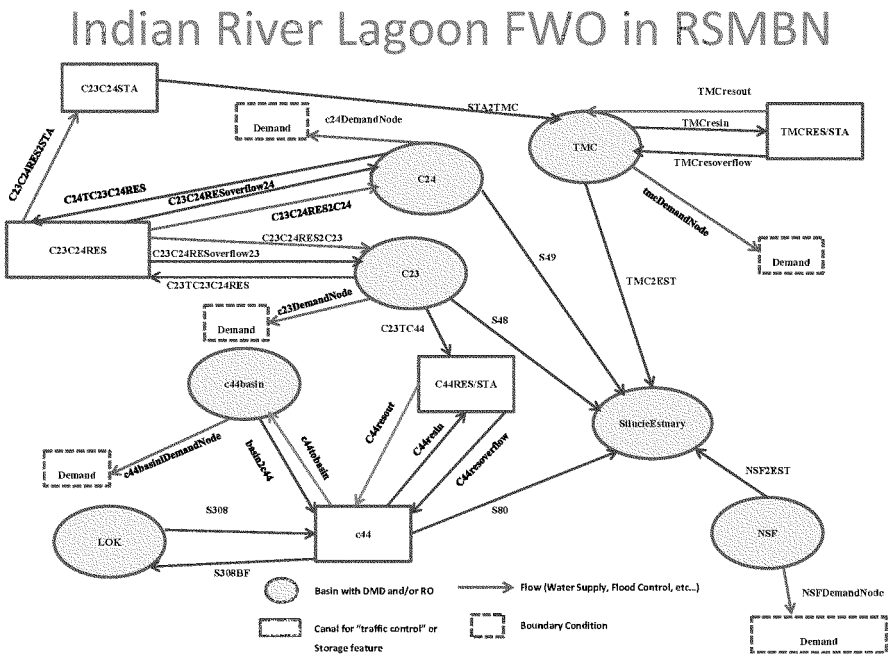


Figure 3.12. Indian River Lagoon-South routing in RSMBN for FWO run.

C-43 Phase 1 Reservoir

The purpose of the C-43 Basin Storage Reservoir - Part 1 project is to improve the timing, quantity, and quality of freshwater flows to the Caloosahatchee River estuary. **Figures 3.13 and 3.14** show the model configuration for the RSMBN ECB and FWO run, respectively:

- Modeled consistent with September 2007 PIR
- Storage capacity: 175,800 acre-feet
- Maximum footprint: 9,379 acres
- Inflow, capacity 1500 cfs, modeled as pump; destination: C43 Reservoir
- Outflow, capacity 1200 cfs modeled as pump; destination: C43 Canal
- Operates to meet estuary environmental target time-series (EST05)
- Can divert Lake Okeechobee regulatory releases into storage

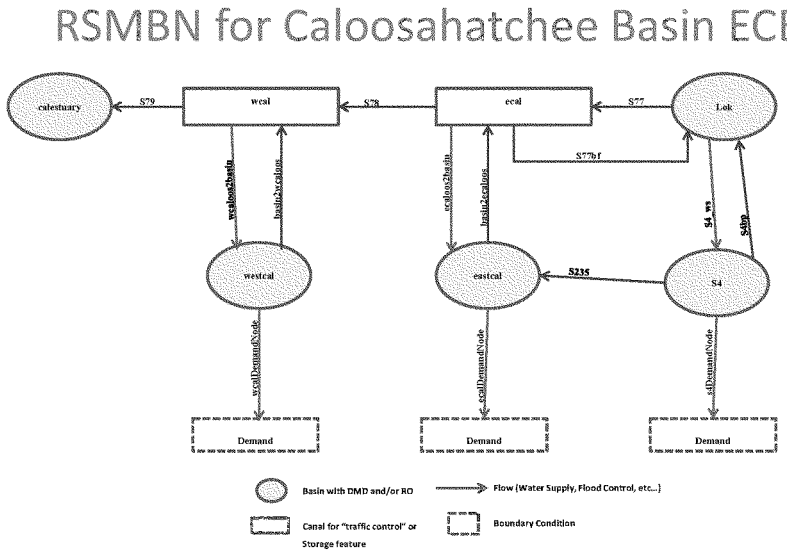


Figure 3.13. C43 Basin and Reservoir routing for ECB in RSMBN.

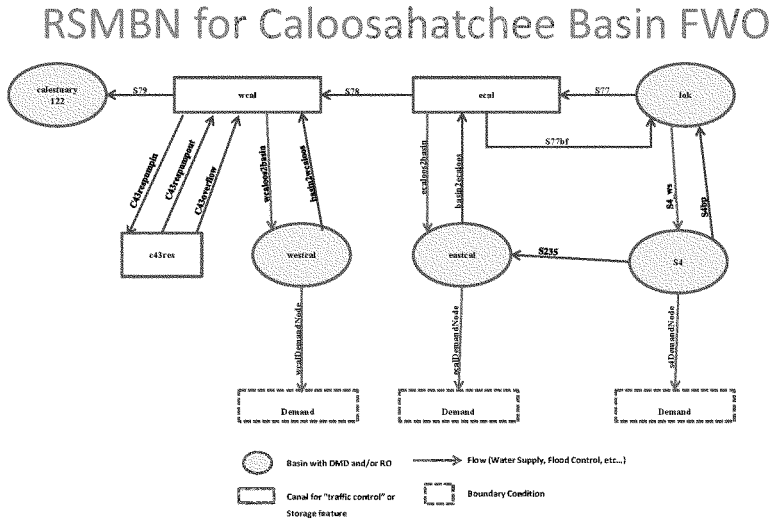


Figure 3.14. C43 Basin and Reservoir routing for FWO in RSMBN.

A-1 FEB & Compartment B & C Expansions

As part of the Everglades Construction Project and Restoration Strategies program, the state of Florida plans to expand water quality treatment facilities to improve the quality of water entering the Everglades Protection Area (see **Figure 3.15** for component locations). The FWO scenario assumes the following:

A-1 FEB Assumptions

- Assumed Flowage Equalization Basin Effective Footprint = 15,853 acres
- FEB operating limits:
  - EAA runoff accepted when FEB stage < 3.8 ft.
  - Lake Okeechobee flood control water can be accepted into FEB
  - Discharges discontinued when depths < 0.5 ft.
  - No supplemental water supply provided to FEB.
  - FEB outflows are used to help meet established inflow targets, as estimated using the Dynamic Model for Stormwater Treatment Areas (**Wang, 2012**) at STA-3/4, STA-2N, and STA-2S

Compartment C Build-out Components

	Inflow Capacity (cfs)	Outflow Capacity (cfs)	Total Area (acres)
STA5N	1329	limited by gravity and vegetative resistance	5025
STA5S	2180	limited by gravity and vegetative resistance	8494
STA6	1391	limited by gravity and vegetative resistance	3084

Compartment B Build-out Components

	Inflow Capacity (cfs)	Outflow Capacity (cfs)	Total Area (acres)
STA2	3885	limited by gravity and vegetative resistance	7775
North build-out + Cell4 (STA2N)	2140	limited by gravity and vegetative resistance	6534
South build-out (STA2S)	480	limited by gravity and vegetative resistance	3570

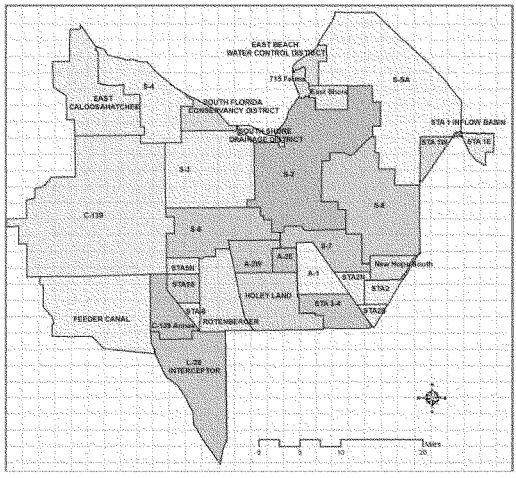


Figure 3.15. Location of A1, Comp B (STA2N and STA2S) and Comp C (STA5N, STA5S and STA6) basins in RSMBN.

Everglades Restoration Transition Plan (ERTP)

The Everglades Restoration Transition Plan (ERTP) supersedes the 2006 Interim Operational Plan (IOP) for the operations of WCA3a, inflows to ENP and protection of the Cape Sable Seaside Sparrow. As modeled in the FWO:

- Modeled as per Run 9E1 of March 2011 EIS (**USACE, 2011**).
- Revised WCA3A Regulation Schedule with lower Zone A line (**Figures 3.16** and **3.17**).
- Modifications to Tamiami Trail structure operations and closures consistent with Run 9E1 (e.g. S12 closure dates).
- L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD.
- G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD.

Subsequent to the CEPP modeling delivery, an error was identified in this input set. The fraction of environmental target to be delivered to S333/S12s was inadvertently retained at 55%/45% instead of the ERTP recommended 80%/20%. This error is not deemed to be significant since the operational intent is dominated by the L29 and G-3273 constraints, not the target and since regional performance checks as shown in Section 4 was still reasonable. A subsequent sensitivity run verified this conclusion. This error is contained in all CEPP modeling representations of ERTP where the rainfall plan calculation is not superseded by CEPP rainfall driven operation targets (i.e. affects FWO, 2012EC and IORBL1).

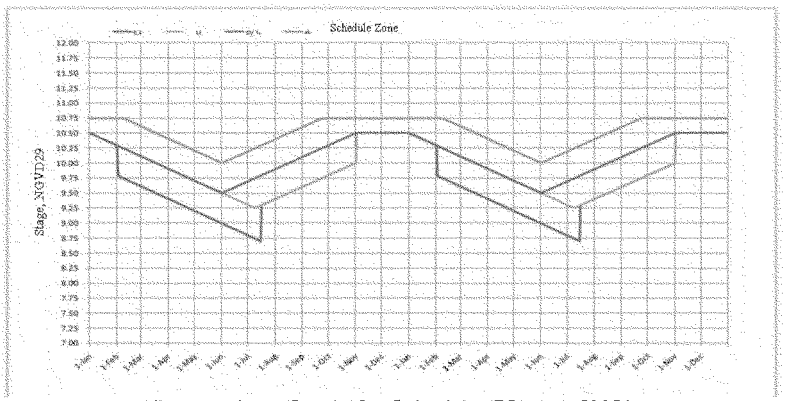


Figure 3.16: WCA3A IOP Schedule, ECB in RSMGL

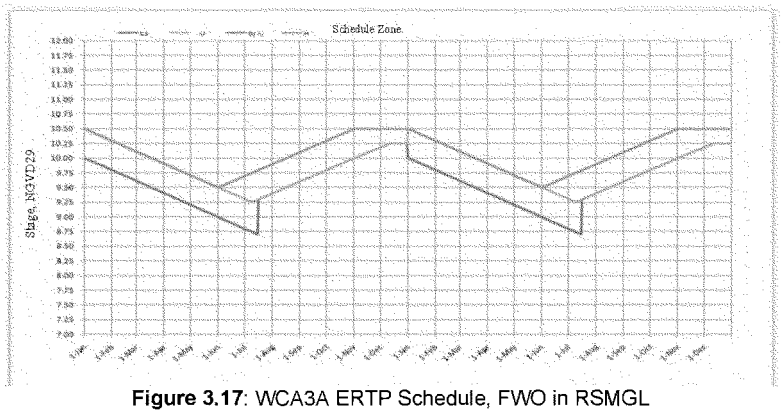


Figure 3.17: WCA3A ERTP Schedule, FWO in RSMGL

One-mile Tamiami Trail Bridge

Construction of the One-mile Tamiami Trail bridge per the 2008 Tamiami Trail Limited Reevaluation Report is intended to improve connectivity between ENP and upstream water bodies and allow for increased flow into northeastern ENP

- Modeled as a one-mile weir located east of the L67 extension and west of the S334 structure. Tamiami Trail culverts that fall within the one-mile location are removed.

Site 1 Impoundment

The Site 1 Impoundment Project (**Figure 3.18**) is designed to meet water supply demands in the LEC Service Area 1 through the collection of stormwater runoff from the Hillsboro canal that is currently discharged to tide. The project also intends to improve water levels in WCA-1/WCA-2A, provide long term storage for dry season water supply deliveries to the LWDD, and reduce demand from the regional system (Lake Okeechobee and WCA-1) to meet water supply needs.

- Footprint: Design: 1660 acres, Modeled: 1599 acres
- Inflow pump S-525A, capacity 650 cfs
- Pump on when G-56-H stage is > 7.7 ft (wet season) and 8.7 ft (dry season), and off when impoundment reaches 18.0 ft. NGVD
- Water supply outflows through S-526A culvert with discharge capacity 700 cfs
- Water supply priority for Hillsboro canal is first from the impoundment and second from S-39 regional supply

Assumed levee seepage coefficients in the southern L-40 reach were reduced by 75% to be consistent with best available information from the project field observations.

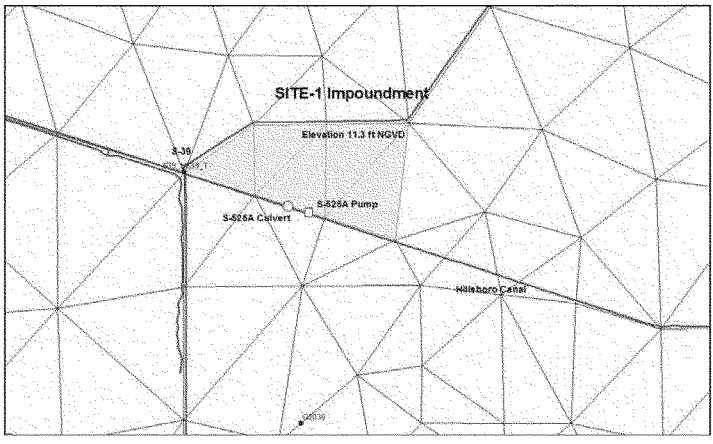


Figure 3.18. Site 1 Impoundment Project location with RSMGL mesh overlay.

Broward County Water Preserve Areas

The Broward County Water Preserve Areas Project in Broward County, is designed to reduce seepage losses from WCA-3A and WCA-3B and to capture and store excess runoff from the C-11 basin which is currently discharged untreated into WCA-3A via the S9 and S9A pumps. The project consists of two above ground impoundments, the C-11 impoundment (**Figure 3.19**) north of the C-11 canal, and the C-9 impoundment (**Figure 3.20**) north of the C-9 canal.

C-11 Impoundment

- Footprint: Design: 1078 acres, Modeled: 1355 acres
- Inflow pump S-503, capacity 1050 cfs
- Pump on when C-11 canal reaches 3.3 ft NGVD, and off when C-11 impoundment reaches 10.3 ft NGVD
- Outflow structure S-504 (1000 cfs) into C-9 impoundment when there is capacity
- Water supply outflow structure S-503A (200 cfs capacity)

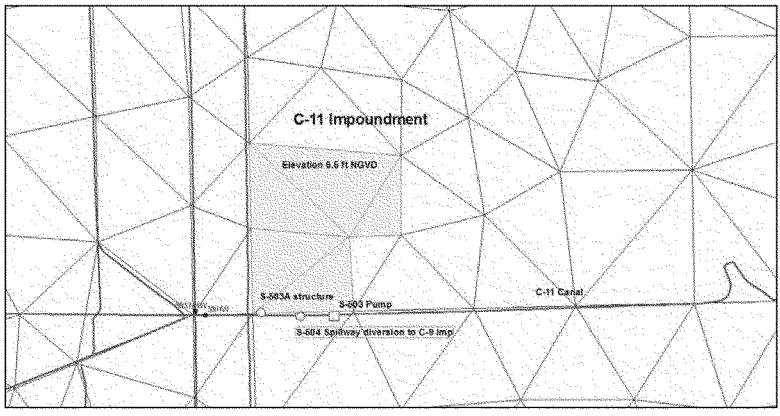


Figure 3.19. C-11 Impoundment Project location with RSMGL mesh overlay.

C-9 Impoundment

- Footprint: Design: 1641 acres, Modeled: 1970 acres
- Inflow Pump S-509, 1075 cfs capacity
- Pump on when C-9 canal stage above 2.7 ft NGVD and off when impoundment reaches 8.5 ft NGVD
- Outflow structure S-510, 500 cfs capacity
- Diversion flows into C-9 impoundment from C-11 impoundment through US27 canal and S-504 structure (capacity 1000cfs)

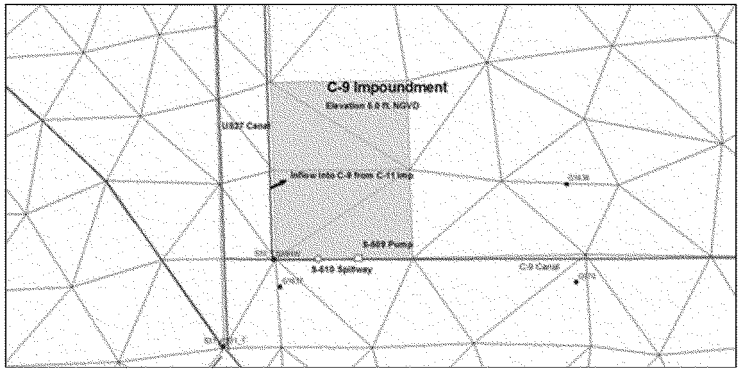


Figure 3.20. C-9 Impoundment Project location with RSMGL mesh overlay.

C111 & 8.5 Square Mile Area

The C-111 project is a federally authorized project that has altered the south Florida system over the last twenty years to improve seepage management from ENP and hydrologic

conditions in Taylor Slough. Consistent with a 1994 General Reevaluation Report, the project has constructed a number of shallow impoundments and associated water control structures along the south-eastern boundary of ENP (adjacent to urban development) and also altered levees and spoil mounds in the vicinity.

The 8.5 Square Mile Area Project (8.5 SMA) is a part of the Modified Water Deliveries (MWD) to ENP Project, authorized in the 2000 Water Resources Development Act and authorized specifically by the U.S. Congress in the 2003 Appropriations Act. Operations are based on the proposed water management operating criteria in this Environmental Assessment (**USACE, 2011**) which are interim and subject to change prior to completion of the ongoing long-term construction of the MWD Project and the Canal-111 South Dade Project.

Assumed project features are as follows and illustrated in **Figure 3.21**:
ECB:

- Partial construction of C-111 project reservoirs consistent with 2009 as-built information from USACE.
- 8.5 SMA project per Alternative 6D (**USACE, 2000 GRR**); operations per USACE 2011 Interim Operating Criteria.

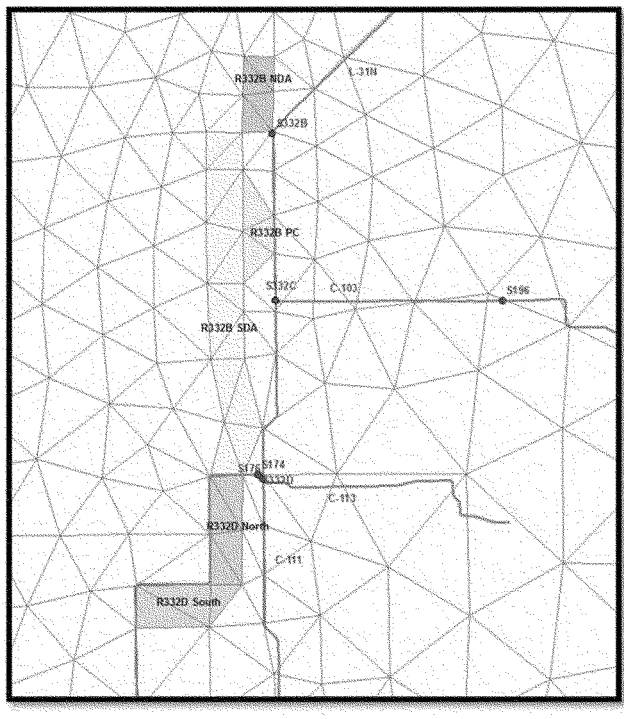


Figure 3.21: C-111 features as implemented in ECB

Five reservoirs (**Table 3.3**) are added as impoundments per 2009 as-built C-111 South Dade project:

Table 3.3: C-111 project reservoirs details

Reservoirs	Average topography (ft NGVD29)	Modeled area (acres)
R-332B North Detention Area (R-332B NDA)	6.5	257
R-332B South Detention Area (R-332B SDA)	6	1404
R-332 Partial Connector (R-332PC)	6	264
R-332 D North (R-332DN)	5.5	399
R-332 D South (R-332BN)	5.5	428

Table 3.4 shows the structures that are added for the purpose of flood control in S332 reservoir area.

Table 3.4: S332 reservoir flood control structures

	Type (as modeled)	capacity	upstream	downstream
S316D	gravity	400	R332B NDA	eastern cell
S322A	gravity	350	R332B SDA	R332PC
S322B	gravity	125	R332B SDA	R332PC
S322D	gravity	250	R332B SDA	R332PC
S322E	gravity	500	R332B SDA	R332PC
S322G	gravity	1500	R332B SDA	eastern cell
SDNWE	gravity	500	R332DN	R332DS
S329	gravity	1000	R332DS	south cell

Other information:
S-332, S-174 and S-175 are not operational. S-332A pump is not added.

FWO:
Assumed project features are as follows and illustrated in **Figure 3.22**:

- Full construction of C-111 project including addition of contract 8 and 9 features. Contract 9 includes degrading 500 feet of S-327, but the high head cell is not represented in the RSM due to resolution.
- 8.5 SMA project same as ECB, plus 1259 acre R-332B North Detention Area plus outflow assumed to the C-111 North Detention Area from 8.5 SMA through S-360E and S-360W structures.

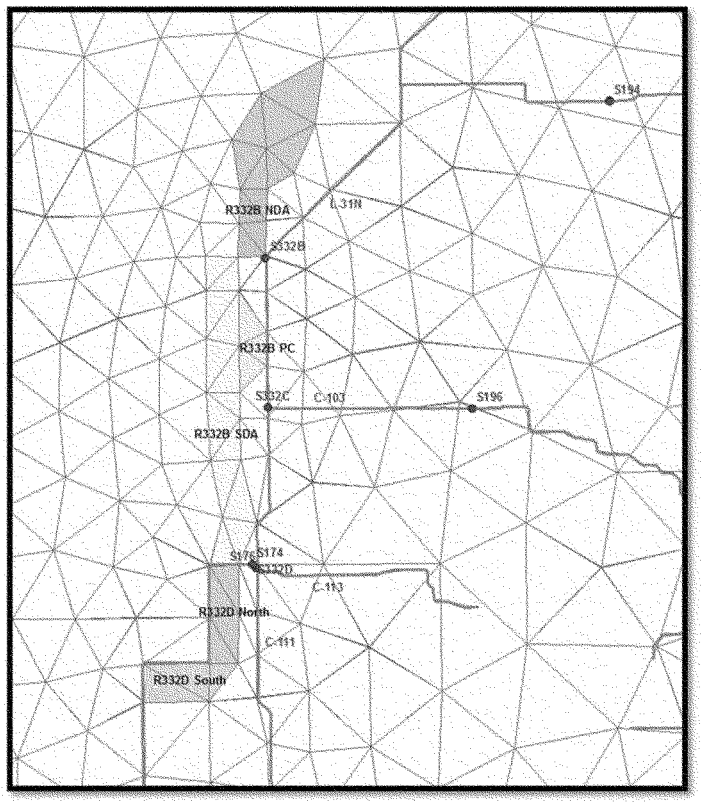


Figure 3.22: C-111 features as implemented in FWO

In addition to the flood control structures added in S-332 reservoir areas (shown in **Table 3.3**), following flood control structures are also added (**Table 3.5**):

Table 3.5: S332 reservoir flood control structures (in addition to ECB)

Structures	Type (as modeled)	capacity	upstream	downstream
S316A	gravity	500	R332B NDA	eastern cell
S316B	gravity	500	R332B NDA	eastern cell
S316C	gravity	500	R332B NDA	eastern cell
S322C	gravity	500	R332B SDA	R332PC
S322F	gravity	500	R332B SDA	eastern cell
S322H	gravity	500	R332B SDA	eastern cell

C-111 Spreader Canal

The C-111 Spreader Canal (SC) Western project is part of the original C-111 SC Project to assist operators in maximizing flows to Central Florida Bay via Taylor Slough, and improving hydroperiods within the Model Lands, while maintaining or improving the existing Central and Southern Florida Project purposes (e.g., flood damage reduction). The project proposes the construction of a set of features as shown in **Figure 3.23**, including the construction of the Frog Pond Detention Area, improvements to the Aerojet Canal and operations of new S199 and S200 pump stations:

- Frog Pond Detention Area (FPDA)
  - 590 Acres (including header canal)
- S-200 inflow pumps
  - Three 75 cfs pumps divert water to FPDA
- Added Aerojet Canal
  - S-199 inflow pumps
  - Three 75 cfs pumps divert water to Aerojet Canal
- Partial backfill of L31W Canal

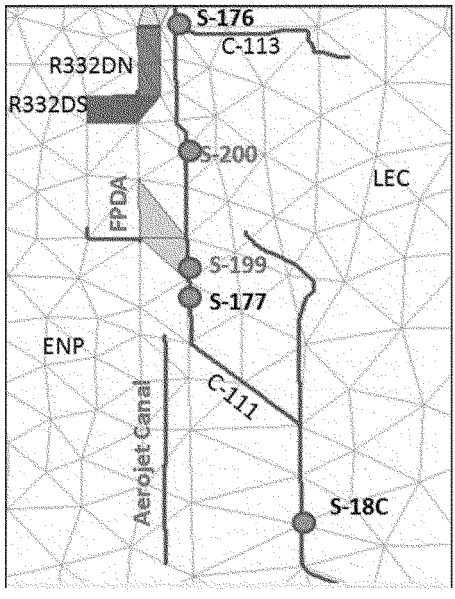


Figure 3.23. C-111 Spreader Canal Project location with RSMGL mesh overlay.

For additional information, a detailed list of operational assumptions in the vicinity of Miami-Dade County is provided in **Appendix C**.

Regarding the Project Assurances Baselines

The 2012EC and IORBL1 scenarios were developed in support of project assurances work and refinement to the CEPP TSP effort later in the project planning timeline. As a result, some updated information was available and utilized in these scenarios to reflect the best available information as shown below:

Changes from ECB to 2012EC:

- Incorporated ERTP operations
- Improved the representation of the L28 Weir by removing a small segment of the L28 canal downstream of the weir which, in the ECB, was allowing inter-basin transfer around the assumed weir from ponded water in the L28 triangle into the L28 canal north of I-75.
- Assumed levee seepage coefficients in the southern L-40 reach were reduced by 75% to be consistent with best available information from the Site 1 project (the 2012EC has the same assumed coefficients as the FWO, IORBL1 and all CEPP alternatives)

Changes from FWO to IORBL1

- Operational updates to Indian River Lagoon South (IRLS) project, consistent with Opti6-revised targets increasing flow down Ten Mile Creek (as conceptually shown by the red line) in **Figure 3.24.** Use of these revised targets will attempt to more frequently deliver water to meet demands assumed at the TMC2EST location (Gordy Rd structure), thereby increasing the utilization of the C23/C24 Reservoir/STA facilities and reducing discharges at S48 and S49.
- Improved the representation of the L28 Weir by removing a small segment of the L28 canal downstream of the weir which, in the FWO, was allowing inter-basin transfer around the assumed weir from ponded water in the L28 triangle into the L28 canal north of I-75.
- Operational refinement to Broward Water Preserve Areas project to reduce discharges to S29 and refine model representation of S9/S9A operations.
- High exchange between some assumed Lake cells and their adjacent canals was observed in the FWO scenario in northern Miami-Dade county. This resulted in excess volumes of water being conveyed to downstream structures. In the IORBL1, cells where this behavior was observed (as shown in **Figure 3.25**) were modified to utilize a reduced hydraulic conductivity value (K) for groundwater exchange with the canal. These IORBL1 K values were taken from the ECB scenario (in which the assumed Lakes had not yet expanded spatially to interact with these canal reaches).
- Refined 8.5 SMA representation, including expansion of assumed length of collector canals to prevent higher groundwater stages in the western portion of the 8.5 SMA.
- Modified operations of the S200 structures as shown in **Appendix C** to closer match real-world operational practices.

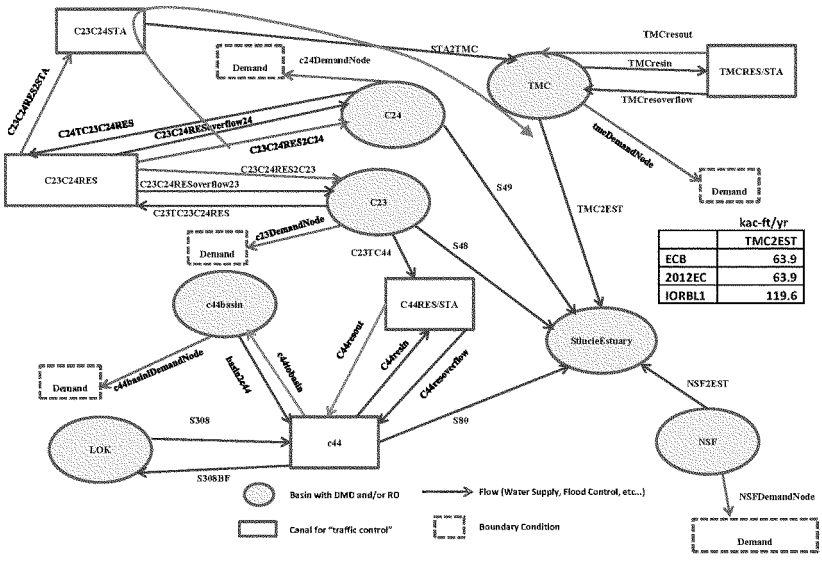
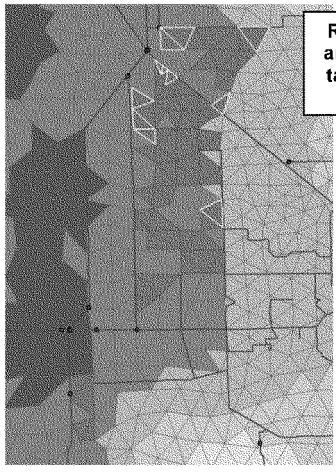


Figure 3.24. Changes to Indian River Lagoon-South routing in RSMBN for IORBL1 run (see also **Figures 3.11 and 3.12**).



RSMGL lake cells (shown in purple) that are highlighted in blue (and shown in the table below) utilized lower assumed K in IORBL1 compared to FWO

CellId	HighK_IORBL1	HighK_FWO
4854	11826.50	100000
4399	13941.10	100000
4409	14066.20	100000
4157	14142.60	100000
4161	13854.00	100000
4164	13727.30	100000
4644	14041.50	100000
4652	10649.00	100000
5100	12125.60	100000
7440	14214.70	100000
7442	14184.70	100000

Figure 3.25. RSMGL lake cells modified in the IORBL1 run

4.0 Results

Final CEPP modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. This system can be accessed at http://www.evergladesplan.org/pm/progr_mms.aspx. CEPP modeling products in MMS can be accessed directly at the project page:

http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

Due to the large size of many of the CEPP modeling files, the majority of the modeling output has been archived in the Data Access Storage and Retrieval (DASR) application of CERPzone at www.cerpzone.org. CEPP modeling products in DASR can be accessed within the project modeling folder:

P:\IMC_Final_Modeling_Results\PROJ 51 - Central Everglades Planning

While the modeling products have been archived in the above systems, the table below lists more specific information including model version, inputs used and detailed DASR archival location. Version numbers and "svnroot" paths refer to a model version control system found on the SFWMD network that is not generally accessible, but inputs, model executables and source code have been copied into the MMS system for ease of access.

Version information and model file locations

RSMBN ECB 12132012	**RSM_v4728 and xml_v8948**
Input: ...svnroot/trunk/CentEver/rsmbn/1Baselines/12132012/ECB Output (DASR): .../2PlanFormulation/1Baselines/Final_Output_121312/rsmbn_model_output/ECB	
RSMBN FWO 12132012	**RSM_v4728 and xml_v8948**
Input:...svnroot/trunk/CentEver/rsmbn/1Baselines/12132012/ECB Output (DASR): .../2PlanFormulation/1Baselines/Final_Output_121312/rsmbn_model_output/FWO	
RSMBN 2012EC 02282013	**RSM_v4728 and xml_v8948**
Input:...svnroot/trunk/CentEver/rsmbn/TSP_Assurances/Baselines/02282013/2012EC Output (DASR): ...\3TSP_Assurances\1Baselines\Final_Output_022813\rsmbn_model_output\2012EC	
RSMBN IORBL1 06032013	**RSM_v4728 and xml_v9357**
Input:...svnroot/trunk/CentEver/rsmbn/OtherWRN_Sens/06032013/IORBL1 Output (DASR): ...\4OtherWRN_Sens\Sens_Output_060313\rsmbn_model_output\IORBL1	
RSMGL ECB 12132012	**RSM_REL_2.3.5 and xml_v8885**
Input: .....svnroot/trunk/CentEver/rsmgl/ECB_2010-11 Output (DASR): .../2PlanFormulation/1Baselines/Final_Output_121312/rsmgl_model_output/ECB	
RSMGL FWO 12132012	**RSM_REL_2.3.5 and xml_v8886**
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RSMGL 2012EC 02282013	**RSM_REL_2.3.5 and xml_v9189**
Input: ...svnroot/trunk/CentEver/rsmgl/Assurances/2012EC Output (DASR): .../3TSP_Assurances/1Baselines/Final_Output_022813/rsmgl_model_output/2012EC	
RSMGL IORBL1 06032013	**RSM_REL_2.3.5 and xml_v9361**
Input: ...svnroot/trunk/CentEver/rsmgl/Assurances/IORBL1 Output (DASR):.../4OtherWRN_Sens/Sens_Output_060313/rsmgl_model_output/IORBL1	

Review of Local and Regional-Level Results

The RSMBN and RSMGL baseline modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. Specific checks on RSM outputs included the following:

- Kissimmee area outcomes were cross validated to work from the Kissimmee Basin Modeling and Operations Study (KBMOS) team with resulting changes as shown in **Figure 4.1**
- Regional results for Lake Okeechobee and the Northern Estuaries demonstrated expected trends (reduced high discharge events, improved baseflow to the Caloosahatchee estuary, etc...) resulting from IRL, C43, A1FEB and other project activities as shown in **Figures 4.2** and **4.3**.
- Regional results for the WCAs and ENP demonstrated expected trends (lower WCA3A stages, increased flows to eastern ENP and decreased flows to western ENP, etc...) resulting from ERTP, Tamiami Trail and other project activities as shown in **Figures 4.4** to **4.7.**
- LEC and ENP buffer impoundment performance was reasonable and demonstrated expected sub-regional changes in LEC groundwater as shown in **Figures 4.8** through **4.11**.
- Expected trends moving from plan formulation baselines (ECB and FWO) to assurances baseline (2012EC and IORBL1), such as lower WCA3A stages in 2012EC and improved baseflow to the St. Lucie estuary in IORBL1 were observed as shown in **Figures 4.12** and **4.13**. Comparing back to FWO performance, it is also evident that locally triggered high discharge events to the St. Lucie Estuary are reduced due to the previously described reductions at S48 and S49.

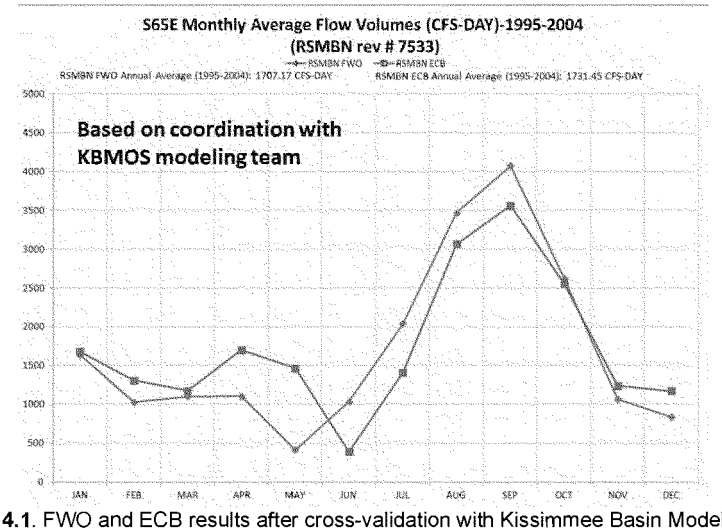

Figure 4.1. FWO and ECB results after cross-validation with Kissimmee Basin Modeling and Operations Study (KBMOS) outcomes.

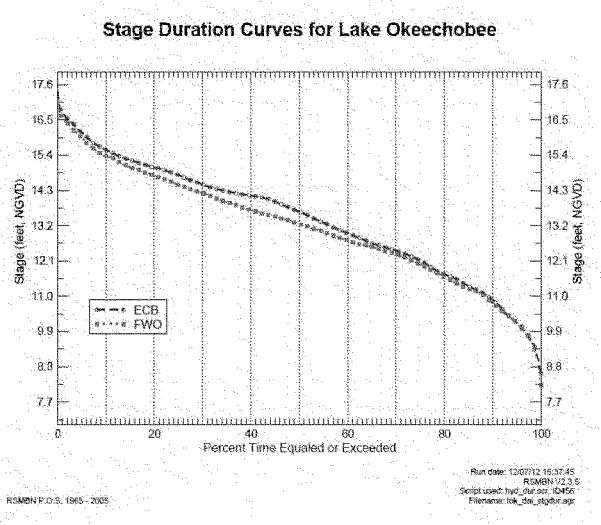

Figure 4.2. Lake Okeechobee demonstrated expected trends resulting from project activities included in the FWO run.

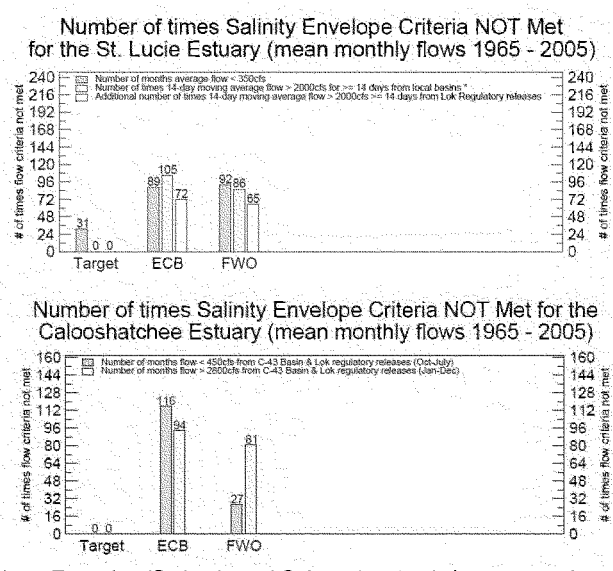

Figure 4.3. Northern Estuaries (St. Lucie and Caloosahatchee) demonstrated expected trends resulting from project activities included in FWO runs.

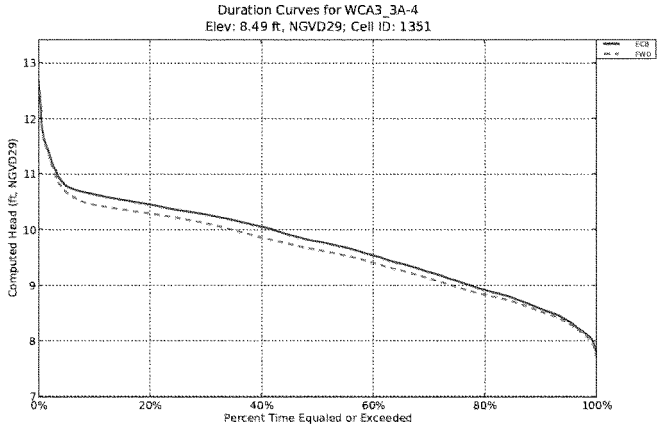

Figure 4.4. A representative gauge in WCA3A showing changes in stage duration between ECB (IOP schedule) and FWO (ERTP schedule)

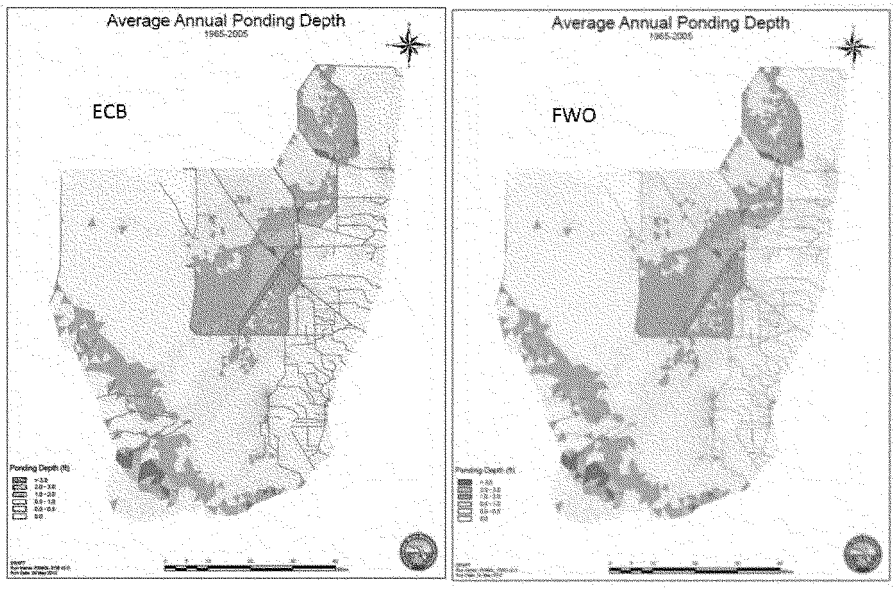

Figure 4.5. System-wide average ponding ECB (IOP schedule) and FWO (ERTP schedule)

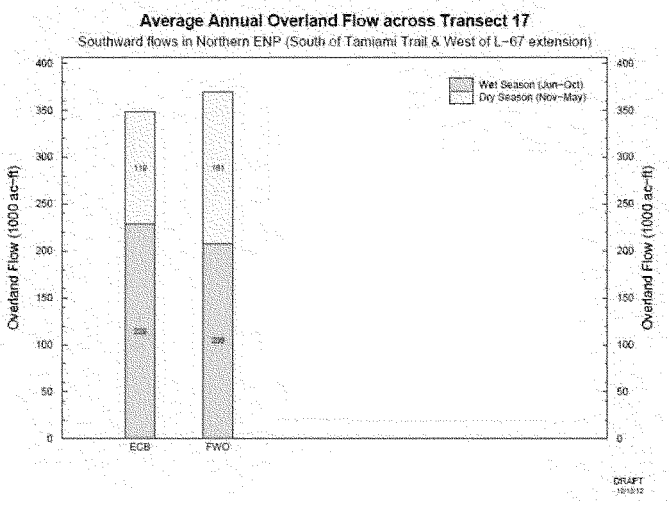

Figure 4.6. Flow differences between ECB and FWO at western Tamiami Trail.

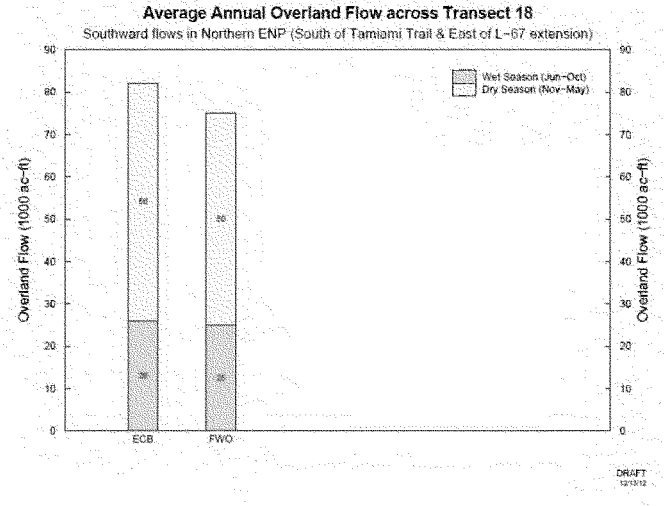

Figure 4.7. Flow differences between ECB and FWO at eastern Tamiami Trail.

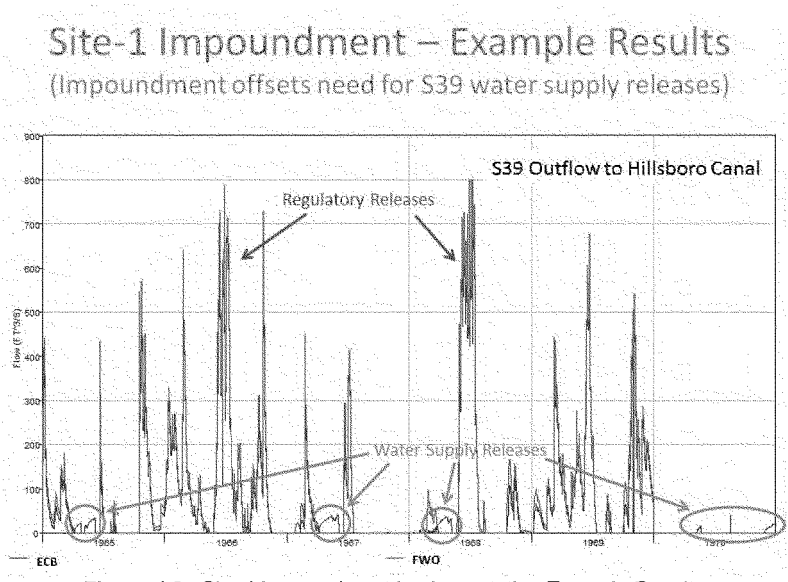

Figure 4.8. Site 1 Impoundment Implementation Example Results

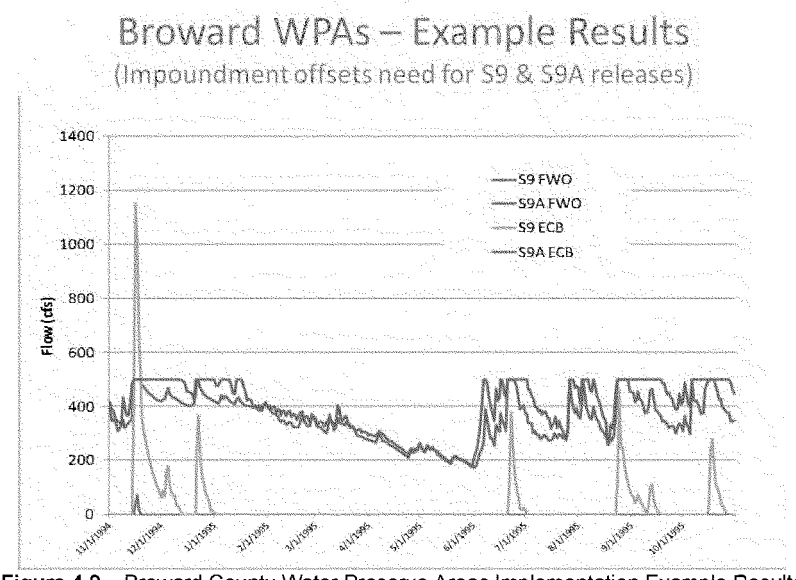

Figure 4.9. Broward County Water Preserve Areas Implementation Example Results

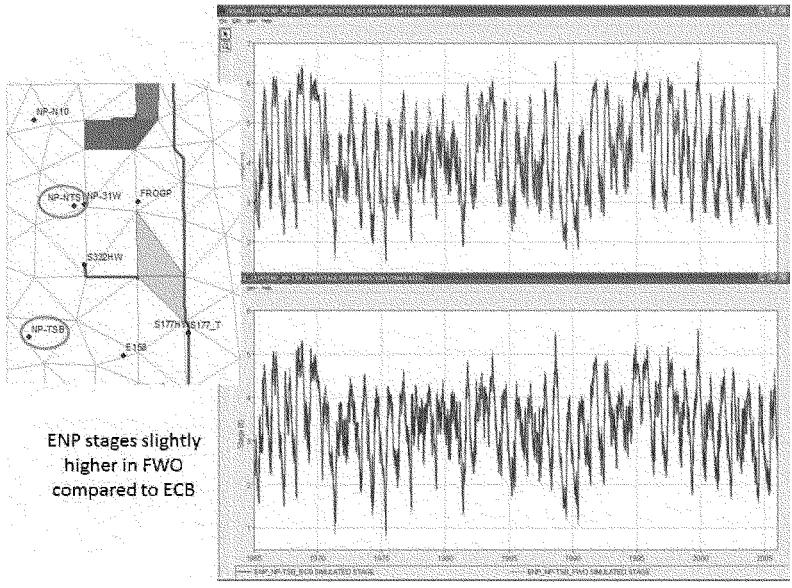

Figure 4.10. C-111 Spreader Canal Project Implementation Example Results

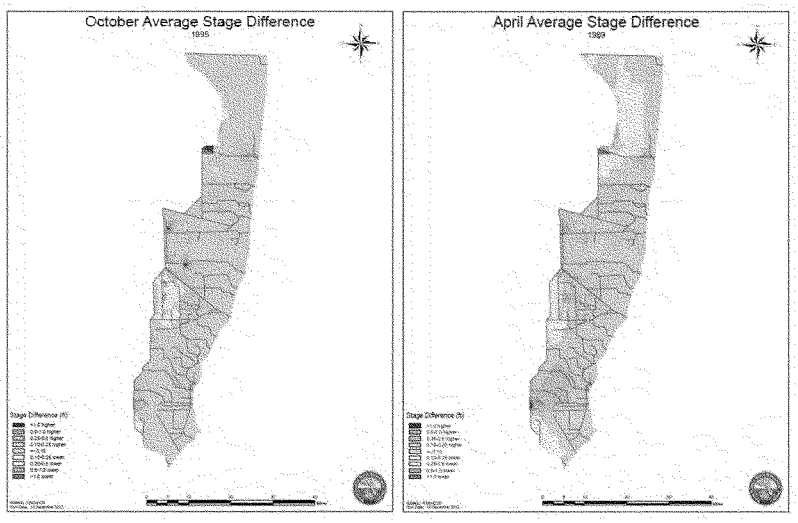

Figure 4.11. Difference between FWO and ECB stages in an average water year, in October 1995 (left) and April 1989 (right).

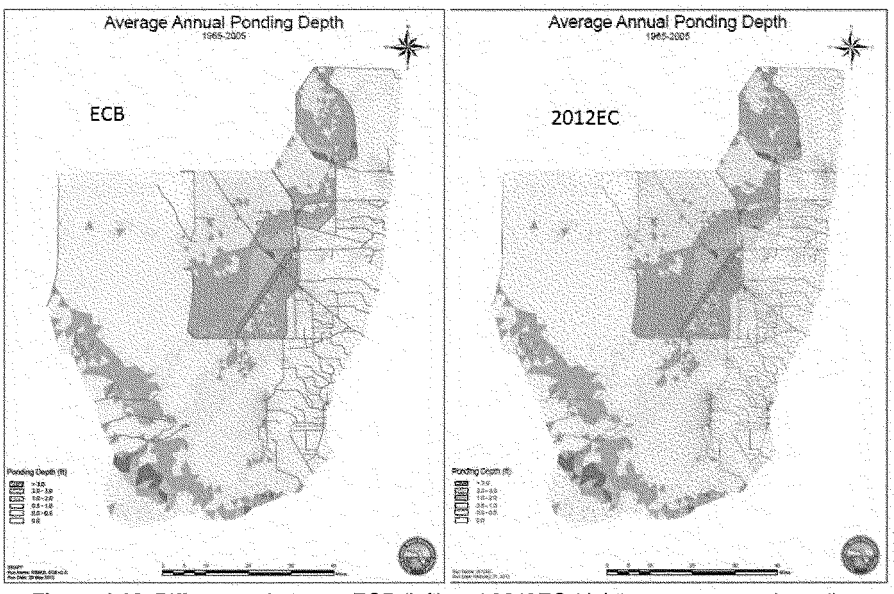

Figure 4.12. Differences between ECB (left) and 2012EC (right) average annual ponding depths throughout the RSMGL model domain.

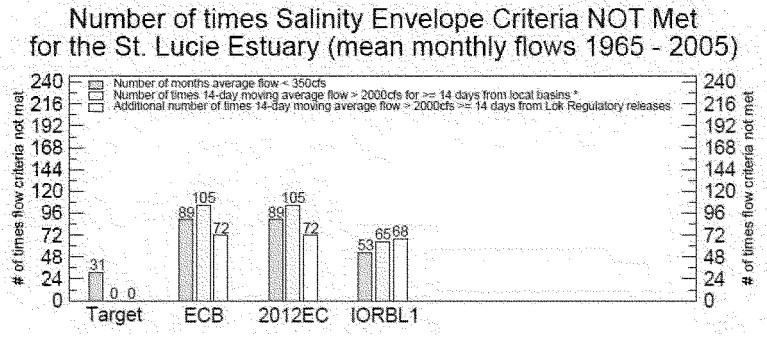

Figure 4.13. Increased St Lucie Estuary low flow counts in 2012EC and IORBL1 (relative to those shown in **Figure 4.3**)

In summary, the four delivered baseline runs provided to the CEPP project team are deemed to adequately represent the intended planning conditions and when utilized in conjunction with proposed with-CEPP project alternatives, provide a reasonable basis of comparison for the necessary evaluations required to draft the PIR.

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Appendix A – Tables of Assumptions

RSMBN:

- **ECB**
- **FWO**
- **2012EC**
- **IORBL1**

RSMGL:

- **ECB**
- **FWO**
- **2012EC**
- **IORBL1**

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) 2010 / 2011 Existing Conditions Baseline (ECB) Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships from G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/12, as reflected in the LOSA Ledger produced by the Water Use Bureau • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).

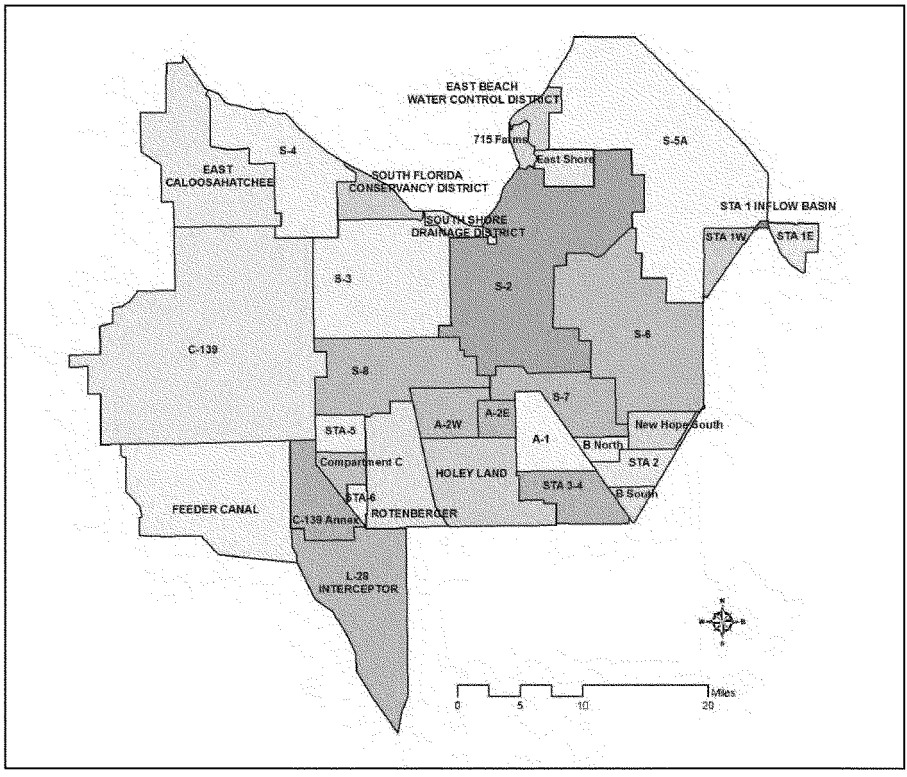
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008)
	  ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals
	  ○ A regional hydrologic surrogate for the 2010 Adaptive Protocol operations utilized. This attempts to mimic desired timing of releases without estimating salinity criteria
	• Lake Okeechobee Water Shortage Management (LOWSM) Plan
	• Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and s-3 is to be minimized)
	• "Temporary" forward pumps as follows:
	  ○ S354 – 400 cfs
	  ○ S351 – 600 cfs
	  ○ S352 – 400 cfs
	  ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft.
	• No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water

Feature	
	deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Kissimmee River inflows based on interim schedule for Kissimmee Chain of Lakes using the UKISS model • Restored reaches / pools of Kissimmee River as of 2010 • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Public water supply daily intake from the river is included in the analysis.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Basin demands include the Florida Power & Light reservoir at Indiantown.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage • The 2 in 10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons/month). AFSIRS modeled 2 in 10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2 in 10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2 in 10 demands equaled 2,659 MGM • 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
Everglades Agricultural Area	• Model water-body components as shown in Figure 1 below. • Simulated runoff from the North New River – Hillsboro basin will be apportioned based on the relative size of contributing basins via s7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin • EAA runoff and irrigation demand compared to SFWMM (ECB) simulated runoff and demand from 1965-2005 for reasonability

Feature	
	• Compartment C land in the Miami Canal Basin between STA-5 and STA-6 is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area. • Compartment B (excluding cell 4) land in the North New River/Hillsboro is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area.

Stormwater Treatment Areas	• STAs are simulated as single waterbodies
	• STA-1E: 6,546 acres total area
	• STA-1W: 7,488 acres total area
	• S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E
	• STA-2: includes first four cells: 9,910 acres total area
	• STA-3/4: 17,126 acres total area
	• STA-5: includes first 3 cells: 7,619 acres total area
	• STA-6: 2,486 acres total area
	• Assumed operations of STAs:
	  • 0.5 ft minimum depth below which supply for external sources is triggered
	  • 4 ft maximum depth above which inflows are discontinued
	• STA-3/4 receives Lake Okeechobee regulation target releases at or below 60,000 acre-feet annual average for entire period of record

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL ECB.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342s flows routed to STA5; G406 flows routed to STA6: C139 Annex flows routed to STA6 • C139 basin demand is met primarily by local groundwater
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2W
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + A-1 + B North
+ B South + New Hope South
WPB Water-Body = S-5A

Fig. 1 RSMBSN Basin Definition within the EAA: Existing Conditions Baseline Simulation

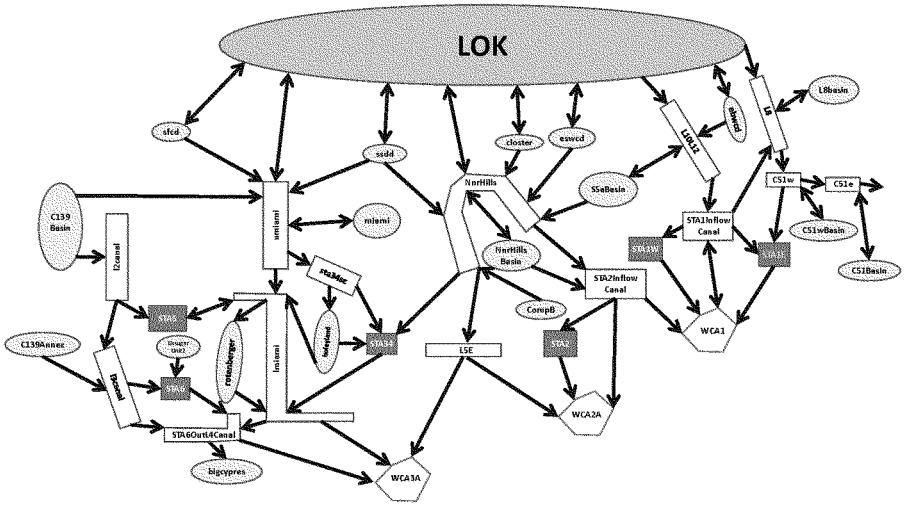


Fig. 2 RSMBSN Link-Node Routing Diagram: Existing Conditions Baseline Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN)
2050 Future Without Project Baseline (FWO)
Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships from G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).

Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008)
	  ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals
	  ○ Releases via S-77 can be diverted into C43 Reservoir
	• Lake Okeechobee Water Shortage Management (LOWSM) Plan
	• Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and s-3 is to be minimized)
	• "Temporary" forward pumps as follows:
	  ○ S354 – 400 cfs
	  ○ S351 – 600 cfs
	  ○ S352 – 400 cfs
	  ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft.
	• No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs

Feature	
	• Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.

St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row).
	• Basin demands include the Florida Power & Light reservoir at Indiantown.
	• Indian River Lagoon South Project features
	  • Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin
	  • C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint
	  • C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint
	  • C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint
	  • All proposed reservoirs meet estuary demands

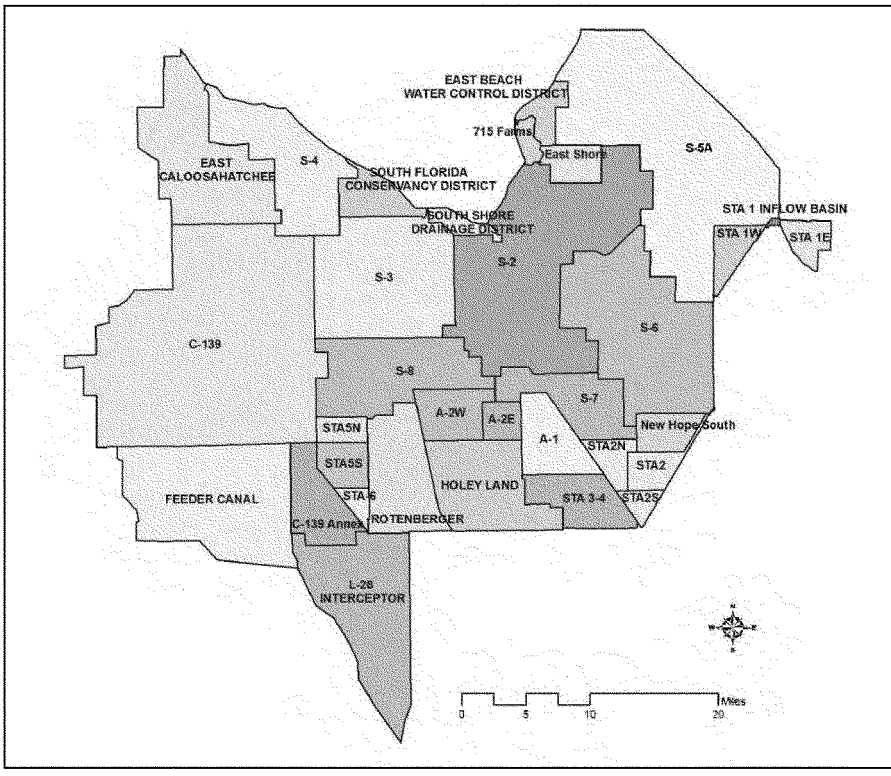
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2 in 10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons/month). AFSIRS modeled 2 in 10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement

Feature	
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2 in 10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2 in 10 demands equaled 2,659 MGM • 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
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via s7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basi • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.

Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies
	• STA-1E: 6,546 acres total area
	• STA-1W: 7,488 acres total area
	• S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E
	• STA-2: cells 1,2 & 3: 7,681 acres total area
	• STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area
	• STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area
	• STA-3/4: 17,126 acres total area
	• STA-5N: includes cells 1 & 2: 5,081 acres total area
	• STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area
	• STA-6: expanded with phase 2: 3,054 acres total area
	• Assumed operations of STAs:
	  • 0.5 ft minimum depth below which supply for external sources is triggered
	  • 4 ft maximum depth above which inflows are discontinued
	• STA-3/4 receives Lake Okeechobee regulation target releases at or below 60,000 acre-feet annual average for entire period of record

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD

Feature	
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL FWO.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342s flows routed to STA5; G406 flows routed to STA6: C139 Annex flows routed to STA6 • C139 basin demand is met primarily by local groundwater
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan



Water-Body Components:
Miami Water-Body = S3 + S8
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + A-1+ New Hope South
WPB Water-Body = S-5A

Fig. 1 RSMBSN Basin Definition within the EAA: Future Without Project Baseline Simulation

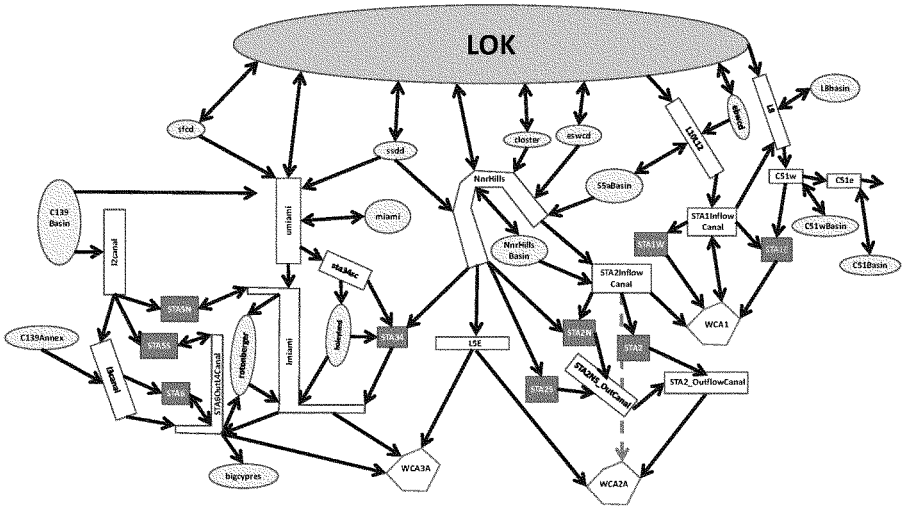


Fig. 2 RSMBSN Link-Node Routing Diagram: Future Without Project Baseline Simulation

Note:

- 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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) 2012 Existing Conditions (2012EC) Baseline Table of Assumptions

Note: RSMBN CEPP 2012EC (2/28/13) is identical to the RSMBN CEPP ECB (12/13/12)

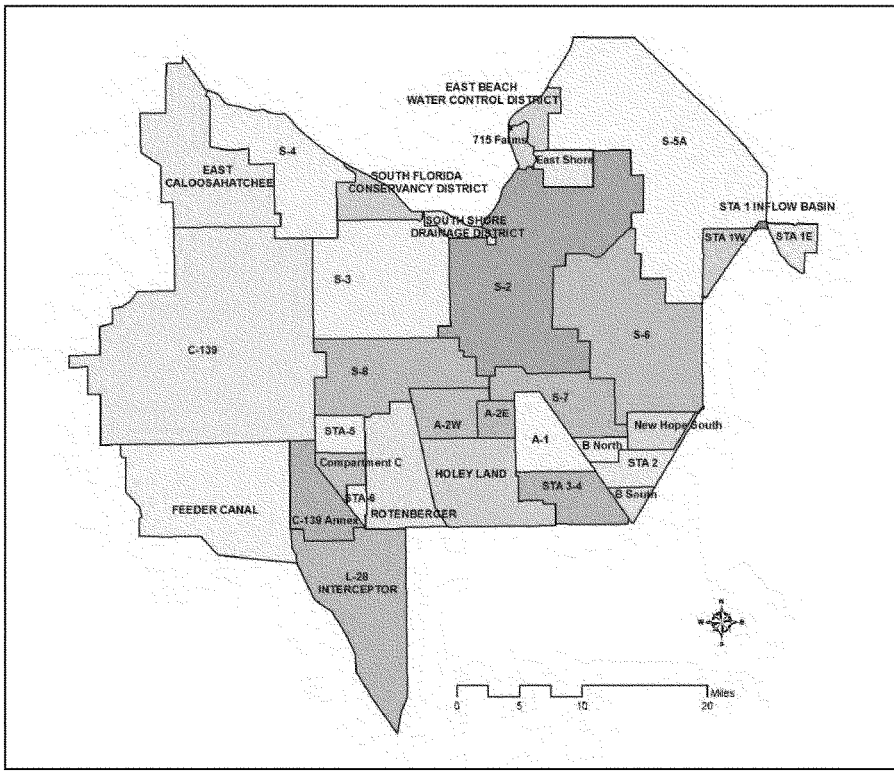
Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/12, as reflected in the LOSA Ledger produced by the Water Use Bureau • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).

Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008)
	  ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals
	  ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE.
	  ○ A regional hydrologic surrogate for the 2010 Adaptive Protocol operations utilized. This attempts to mimic desired timing of releases without estimating salinity criteria
	• Lake Okeechobee Water Shortage Management (LOWSM) Plan
	• Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized)
	• "Temporary" forward pumps as follows:
	  ○ S354 – 400 cfs
	  ○ S351 – 600 cfs
	  ○ S352 – 400 cfs

Feature	
	○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Kissimmee River inflows based on interim schedule for Kissimmee Chain of Lakes using the UKISS model • Restored reaches / pools of Kissimmee River as of 2010 • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Public water supply daily intake from the river is included in the analysis.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if the lake stage is 0.25 ft below the Zone D pulse release line. • Basin demands include the Florida Power & Light reservoir at Indiantown.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage • The 2-in10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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

Feature	
Everglades Agricultural Area	• Model water-body components as shown in Figure 1 below. • Simulated runoff from the North New River – Hillsboro basin will be apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin • EAA runoff and irrigation demand compared to SFWMM (ECB) simulated runoff and demand from 1965-2005 for reasonability • Compartment C land in the Miami Canal Basin between STA-5 and STA-6 is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area. • Compartment B (excluding cell 4) land in the North New River/Hillsboro is not considered to be in production (shrub Land Use). Then, no irrigation demands are required in this area.
Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: includes first four cells: 9,910 acres total area • STA-3/4: 17,126 acres total area • STA-5: includes first 3 cells: 7,619 acres total area • STA-6: 2,486 acres total area • Assumed operations of STAs: o 0.5 ft minimum depth below which supply from external sources is triggered o 4 ft maximum depth above which inflows are discontinued • STA-3/4 receives Lake Okeechobee regulatory releases approximately at 60,000 acre-feet annual average for the entire period of record.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL ECB.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5; G406 flows routed to STA6 • C139 basin demand is met primarily by local groundwater

Feature	
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:

Miami Water-Body = S3 + S8 + A-2W --

NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + B North
+ B South + New Hope South

WPB Water-Body = S-5A

Fig. 1 RSMBSN Basin Definition within the EAA: 2012 Existing Conditions Simulation

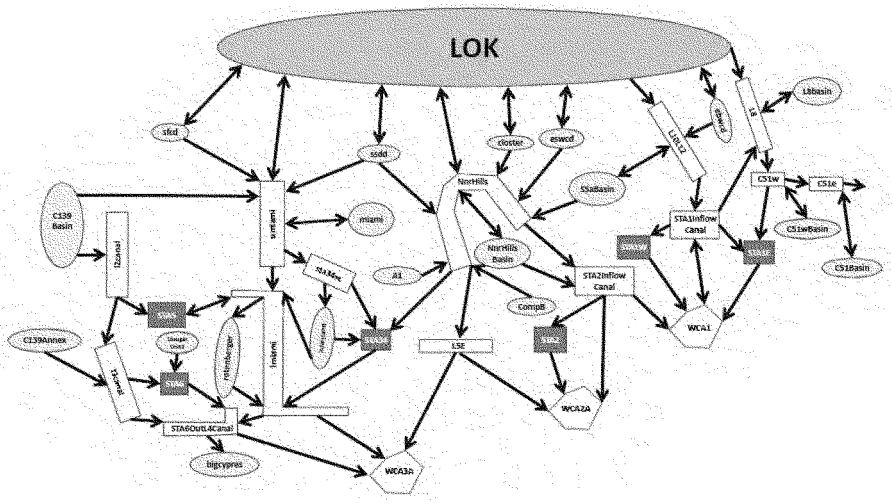


Fig. 2 RSMBSN Link-Node Routing Diagram: 2012 Existing Conditions Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- 2012EC assumptions were updated from the CEPP 12/13/2012 ECB scenario at the time that the CEPP tentatively selected plan was identified.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN)
Initial Operating Regime Baseline 1 (IORBL1)
Table of Assumptions

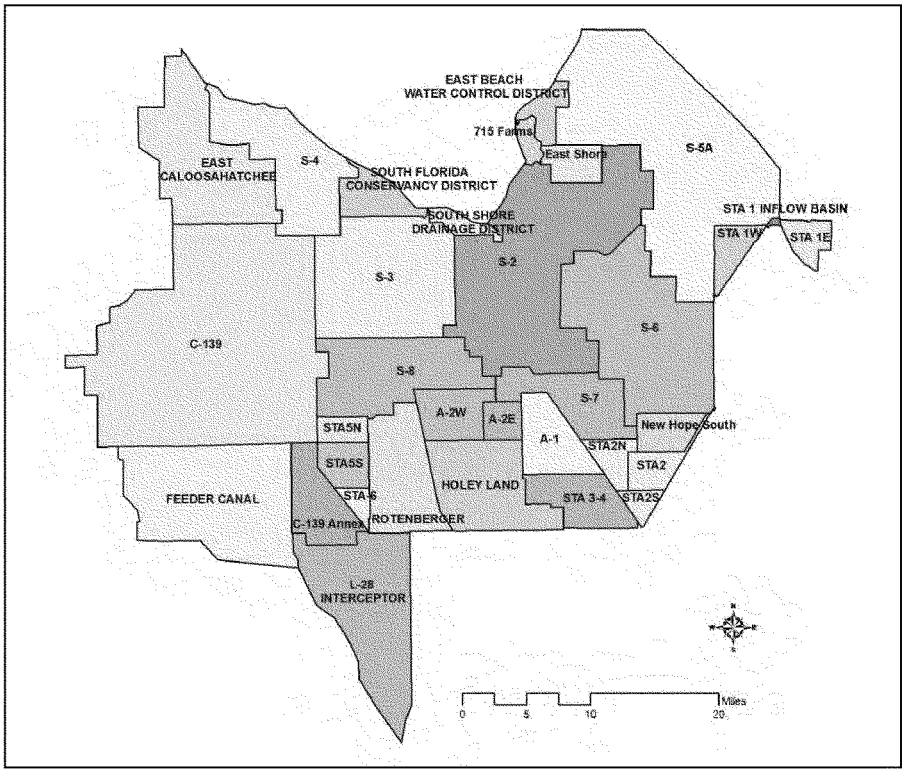
Feature	
Climate	• The climatic period of record is from 1965 to 2005 • Rainfall estimates have been revised and updated for 1965-2005 • Revised evapotranspiration methods have been used for 1965-2005
Topography	The topography dataset for RSM was updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004 • High Accuracy Elevation Data , US Geological Survey 2007 • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004 • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007 • Palm Beach County LiDAR Survey, Dewberry and Davis, 2004 • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).

Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008)
	  ○ Includes Lake Okeechobee regulatory releases to tide via L8/C51 canals
	  ○ Lake Okeechobee regulatory releases limited to 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal based on studies performed by USACE.
	  ○ Releases via S-77 can be diverted into C43 Reservoir
	• No Lake Okeechobee environmental releases.
	• Lake Okeechobee Water Shortage Management (LOWSM) Plan
	• Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized)
	• "Temporary" forward pumps as follows:
	  ○ S354 – 400 cfs
	  ○ S351 – 600 cfs
	  ○ S352 – 400 cfs

Feature	
	○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft. • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Operational intent is to treat LOK regulatory releases to the south through STA-3/4 • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012(see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is 0.25 ft. below the Zone D pulse release line before being pumped into the C-44 reservoir. • Basin demands include the Florida Power & Light reservoir at Indiantown. • Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint ○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint ○ All proposed reservoirs meet estuary demands ○ IRL operations assumed are consistent with the March 2010 St. Lucie River Water Reservation Rule update. ○ Excess C23 basin water not needed to meet estuary demands can be diverted to the C44 reservoir if capacity exists.
Seminole Brighton	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage.

Feature	
Reservation	• The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved • LOWSM applies to this agreement
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM • 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
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area • STA-3/4: 17,126 acres total area • STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area • Assumed operations of STAs: o 0.5 ft minimum depth below which supply from external sources is triggered

Feature	
	○ 4 ft maximum depth above which inflows are discontinued ○ Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK regulatory discharge and available A1FEB storage. ○ STA-3/4 receives Lake Okeechobee regulation target releases approximately at 60,000 acre-feet annual average for the entire period of record. • A 15,853-acre Flow Equalization Basin (FEB) located north of STA-3/4 with assumed operations as follows: ○ FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south. ○ FEB outflows are used to help meet established inflow targets (as estimated using the Dynamic Model for Stormwater Treatment Areas) at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK regulatory discharge are not sufficient. ○ 0.5 ft minimum depth below which no releases are allowed ○ 3.8 ft maximum depth above which inflows are discontinued ○ Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures. ○ Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower North New River canal. ○ Structure capacities and water quality operating rules are consistent with modeling assumptions assumed during the A-1 FEB EIS application process.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for environmental purposes only • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FWC and the SFWMD
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA (SFWMD, March 2010)
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6C139 basin demand is met primarily by local groundwater
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2W
NNR/HILLS Water-Body = S2 + S6 + S7 + A-2E + New Hope South
WPB Water-Body = S-5A
A1FEB = A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Initial Operating Regime Baseline Simulation

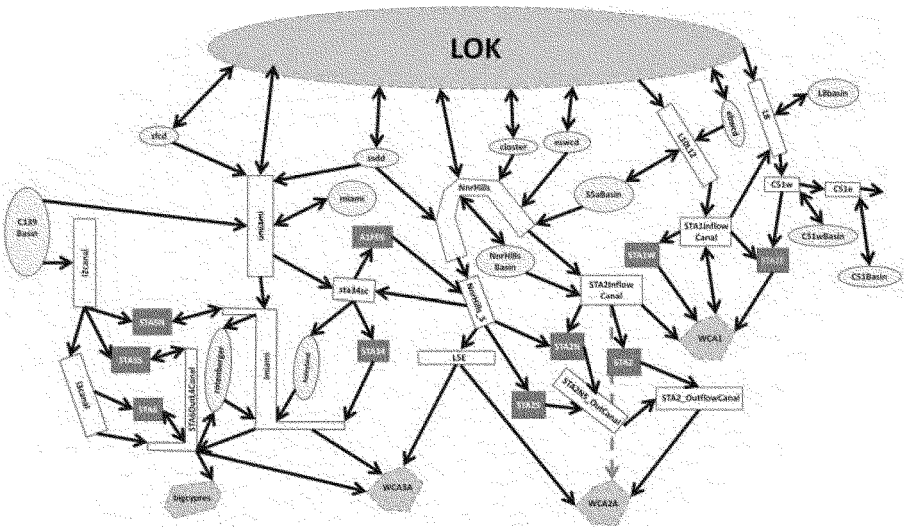


Fig. 2 RSMBSN Link-Node Routing Diagram: Initial Operating Regime Baseline Simulation

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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- IORBL assumptions were updated from the CEPP 12/13/2012 FWO scenario at the time that the CEPP tentatively selected plan was identified and then adjusted for the IRL project to produce the IORBL1.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) 2010 / 2011 Existing Conditions Baseline (ECB) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • 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 and in the Western Basins assumed.
Lake Belt Lakes	• Based on 2005 Lake Belt Lake coverage obtained from USACE.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional System

Feature	
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule. 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	• Current C&SF regulation schedule for WCA-3A, as per Water Control Plan –Interim Operational Plan (IOP) for protection of the Cape Sable seaside sparrow- C&SF Project for Flood Control and other Purposes (USACE, June 2006) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon the Interim Operational Plan (IOP) • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • Tamiami Trail culverts east of the L67 Extension are simulated. • 5.5 miles remain of the L-67 Extension Levee. • S-355A & S-355B are operated. • S-356 is not operated. • Partial construction of C-111 project reservoirs consistent with the 2009 as-built information from USACE (does not include contract 8 or contract 9). A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • S-332DX1 is not operated. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay

Feature	
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Industrial pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2010 • 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) • S-25B and S-26 pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Interim Operational Plan (IOP): o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15 o Structure S-12C is closed Feb. 1 to July 15 • South Dade Conveyance System operations will follow IOP for protection of the Cape Sable seaside sparrow
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • 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.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
2050 Future Without Project Baseline (FWO)
Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.

Feature	
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 Tamiami Trail Limited Reevaluation Report is modeled as a one mile weir. Located east of the L67 extension and west of the S334 structure. • 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. • S-356 is not operated. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2010 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is based on 2010 permits. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2010 • 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

Feature	
	• C-11 Water Quality Treatment Critical Project (S-381 and S-9A) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15
Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal and CERP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO 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.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
2012 Existing Conditions (2012EC)
Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. • 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 and in the Western Basins assumed.
Lake Belt Lakes	• Based on 2005 Lake Belt Lake coverage obtained from USACE.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • Structure S10E connecting LNWR to the northeastern portion of WCA-2A is no longer considered part of the simulated regional System

Feature	
Water Conservation Area 2A & 2B	• Current C&SF regulation schedule. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012). • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • Tamiami Trail culverts east of the L67 Extension are simulated. • 5.5 miles remain of the L-67 Extension Levee. • S-355A & S-355B are operated. • S-356 is not operated. • Partial construction of C-111 project reservoirs consistent with the 2009 as-built information from USACE (does not include contract 8 or contract 9). A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • S-332DX1 is not operated. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay

Feature	
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Industrial pumpage are based on 2030 projections from the SFWMD Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012
	• 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).
	  ○ S9/S9A operations modified for performance consistency with SFWMM ECB.
	• S-25B and S-26 pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary
	• 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 flood control discharges are sent to STA-1E through the S-319 structure
	• Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1
	  ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15
	  ○ Structure S-12B is closed Jan. 1 to July 15
	• South Dade Conveyance System operations will follow ERTP for protection of the Cape Sable seaside sparrow

Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal.
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. The Lower East Coast Subregional (LECsR) model is the source of this data.

Feature	
	• 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.
- 2012EC assumptions were updated from the CEPP 12/13/2012 ECB scenario at the time that the CEPP tentatively selected plan was identified.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL)
Initial Operating Regime Baseline 1 (IORBL1)
Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. Operations refined in RSM model to closer represent project intent and outcomes.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.

Feature	
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. • L-29 stage constraint for operation of S-333 assumed to be 7.5 ft, NGVD. • G-3273 constraint for operation of S-333 assumed to be 6.8 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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. • S-356 is not operated. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. ○ An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation.
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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.

Feature	

Canal Operations	• C&SF system and operating rules in effect in 2012
	• 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).
	  ○ S9/S9A operations modified for performance consistency with SFWMM ECB.
	• S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary
	• 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 flood control discharges are sent to STA-1E through the S-319 structure
	• Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1
	  ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15
	  ○ Structure S-12B is closed Jan. 1 to July 15

Canal Configuration	• Canal configuration same as calibration except only 5.5 miles remain of the L-67 Extension Canal and CERP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the RSMBN FWO 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.
- IORBL assumptions were updated from the CEPP 12/13/2012 FWO scenario at the time that the CEPP tentatively selected plan was identified and then adjusted for the Broward County WPA project to produce the IORBL1.

Appendix B – LORS08 Operations Schedule

The LORS08 schedule is used for operation of Lake Okeechobee in all CEPP baselines. **Figure B-1** shows the LORS08 schedule. **Figures B-2 and B-3** show the pulse releases from Lake Okeechobee into the Caloosahatchee and St. Lucie Estuary, respectively.

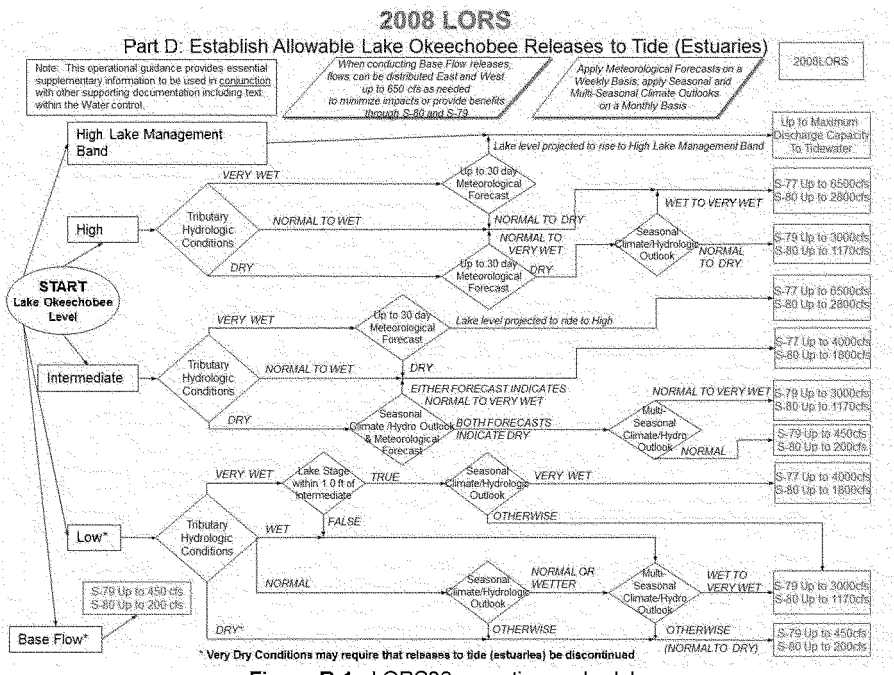


Figure B-1. LORS08 operations schedule.

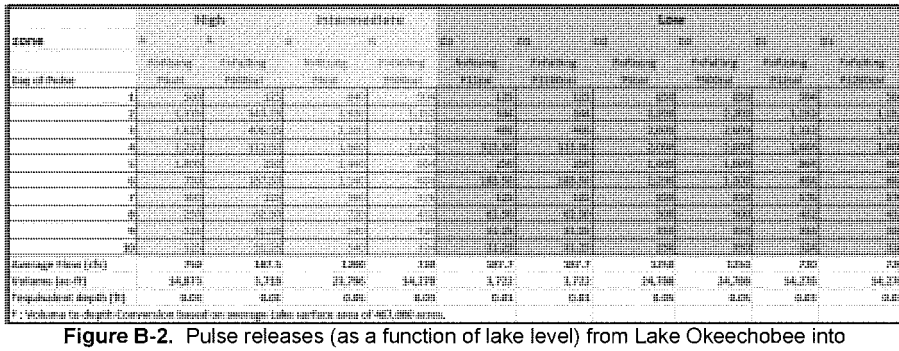


Figure B-2. Pulse releases (as a function of lake level) from Lake Okeechobee into Caloosahatchee Estuary in cubic feet per second (cfs).

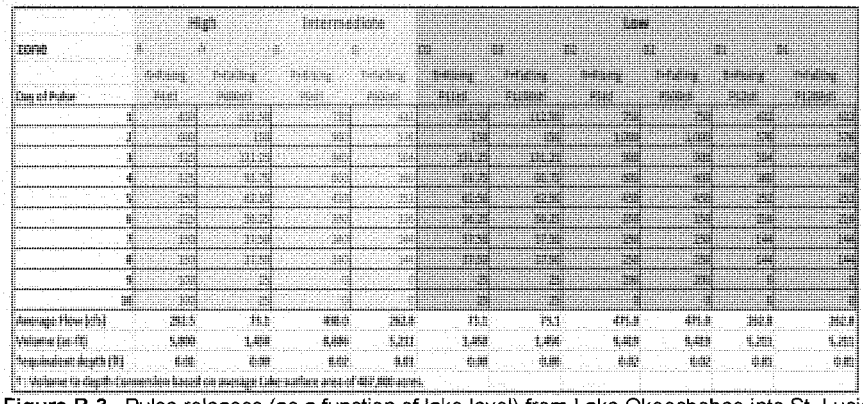


Figure B-3. Pulse releases (as a function of lake level) from Lake Okeechobee into St. Lucie Estuary in cubic feet per second (cfs).

Details of the model implementation of the schedule can be found in **Figures B-4, B-5 and B-6. Figure B-4** lists the range of values used to classify the tributary hydrologic conditions. **Figure B-5** lists the range of values used to classify the net inflow seasonal outlook. **Figure B-6** lists the range of values used to classify the net inflow multi-seasonal outlook.

LORS2008		
Classification of Lake Okeechobee Tributary Hydrologic Conditions		
Palmer Index	2-wk Mean LO	Tributary
Class	Inflow Class	Hydrologic
Limits	Limit	Classification*
> 3.0	>= 6000 cfs	Very Wet
1.5 to 2.99	2500 - 5999 cfs	Wet
-1.49 to 1.49	500 - 2499 cfs	Near Normal
-2.99 to -1.5	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry
*use the wettest of the two indicators		

Figure B-4. LORS08 Tributary Hydrologic Conditions Classifications

LORS2008		
Classification of Lake Okeechobee Net Inflow Seasonal Outlook**		
Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 0.93	> 2.0	Very Wet
0.71 to 0.93	1.51 to 2.0	Wet
0.35 to 0.70	0.75 to 1.5	Normal
< 0.35	< 0.75	Dry
**volume-depth conversion based on average lake surface area of 467,000 acres.		

Figure B-5. LORS08 Seasonal Outlook Classifications

LORS2008		
Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**		
Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.5 to 1.17	1.1 to 2.5	Normal
< 0.5	< 1.1	Dry
**volume-depth conversion based on average lake surface area of 467,000 acres.		

Figure B-6. LORS08 Multi-Seasonal Outlook Classifications

Appendix C – Structure Operations in South Miami-Dade County for CEPP Baseline Runs

In **Table C.1**, the list of structures is color-coded in three groupings:

green	Structures on the L-67, L-28, and L-29 canals. Structures included are S-345, S-349, S-344, S-343A-B, S-12A-D, S-333, S-334, S-355, and S-356
blue	Structures on the L-30 and part of the L-31 canals Structures included are S-337, S-151, S-335, S-338, G-211, S-173 & S-331P (COMBQ), S-176 and S-174
yellow	Structures on part of the L-31 canal and L-31W and C-111 canals Structures included are S-332A-D, S-357, S-332, S-175, S-200, S-199, S-177, S-18C, S-197 and S-332E

Table C.1 includes the four baselines (ECB 2010-11, 2050FWO, 2012EC, IORBL1).

Table C.1 Baselines (ECB 2010-11, 2050FWO, 2012EC, IORBL1)

Canal	Structure	ECB 2010-11 (RSMGL)	2050FWO (RSMGL)
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	Non-existent	Non-existent
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each
L-29	S-12A-D*	S12A closed Nov 1 to Jul 15; S12B closed Jan 1 to Jul 15; S12C closed Feb 1 to Jul 15; S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only
	S-333*	Special code 1) L-29 stage constraint of 7.5 Wet/Dry 2) Design Q=1350 cfs 3) G-3273 stage constraint of 6.8 4) Flood Control only	Special code 1) L-29 stage constraint of 7.5 Wet/Dry 2) Design Q=1350 cfs 3) G-3273 stage constraint of 6.8 4) Flood Control only
	S-334	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs
	S-355*	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 7.5' 3) Flood control only 4)G-3273 stage constraint of 6.8 5)L-29 stage constraint of 7.5	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 7.5' 3) Flood control only 4)G-3273 stage constraint of 6.8 5)L-29 stage constraint of 7.5
	S-356*	Not operational	Not operational

Canal	Structure	2012EC (RSMGL)	IORBL1 (RSMGL)
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	Non-existent	Non-existent
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each
L-29	S-12A-D*	Per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates; S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only
	S-333*	Special code 1) L-29 stage constraint of 7.5 Wet/Dry 2) Design Q=1350 cfs 3) G-3273 stage constraint of 6.8 4) Flood Control only	Special code 1) L-29 stage constraint of 7.5 Wet/Dry 2) Design Q=1350 cfs 3) G-3273 stage constraint of 6.8 4) Flood Control only
	S-334	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs	Non-existent Special code 1) Flood Control 2) No open/close ops, structure flow is based on L31N stage 4) Design Q=1230 cfs
	S-355*	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 7.5' 3) Flood control only 4)G-3273 stage constraint of 6.8	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 7.5' 3) Flood control only 4)G-3273 stage constraint of 6.8
	S-356*	Not operational	Not operational

Canal	Structure	**ECB 2010-11 (RSMGL)**	**2050FWO (RSMGL)**
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	 Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_2050FWO.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_2050FWO.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_2050FWO.so) S151_TWi & S151_HWi (input variable Special_Assessors_2050FWO.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml
	S-335	**7.5/ 7.2** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0	**7.5/ 7.2** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0

Canal	Structure	**2012EC (RSMGL)**	**IORBL1 (RSMGL)**
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_2050FWO.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_2050FWO.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_2050FWO.so) S151_TWi & S151_HWi (input variable Special_Assessors_2050FWO.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml
	S-335	**7.5/ 7.2** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0	**7.5/ 7.2** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0

Canal	Structure	ECB 2010-11 (RSMGL) Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	2050FWO (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve
	S-173 & S-331P (COMBQ) *	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	2012EC (RSMGL)	IORBL1 (RSMGL)
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve
	S-173 & S-331P (COMBQ) *	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	ECB 2010-11 (RSMGL)	2050FWO (RSMGL)
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	 Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) desigh Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) desigh Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	2012EC (RSMGL)	IORBL1 (RSMGL)
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	ECB 2010-11 (RSMGL)		2050FWO (RSMGL)	
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A 5.0/4.7 S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A 5.0/4.7 S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65
		S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	**6.2 / 5.7** open/closed wet & dry season 1) Flood Control Pump Q = 126 cfs		**6.2 / 5.7** open/closed wet & dry season 1) Flood Control Pump Q = 126 cfs	
L-31W	S-332 (pumps)*	Non-existent		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	Structure not simulated		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	Structure not simulated		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Canal	Structure	2012EC (RSMGL)		IORBL1 (RSMGL)	
		Recommended for ECB Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B 5.0/4.7 (4.8/4.5) using IOP dual ops. S332BN 5.0/4.7 (4.8/4.5) using IOP dual ops. S332C 5.0/4.7 (4.8/4.5) using IOP dual ops. S332D 4.85/4.65 (4.7/4.5) using IOP dual ops.	S332A Non-Existent S332B 5.0/4.7 (4.8/4.5) using IOP dual ops. S332BN 5.0/4.7 (4.8/4.5) using IOP dual ops. S332C 5.0/4.7 (4.8/4.5) using IOP dual ops. S332D 4.85/4.65 (4.7/4.5) using IOP dual ops.	S332A Non-Existent S332B 5.0/4.7 (4.8/4.5) using IOP dual ops. S332BN 5.0/4.7 (4.8/4.5) using IOP dual ops. S332C 5.0/4.7 (4.8/4.5) using IOP dual ops. S332D 4.85/4.65 (4.7/4.5) using IOP dual ops.	S332A Non-Existent S332B 5.0/4.7 (4.8/4.5) using IOP dual ops. S332BN 5.0/4.7 (4.8/4.5) using IOP dual ops. S332C 5.0/4.7 (4.8/4.5) using IOP dual ops. S332D 4.85/4.65 (4.7/4.5) using IOP dual ops.
		S332B =250 cfs S332BN =250cfs S332C = 500 cfs S332D = 500 cfs Jul15-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul14 All Flood Control		S332B =250 cfs S332BN =250cfs S332C = 500 cfs S332D = 500 cfs Jul15-Nov30, 325cfs Dec 1-Jan31, 250cfs Feb 1-Jul14 All Flood Control	
	S-357 (pump)	**6.2 / 5.7** open/closed wet & dry season 1) Flood Control Pump Q = 126 cfs		**6.2 / 5.7** open/closed wet & dry season 1) Flood Control Pump Q = 126 cfs	
L-31W	S-332 (pumps)*	Non-existent		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	Structure not simulated		S-200A=75cfs; **3.6/3.4** S-200B=75cfs; **3.7/3.4** S-200C=75cfs; **3.8/3.4**	
	S-199	Structure not simulated		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3 (2.25/2.0) using IOP dual ops** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3 (2.25/2.0) using IOP dual ops** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
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Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Central Everglades Planning Project (CEPP) Final Array of Alternatives Model Documentation Report

IMC MSR 368 **February 14, 2014**

1.0 Overview

Identification

The Central Everglades Planning Project (CEPP) is an expedited planning effort undertaken as part of the overall Comprehensive Everglades Restoration Plan (CERP), a program led by the United States Army Corps of Engineers (USACE) with the South Florida Water Management District (SFWMD) as local sponsor. The project worked throughout 2012 and 2013 to develop a Project Implementation Report (PIR; **USACE, 2013b**) that combines planning and design activities for three primary areas of interest in the south Florida system as follows: 1) Storage & water treatment facilities in the Everglades Agricultural Area, 2) Decompartmentalization of levees within the Everglades Protection Area (EPA) and 3) Levee seepage management features along the Everglades / urban boundary in southeastern Florida. Modeling support to the CEPP effort was provided by a team comprised of modelers from the Hydrologic & Environmental Systems Modeling Section of the SFWMD and the Interagency Modeling Center (IMC), with direct support also provided by the USACE and Everglades National Park of the Department of the Interior (DOI). Modeling workflow and coordination were performed in a manner consistent with the procedures outlined in IMC Modeling Services Request (MSR) 368 and the CEPP Modeling Strategy (**SFWMD, 2012a**).

Scope and Objectives

Modeling support for CEPP focused on working with the larger project planning team and other interested parties to formulate and test project features leading to the ultimate identification and refinement of a tentatively selected plan (TSP). Modeling products were developed at the appropriate level of detail to support feature screening and detailed representation of project features and to provide information to all necessary evaluations required for plan development and documentation in the PIR. The project plan formulation framework is shown in **Figure 1.1** and illustrates a spatially determined workflow (moving north to south through the south Florida system) utilizing initial screening followed by detailed evaluation to identify final project planning alternatives and ultimately a TSP for the effort.

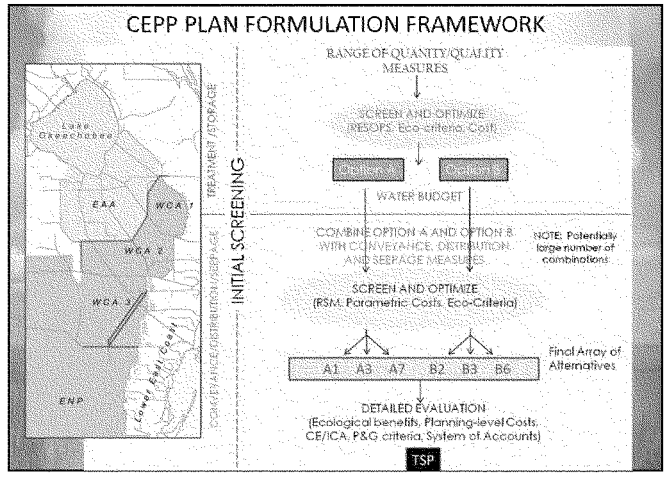

Figure 1.1. Central Everglades Planning Project Plan Formulation Framework

The CEPP Modeling Strategy document (**SFWMD, 2012a**) describes the modeling process and tools utilized, the associated rationale of the selection process and the means by which the tools could expediently support the project workflow. The primary model support tools utilized in CEPP are as follows:

Screening Tools:

- REservoir Sizing and OPerations Screening (RESOPS)
- Lake Okeechobee OPerations Screening (LOOPS)
- C-43 Spreadsheet Model
- iModel©

Detailed Planning Models:

- Regional Simulation Model Basins (RSMBN)
- Regional Simulation Model Glades-LECSA (RSMGL)
- Dynamic Model for Stormwater Treatment Areas (DMSTA)

From a modeling deliverable perspective, the entirety of the CEPP modeling support can be summarized by reviewing the following four Model Documentation Reports (MDRs):

1. CEPP Baseline Runs – Reviews the various non-CEPP model representations (e.g., current and future without project conditions) used in various aspects of the project planning (**SFWMD & IMC, 2014a**).
2. CEPP Final Array of Alternatives – Reviews four proposed with-CEPP project model representations examined during plan formation (this document)
3. CEPP Tentatively Selected Plan – Reviews the model representation of the CEPP TSP and subsequent refinements during final plan formulation and project assurance planning (**SFWMD & IMC, 2014c**).
4. CEPP Model Supported Screening Efforts – Reviews the various model-supported feature screening efforts undertaken at various points in the planning process (**SFWMD & IMC, 2014d**).

This Final Array of Alternatives MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling representations of various future with-CEPP project features model scenarios. These model runs were predominantly used to identify the final CEPP project features carried forward into the CEPP TSP in support of plan formulation. This document will focus on the modeling details of these scenarios; information on the use and rationale for the definition of these conditions is contained in the CEPP PIR (**USACE, 2013b**).

2.0 Basis

Project Assumptions

This Final Array of Alternatives MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling the following scenarios:

CEPP Final Array of Alternatives - released 12/20/2012

- Alternatives 1, 2, 3 and 4 (ALT1, ALT2, ALT3, and ALT4)

The CEPP project team identified a series of infrastructure changes for each alternative as shown in **Figure 2.1**. More detailed figures describing each alternative are included in **Appendix A.**

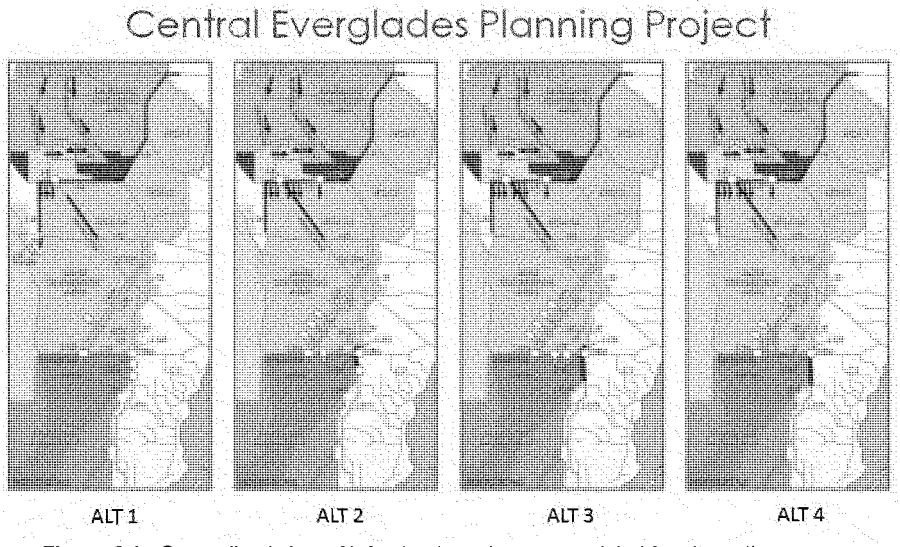

Figure 2.1. Generalized view of infrastructure changes modeled for alternatives ALT1, ALT2, ALT3, and ALT4.

In addition to the infrastructure changes identified in **Figure 2.1**, the project team also identified a series of performance objectives to help guide operational decision-making as follows:

- Maintain the weighted average of Lake Okeechobee Standard Score performance measures near baseline levels.
- Keep percent of time that Lake stages are greater than 15.0 ft, NGVD less than 25% for the period of simulation; reduce frequency and magnitude of Lake Okeechobee-triggered high discharge events to the Northern Estuaries.
- Maintain level of low flow performance for the Caloosahatchee Estuary consistent with C43 Reservoir Project; reduce the frequency, duration and severity of Lake Okeechobee triggered water shortage events.
- Improve cutback percentages relative to the baseline conditions for the "8 worst years" of drought conditions, with emphasis on the most severe drought years.
- Strive to achieve approximately 200 kac-ft average annual additional water delivery to the Everglades system, promoting significant additional dry season deliveries
- Maintain a hydrologic regime in the FEB and STAs consistent with water quality objectives
- Utilize operational protocols for the CEPP Greenline screening exercise (including L6 Diversions and Everglades Rainfall Driven Operations) to improve hydrologic indicators in the Greater Everglades.
- Promote additional flow through WCA3A and into ENP while maintaining performance for identified species and flood protection criteria.
- To the extent possible with assumed infrastructure, minimize changes in Lower East Coast performance relative to the CEPP project baselines (ECB and FWO).

The modeling team in implementing the RSM scenarios relied heavily on the outcomes of the screening and optimization steps summarized in the CEPP Model Supported Screening Efforts MDR. Completion of these scenarios within the expedited project schedule would not have been possible without extensive use of iModel©, LOOPs and other tools to inform operational guidance prior to detailed modeling.

Detailed project assumption tables were not developed for ALTs 1 to 4, but other than the specific with-CEPP project details identified in Section 3 and the Appendices, the assumptions are all consistent with those of the FWO baseline scenario.

Model Limitations and Intended Use of Results

The primary modeling products of CEPP 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, 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 RSMBN, RSMGL (**SFWMD, 2010** and **2011**), and DMSTA (**Walker & Kadlec, 2005**; **Wang, 2012**) models were reviewed through the USACE validation process for engineering software, as part of the CEPP project. The RSM and DMSTA models were classified as "allowed for use" for south Florida applications in August 2012 and January

2013, respectively. Additionally, the RESOPS (**SFWMD, 2009**), LOOPS (**Neidrauer et al, 2006**), and C-43 spreadsheet model (**Starnes & Marlowe, 2007**) tools and the iModel© optimization tool (**Ali, 2009**) used in CEPP underwent USACE Agency Technical Review (ATR). Approval of these modeling tools for CEPP application was completed in November, 2012.

3.0 Simulation

Modeling Tools Used

RSM version 2.3.5 was used to run both the RSMBN and RSMGL models.
Release date 12/6/2012, SVN Version #4730.

Model Set Up

The CEPP final array of alternative was developed using the RSMBN and RSMGL models. Collectively, these two models cover the spatial extent of the project planning area as shown in **Figure 3.1**. The RSMBN modeling for the final array was built upon the CEPP FWO baseline representation and since only one configuration was proposed by the project team for the area north of the redline, one RSMBN scenario (ALTS) is representative and used for all defined Alternatives. The RSMGL modeling for the final array was built upon the CEPP FWO baseline representation. The period of simulation for both models utilizes a climate record from 1965 to 2005. Details about project rationale for defining these scenarios can be found in the CEPP PIR.

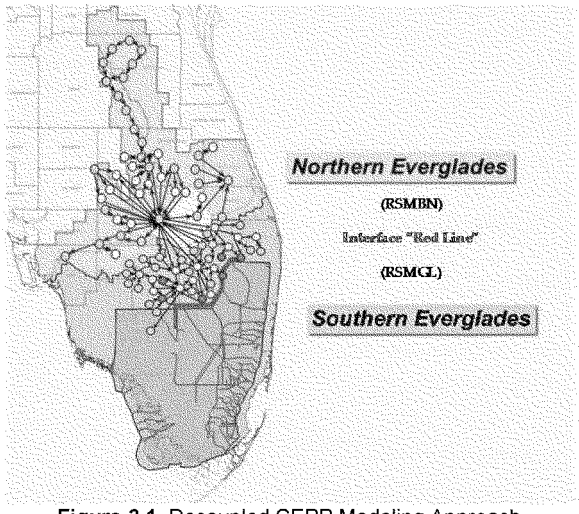

Figure 3.1. Decoupled CEPP Modeling Approach

This section will focus on the project plan formation alternative and assumed model implementation changes relative to the CEPP FWO project baseline (**SFWMD, 2014a**). The RSMBN modeling review will only describe the one representative scenario (ALTS)

that is applicable to all four defined CEPP alternatives while the RSMGL modeling review will describe the changes specific to each alternative.

RSMBN ALTS Scenario

The CEPP project alternatives all share a common configuration north of the Redline which is an integrated A1/A2 Flow Equalization Basin (FEB) as shown in **Figure 3.2,** operated to allow for the additional treatment and discharge of Lake Okeechobee water into the Everglades.

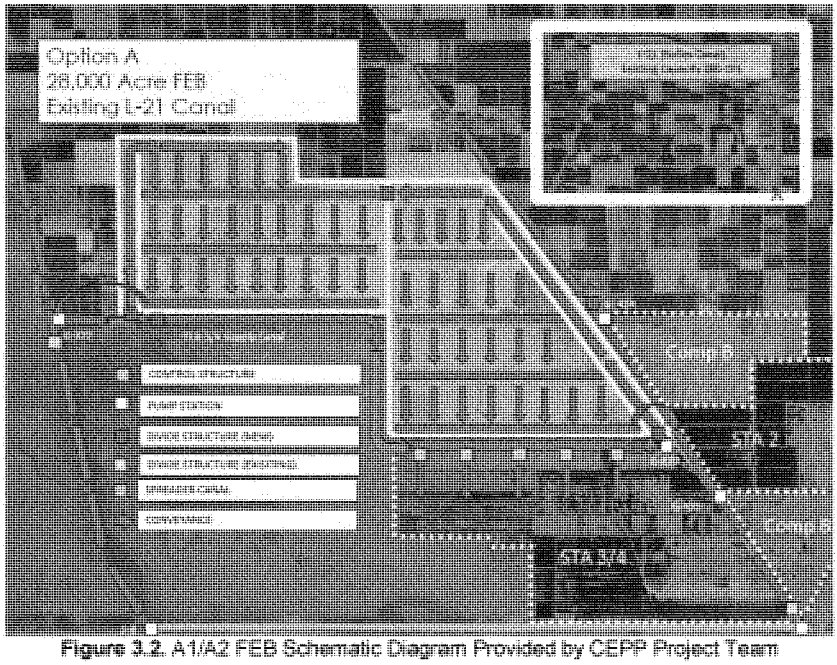

Figure 3.2. A1/A2 FEB Schematic Diagram Provided by CEPP Project Team

In RSMBN, this feature is modeled as a single element (see **Figure 3.3** for component locations). The ALTS scenario assumes the following:

A-1/A-2 FEB Assumptions

- Assumed Flowage Equalization Basin Effective Footprint = 28,467 acres
- FEB operating limits:
  - EAA runoff accepted when FEB stage < 3.8 ft.
  - Lake Okeechobee water accepted when FEB stage < 2.0 ft.
  - Discharges discontinued when depths < 0.5 ft.
  - No supplemental water supply provided to FEB.
  - FEB outflows are used to help meet established inflow targets, as estimated using the Dynamic Model for Stormwater Treatment Areas (**Wang, 2012**) at STA-3/4, STA-2N, and STA-2S

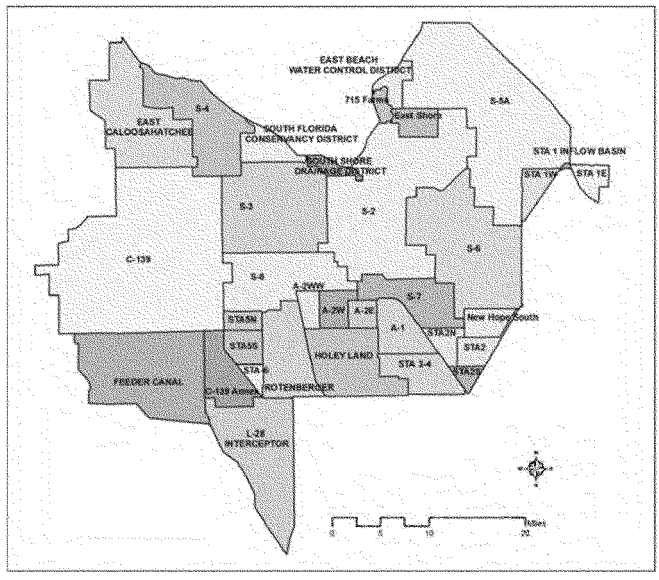

Figure 3.3. Location of CEPP FEB (A-2W + A-2E + A-1) in RSMBN.

The operations of the ALTS FEB are integrated with the regional objectives by including operational modifications to the Lake Okeechobee regulation schedule as follows:

- Lake Okeechobee regulatory releases to the south are made when the Lake is in or above the baseflow zone of the LORS08 schedule and when criteria as identified in **Figure 3.4** are satisfied.
- In order to promote opportunity for Lake discharges to the south, release criteria from the Northern Estuaries are also modified to result in lower overall discharges. Specific changes can be found in **Appendix B.**

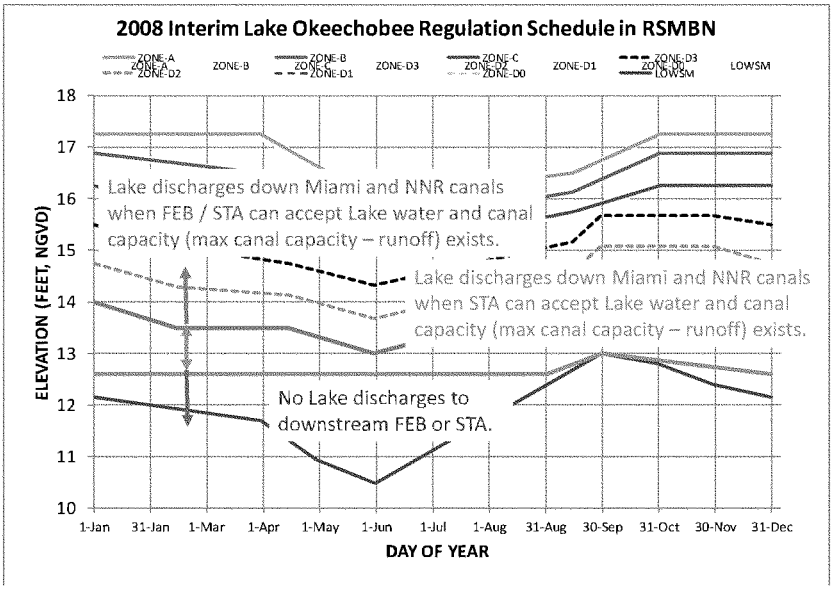

Figure 3.4. Lake Okeechobee Operational Criteria for Determining Discharges South to FEB and STA Facilities.

RSMGL ALT1 Scenario

For ALT1, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.5**. Specific modeling details related to these elements are listed below. Notes on operational intent as applied for the RSMGL scenarios may be found in a consolidated discussion at the end of this section. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or the baseline assumption table / previous model documentation for other regions (**SFWMD, 2014a**).

- Western Hydropattern Restoration Feature (HRF) not modeled as a canal within the model domain but with boundary inflows into the three edge cells west of S8
- Miami Canal removed from Alligator Alley to 1.5 mi south of S8 structure
- Breaches across L28 levee modeled as weirs connecting two pairs of mesh cells between the L28 triangle south of Alligator Alley and WCA3A (9000 ft total length)
- One canal segment in L28 canal reach disabled to represent backfill of a portion of the L28 canal within the L28 triangle area
- Single S345 structure (S345E) with a design discharge of 750 cfs at 1.5 ft differential head (flow is jumped directly into the nearest mesh cell within WCA3B east of the L67C levee) located ~13 mi south of S151
- L-67ext partial levee removal ~3.9 mi remaining
- Two L31N pumps stations (L31PA and L31PB) at 250 cfs each – L29A pump ~1.5 mi south of the L29 canal and L29B pump ~3.6 mi south of the L29 canal
- S333 design capacity increased from 1350 cfs to 3000 cfs (discharge coefficient increased proportionally from 2548 to 5662)
- Western Tamiami Trail Bridge modeled as weirs connecting the L29 canal and the mesh cells intersecting the bridge location (~2.6 mi total length)

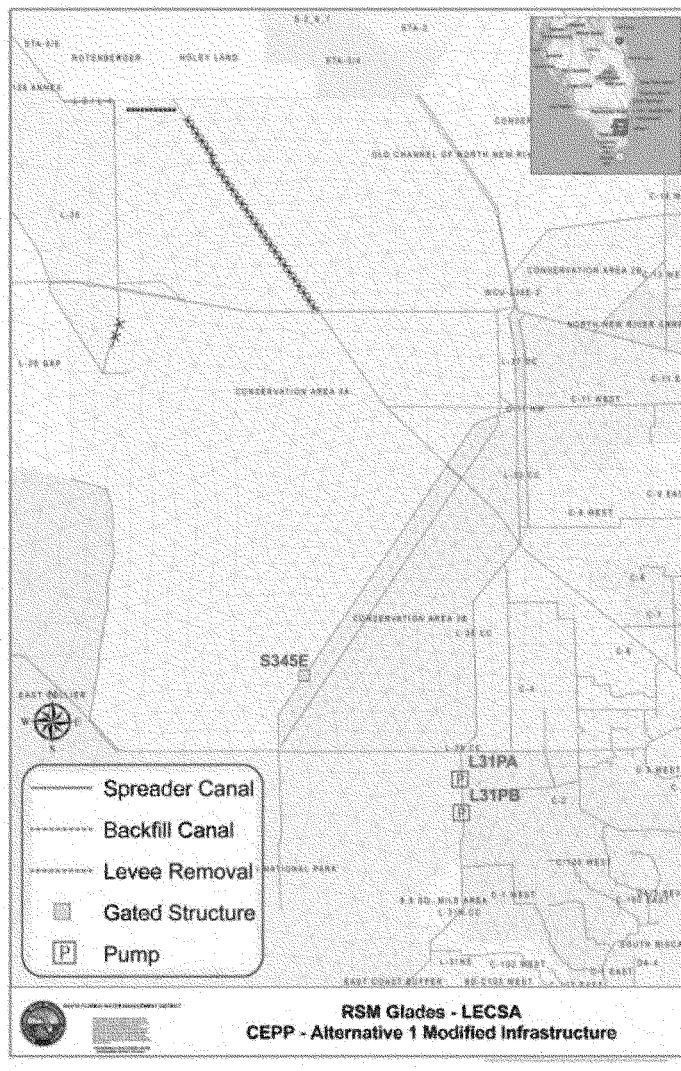

Figure 3.5. Alternative 1 Modified Infrastructure Relative to FWO Baseline

RSMGL ALT2 Scenario

For ALT2, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.6**. Specific modeling detail related to these elements are listed below. Notes on operational intent as applied for the RSMGL scenarios may be found in a consolidated discussion at the end of this section. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or the baseline assumption table / previous model documentation for other regions.

- Western HRF not modeled as a canal within the model domain but with boundary inflows into the three edge cells west of S8
- Eastern HRF not modeled as a canal within the model domain but with boundary inflows into the three cells west of G206
- Central HRF modeled as a canal within the model domain just south of the L5 levee and east of the S8 structure (~3 mi total length) - S8 structure discharges into westernmost segment of canal
- Miami Canal removed from Alligator Alley to S8 structure
- Three S345 structures (S345D, S345E, S345F) where S345E has a design discharge of 750 cfs at 1.5 ft differential head and S345D and S345F have a design discharge of 500 cfs at 1.5 ft differential head (flow is jumped directly into the nearest respective mesh cell within WCA3B east of the L67C levee). S345E is located ~13 mi south of S151 (as in ALT1), S345D is located ~3.3 mi north of S345E, and S345F is located ~4.9 mi south of S345E.
- Full L-67ext levee removal
- Single L31N pump station (L31PB) at 250 cfs is located ~3.6 mi south of the L29 canal
- S333 design capacity increased from 1350 cfs to 3000 cfs (discharge coefficient increased proportionally from 2548 to 5662)
- Western Tamiami Trail Bridge modeled as weirs connecting the L29 canal and the mesh cells intersecting the bridge location (~2.6 mi total length)
- Single L29 gravity structure (L29SA) with a discharge coefficient of 750 is located ~1.7 mi east of S333 and discharges into the L29 canal upstream of the Tamiami Trail Bridge
- Full L31N seepage curtain wall from L29 canal north to S335
- Partial L31N seepage curtain wall from L29 canal south ~3.1 mi

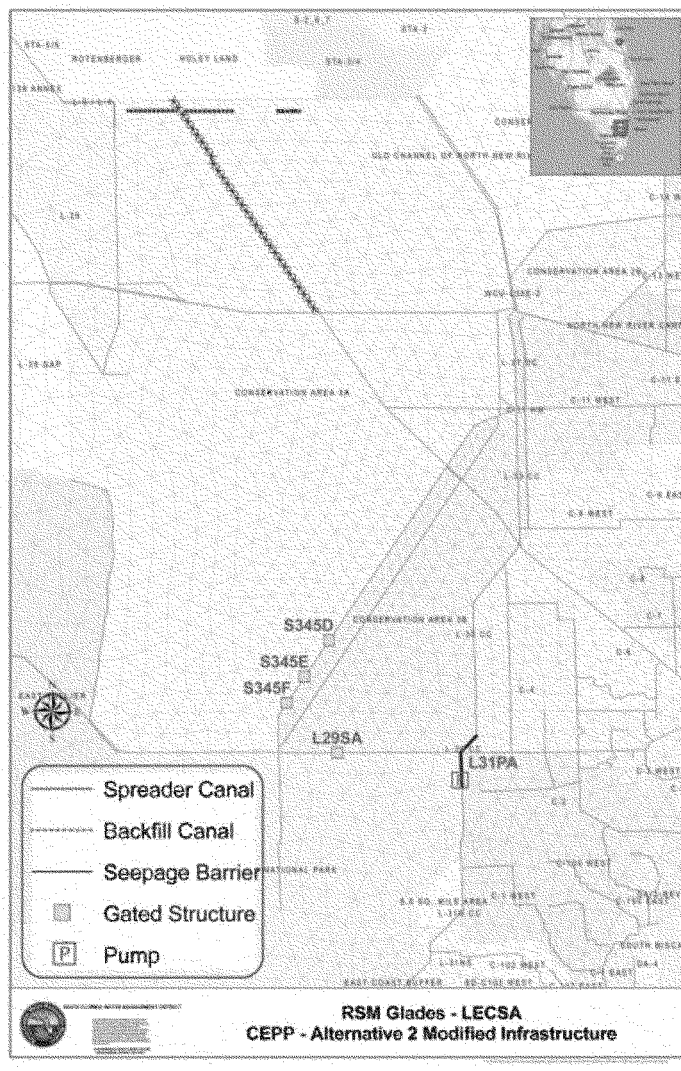

Figure 3.6. Alternative 2 Modified Infrastructure Relative to FWO Baseline

RSMGL ALT3 Scenario

For ALT3, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.7**. Specific modeling detail related to these elements are listed below. Notes on operational intent as applied for the RSMGL scenarios may be found in a consolidated discussion at the end of this section. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or the baseline assumption table / previous model documentation for other regions.

- Western HRF not modeled as a canal within the model domain but with boundary inflows into the three edge cells west of S8
- Eastern HRF not modeled as a canal within the model domain but with boundary inflows into the three cells west of G206
- Central HRF modeled as a canal within the model domain just south of the L5 levee and east of the S8 structure (~3 mi total length) - S8 structure discharges into westernmost segment of canal
- Miami Canal removed from Alligator Alley to S8 structure
- Four S345 structures (S345C, S345D, S345E, S345F), each with a design discharge of 500 cfs at 1.5 ft differential head (flow is jumped directly into the nearest respective mesh cell within WCA3B east of the L67C levee). S345E is located ~13 mi south of S151 (as in ALT1), S345D is located ~3.3 mi north of S345E, S345C is located ~2.5 mi north of S345D, and S345F is located ~4.9 mi south of S345E.
- Full L-67ext levee removal
- S333 design capacity increased from 1350 cfs to 3000 cfs (discharge coefficient increased proportionally from 2548 to 5662)
- Western Tamiami Trail Bridge modeled as weirs connecting the L29 canal and the mesh cells intersecting the bridge location (~2.6 mi total length)
- Two L29 pumps stations (L29PA and L29PB) at 500 cfs each located at the south end of the two westernmost remnant agricultural canals dug in WCA3B (~3 mi and ~7mi east of S333). Modeling included the effects of improving the existing remnant canals for efficient drainage in the southern end of WCA3B.
- Full L31N seepage curtain wall from L29 canal north to S335
- Partial L31N seepage curtain wall from L29 canal south to ~0.6 mi north of C1W canal junction

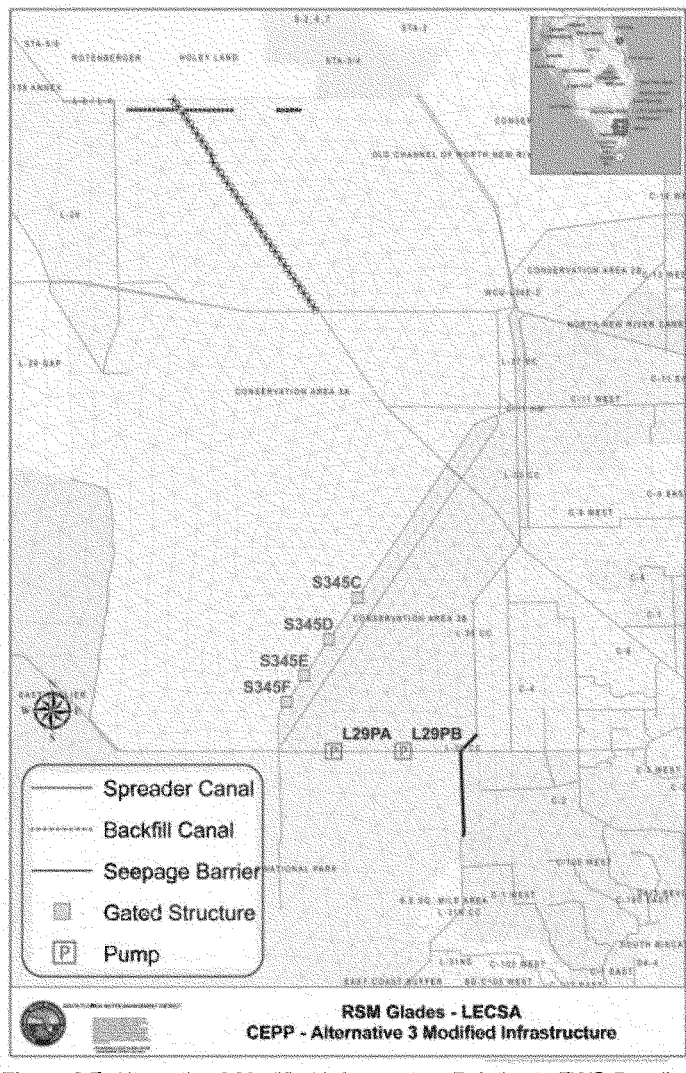

Figure 3.7. Alternative 3 Modified Infrastructure Relative to FWO Baseline

RSMGL ALT4 Scenario

For ALT4, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.8**. Specific modeling details related to these elements are listed below. Notes on operational intent as applied for the RSMGL scenarios may be found in a consolidated discussion at the end of this section. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or the baseline assumption table / previous model documentation for other regions.

- Western HRF not modeled as a canal within the model domain but with boundary inflows into the three edge cells west of S8
- Eastern HRF not modeled as a canal within the model domain but with boundary inflows into the three cells west of G206
- Central HRF modeled as a canal within the model domain just south of the L5 levee and east of the S8 structure (~3 mi total length) - S8 structure discharges into westernmost segment of canal
- Miami Canal removed from Alligator Alley to S8 structure
- S356 design capacity changed from 500 cfs to 1000 cfs
- Three S345 structures (S345D, S345G, S345F), each with a design discharge of 500 cfs at 1.5 ft differential head (flow is jumped directly into the nearest respective mesh cell within WCA3B east of the L67C levee). S345D is located ~9.7 mi south of S151, S345G is located ~16.4 mi south of S151, and S345F is located ~17.9 mi south of S151 along L67-A
- S333 design capacity increased from 1350 cfs to 3000 cfs (discharge coefficient increased proportionally from 2548 to 5662)
- Western Tamiami Trail Bridge modeled as weirs connecting the L29 canal and the mesh cells intersecting the bridge location (~2.6 mi total length)
- Degraded sections of L-29 levee (between S333 and divide structure) as a part of Blue Shanty flowway.
- Divide structure (no flow junction block) east of Blue Shanty Flowway close to western bridge.
- Partial L31N seepage curtain wall from L29 canal south to ~0.6 mi north of C1W canal junction
- Entire section of L-67 extension levee degraded

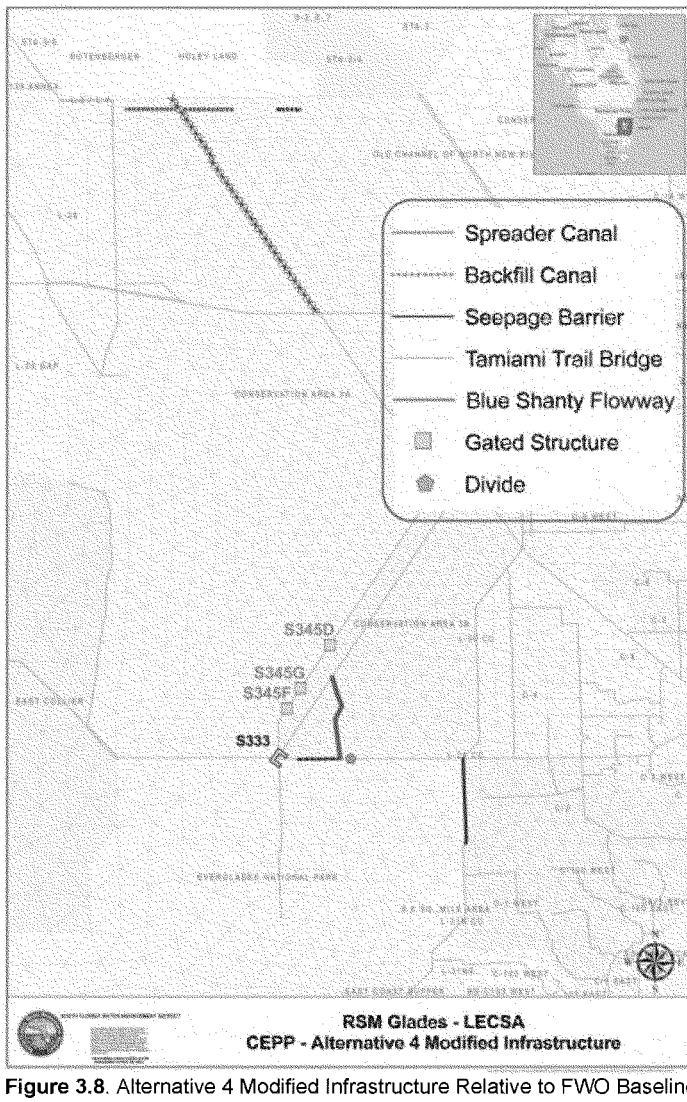

Figure 3.8. Alternative 4 Modified Infrastructure Relative to FWO Baseline

Operational Criteria in RSMGL

Operational criteria in RSMGL for the CEPP alternatives were implemented to mimic the results of the Greenline target and operations screening work (**SFWMD, 2014d**). Using the iModel©, a system-wide simulation and optimization tool that is based on artificial neural network and numerical optimization, WCA3A inflow and outflow structures are managed under a Rainfall Driven Operation (RDO) scheme. Unlike regulation schedule based operations, the RDO estimates inflow releases and outflow delivery to WCA3B and the Everglades National Park (ENP), in response to weekly rainfall and potential evapotranspiration (PET). Goals of the operations consider the following:

- Weekly stage at system-wide locations (3ANW, 3A11, 3ASW, W2, 3A4, 3AS, 3ANE, 3A28, E4, 3A3, 3B-71, Shanty, NESRS2, NP205, NP46 and P33) approach the corresponding weekly restoration targets as agreed upon during Greenline screening. The locations were identified by the CEPP project team. Results of optimization are unique for each alternative and summarized in the CEPP Draft PIR/EIS (**USACE, 2013b**).
- Aims to improved WCA3A recession rates in three range categories: excellent (0.03 to 0.06), acceptable (0 to 0.03 and 0.06 to 0.1) and unacceptable (> 0.1). The recession rate is calculated as the difference between current stage and last week's stage (averaged over 3A4, 3A28 and 3A3 locations).
- Reduce frequency when stage may exceed above Zone "A" of the ERTP regulation schedule.

In addition to those operations predicated on RDO, the following operational changes were made to the CEPP alternatives:

- Tamiami Trail releases (S333 and S12s) use the same operating logic as today's ERTP schedule, namely the Rainfall Plan. CEPP alternatives replace the calculation of the rainfall-driven component (i.e., environmental target) with RDO estimates. Spatially, CEPP alternatives also attempt to deliver 100% of both the environmental and regulatory calculation through S333 subject to capacity and hydraulic constraints (this is different than the current ratio used in ERTP).
    - It is important to note that the model still assumes that the S12s will attempt to discharge regulatory releases once WCA3A stages are in Zone A of the regulation schedule independent of the Rainfall Plan calculation (this assumption is unchanged from the project baseline scenarios).
    - In the final array alternatives, any assumed 345 structures are operated solely based upon RDO environmental targets and are independent of operational considerations at Tamiami Trail.
- L29 canal can receive inflow up to 9.7 ft (applies to western segment only in ALT4, i.e., S333, but not S356); G3273 constraint = 9.5 ft
- Seepage infrastructure and associated LEC canal structures were operated as shown in the detailed table in **Appendix C**.
- L6 diversion operational criteria (common to all alternatives) were assumed as follows:
    - Divert up to 500 cfs (southern L6 canal conveyance without overtopping into southern WCA2A), subject to WCA2A considerations
    - Limit total L5 flow to 3000 cfs (e.g. if STA 3+4 outflows =2800 cfs, only 200 cfs will be diverted), subject to WCA2A considerations
    - When below the WCA2A CEPP diversion line (**Table 3.1**), first 2500 cfs discharge to WCA2A and then 20% toward WCA3A, subject to conveyance

- When above the CEPP diversion line (**Table 3.1**), 67% toward WCA3A, subject to conveyance

Table 3.1. Water Conservation Area 2A Inflow Operational Consideration

			CEPP Diversion Line	2A Schedule
1	1-Jan	1	11.492	11.484
2	31-Jan	2	11.250	11.000
3	30-Jun	3	11.250	11.000
4	30-Sep	4	13.000	13.000
5	310Dec	5	11.500	11.500

4.0 Results

Final CEPP modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. This system can be accessed at http://www.evergladesplan.org/pm/progr_mms.aspx. CEPP modeling products in MMS can be accessed directly at the project page:

http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

Due to the large size of many of the CEPP modeling files, the majority of the modeling output has been archived in the Data Access Storage and Retrieval (DASR) application of CERPzone at www.cerpzone.org. CEPP modeling products in DASR can be accessed within the project modeling folder:

P:\IMC_Final_Modeling_Results\PROJ 51 - Central Everglades Planning

While the modeling products have been archived in the above systems, the table below lists more specific information including model version, inputs used and detailed DASR archival location. Version numbers and "svnroot" paths refer to a model version control system found on the SFWMD network that is not generally accessible, but inputs, model executables and source code have been copied into the MMS system for ease of access.

Version information and model file locations

RSMBN ALTS 12202012	**RSM_v4728 and xml_v8948**
Input: ...svnroot/trunk/CentEver/rsmbn/FinalArray/12202012/run3 Output (DASR): .../2PlanFormulation/4FinalArray/Final_Output_122012/rsmbn_model_output/ALTS	
RSMGL ALT1 12202012	**RSM_REL_2.3.5 and xml_v8965**
Input: .....svnroot/trunk/CentEver/rsmgl/Final_Array/ALT1 Output (DASR): .../2PlanFormulation/4FinalArray/Final_Output_122012/rsmgl_model_output/ALT1	
RSMGL ALT2 12202012	**RSM_REL_2.3.5 and xml_v8965**
Input: ... svnroot/trunk/CentEver/rsmgl/Final_Array/ALT2 Output (DASR):.../2PlanFormulation/4FinalArray/Final_Output_122012/rsmgl_model_output/ALT2	
RSMGL ALT3 12202012	**RSM_REL_2.3.5 and xml_v8965**
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RSMGL ALT4 12202012	**RSM_REL_2.3.5 and xml_v8965**
Input: ... svnroot/trunk/CentEver/rsmgl/Final_Array/ALT4 Output (DASR): .../2PlanFormulation/4FinalArray/Final_Output_122012/rsmgl_model_output/ALT4	

Review of Local and Regional-Level Results

The RSMBN and RSMGL baseline modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. Specific checks on RSM outputs included the following:

- The ALTS scenario generally maintains Lake Okeechobee performance relative to ECB as shown in **Figure 4.1 and Table 4.1**. CEPP ALTS is > 15.0 ft for approximately 23.1% of the time, meeting the desired criteria.
- ALTS reduces the number of high discharge events to northern estuaries relative to the baselines as shown in **Figure 4.2 (a) and (b)**. It can also be observed that maintain low flow event frequency is maintained in the Caloosahatchee Estuary, but increased in the St. Lucie Estuary
- The ALTS scenario generally maintains LOSA and Tribal water supply performance relative to FWO as shown in **Figure 4.3 to 4.6.**
- Compared to FWO, ALTS provides approximately 200 kac-ft additional flow to Everglades as shown in **Table 4.2**.
- Performance of the CEPP FEB is deemed to be reasonable since the depth regime observed in the ALTS run is similar to the "design" criteria utilized for the A1 FEB (based on an emergent vegetation flowway). Flow regimes were checked in DMSTA (**Wang 2012**) to verify compliance with applicable planning standards.
- In RSMGL, CEPP ALT1, ALT2, ALT3 and ALT4 have varying performance.
- In WCA 2A & WCA2B, performance in all alternatives is affected by CEPP L-6 Diversion operations. CEPP runs are similar to ECB (lower highs) in WCA2A (**Figure 4.7**), but lower WCA2B and adjacent LEC areas relative to FWO and ECB (**Figure 4.8**).
- Distribution of northern WCA3A inflows varies between CEPP ALT1 and ALTs 2-4 as illustrated by an example in **Figure 4.9**. All CEPP alternatives increase stages and hydroperiods in northern WCA3A relative to FWO (an example in **Figure 4.10**). In all CEPP alternatives, performance in northeastern WCA3A are similar to defined sawgrass targets
- CEPP alternatives are all similar to FWO (lower highs) in central & southern WCA3A (**Figure 4.11**). In general, more flow is moving through WCA3A system in CEPP relative to FWO (**Figure 4.12**). While stage performance is similar, WCA3A outflow distribution is different across the CEPP ALTs as shown in **Table 4.3**. "Eastern" releases to ENP via S333 have higher priority than S12 discharges, which only make flood control releases as determined by WCA3A regulation schedule.
- High variability is observed across the CEPP alternatives for performance in WCA3B (**Figures 4.13 to 4.14**). All alternatives raise WCA3B stages and increase hydroperiods relative to FWO. Pennsuco & LEC trends are heavily influenced by and related to WCA3B stage conditions. In the alternatives, WCA3B overland flow directionality generally shows poor alignment with landscape patterning.
- CEPP alternatives all significantly increase stages and hydroperiods in Shark River Slough. All alternatives show large flow increases into eastern ENP at Tamiami Trail and subsequently down Shark River Slough (**Figure 4.15**). The

majority of Marl areas do not show increased hydroperiods, but immediately adjacent to Shark River Slough, wetter conditions do exist (**Figure 4.16**). Higher stage conditions could improve conditions in Florida Bay.

- In the Lower East Coast, the alternatives all show differing degrees of seepage management (**Table 4.4**) as could be expected from the diverse assumptions in infrastructure. While extreme canal / groundwater conditions are somewhat mitigated by additional CEPP infrastructure, more moderate and dry conditions (**Figure 4.17**) may show undesirable trends.
- Potential exists in CEPP to reduce surface water discharges throughout LEC east of ENP and toward Biscayne Bay as shown in **Table 4.5**.

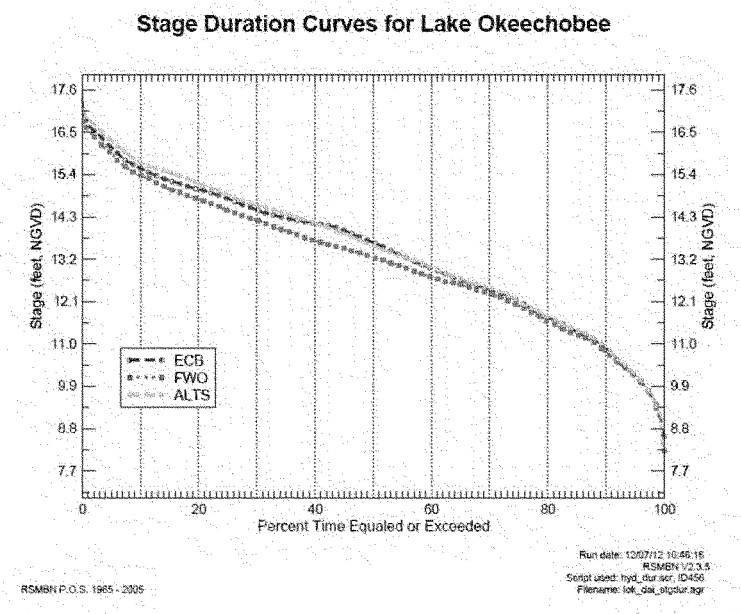

Figure 4.1. Lake Okeechobee performance for ALTS relative to the baselines.

Table 4.1. Lake Okeechobee Standard Score Performance Measure

	ECB	FWO	ALTS
Low Lake (LO1)	86.99	86.02	87.48
High Lake (LO2	99.11	99.11	97.78
Score Below Env (LO3)	40.32	34.29	42.41
Score Above Env (LO3)	75.74	82.50	73.48
Weighted Average:	86.70	86.86	86.02

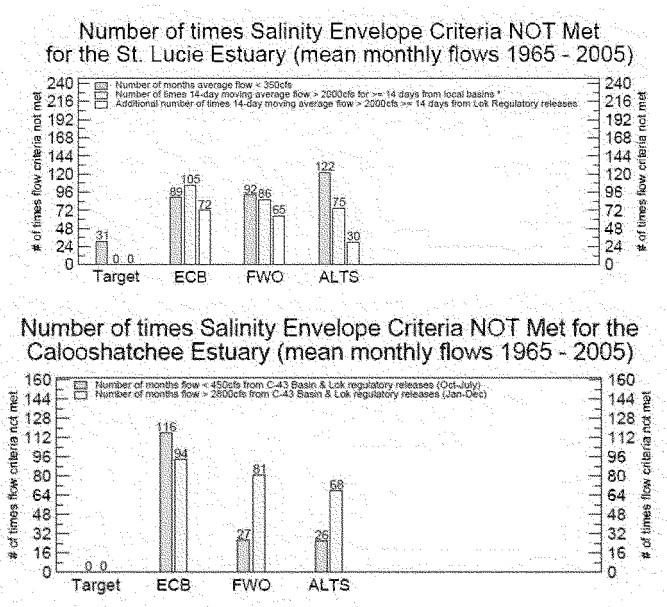

Figure 4.2. High discharge events to northern estuaries (a) St. Lucie Estuary and (b) Caloosahatchee Estuary relative to the baselines for the ALTS alternative.

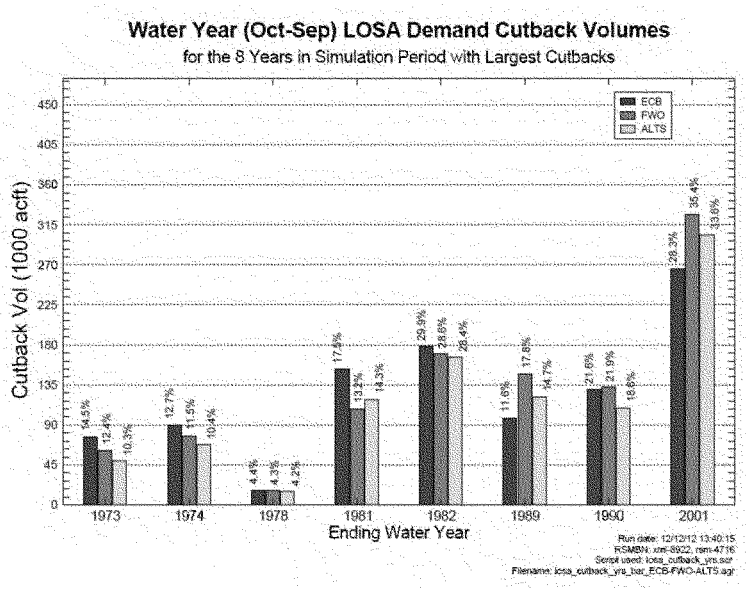

Figure 4.3. Water shortage cutbacks for water years with large cutback volumes

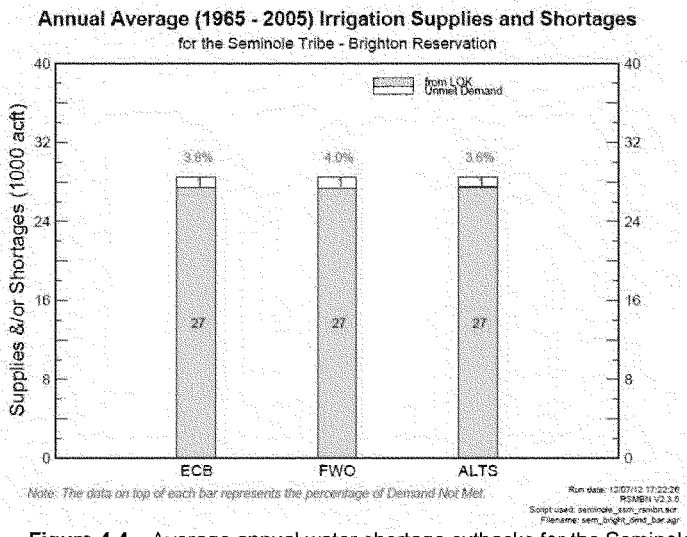

Figure 4.4. Average annual water shortage cutbacks for the Seminole Brighton Reservation

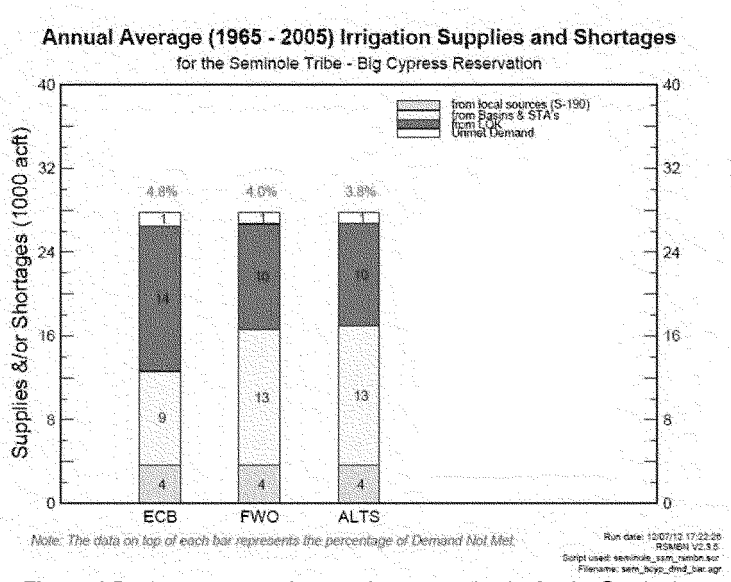

Figure 4.5. Average annual water shortage cutbacks for the Seminole Big Cypress Reservation

Table 4.2. Average annual Discharges (kac-ft) from STA2 and STA34 toward the Greater Everglades

	ECB	FWO	ALTS	Diff (ALTS-FWO)
STA2	234.5	381.0	374.2	(-6.8)
STA34	538.5	382.2	595.9	(213.7)
Total Additional Water =				+206.9

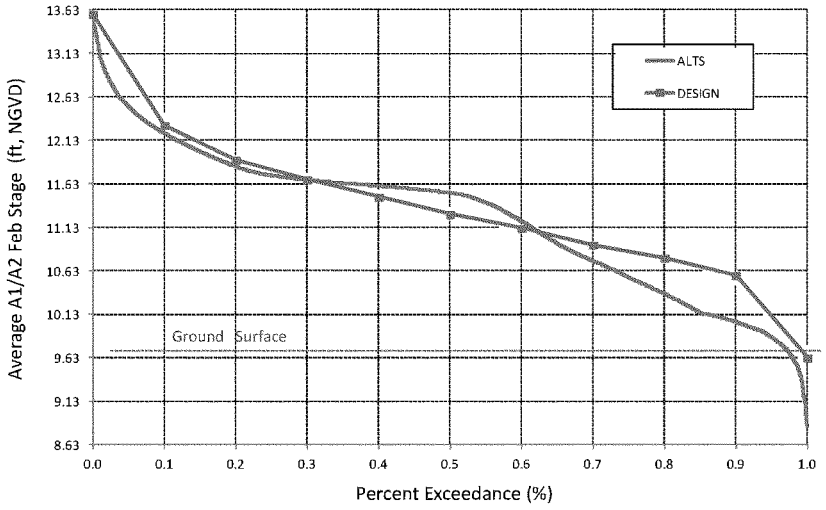

Figure 4.6. A1/A2 FEB stages as modeled relative to "Design" target for an emergent vegetation flowway

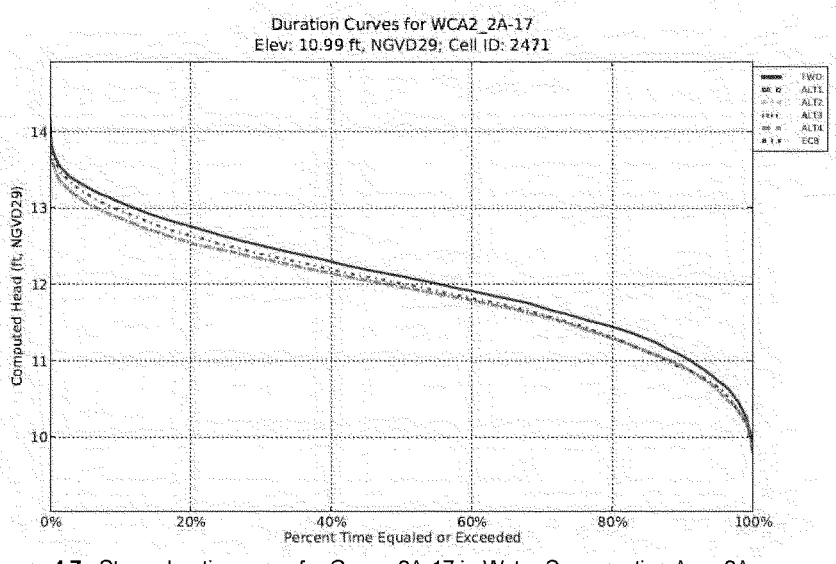

Figure 4.7. Stage duration curve for Gauge 2A-17 in Water Conservation Area 2A

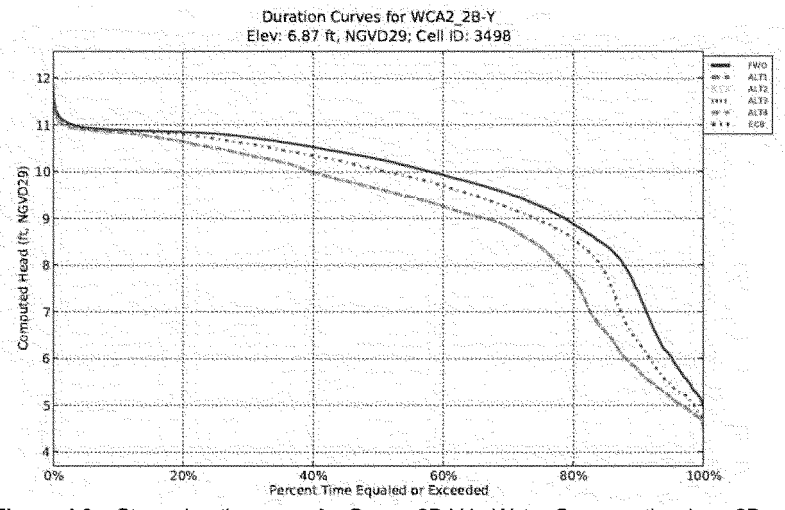

Figure 4.8. Stage duration curve for Gauge 2B-Y in Water Conservation Area 2B

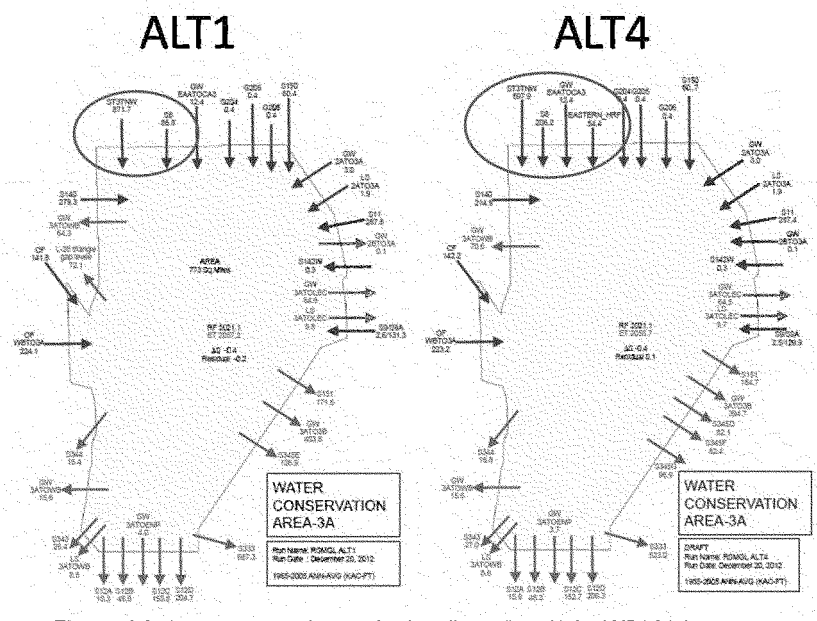

Figure 4.9. Average annual water budget flows (kac-ft) for WCA3A between ALT1 (left) and ALT4 (right)

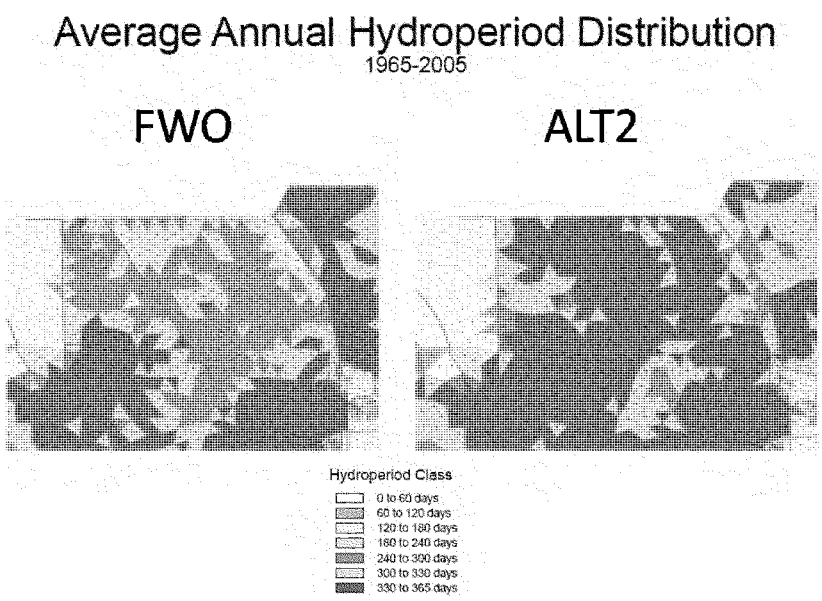

Figure 4.10. Average annual hydroperiod difference in northern WCA3A between FWO (left) and ALT2 (right)

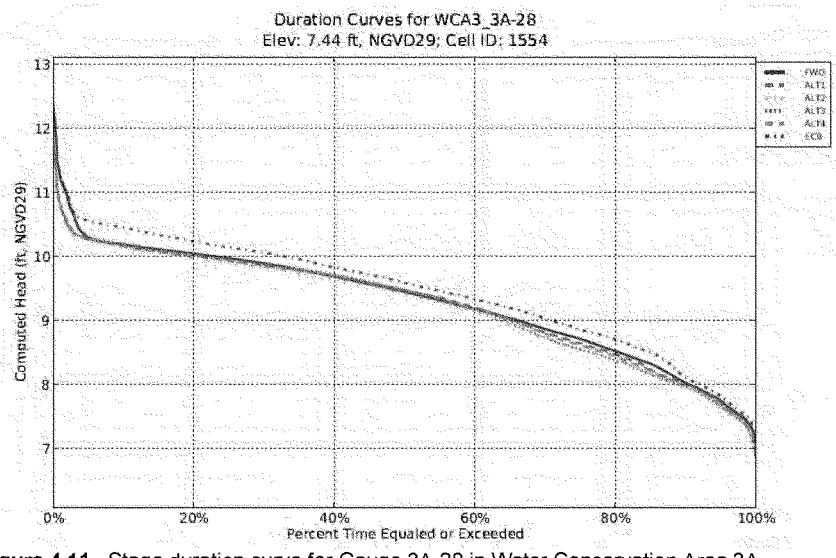

Figure 4.11. Stage duration curve for Gauge 3A-28 in Water Conservation Area 3A

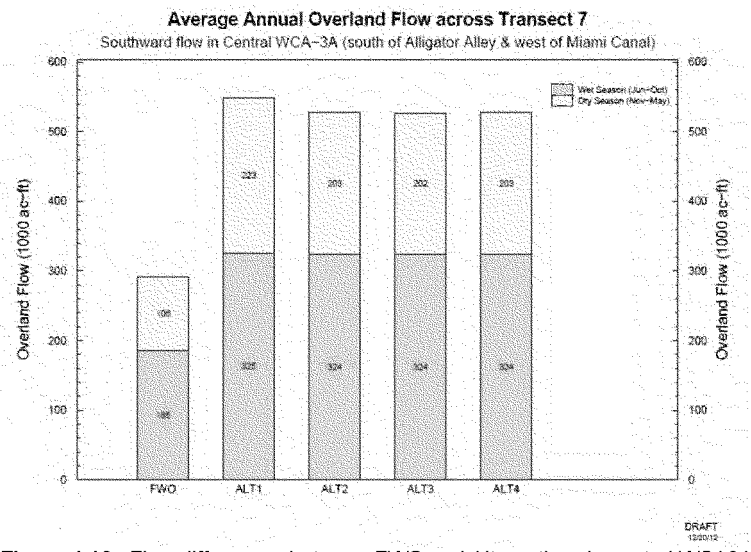

Figure 4.12. Flow differences between FWO and Alternatives in central WCA3A

Table 4.3. WCA3A Tamiami Trail Structural Outflow Distribution (kac-ft)

	ECB	FWO	ALT1	ALT2	ALT3	ALT4
S333	129.72	137.15	667.28	626.32	354.42	522.95
S12A	37.33	29.76	15.25	14.54	16.76	15.87
S12B	98.56	92.16	46.57	44.90	51.06	48.26
S12C	172.91	242.85	150.81	143.93	157.56	152.74
S12D	384.87	320.39	204.73	194.48	211.93	206.29
	693.67	685.16	417.36	397.85	437.31	423.16

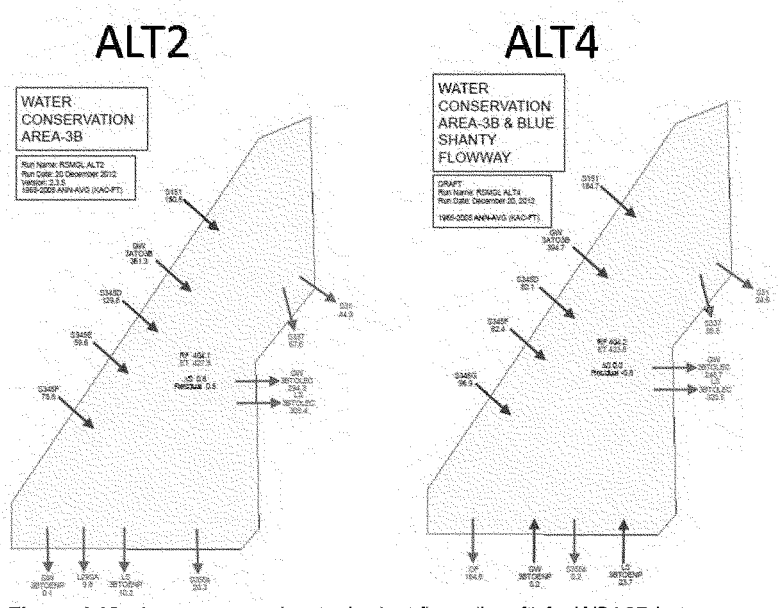

Figure 4.13. Average annual water budget flows (kac-ft) for WCA3B between ALT2 (left) and ALT4 (right)

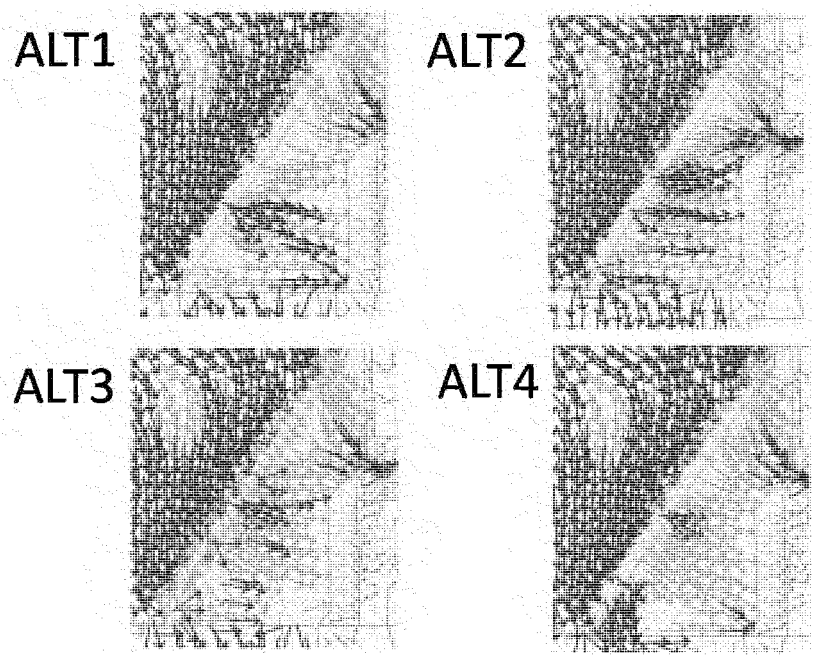

Figure 4.14. Average annual overland flow vectors (showing flow directionality) in WCA3B for ALT1, ALT2, ALT3 and ALT4.

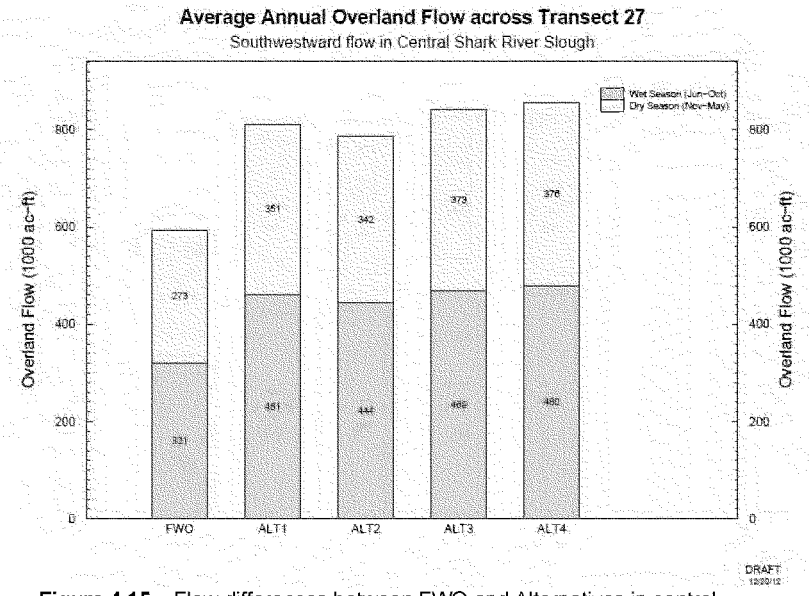

Figure 4.15. Flow differences between FWO and Alternatives in central Shark River Slough

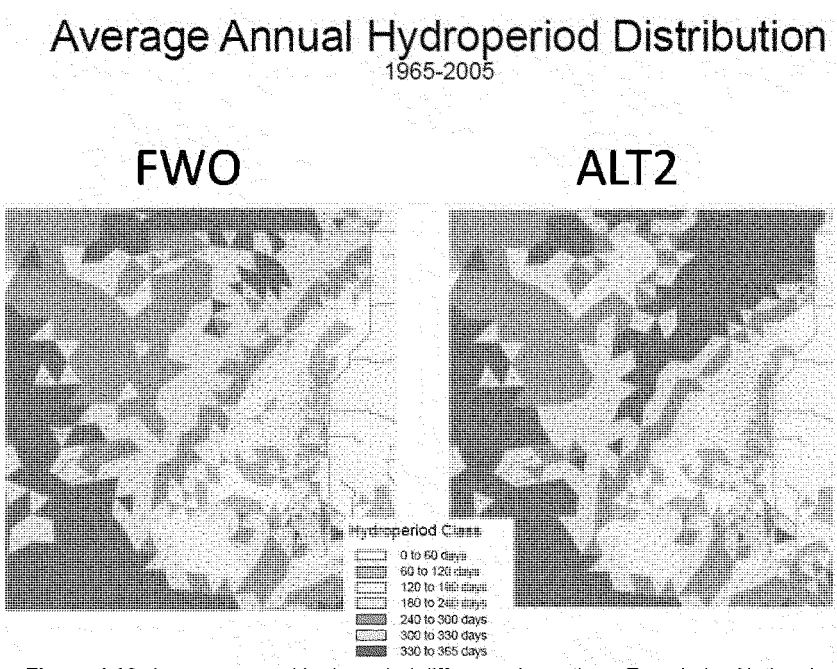

Figure 4.16. Average annual hydroperiod difference in northern Everglades National Park between FWO (left) and ALT2 (right)

Table 4.4. Levee seepage from marsh cell to adjacent canal (Avg. Annual, kac-ft)

	ECB	FWO	ALT1	ALT2	ALT3	ALT4
C-111 from S-176 to S-177	98	188	190	188	190	184
C-111 from S-177 to S-18C	29	43	42	42	43	44
L-30 between S-335 and the bridge	111	107	151	225	162	133
L-30 north of the bridge	218	214	205	236	201	203
L-30 south of S-335	92	82	107	0	0	102
L-31N from G-211 to S-331	29	29	32	31	33	32
L-31N from S-331 to S-176	209	236	286	249	259	286
L-31N north of G-211	149	164	390	31	159	64

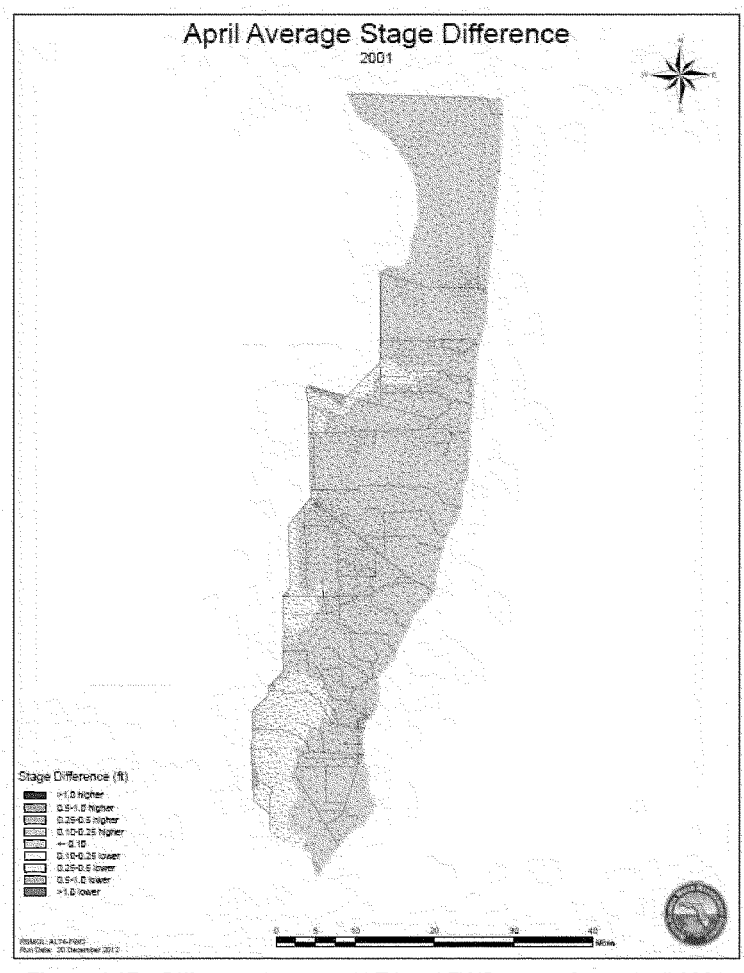

Figure 4.17. Difference between ALT4 and FWO stages for an April 2001 condition in the Lower East Coast

Table 4.5. Surface water flows east of ENP and toward Biscayne Bay.

South Dade	ECB	FWO	ALT1	ALT2	ALT3	ALT4
G211FC	110.17	110.78	2.90	0.66	0.08	6.83
G211WS	60.48	62.41	57.51	60.24	58.58	58.09
S336	5.93	5.71	4.04	4.21	5.73	6.35
S338	58.89	57.13	51.17	53.19	29.02	32.97
S357	2.66	3.27	47.20	45.18	48.22	47.31
S331FC	164.10	164.94	87.39	80.43	80.38	86.29
S331WS	61.41	62.58	53.02	57.35	54.70	54.35
S194	20.98	25.82	15.89	15.63	16.86	18.53
S196	8.99	13.72	6.59	6.09	6.08	7.14
S176	50.25	42.98	42.28	43.04	43.06	42.03
S177	124.33	69.78	73.25	71.96	72.80	71.31
S18C	182.80	144.98	144.38	143.52	145.08	144.56
S197	16.49	6.66	7.91	7.85	8.12	8.25

In summary, the four delivered alternative runs provided to the CEPP project team are deemed to adequately represent the intended planning conditions and when utilized in conjunction with proposed with-CEPP project baselines, provide a reasonable basis of comparison for the necessary evaluations required to draft the PIR.

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Appendix A – Details of Alternatives

Figure A.1 shows spatial perspective of the different modeling zones of the Central Everglades Planning Project. Details of Alternatives ALT1, ALT2, ALT3, and ALT4 are shown in **Figures A.2, A.3, A.4 and A.5**, respectively.

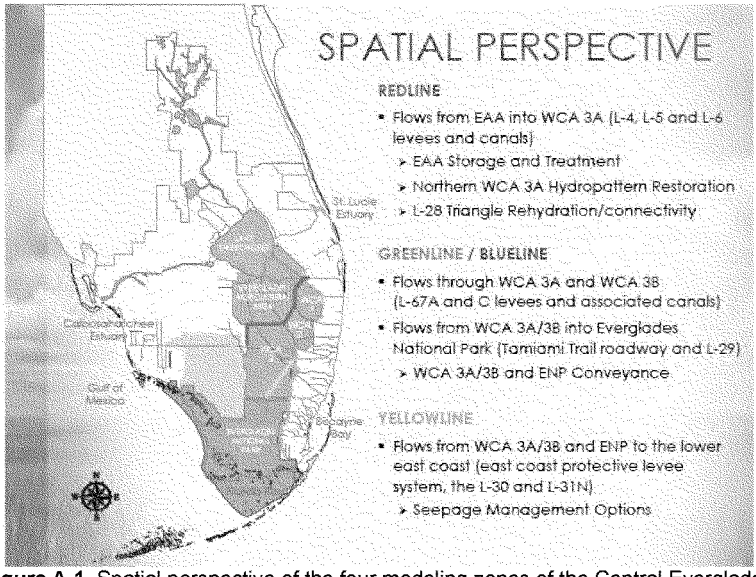

Figure A.1. Spatial perspective of the four modeling zones of the Central Everglades Planning Project.

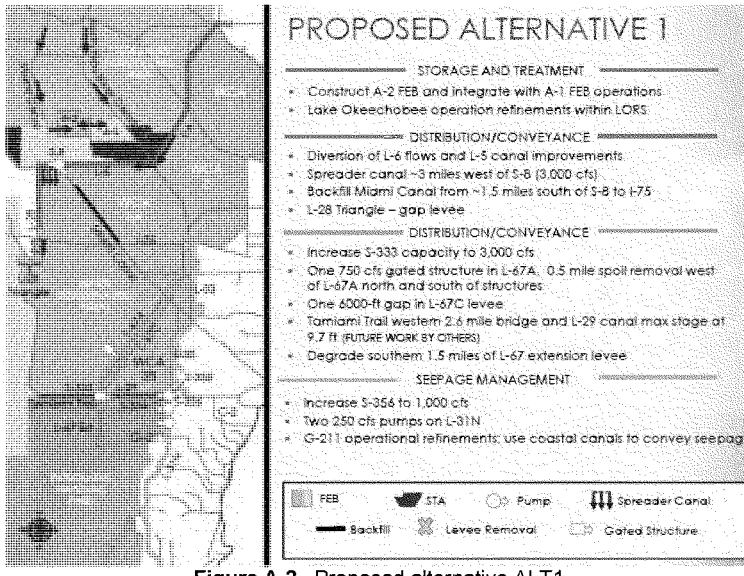

Figure A.2. Proposed alternative ALT1

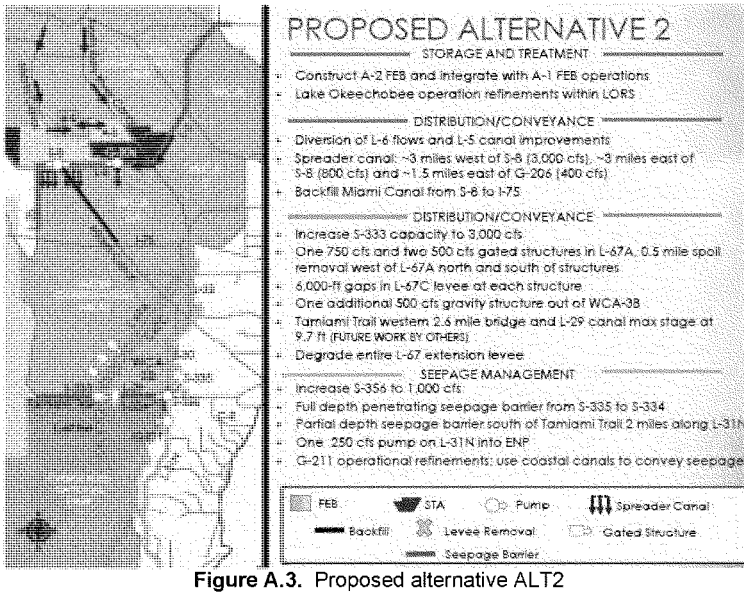

Figure A.3. Proposed alternative ALT2

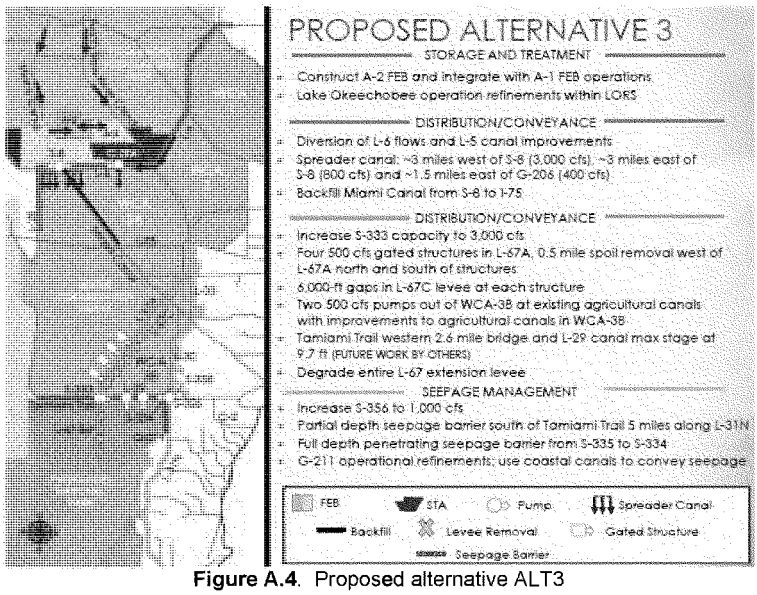

Figure A.4. Proposed alternative ALT3

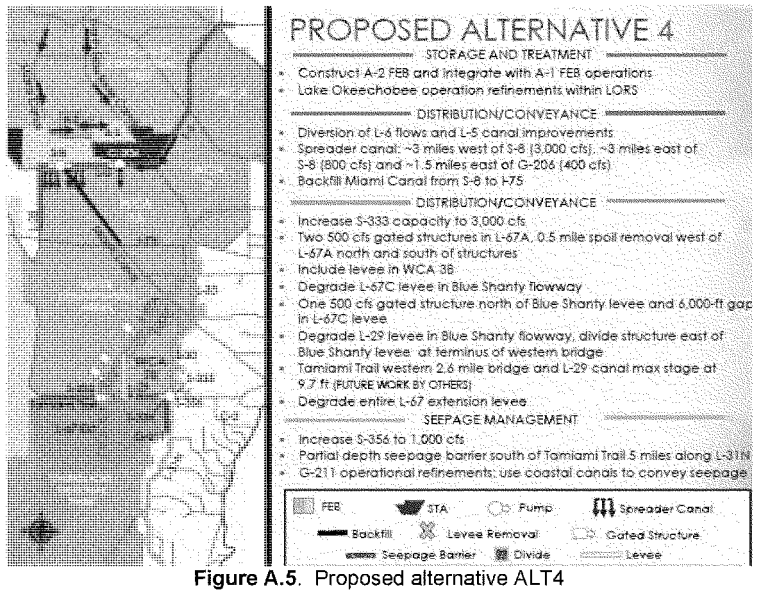

Figure A.5. Proposed alternative ALT4

Appendix B – LORS08 Operations Schedule and CEPP Schedule Modifications as Modeled

The LORS08 schedule used for operation of Lake Okeechobee in the CEPP baselines was modified as shown in **Figure B.1**. **Figures B.2 and B.3** show the pulse releases from Lake Okeechobee into the Caloosahatchee and St. Lucie Estuary, respectively.

Details of the final array model implementation of the schedule can be found in **Figures B.4, B.5 and B.6. Figure B.4** lists the range of values used to classify the tributary hydrologic conditions. **Figure B.5** lists the range of values used to classify the net inflow seasonal outlook. **Figure B.6** lists the range of values used to classify the net inflow multi-seasonal outlook.

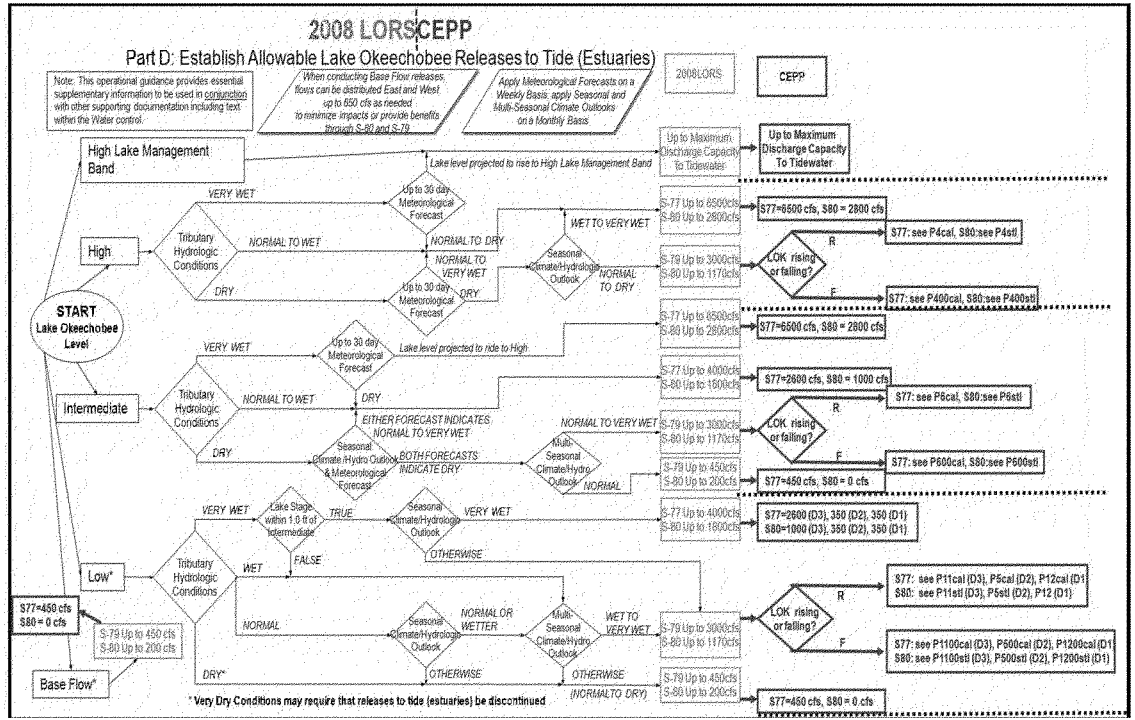

Figure B.1. LORS08 operations schedule, with CEPP final array modifications as modeled shown in blue.

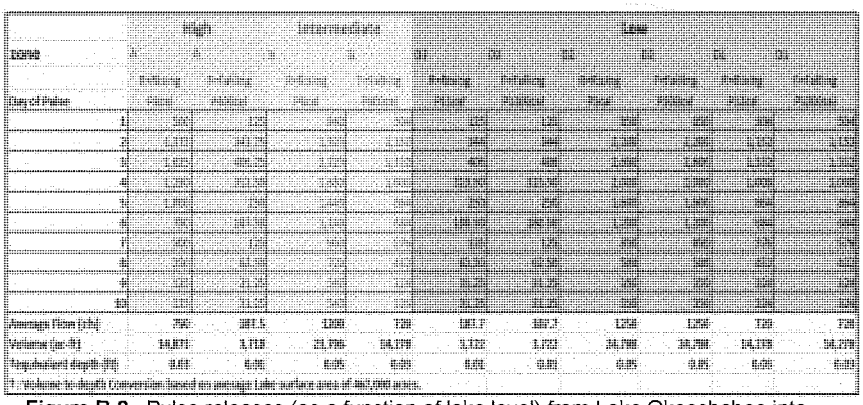

Figure B.2. Pulse releases (as a function of lake level) from Lake Okeechobee into Caloosahatchee Estuary in cubic feet per second (cfs).

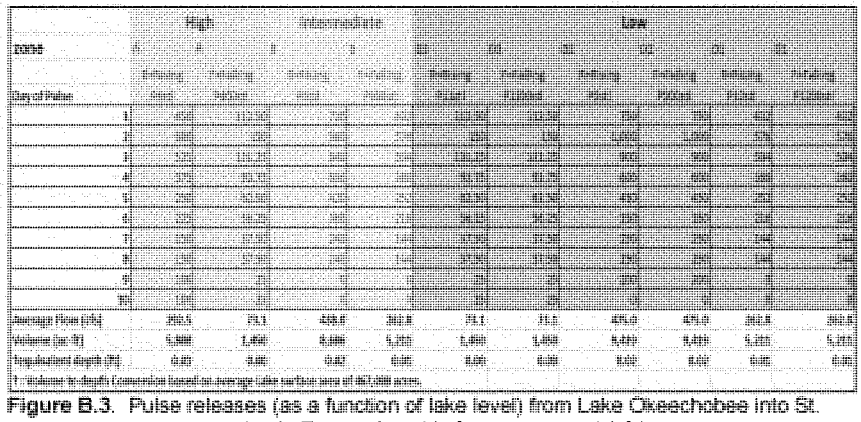

Figure B.3. Pulse releases (as a function of lake level) from Lake Okeechobee into St. Lucie Estuary in cubic feet per second (cfs).

LORS2008

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.0	>= 6000 cfs	Very Wet
1.5 to 2.99	2500 - 5999 cfs	Wet
-1.49 to 1.49	500 - 2499 cfs	Near Normal
-2.99 to -1.5	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry

*use the wettest of the two indicators

CEPP-RSMBN

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.3	>= 8700 cfs	Very Wet
0.01 to 3.29	1000 - 8699 cfs	Wet
-0.5 to 0.0	500 - 999 cfs	Near Normal
NOT USED	-5000 - 500 cfs	Dry
NOT USED	< -5000 cfs	Very Dry

*use the wettest of the two indicators

Figure B.4. LORS08 and CEPP final array modified Tributary Hydrologic Conditions Classifications

LORS2008

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 0.93	> 2.0	Very Wet
0.71 to 0.93	1.51 to 2.0	Wet
0.35 to 0.70	0.75 to 1.5	Normal
< 0.35	< 0.75	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 1.43	> 3.06	Very Wet
0.91 to 1.43	1.93 to 3.06	Wet
0.46 to 0.90	0.98 to 1.92	Normal
< 0.46	< 0.98	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

Figure B.5. LORS08 and CEPP final array modified Seasonal Outlook Classifications

LORS2008

Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.5 to 1.17	1.1 to 2.5	Normal
< 0.5	< 1.1	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
NOT USED	> 4.3	Very Wet
> 1.17	> 2.5	Wet
0.6 to 1.17	1.3 to 2.5	Normal
< 0.6	< 1.3	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

Figure B.6. LORS08 and CEPP final array modified Multi-Seasonal Outlook Classifications.

Appendix C – Structure Operations in South Miami-Dade County for CEPP Final Array Runs

In **Table C.1**, the list of structures is color-coded in three groupings:

green	Structures on the L-67, L-28, and L-29 canals. Structures included are S-345, S-349, S-344, S-343A-B, S-12A-D, S-333, S-334, S-355, and S-356
blue	Structures on the L-30 and part of the L-31 canals Structures included are S-337, S-151, S-335, S-338, G-211, S-173 & S-331P (COMBQ), S-176 and S-174
yellow	Structures on part of the L-31 canal and L-31W and C-111 canals Structures included are S-332A-D, S-357, S-332, S-175, S-200, S-199, S-177, S-18C, S-197 and S-332E

Table C.1 includes final array alternatives ALT1, ALT2, ALT3, and ALT4.

Table C.1. Final Array Alternatives (ALT1, ALT2, ALT3, ALT4)

Canal	Structure	**ALT1 (RSMGL)** Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	**ALT2 (RSMGL)** Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	S345E (physical model) gated spillway at L-67A Design Q= 750 cfs flood control only	S345E (physical model) gated spillway at L-67A Design Q= 750 cfs flood control only S345D & S345F 2 gated spillway at L-67A Design Q= 500 cfs each flood control only
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each
L-29	S-12A-D*	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only
	S-333*	Special code 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=3000 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only	Special code 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=3000 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only
	S-334	Non-existent No IOP wraparound operations. So, no flow through S334	Non-existent No IOP wraparound operations. So, no flow through S334
	S-355*	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5
	S-356*	**6.0/5.5** open/closed wet & dry season 1) Design Q = 1000 cfs 2) Flood control only	**6.0/5.5** open/closed wet & dry season 1) Design Q = 1000 cfs 2) Flood control only

Canal	Structure	**ALT3 (RSMGL)**	**ALT4 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	S345C, S345D, S345E &S345F 4 gated spillways at L-67A Design Q= 500 cfs each flood control only	S345D, S345F &S345G 3 gated spillways at L-67A Design Q= 500 cfs each flood control only
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each
L-29	S-12A-D*	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only
	S-333*	Special code 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=3000 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only	Special code 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=3000 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only
	S-334	Non-existent No IOP wraparound operations. So, no flow through S334	Non-existent No IOP wraparound operations. So, no flow through S334
	S-355*	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5
	S-356*	**6.0/5.5** open/closed wet & dry season 1) Design Q = 1000 cfs 2) Flood control only	**6.0/5.5** open/closed wet & dry season 1) Design Q = 1000 cfs 2) Flood control only

Canal	Structure	**ALT1 (RSMGL)**	**ALT2 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml
	S-335	**7.6/ 7.4** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0	**7.5/ 7.2** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0

Canal	Structure	**ALT3 (RSMGL)**	**ALT4 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 localLevel=7.0 mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ECB.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml	Flow target based on WCA-3A regulation schedule 1) Water Supply / Flood Control 2) Design Q=1800 cfs (discharge coef. = 1154.48 in msestruc*.xml) mse_unit outlet for WCA-3A; "WCA3A local" localLevel = 7.5 mse_unit inlet C-304; C304 localLevel=99.0 Special Code for S151: S151_reg_max_zoneA=1000 (input variable Special_Assessors_ECB.so) S151_reg_max_zoneBC=500 (input variable Special_Assessors_ECB.so) S151_TWi & S151_HWi (input variable Special_Assessors_ECB.so) S151_FracGO & S151_FracGo_high & S151_FracGo_low variable output maxfracS12s xml
	S-335	**7.6/ 7.4** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0	**7.6/ 7.4** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 localLevel=7.0 mse_unit inlet for L31NC; localLevel=99.0

Canal	Structure	ALT1 (RSMGL)	ALT2 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet season **5.6 / 5.4** open/closed dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve
	S-173 & S-331P (COMBQ) *	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	ALT3 (RSMGL)	ALT4 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet & dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0	**5.8 /5.5** open/closed wet season **5.6 /5.4** open/closed dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0 mse_unit inlet for L31NC; localLevel=99.0
	G-211	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve	**6.0 / 5.5** open/closed wet & dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0 no rulecurve
	S-173 & S-331P (COMBQ) *	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	ALT1 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	ALT2 (RSMGL) Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	ALT3 (RSMGL)	ALT4 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet & dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	ALT1 (RSMGL)		ALT2 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332BN (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332C (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332D 4.85/4.65	S332A Non-Existent S332B (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332BN (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332C (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332D 4.85/4.65	S332A non-existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A non-existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65
		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs		S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs	
L-31W	S-332 (pumps)*	Non-existent		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Canal	Structure	ALT3 (RSMGL)		ALT4 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A non-existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A non-existent S332B 5.0/4.7 S332BN 5.0/4.7 S332C 5.0/4.7 S332D 4.85/4.65	S332A Non-Existent S332B (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332BN (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332C (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332D 4.85/4.65	S332A Non-Existent S332B (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332BN (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332C (5.0 Dec 1-Jul15, 4.9 Jul16-Nov30)/4.7 S332D 4.85/4.65
		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control		S332A =300 cfs S332B =325 cfs S332BN =250cfs S332C = 575 cfs S332D = 500 cfs Jul16-Nov30, 325cfs Dec 1-Jan31, 165cfs Feb 1-Jul15 All Flood Control	
	S-357 (pump)	S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs		S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs	
L-31W	S-332 (pumps)*	Non-existent		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Central Everglades Planning Project (CEPP) Tentatively Selected Plan Model Documentation Report

IMC MSR 368 **February 14, 2014**

1.0 Overview

Identification

The Central Everglades Planning Project (CEPP) is an expedited planning effort undertaken as part of the overall Comprehensive Everglades Restoration Plan (CERP), a program led by the United States Army Corps of Engineers (USACE) with the South Florida Water Management District (SFWMD) as local sponsor. The project worked throughout 2012 and 2013 to develop a Project Implementation Report (PIR) that combines planning and design activities for three primary areas of interest in the south Flroida system as follows: 1) Storage & water treatment facilities in the Everglades Agricultural Area, 2) Decompartmentalization of levees within the Everglades Protection Area (EPA) and 3) Levee seepage management features along the Everglades / urban boundary in southeastern Florida. Modeling support to the CEPP effort was provided by a team comprised of modelers from the Hydrologic & Environmental Systems Modeling Section of the SFWMD and the Interagency Modeling Center (IMC), with direct support also provided by the USACE and Everglades National Park of the Department of the Interior (DOI). Modeling workflow and coordination were performed in a manner consistent with the procedures outlined in IMC Modeling Services Request (MSR) 368 and the CEPP Modeling Strategy (**SFWMD, 2012a**).

Scope and Objectives

Modeling support for CEPP focused on working with the larger project planning team and other interested parties to formulate and test project features leading to the ultimate identification and refinement of a tentatively selected plan (TSP). Modeling products were developed at the appropriate level of detail to support feature screening and detailed representation of project features and to provide information to all necessary evaluations required for plan development and documentation in the PIR. The project plan formulation framework is shown in **Figure 1.1** and illustrates a spatially determined workflow (moving north to south through the south Florida system) utilizing initial screening followed by detailed evaluation to identify final project planning alternatives and ultimately a TSP for the effort.

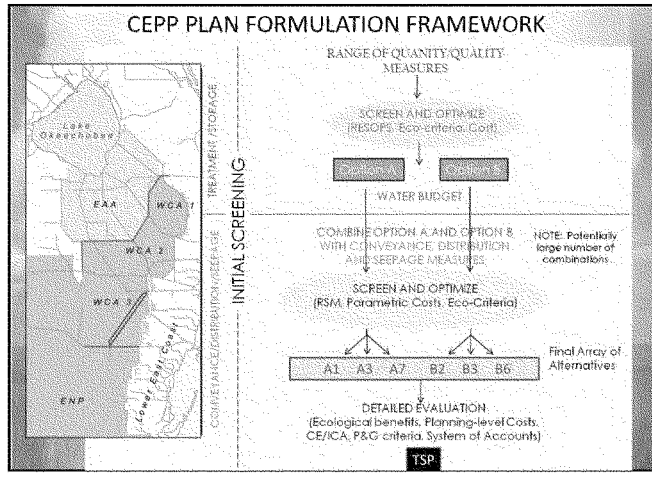

Figure 1.1. Central Everglades Planning Project Plan Formulation Framework

The CEPP Modeling Strategy document (**SFWMD, 2012a**) describes the modeling process and tools utilized, the associated rationale of the selection process and the means by which the tools could expediently support the project workflow. The primary model support tools utilized in CEPP are as follows:

Screening Tools:

- REservoir Sizing and OPerations Screening (RESOPS)
- Lake Okeechobee OPerations Screening (LOOPS)
- C-43 Spreadsheet Model
- iModel©

Detailed Planning Models:

- Regional Simulation Model Basins (RSMBN)
- Regional Simulation Model Glades-LECSA (RSMGL)
- Dynamic Model for Stormwater Treatment Areas (DMSTA)

From a modeling deliverable perspective, the entirety of the CEPP modeling support can be summarized by reviewing the following four Model Documentation Reports (MDRs):

1. CEPP Baseline Runs – Reviews the various non-CEPP model representations (e.g. current and future without project conditions) used in various aspects of the project planning. (**SFWMD & IMC, 2014a**)
2. CEPP Final Array of Alternatives – Reviews four proposed with-CEPP project model representations examined during plan formation (**SFWMD & IMC, 2014b**)
3. CEPP Tentatively Selected Plan – Reviews the model representation of the CEPP TSP and subsequent refinements during final plan formulation and project assurance planning (this document).
4. CEPP Model Supported Screening Efforts – Reviews the various model-supported feature screening efforts undertaken at various points in the planning process. (**SFWMD & IMC, 2014d**)

This Tentatively Selected Plan MDR describes the assumptions, model implementation steps and observed outcomes associated with the initial representation and subsequent refinement of the CEPP TSP. These model runs were predominantly used by the CEPP project team as the with-project plan representation compared back to various project baselines for various purposes. This document will focus on the modeling details of these scenarios; information on the use and rationale for the definition of these conditions is contained in the CEPP PIR (**USACE, 2013b**).

2.0 Basis

Project Assumptions

This Tentatively Selected Plan MDR describes the assumptions, model implementation steps and observed outcomes associated with modeling the following scenarios:

CEPP Initial Tentatively Selected Plan - released 2/28/2013
- 2050 Future With Project Alternative 4R (ALT4R)

CEPP Tentatively Selected Plan Sensitivity Run - released 6/25/2013
- 2050 Future With Project Alternative 4R1 (ALT4R1)

CEPP Final Tentatively Selected Plan - released 6/25/2013
- 2050 Future With Project Alternative 4R2 (ALT4R2)

The three TSP runs were identified and produced sequentially with the following high level intent:

1. ALT4R was developed as an initial representation of the project TSP incorporating all decisions from the final array analysis and plan formulation into one modeling scenario. From a modeling perspective, this scenario combined elements of the previously modeled ALTS RSMBN scenario and ALT1 (for northern and western WCA3A areas) & ALT4 (for other Greater Everglades areas) RSMGL scenarios with additional operational objectives to improve natural, developed and agricultural system performance beyond that observed in the final array. The CEPP project team identified a series of infrastructure changes relative to the FWO Baseline ALT4R as shown in **Figure 2.1**. In addition to the physical changes identified in the figure, the project team also identified a series of performance objectives to help guide operational decision making. These objectives largely remained the same as those utilized in the CEPP Final Array (**SFWMD, 2014b**), but final TSP modeling also sought additional improvement in areas where performance shortfalls were identified as follows:
    - Attempt to reduce water supply cutbacks in the Lake Okeechobee Service Area in particular for water year 2001, the worst drought in the simulation period, relative to ECB.
    - Maintain stages in WCA2B and adjacent LEC areas closer to ECB. Potentially, decrease the magnitude of L6 diversion operations
    - Increase stages in WCA3B (which in ALT4 were lower than ECB) and adjacent Pennsuco & LEC areas.
    - Reduce the impact of the assumed ENP seepage wall adjacent to the L31N canal which in ALT4 was resulting in significant reduction in groundwater entering the LEC and consequently lower stages and reduced flow to Biscayne Bay.

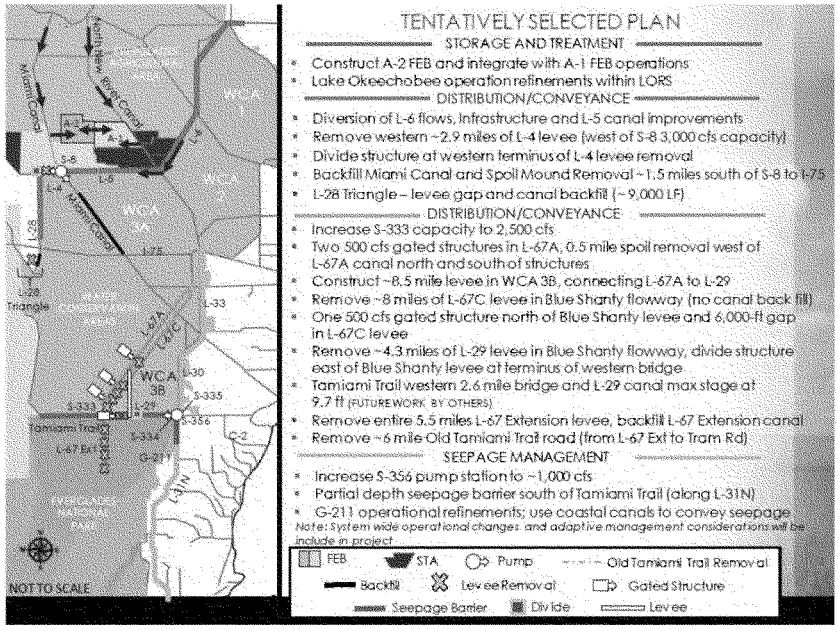

Figure 2.1. Generalized view of infrastructure changes modeled for alternative ALT4R

2. Building upon ALT4R, ALT4R1 was developed as a model sensitivity scenario to incorporate the following TSP changes:
    - Incorporate changes made in the IORBL1 baseline scenario (**SFWMD, 2014a**)
    - Project assumed modifications to infrastructure, namely the removal of the L28 project features and refined information related to the western hydropattern restoration feature. These changes relative to the FWO Baseline are shown in **Figure 2.2**.
    - Test the model response to additional assumed Lower East Coast surficial aquifer municipal pumping as provided by the project and shown in **Figure 2.3**.

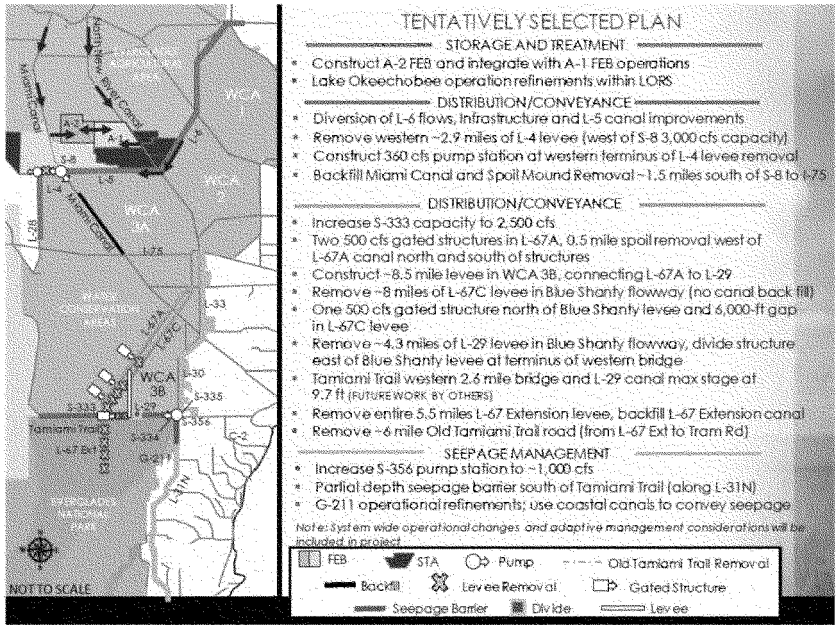

Figure 2.2. Generalized view of infrastructure changes modeled for alternatives ALT4R1 and ALT4R2

	IORBL1*	ALT4R1	
	CEPP Current ~2030	CEPP Proposed ~2050	Restudy 2050 w/ conservation
		MGD	
NPBSA	48	48	66
LECSA1	259	259	280
LECSA2	277	295	295
LECSA3	412	465	562
Total	996	1067	1203

Considers demands on surficial aquifer system only

Note: IORBL1 demand are the same as other CEPP runs to date including ECB, FWO, all ALT runs, 2012EC and IORBL

Figure 2.3. Assumed Lower East Coast surficial aquifer municipal pumping as provided by the project (CEPP Proposed 2050) for ALT4R1

3. ALT4R2 was the final representation of the CEPP TSP. No infrastructure changes were included in ALT4R2 relative to ALT4R1. The magnitude of Lower East Coast municipal pumping was reduced iteratively relative to ALT4R1 to minimize regional impacts and overall system operational refinement continued with the same objectives as those outlined for ALT4R.

The modeling team in implementing the RSM scenarios relied heavily on the outcomes of the screening and optimization steps summarized in the CEPP Model Supported Screening Efforts MDR (**SFWMD, 2014d**). Completion of these scenarios within the expedited project schedule would not have been possible without extensive use of iModel©, LOOPs and other tools to inform operational guidance prior to detailed modeling.

Detailed project assumption tables for all three scenarios are provided in **Appendix A** and key elements of model implementation are described in Section 3.

Model Limitations and Intended Use of Results

The primary modeling products of CEPP 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, 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 RSMBN, RSMGL (**SFWMD, 2010** and **2011**), and DMSTA (**Walker & Kadlec, 2005**; **Wang, 2012**) models were reviewed through the USACE validation process for engineering software, as part of the CEPP project. The RSM and DMSTA models were classified as "allowed for use" for South Florida applications in August 2012 and January 2013, respectively. Additionally, the RESOPS (**SFWMD, 2009**), LOOPS (Neidrauer et al, 2006), and C-43 spreadsheet model (**Starnes & Marlowe, 2007**) tools and the iModel© optimization tool (**Ali, 2009**) used in CEPP underwent USACE Agency Technical Review (ATR). Approval of these modeling tools for CEPP application was completed in November, 2012.

3.0 Simulation

Modeling Tools Used

RSM version 2.3.5 was used to run both the RSMBN and RSMGL models.
Release date 12/6/2012, SVN Version #4730.

Model Set Up

The CEPP TSP scenarios were developed using the RSMBN and RSMGL models. Collectively, these two models cover the spatial extent of the project planning area as shown in **Figure 3.1**. The RSMBN modeling for the TSP scenarios was built upon the CEPP ALTS final array representation. The RSMGL modeling for the final array was built upon a combination of the CEPP ALT1 & ALT4 final array representations. The period of simulation for both models utilizes a climate record from 1965 to 2005. Details about project rationale for defining these scenarios can be found in the CEPP PIR.

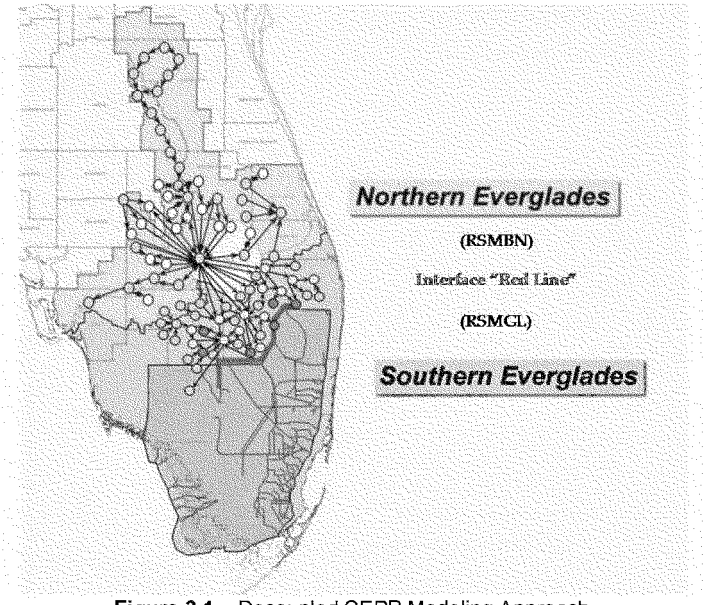

Figure 3.1. Decoupled CEPP Modeling Approach

RSMBN and RSMGL ALT4R Scenario

For ALT4R, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.2**. Specific modeling details related to these elements are listed below. Operational intent for this scenario is generally consistent with that previously identified for the ALTS, ALT1 or ALT4 Final Array runs, unless otherwise described. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or in the assumption table in **Appendix A**.

- Water in the C44 reservoir is discharged and allowed to backflow to Lake Okeechobee when the Lake is below the baseflow zone. Environmental targets for the St Lucie Estuary are met from the reservoir prior to implementing this operation. C44 basin backflow is allowed when Lake stages are below 14.5 ft (this is a change from the baseline that assumes that backflow is allowed when Lake stages are lower than 0.25 feet below the low subband).
- For RSMBN, the FEB inflows and outflows are used to help meet established targets (improved model representation relative to ALTS scenario), as estimated using the Dynamic Model for Stormwater Treatment Areas (**Wang, 2012**) at STA-3/4, STA-2N, and STA-2S
- Western Hydropattern Restoration Feature (HRF) not modeled as a canal within the model domain but with boundary inflows into the three edge cells west of S8. No Central and Eastern HRF.
- Breaches across L28 levee modeled as weirs connecting two pairs of mesh cells between the L28 triangle south of Alligator Alley and WCA3A (9000 ft total length)
- One canal segment in L28 canal reach disabled to represent backfill of a portion of the L28 canal within the L28 triangle area
- Miami Canal removed from Alligator Alley to S8 structure
- S356 design capacity changed from 500 cfs to 1000 cfs
- Three S345 structures (S345D, S345G, S345F), each with a design discharge of 500 cfs at 1.5 ft differential head (flow is jumped directly into the nearest respective mesh cell within WCA3B east of the L67C levee). S345D is located ~9.7 mi south of S151, S345G is located ~16.4 mi south of S151, and S345F is located ~17.9 mi south of S151 along L67-A.
- S333 design capacity increased from 1350 cfs to 2500 cfs (discharge coefficient increased proportionally from 2548 to 4718)
- Using the iModel©, a system wide simulation and optimization tool that is based on artificial neural network and numerical optimization, WCA3A inflow and outflow structures are managed under a Rainfall Driven Operation (RDO) scheme, as in the Final Array modeling.
- WCA3A floor is defined in the modeling as being crossed when either of the following two criteria are met:
    - Stages at 3-69W marsh gauge falls below 7.5 ft
    - Stages in CA3 canal fall below 7.0 ft
- Western Tamiami Trail Bridge modeled as weirs connecting the L29 canal and the mesh cells intersecting the bridge location (~2.6 mi total length)
- Degraded sections of L-29 levee (between S333 and divide structure) as a part of Blue Shanty flowway
- Divide structure on L-29 canal at the end of 2.6 mile bridge (design capacity = 1230 cfs, discharge coefficient = 2841, consistent with S334 sizing)

- Operate to send water from L29W to L29E to equilibrate canals when L29E falls below 7ft

- Tamiami Trail releases (S333 and S12s) use the same operating logic as today's ERTP schedule, namely the Rainfall Plan. CEPP alternative replace the calculation of the rainfall-driven component (i.e. environmental target) with RDO estimates. Spatially, CEPP alternatives also attempt to deliver 100% of both the environmental and regulatory calculation through S333 subject to capacity and hydraulic constraints (this is different than the current ratio used in ERTP).
  - After final calculations have been completed, a final check is made to quantify any flood control water to be delivered through the S12s. If hydraulic capacity exists at the 345s, then this discharge is made into 3B instead of at the S12s, essentially adding a flood control component to the 345s in addition to the existing RDO environmental target.
- Partial L31N seepage curtain wall from L29 canal ~4.9 miles south of L29
- Entire section of L-67 extension levee degraded
- CEPP delivers water supply from regional system (from WCA3A: S-151/S-337) to maintain the L30 as follows:
  - Seasonally varying maintenance level:

01jan	6.45
01jun	5.40
01nov	6.45
31dec	6.45

  - A lowered maintenance level (called reserve level); applies when WCA3A is below the floor and no in-kind Lake Okeechobee releases are occurring (i.e. when regional water availability does not meet water supply requirements). Seasonally varying reserve level:

01jan	6.25
01jun	5.20
01nov	6.25
31dec	6.25

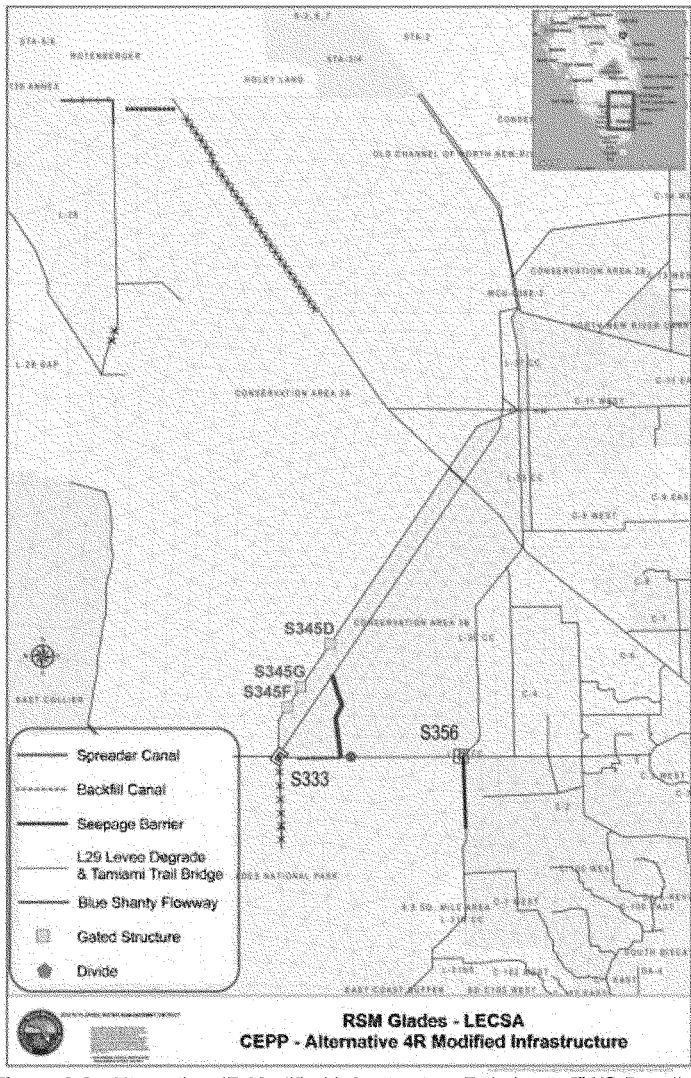

Figure 3.2. Alternative 4R Modified Infrastructure Relative to FWO Baseline

RSMBN and RSMGL ALT4R1 Scenario

For ALT4R1, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.3.** The ALT4R1 scenario was built from the ALT4R scenario (retaining all modified assumptions) with the changes listed below. Specific operational criteria may also be referenced in **Appendix C** for the South Dade area or in the assumption table in **Appendix A**.

- In order to promote opportunity for Lake discharges to the south, LORS release criteria from the Northern Estuaries are modified to result in lower overall discharges. Specific changes can be found in **Appendix B**.
- Operational updates to Indian River Lagoon South (IRLS) project, consistent with Opti6-revised targets increasing flow down Ten Mile Creek (same assumptions as the IORBL1 Baseline run)
- A 360cfs conveyance limitation is implemented in the RSMBN model for water supply deliveries to the Seminole Big Cypress reservation and for water supply to maintain minimum depths in STA 5/6 from the L4 canal. The priority for deliveries is 1) tribal entitlement and 2) STA water supply
- Western HRF not modeled as a canal within the model domain but with boundary inflows into the two edge cells west of S8. No Central and Eastern HRF.
- No Breaches across L28 levee.
- No backfill for any of the segments of the L28 canal.
- Operational refinement to Broward Water Preserve Areas project to reduce discharges to S29 and refine model representation of S9/S9A operations (same assumptions as the IORBL1 Baseline run)
- Refined 8.5 SMA representation, including expansion of assumed length of collector canals to prevent higher groundwater stages in the western portion of the 8.5 SMA. (same assumptions as the IORBL1 Baseline run).
- Additional municipal public water supply pumping was assumed in ALT4R1 as shown in **Figure 3.4**. In Broward County, this was represented as a 28 MGD increase at the displayed wellfields, with a spatial distribution that was prorated based on the current wellfield allocation. In Miami-Dade County, this was represented as a 53 MGD increase at the displayed wellfields, with a spatial distribution that was prorated based on the current wellfield allocation.

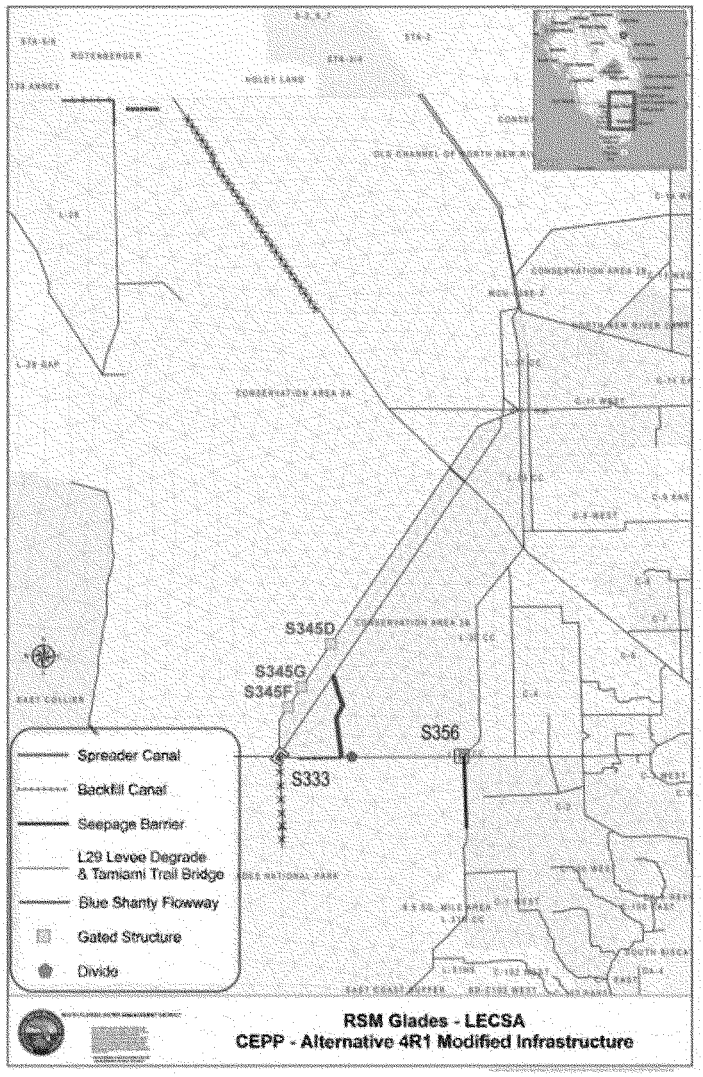

Figure 3.3. Alternative 4R1 Modified Infrastructure Relative to FWO Baseline

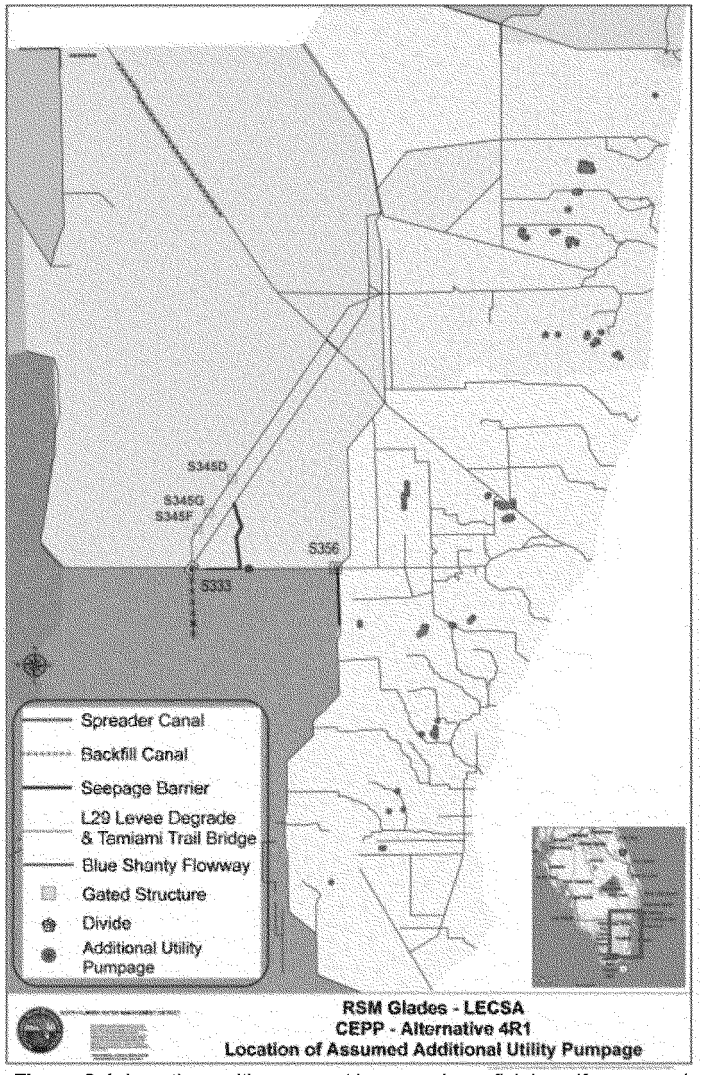

Figure 3.4. Locations with assumed increase in surficial aquifer pumped withdrawals in the Lower East Coast for ALT4R1

RSMBN and RSMGL ALT4R2 Scenario

For ALT4R2, modifications to system infrastructure relative to the FWO baseline are shown in **Figure 3.5**. The ALT4R2 scenario was built from the ALT4R1 scenario (retaining all modified assumptions) with the changes listed below. For the RSMBN model, no changes were made from ALT4R1 to ALT4R2, so the model assumptions and runs are identical. Specific operational criteria may also be referenced in Appendix B for the South Dade area or in the assumption table in Appendix A.

- After L6 diversion criteria are applied as in the Final Array, 40% of L6 diverted water targeted for S8 is returned to the S7 pump station. In the real world, this water would not need to be pumped and could just be released across the southern L6 levee degrade into WCA2A.
- WCA2A floor is defined in the modeling as being crossed when either of the following two criteria are met:
    - Stages at 2A-U1 marsh gauge falls below 10.5 ft
    - Stages in L38 canal fall below 10.0 ft
- Revised South Dade operations (see Appendix B)
- Additional municipal public water supply pumping was assumed in ALT4R2 as shown in **Figure 3.6**. In Broward County, this was represented as a 10 MGD increase at wellfield 06-01474-W and a 2 MGD combined increase for wellfields 06-00123-W, 06-00129-W, and 06-00103W. In Miami-Dade County, 5 MGD increase was assumed for the west wellfield, 13-0017-W.

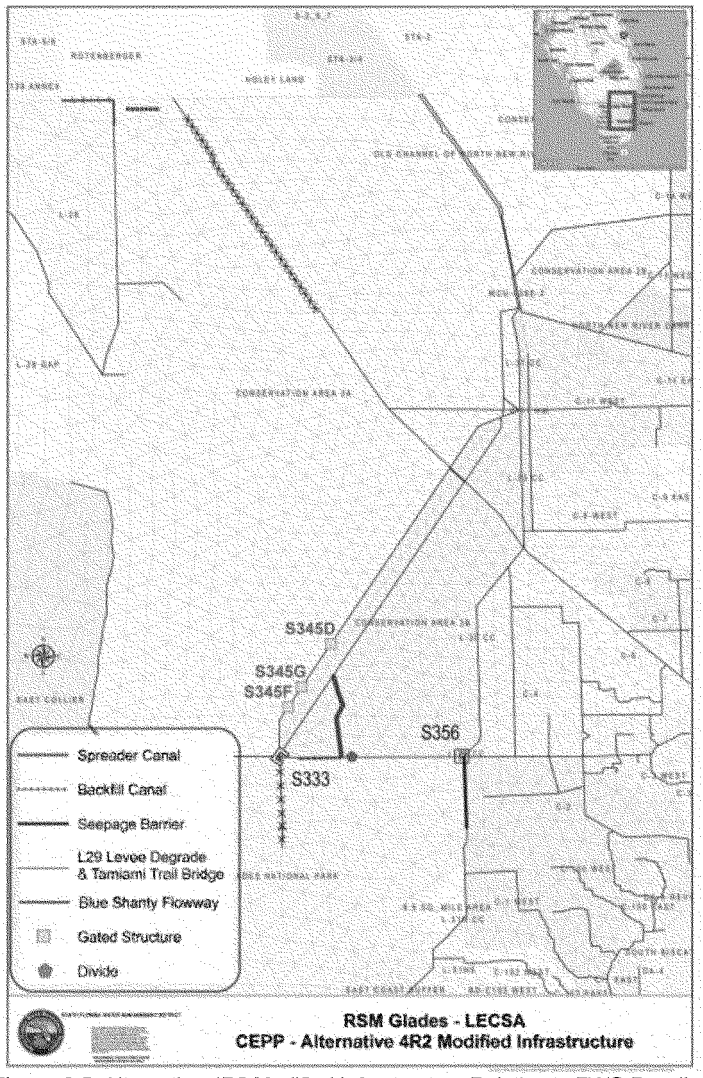

Figure 3.5. Alternative 4R2 Modified Infrastructure Relative to FWO Baseline

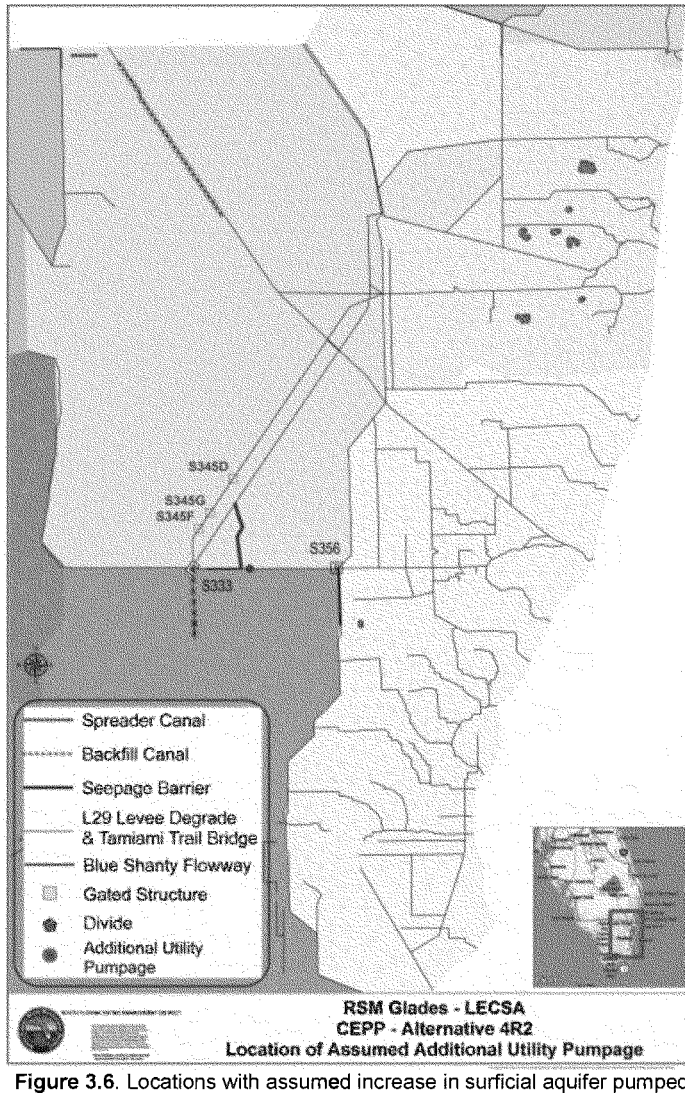

Figure 3.6. Locations with assumed increase in surficial aquifer pumped withdrawals in the Lower East Coast for ALT4R2

4.0 Results

Final CEPP modeling products have been uploaded to the CERP Model Management System (MMS), a geographic information system (GIS) based application that includes model input data, select model output data, source code/executable files and documentation. This system can be accessed at http://www.evergladesplan.org/pm/progr_mms.aspx. CEPP modeling products in MMS can be accessed directly at the project page:

http://cerpmap1.cerpzone.org/arcgisapps/CERPMMS/CerpReport/ProjectReport.aspx?projectID=687

Due to the large size of many of the CEPP modeling files, the majority of the modeling output has been archived in the Data Access Storage and Retrieval (DASR) application of CERPzone at www.cerpzone.org. CEPP modeling products in DASR can be accessed within the project modeling folder:

P:\IMC_Final_Modeling_Results\PROJ 51 - Central Everglades Planning

While the modeling products have been archived in the above systems, the table below lists more specific information including model version, inputs used and detailed DASR archival location. Version numbers and "svnroot" paths refer to a model version control system found on the SFWMD network that is not generally accessible, but inputs, model executables and source code have been copied into the MMS system for ease of access.

Version information and model file locations

RSMBN ALT4R 02282013	**RSM_v4728 and xml_v9207**
Input: ...svnroot/trunk/CentEver/rsmbn/TSP_Assurances/InitialOperatingRegime/02282013/ALT4R Output (DASR):...\3TSP_Assurances\2InitialOperatingRegime\Final_Output_022813\rsmbn_model_output\ALT4R	
RSMBN ALT4R1/ALT4R2 06252013	**RSM_v4728 and xml_v9362**
Input: ...svnroot/trunk/CentEver/rsmbn/FinalArray/06252013/alt4r2 Output (DASR): ...\2PlanFormulation\4FinalArray\Final_Output_062513\rsmbn_model_output\ALT4R2	
RSMGL ALT4R 02282013	**RSM_REL_2.3.5 and xml_v9188**
Input: ……svnroot/trunk/CentEver/rsmgl/Assurances/ALT4R Output (DASR):.../2PlanFormulation/4FinalArray/Final_Output_022813/rsmgl_model_output/ALT4R	
RSMGL ALT4R1 06032013	**RSM_REL_2.3.5 and xml_v9362**
Input: ... svnroot/trunk/CentEver/rsmgl/Assurances/ALT4R1 Output (DASR):../4OtherWRN_Sens/Sens_Output_060313/rsmgl_model_output/ALT4R1	
RSMGL ALT4R2 06252013	**RSM_REL_2.3.5 and xml_v9386**
Input: ... svnroot/trunk/CentEver/rsmgl/Assurances/ALT4R2 Output (DASR):.../2PlanFormulation/4FinalArray/Final_Output_062513/rsmgl_model_output/ALT4R2	

Review of Local and Regional-Level Results

The RSMBN and RSMGL baseline modeling scenarios were reviewed from the perspective of ensuring that localized effects of project implementations were observed as expected and that regional performance was considered reasonable. Specific checks on RSM outputs included the following:

- The TSP scenarios generally maintain Lake Okeechobee performance relative to ECB as shown in **Figure 4.1**.

- There is a progression in performance from ALT4R to ALT4R2 for the St. Lucie and Caloosahatchee Estuaries. Ultimately, ALT4R2 reduces the number of high discharge events to northern estuaries and maintain Caloosahatchee Estuary low flow performance as shown in **Figure 4.2(a) and (b)**. An improvement in low flow event counts in the St Lucie Estuary is observe due to updated assumptions in the IORBL1; ALT4R2 (labeled as ALT4R1, which was the same run for RSMBN) maintains low flow event frequency relative to the updated baseline as shown in **Figure 4.3.**
- The ALT42 scenario demonstrates improved or equal LOSA (**Figure 4.4**) and Tribal water supply performance relative to the project baselines.
- Compared to FWO, ALT4R2 provides approximately 200 kac-ft additional flow to Everglades as shown in **Table 4.1**.
- There is reduced frequency & magnitude of CEPP L-6 Diversion operations in ALT4R2 relative to ALT4R. ALT4R2 performs similar to ECB (lower highs) in WCA2A (**Figure 4.5**) and WCA2B (**Figure 4.6**). Adjacent LEC areas perform similarly to baselines.
- CEPP TSP scenarios all perform similarly and increase stages and hydroperiods in northern WCA3A (an example in **Figure 4.7**). In CEPP TSP scenarios, performance in northeastern WCA3A is similar to defined sawgrass targets.
- CEPP TSP scenarios all perform similarly to FWO (lower highs) in central & southern WCA3A (**Figure 4.8**).
- CEPP TSP scenarios all perform similarly and increase stages in WCA3B relative to ALT4 in the Final Array. Results now show water depths equal to or higher than the ECB baseline (**Figure 4.9**).
- CEPP TSP scenarios all perform similarly and all significantly increase stages and hydroperiods (**Figure 4.10**) in Shark River Slough. All alternatives show flow increases down Shark River Slough (**Figure 4.11**). The majority of Marl areas do not show increased hydroperiods, but immediately adjacent to Shark River Slough, wetter conditions do exist. Higher stage conditions could improve conditions in Florida Bay.
- In the Lower East Coast, the additional pumpage assumed in ALT4R1 resulted in significant local groundwater impacts (**Figure 4.12**). The reduced pumpage assumed in ALT4R2 minimized the spatial extent of these local effects (**Figures 4.13 to 4.14**), returning conditions to ALT4R levels despite the increased withdrawals.
- Extreme canal / groundwater conditions are generally somewhat mitigated by additional CEPP infrastructure (**Figure 4.15**), but in some reaches more moderate and dry conditions (**Figure 4.16**) may show undesirable trends, such as lower stages in the lowest 3% of the distribution.
- Surface water discharges throughout the LEC east of ENP and toward Biscayne Bay are increased relative to the final array and generally show an increasing trend through the TSP refinement as shown in **Table 4.2**. The obvious exception to this observation is S29 which is influenced by baseline updates from the IORBL1 and as shown in comparison to the assurances baseline in **Table 4.3**. The ALT4R2 volumes and timing return these conditions to near baseline levels.

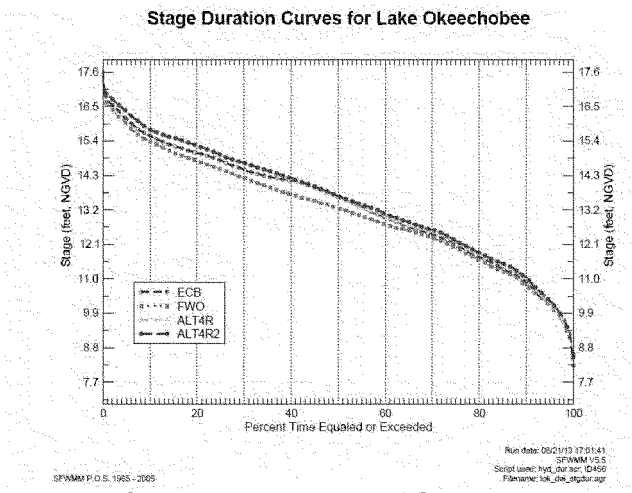

Figure 4.1. Lake Okeechobee performance for TSP runs relative to the baselines.

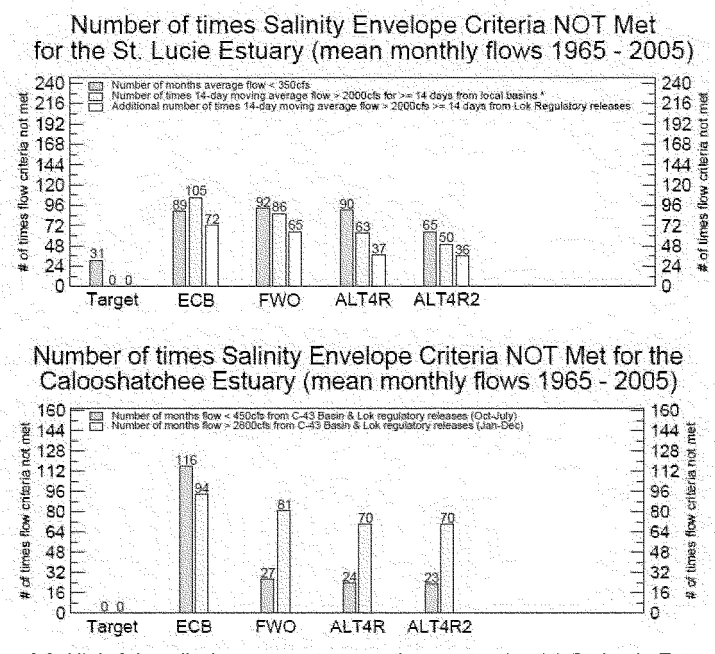

Figure 4.2. High & low discharge events to northern estuaries (a) St. Lucie Estuary and (b) Caloosahatchee Estuary relative to the plan formulation baselines for TSP scenarios.

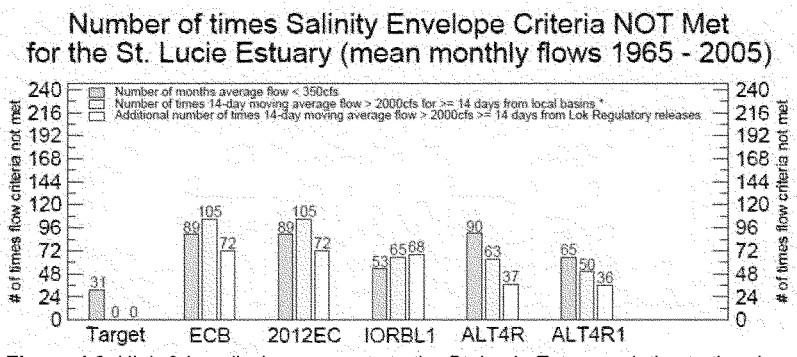

Figure 4.3. High & low discharge events to the St. Lucie Estuary relative to the plan assurances baselines for TSP scenarios.

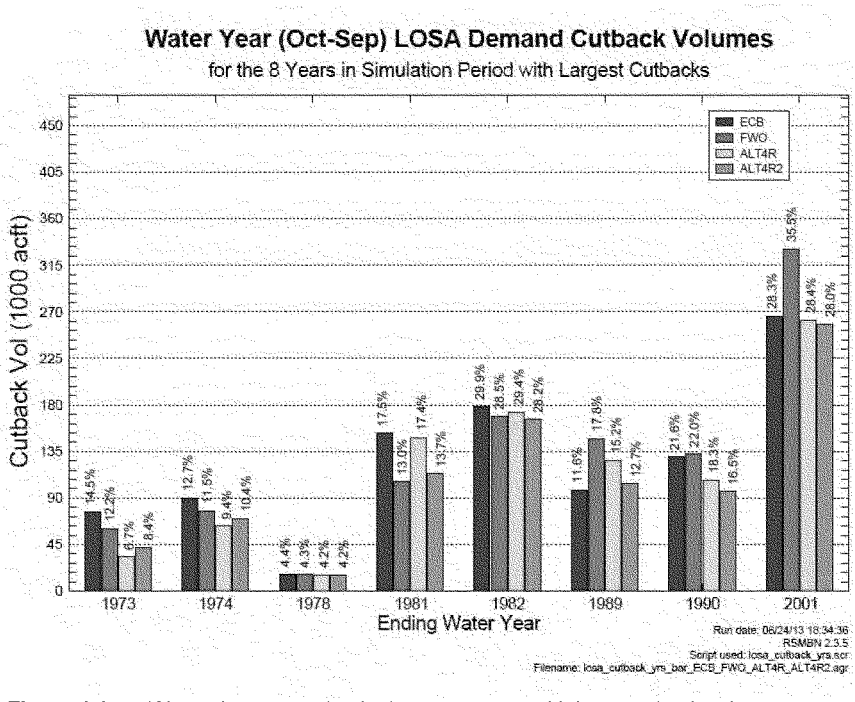

Figure 4.4. . Water shortage cutbacks for water years with large cutback volumes

Table 4.1. Average annual Discharges (kac-ft) from STA2 and STA34 toward the Greater Everglades

	ECB	FWO	ALT4R	ALT4R2	Diff (ALT4R2-FWO)
STA2	234.5	381.0	374.2	383.7	(2.7)
STA34	538.5	382.2	596.2	596.2	(214.0)
Total Additional Water in ALT4R2 =					+216.7
Total Additional Water in ALT4R =					+207.2

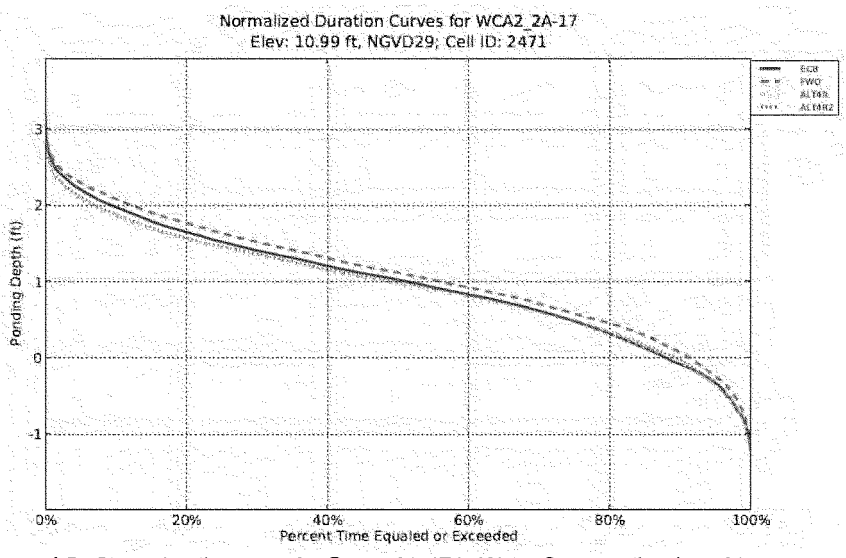

Figure 4.5. Stage duration curve for Gauge 2A-17 in Water Conservation Area 2A

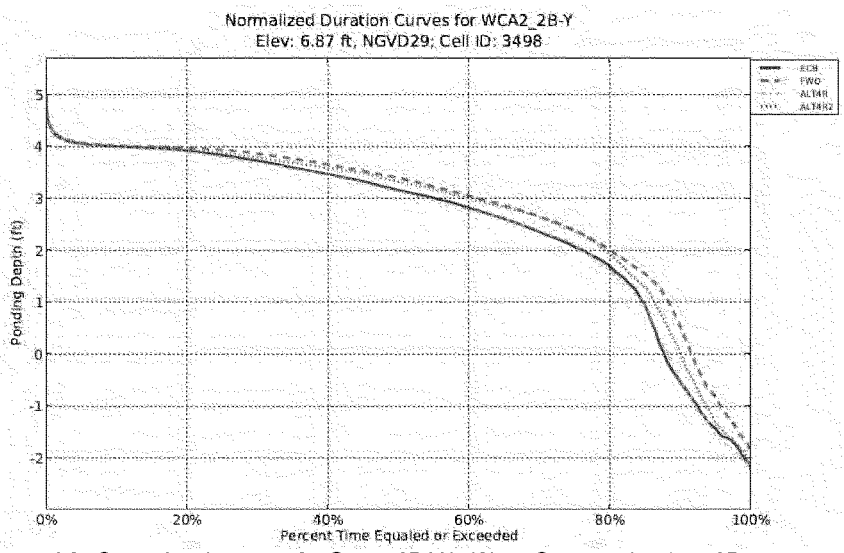

Figure 4.6. Stage duration curve for Gauge 2B-Y in Water Conservation Area 2B.

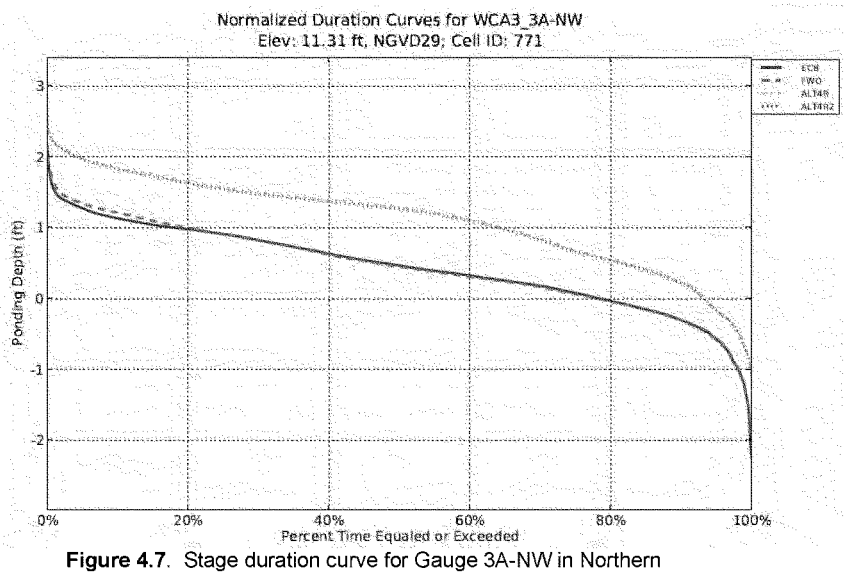

Figure 4.7. Stage duration curve for Gauge 3A-NW in Northern Water Conservation Area 3A

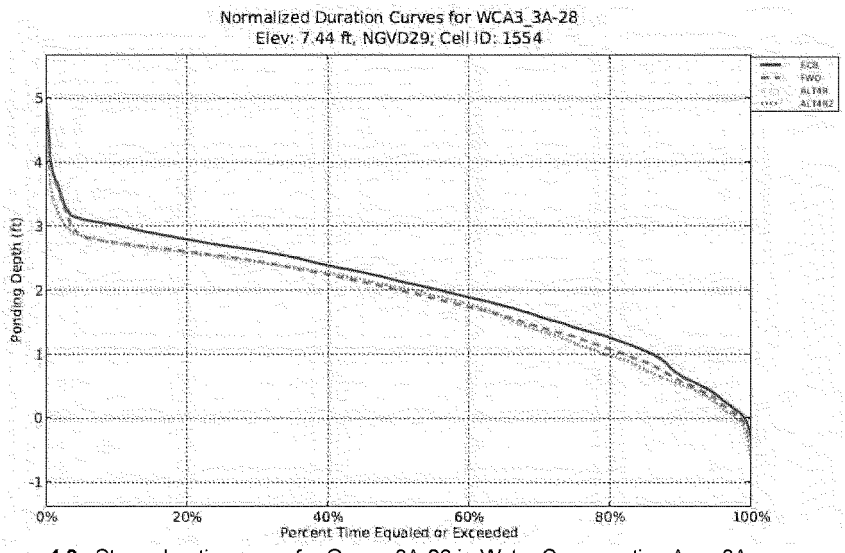

Figure 4.8. Stage duration curve for Gauge 3A-28 in Water Conservation Area 3A

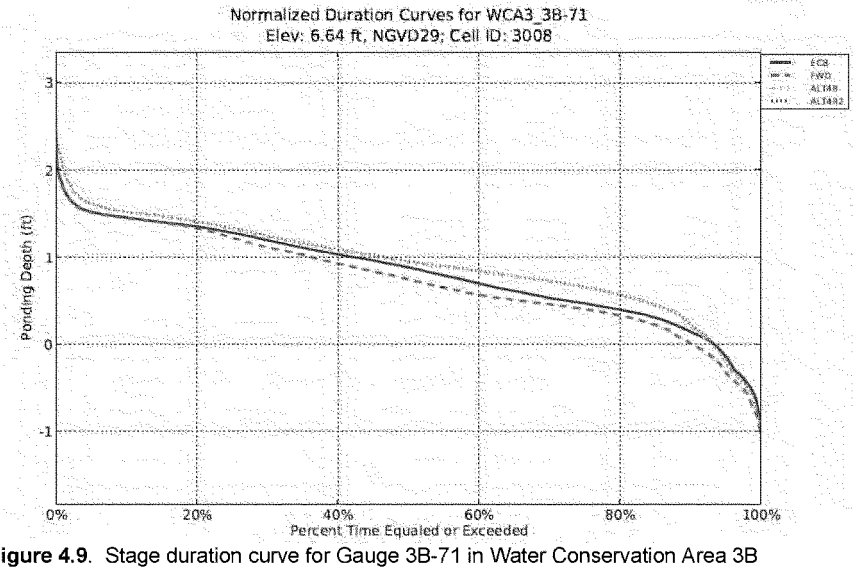

Figure 4.9. Stage duration curve for Gauge 3B-71 in Water Conservation Area 3B

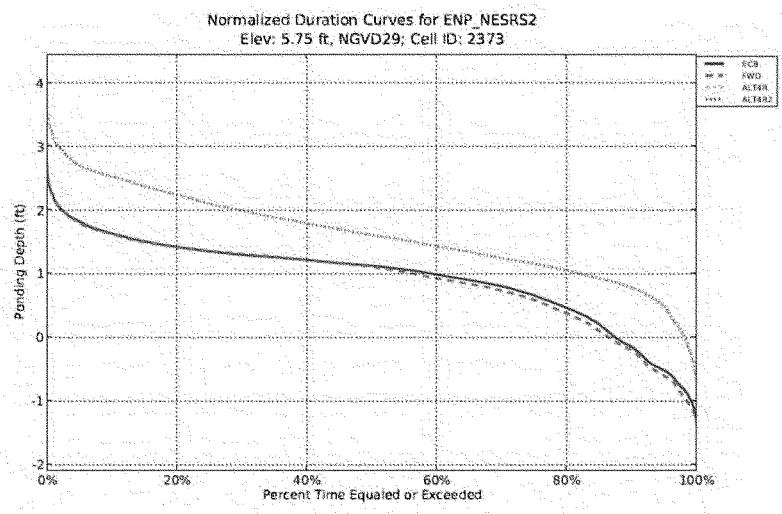

Figure 4.10. Stage duration curve for Gauge NESRS2 in Everglades National Park

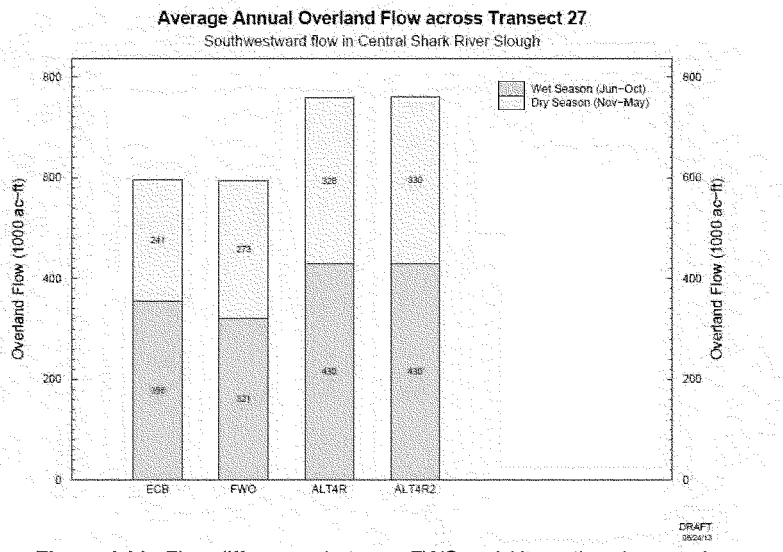

Figure 4.11. Flow differences between FWO and Alternatives in central Shark River Slough

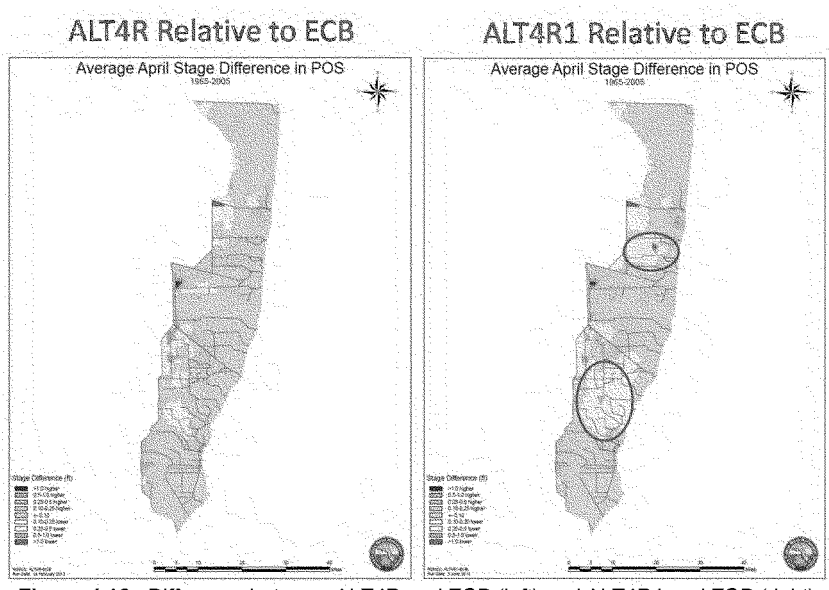

Figure 4.12. Difference between ALT4R and ECB (left) and ALT4R1 and ECB (right) stages for an average April condition in the Lower East Coast

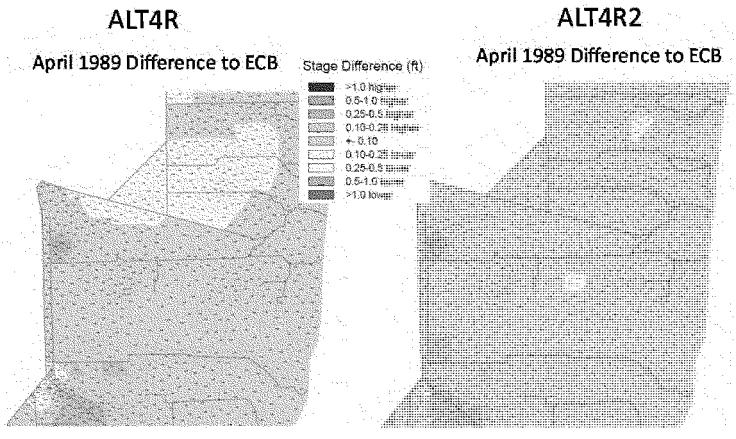

Figure 4.13. Difference between ALT4R and ECB (left) and ALT4R2 and ECB (right) stages for the April 1989 condition in Broward County

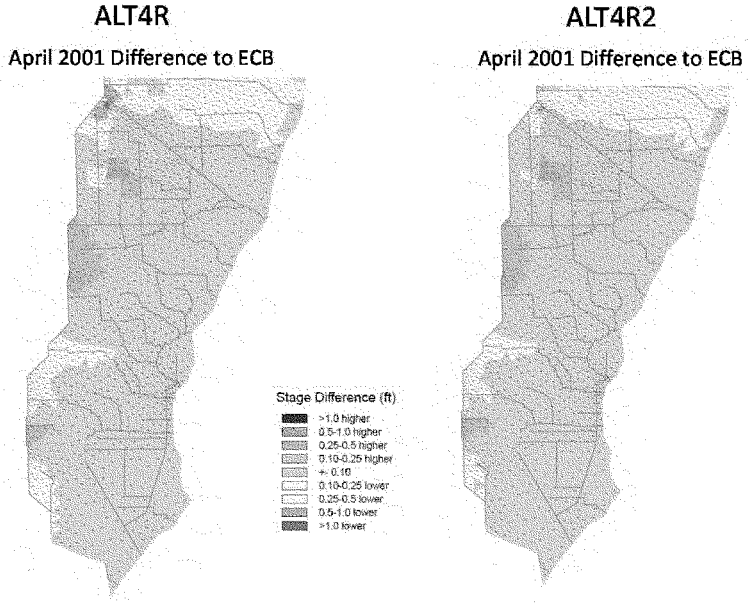

Figure 4.14. Difference between ALT4R and ECB (left) and ALT4R2 and ECB (right) stages for the April 2001 condition in Miami-Dade County

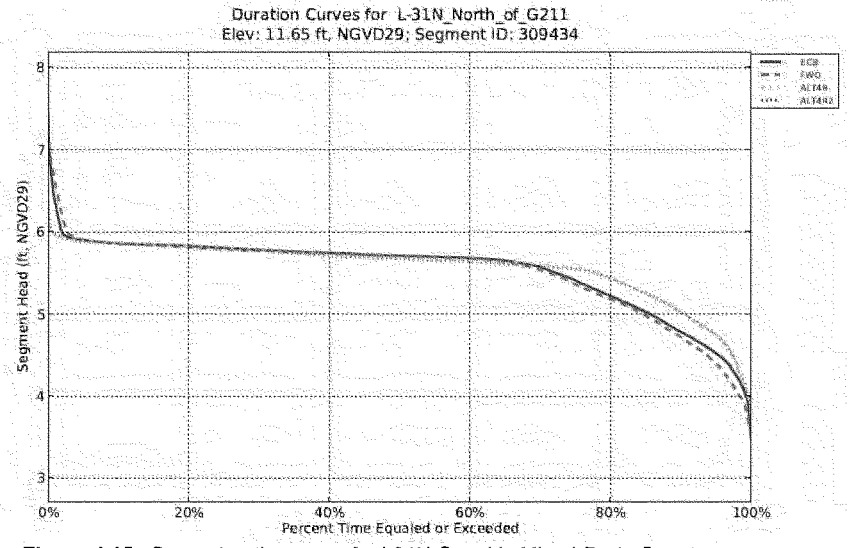

Figure 4.15. Stage duration curve for L31N Canal in Miami-Dade County

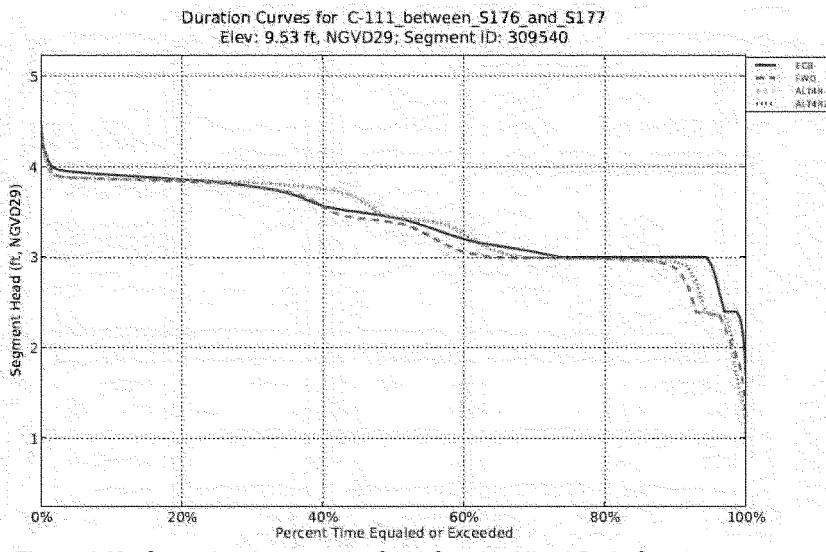

Figure 4.16. Stage duration curve for C111 Canal in Miami-Dade County

Table 4.2. Average annual (kac-ft) surface water discharges at coastal structures toward Biscayne and Florida Bay (comparison with plan formulation baselines).

	ECB	ECB	FWO	FWO	FWO	ALT4R	ALT4R	ALT4R	ALT4R2	ALT4R2	ALT4R2
Structure	Mean	% within PM	Mean	% dif ECB	% within PM	Mean	% dif ECB	% within PM	Mean	% dif ECB	% within PM
S29	282.8	68%	372.3	32%	79%	374.5	32%	81%	310.8	10%	73%
S28	90.9	--	93.2	3%	--	93.0	2%	--	90.8	0%	--
S27	115.2	--	114.5	-1%	--	115.1	0%	--	115.1	0%	--
S26	124.6	--	116.4	-7%	--	124.5	0%	--	124.9	0%	--
S25B	109.3	--	102.4	-6%	--	103.3	-5%	--	105.6	-3%	--
S25	9.7	--	9.6	-2%	--	9.6	-2%	--	9.7	-1%	--
G93	28.4	--	26.7	-6%	--	26.8	-6%	--	27.8	-2%	--
S22	121.2	12%	113.9	-6%	11%	115.3	-5%	12%	117.7	-3%	12%
S123	17.5	21%	17.3	-1%	21%	17.5	0%	22%	17.7	1%	22%
S21	101.3	67%	101.9	1%	66%	106.3	5%	64%	115.3	14%	65%
S21A	58.2	46%	60.6	4%	46%	60.8	5%	45%	62.8	8%	44%
S20G	0.4	--	0.3	-1%	--	0.3	0%	--	0.4	0%	--
S20F	145.7	43%	154.7	6%	43%	152.7	5%	44%	154.9	6%	42%
S20	6.6	--	6.6	0%	--	6.6	0%	--	6.6	0%	--
S197	22.8	3%	9.2	-60%	1%	11.2	-51%	1%	11.3	-50%	2%
Sum	1234.5		1299.6			1317.7			1271.2		

Table 4.3. Average annual (kac-ft) surface water discharges at coastal structures toward Biscayne and Florida Bay(comparison with assurances baselines).

	ECB	ECB	2012EC	2012EC	2012EC	IORBL1	IORBL1	IORBL1	ALT4R	ALT4R	ALT4R	ALT4R1	ALT4R1	ALT4R1
Structure	Mean	% within PM	Mean	% dif ECB	% within PM	Mean	% dif ECB	% within PM	Mean	% dif ECB	% within PM	Mean	% dif ECB	% within PM
S29	282.8	68%	282.3	0%	67%	315.5	12%	72%	374.5	32%	81%	305.8	8%	72%
S28	90.9	--	91.0	0%	--	90.9	0%	--	93.0	2%	--	89.4	-2%	--
S27	115.2	--	115.4	0%	--	115.4	0%	--	115.1	0%	--	110.3	-4%	--
S26	124.6	--	131.5	6%	--	124.8	0%	--	124.5	0%	--	113.8	-9%	--
S25B	109.3	--	109.7	0%	--	106.9	-2%	--	103.3	-5%	--	97.2	-11%	--
S25	9.7	--	9.7	0%	--	9.7	0%	--	9.6	-2%	--	9.1	-7%	--
G93	28.4	--	28.5	0%	--	27.8	-2%	--	26.8	-6%	--	25.8	-9%	--
S22	121.2	12%	122.0	1%	12%	118.7	-2%	12%	115.3	-5%	12%	107.8	-11%	11%
S123	17.5	21%	17.4	-1%	21%	17.6	0%	22%	17.5	0%	22%	15.8	-10%	19%
S21	101.3	67%	100.4	-1%	66%	103.0	2%	66%	106.3	5%	64%	100.9	0%	62%
S21A	58.2	46%	59.3	2%	47%	61.4	5%	46%	60.8	5%	45%	59.5	2%	43%
S20G	0.4	--	0.4	1%	--	0.4	1%	--	0.3	0%	--	0.3	-1%	--
S20F	145.7	43%	146.3	0%	43%	155.0	6%	43%	152.7	5%	44%	149.7	3%	42%
S20	6.6	--	6.6	0%	--	6.6	0%	--	6.6	0%	--	6.6	0%	--
S197	22.8	3%	22.8	0%	3%	9.3	-59%	1%	11.2	-51%	1%	11.6	-49%	2%
Sum	1234.5		1243.2			1263.0			1317.7			1203.6		
S26+S25B+S25	243.6	35%	250.9	3%	34%	241.4	-1%	34%	237.3	-3%	31%	220.1	-10%	28%

In summary, the three progressively delivered TSP runs provided to the CEPP project team are deemed to adequately represent the intended planning conditions and when utilized in conjunction with the CEPP Baseline scenarios, provide a reasonable basis of comparison for the necessary evaluations required to draft the PIR.

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Appendix A – Tables of Assumptions

RSMBN:

- **ALT4R**
- **ALT4R1**
- **ALT4R2**

RSMGL:

- **ALT4R**
- **ALT4R1**
- **ALT4R2**

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) Alternative 4 Revised (ALT4R) Scenario Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005. • Rainfall estimates have been revised and updated for 1965-2005. • Revised evapotranspiration methods have been used for 1965-2005.
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004; • High Accuracy Elevation Data, US Geological Survey 2007; • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004; • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007; • Palm Beach County LiDAR Surve, Dewberry and Davis, 2004; and • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information . • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass.
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ CEPP optimized release guidance in order to improve selected performance within LOK, the northern estuaries and LOSA while meeting environmental targets in the Glades. ○ Lake Okeechobee can send flood releases south through the Miami Canal and North New River Canal to the FEB when the LOK stage is above the bottom of Zone D and the FEB depth is below 2' (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Lake Okeechobee can send flood releases south to help meet water-quality based flow targets at STA-3/4, STA-2N, and STA-2S when the LOK stage is above the bottom of the Baseflow Zone (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Includes Lake Okeechobee regulatory releases to tide via L8 canal.

Feature	
	○ Releases via S-77 can be diverted into C43 Reservoir • Lake Okeechobee Water Shortage Management (LOWSM) Plan. • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized). • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model. • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	• St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). • Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is below 14.5 ft before being pumped into the C-44 reservoir. • Basin demands include the Florida Power & Light reservoir at Indiantown. • Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin; ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint; C44 reservoir releases water back to Lake Okeechobee when Lake stages are below the bottom of the Baseflow Zone. ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint; ○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint; and ○ All proposed reservoirs meet estuary demands.

Feature	
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved. • LOWSM applies to this agreement.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. • 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.
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total area • STA-3/4: 17,126 acres total area • STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area

Feature	

	• Assumed operations of STAs:
	  ○ 0.5 ft minimum depth below which supply from external sources is triggered;
	  ○ 4 ft maximum depth above which inflows are discontinued; and
	  ○ Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK flood releases and available FEB storage.
	• A 29,617-acre Flow Equalization Basin (FEB) located north of STA-3/4 and Holeyland. The total footprint represents the original 15,853-acre A-1 footprint plus the additional 13,764-acre A-2 footprint operated as follows:
	  ○ Assumed average topography of 9.63 ft NGVD. FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south;
	  ○ FEB outflows are used to help meet established inflow targets at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK flood releases are not sufficient;
	  ○ 0.5 ft minimum depth below which no releases are allowed;
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	  ○ No supplemental water supply provided to FEB;
	  ○ Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures; and
	  ○ Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower Miami and lower North New River canals.

Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for keeping the water table from going lower than half a foot below land surface elevation. • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FL Fish and Wildlife Conservation (FWC) Commission and the SFWMD.
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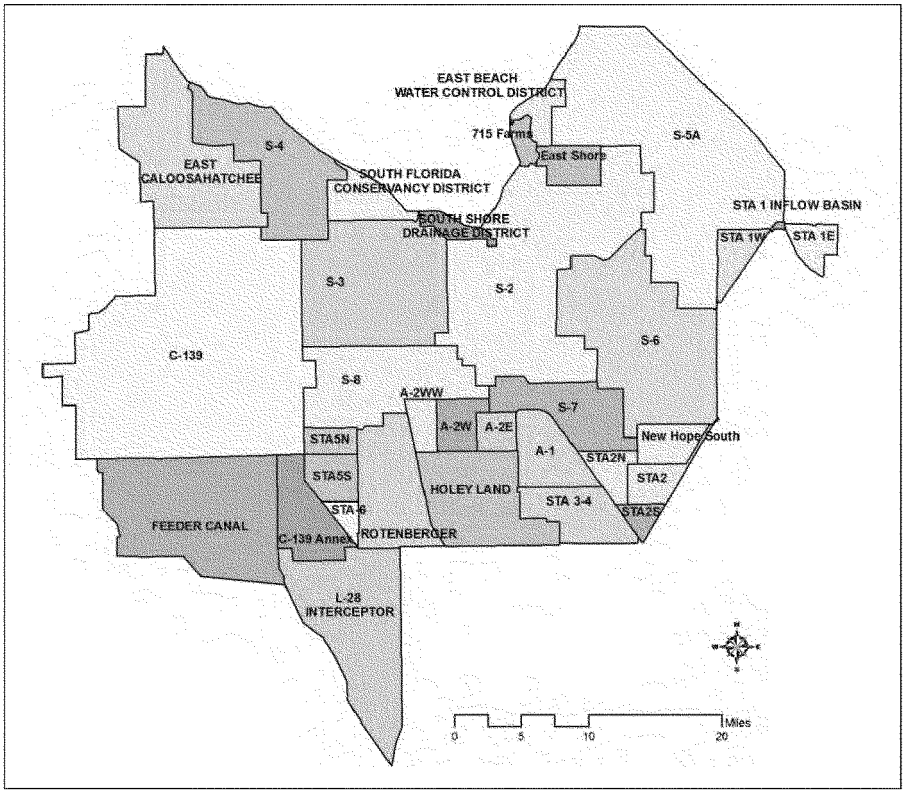
Feature	
Water Shortage Rules	• Reflects the existing water shortage policies as in South Florida Water Management District Chapters 40E-21 and 40E-22, FAC, including Lake Okeechobee Water Shortage Management (LOWSM) Plan.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2WW
NNR/HILLS Water-Body = S2 + S6 + S7 + New Hope South
WPB Water-Body = S-5A
FEB = A-2W + A-2E + A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Alternative 4 Revised (ALT4R) Scenario

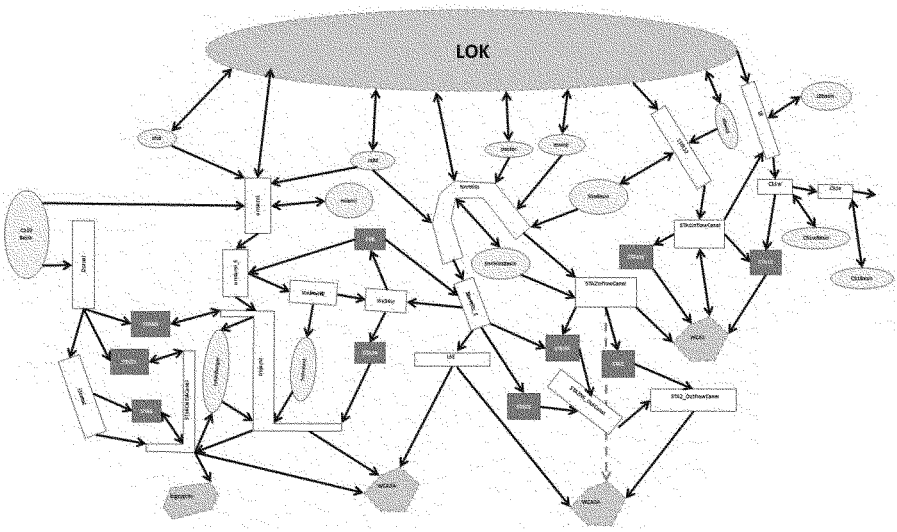


Fig. 2 RSMBSN Link-Node Routing Diagram: Alternative 4 Revised (ALT4R) Scenario

Note:

- 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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) Tentatively Selected Plan Other Water Related Needs Sensitivity Scenario (ALT4R1) Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005. • Rainfall estimates have been revised and updated for 1965-2005. • Revised evapotranspiration methods have been used for 1965-2005.
Topography	The Topography dataset for RSM was Updated in 2009 using the following datasets: • South Florida Digital Elevation Model, USACE, 2004; • High Accuracy Elevation Data, US Geological Survey 2007; • Loxahatchee River LiDAR Study, Dewberry and Davis, 2004; • St. Lucie North Fork LiDAR, Dewberry and Davis, 2007; • Palm Beach County LiDAR Surve, Dewberry and Davis, 2004; and • Stormwater Treatment Area stage-storage-area relationships based on G. Goforth spreadsheets.
Land Use	• Lake Okeechobee Service Area (LOSA) Basins were updated using consumptive use permit information as of 2/21/2012, as reflected in the LOSA Ledger produced by the Water Use Bureau. • C-43 Groundwater irrigated basins – Permitted as of 2010, the dataset was updated using land use, aerial imagery and 2010 consumptive use permit information . • Dominant land use in EAA is sugar cane other land uses consist of shrub land, wet land, ridge and slough, and sawgrass.
LOSA Basins	• Lower Istokpoga, North Lake Shore and Northeast Lake Shore demands and runoff estimated using the AFSIRS model and assumed permitted land use (see land use assumptions row).
Lake Okeechobee	• Lake Okeechobee Regulation Schedule 2008 (LORS 2008) ○ CEPP optimized release guidance in order to improve selected performance within LOK, the northern estuaries and LOSA while meeting environmental targets in the Glades. ○ Lake Okeechobee can send flood releases south through the Miami Canal and North New River Canal to the FEB when the LOK stage is above the bottom of Zone D and the FEB depth is below 2' (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal). ○ Lake Okeechobee can send flood releases south to help meet water-quality based flow targets at STA-3/4, STA-2N, and STA-2S when the LOK stage is above the bottom of the Baseflow Zone (EAA basin runoff used to limit conveyance capacity: 1,550 cfs for Miami Canal and 1,350 cfs for North New River Canal).

Feature	
	○ Includes Lake Okeechobee regulatory releases to tide via L8 canal. ○ Releases via S-77 can be diverted into C43 Reservoir • Lake Okeechobee Water Shortage Management (LOWSM) Plan. • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized). • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Backpumping of 298 Districts and 715 Farms into lake minimized
Northern Lake Okeechobee Watershed Inflows	• Headwaters Revitalization schedule for Kissimmee Chain of Lakes using the UKISS model. • Kissimmee River Restoration complete. • Fisheating Creek, Istokpoga & Taylor Creek / Nubbin Slough Basin Inflows calculated from historical runoff estimates.
Caloosahatchee River Basin	• Caloosahatchee River Basin irrigation demands and runoff estimated using the AFSIRS model and assumed permitted land use as of February 2012. (see land use assumptions row) • Public water supply daily intake from the river is included in the analysis. • Maximum reservoir height of 41.7 ft NGVD with a 9,379-acre footprint in Western C43 basin with a 175,800 acre-feet effective storage. • Proposed reservoir meets estuary demands while C-43 basin supplemental demands for surface water irrigation are met by Lake Okeechobee.
St. Lucie Canal Basin	○ St. Lucie Canal Basin demands estimated using the AFSIRS model and assumed permitted land use as of February 2012 (see land use assumptions row). ○ Excess C-44 basin runoff is allowed to backflow into the Lake if lake stage is below 14.5 ft before being pumped into the C-44 reservoir. ○ Basin demands include the Florida Power & Light reservoir at Indiantown. ○ Indian River Lagoon South Project features ○ Ten-mile Creek Reservoir and STA: 7,078 acre-feet storage capacity at 10.79 maximum depth on 820 acre footprint; receives excess water from North Folk Basin; ○ C-44 reservoir: 50,246 acre-feet storage capacity at 5.18 feet maximum depth on 12,125 acre footprint; C44 reservoir releases water back to Lake Okeechobee when Lake stages are below the bottom of the Baseflow Zone. ○ C-23/C-24 reservoir: 92,094 acre-feet storage capacity at 13.27 maximum depth on 8,675 acre footprint;

Feature	
	○ C-23/C-24 STA: 3,852 acre-feet storage capacity at 1.5 maximum depth on 2,568 acre footprint; and ○ All proposed reservoirs meet estuary demands. ○ IRL operations assumed are consistent with the March 2010 St. Lucie River Water Reservation Rule update. ○ Excess C23 basin water not needed to meet estuary demands can be diverted to the C44 reservoir if capacity exists. ○ C44 reservoir can discharge to C44 canal and backflow to Lake Okeechobee when the lake is below the baseflow zone.
Seminole Brighton Reservation	• Brighton reservation demands were estimated using AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work plan equals 2,262 MGM (million gallons per month). AFSIRS modeled 2-in-10 demands equaled 2,383 MGM. • While estimated demands, and therefore deliveries, for every month of simulation do not equate to monthly entitlement quantities as per Table 7, Agreement 41-21 (Nov. 1992), tribal rights to these quantities are preserved. • LOWSM applies to this agreement.
Seminole Big Cypress Reservation	• Big Cypress Reservation irrigation demands and runoff were estimated using the AFSIRS method based on existing planted acreage. • The 2-in-10 demand set forth in the Seminole Compact Work Plan equals 2,606 MGM. • AFSIRS modeled 2-in-10 demands equaled 2,659 MGM. • 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.
Everglades Agricultural Area	• Model water-body components as shown in Figure 1. • Simulated runoff from the North New River – Hillsboro basin apportioned based on the relative size of contributing basins via S7 route vs. S6 route. • G-341 routes water from S-5A Basin to Hillsboro Basin. • RSMBN ECB EAA runoff and irrigation demand compared to SFWMM ECB simulated runoff and demand from 1965-2005 for reasonability.
Everglades Construction Project Stormwater Treatment Areas	• STAs are simulated as single waterbodies • STA-1E: 6,546 acres total area • STA-1W: 7,488 acres total area • S-5A Basin runoff is to be treated in STA-1W first and when conveyance capacities are exceeded, rerouted to STA-1E • STA-2: cells 1,2 & 3: 7,681 acres total area • STA-2N: cells 4,5 & 6; refers to Comp B-North; 6,531 acres total area • STA-2S: cells 7 & 8; refers to Comp B-South; 3,570 acres total

Feature	
	area • STA-3/4: 17,126 acres total area • STA-5N: includes cells 1 & 2: 5,081 acres total area • STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area • STA-6: expanded with phase 2: 3,054 acres total area • Assumed operations of STAs: o 0.5 ft minimum depth below which supply from external sources is triggered; o 4 ft maximum depth above which inflows are discontinued; and o Inflow targets established for STA-3/4, STA-2N and STA-2S based on DMSTA simulation; met from local basin runoff, LOK flood releases and available FEB storage. • A 29,617-acre Flow Equalization Basin (FEB) is located north of STA-3/4 and Holeyland. The total footprint represents the original 15,853-acre A-1 footprint plus the additional 13,764-acre A-2 footprint operated as follows: o Assumed average topography of 9.63 ft NGVD. FEB inflows are from excess EAA basin runoff above the established inflow targets at STA-3/4, STA-2N, and STA-2S, and from LOK flood releases south; o FEB outflows are used to help meet established inflow targets at STA-3/4, STA-2N, and STA-2S if EAA basin runoff and LOK flood releases are not sufficient; o 0.5 ft minimum depth below which no releases are allowed; o 3.8 ft maximum depth above which inflows are discontinued; o No supplemental water supply provided to FEB; o Assumed inlet pump from STA-3/4 supply canal with capacity equal to combined capacity of G-372 and G-370 structures; and o Outflow weirs, with similar discharge characteristics as STA-3/4 outlet structure, discharging into lower Miami and lower North New River canals.
Holey Land Wildlife Management Area	• G-372HL is the only inflow structure for Holey Land used for keeping the water table from going lower than half a foot below land surface elevation. • Operations are similar to the existing condition as in the 1995 base simulation for the Lower East Coast Regional Water Supply Plan (LECRWSP, May 2000), as per the memorandum of agreement between the FL Fish and Wildlife Conservation (FWC) Commission and the SFWMD.
Rotenberger Wildlife Management Area	• Operational Schedule as defined in the Operation Plan for Rotenberger WMA. (SFWMD, March 2010)

Feature	
Public Water Supply and Irrigation	• Regional water supply demands to maintain Lower East Coast canals as simulated from RSMGL FWO.
Western Basins	• C139 RSM basin is being modeled. Period is 1965-2005. • C139 basin runoff is modeled as follows: G136 flows is routed to Miami Canal; G342A-D flows routed to STA5N; G508 flows routed to STA5S; G406 flows routed to STA6. • C139 basin demand is met primarily by local groundwater.
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Notes:

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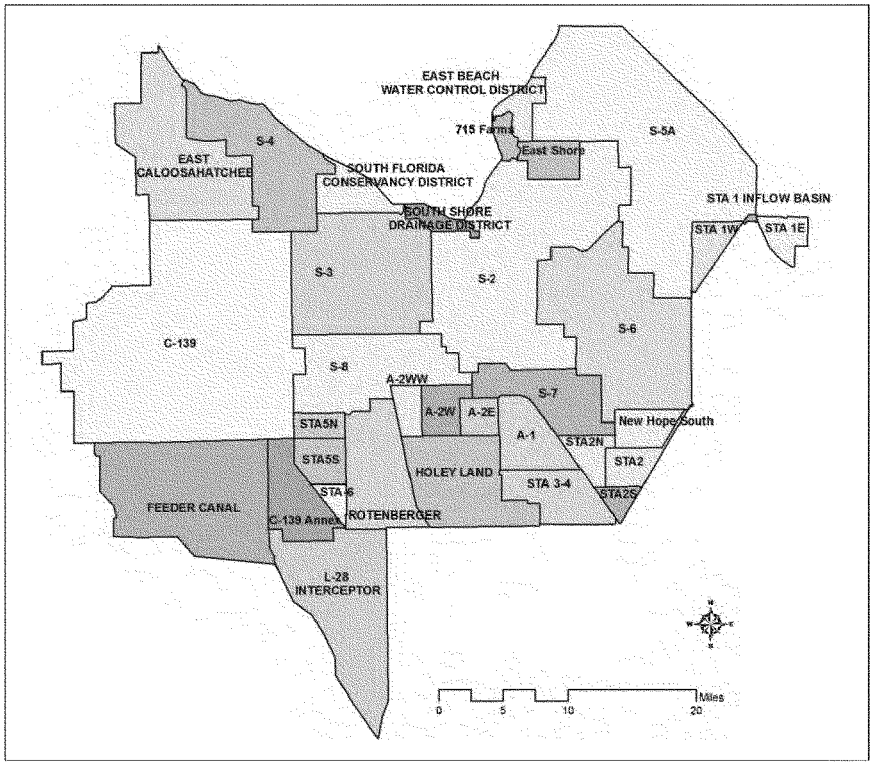
- The RSMBN CEPP representation of ALT4R1 is the same as the June 25, 2013 ALT4R2 scenario.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2WW
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WPB Water-Body = S-5A
FEB = A-2W + A-2E + A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Updated Tentatively Selected Plan (ALT4R2)

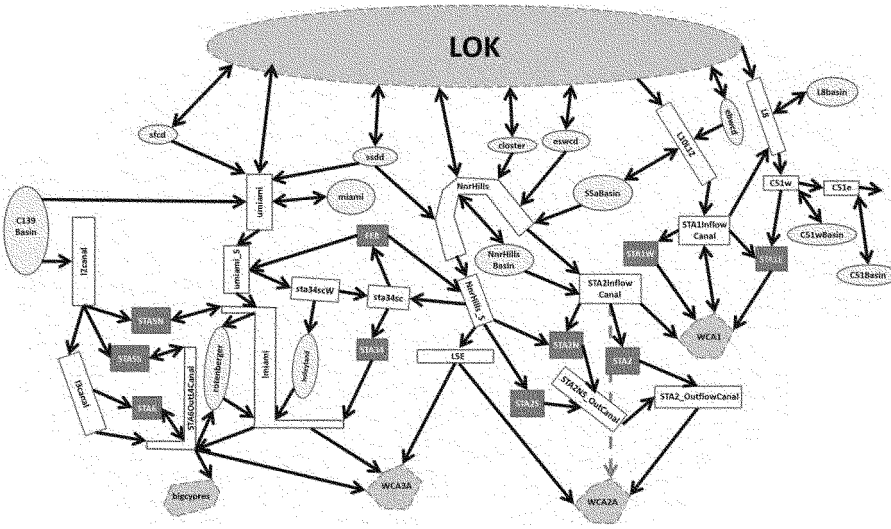

Fig. 2 RSMBSN Link-Node Routing Diagram: Updated Tentatively Selected Plan (ALT4R2)

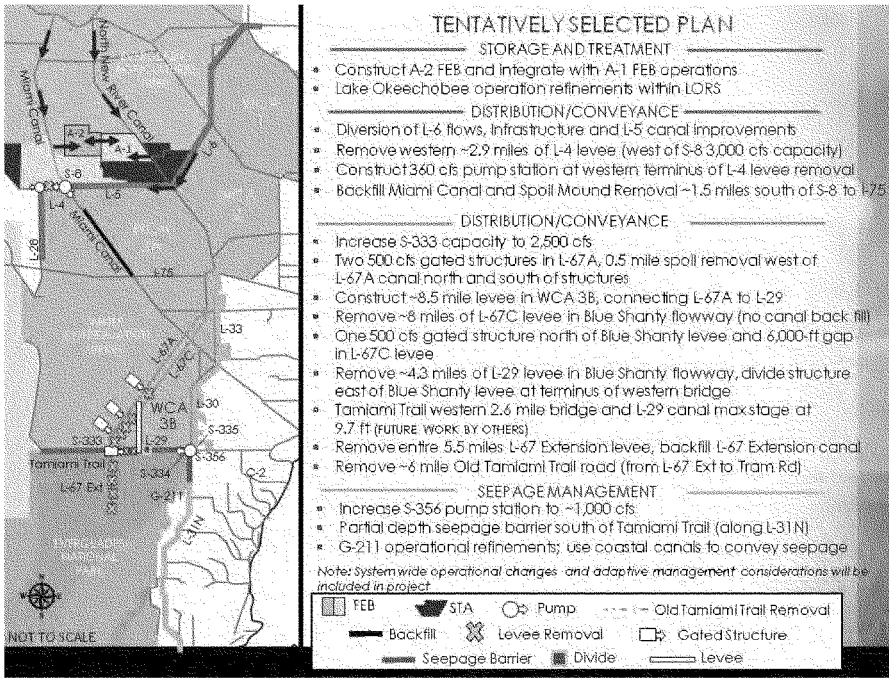

Fig. 3 CEPP ALT4R2 Features as defined by CEPP project team

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Basins (RSMBN) Updated Tentatively Selected Plan (ALT4R2) Table of Assumptions

Feature	
Climate	• The climatic period of record is from 1965 to 2005. • Rainfall estimates have been revised and updated for 1965-2005. • Revised evapotranspiration methods have been used for 1965-2005.
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	○ Releases via S-77 can be diverted into C43 Reservoir • Lake Okeechobee Water Shortage Management (LOWSM) Plan. • Interim Action Plan (IAP) for Lake Okeechobee (under which backpumping to the lake at S-2 and S-3 is to be minimized). • "Temporary" forward pumps as follows: ○ S354 – 400 cfs ○ S351 – 600 cfs ○ S352 – 400 cfs ○ All pumps reduce to the above capacities when Lake Okeechobee stage falls below 10.2 ft and turn off when stages recover to greater than 11.2 ft • No reduction in EAA runoff associated with the implementation of Best Management Practices (BMPs); No BMP makeup water deliveries to the WCAs • Backpumping of 298 Districts and 715 Farms into lake minimized
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Feature	

	• STA-5N: includes cells 1 & 2: 5,081 acres total area
	• STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area
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	• Assumed operations of STAs:
	  ○ 0.5 ft minimum depth below which supply from external sources is triggered;
	  ○ 4 ft maximum depth above which inflows are discontinued; and
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Feature	
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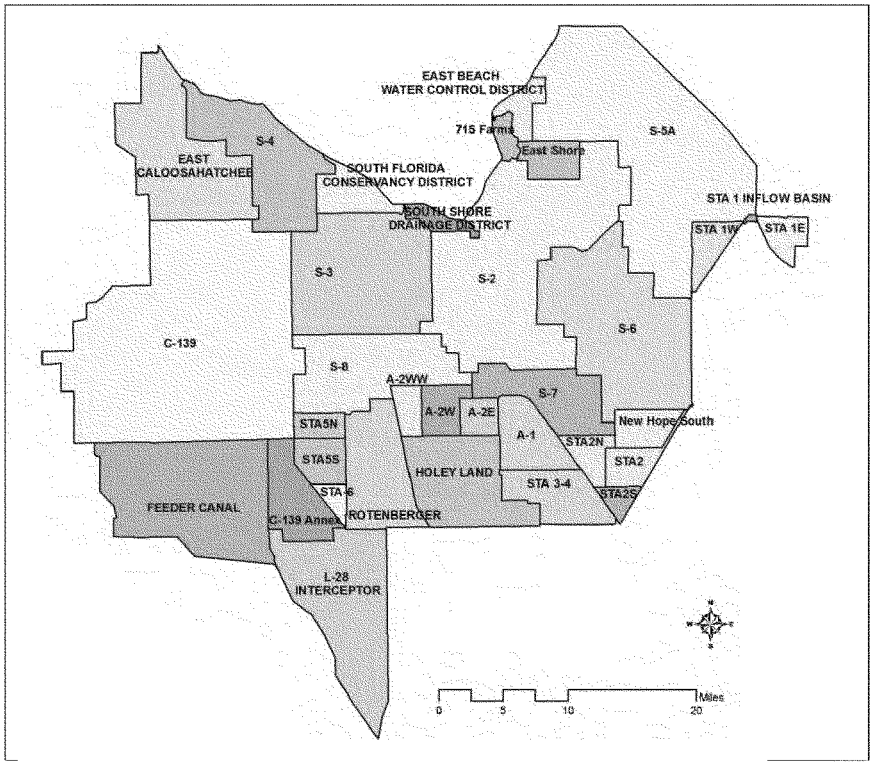
Notes:

- 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 eastern and southern boundaries of the RSMBN model were provided from either the South Florida Water Management Model (SFWMM) or the RSM Glades-LECSA Model (RSMGL). The SFWMM was the source of the eastern boundary groundwater/surface water flows, while the RSMGL was the source of the southern boundary structural flows.
- The RSMBN CEPP representation of ALT4R2 is the same as the June 2, 2013 ALT4R1 scenario.



Water-Body Components:
Miami Water-Body = S3 + S8 + A-2WW
NNR/HILLS Water-Body = S2 + S6 + S7 + New Hope South
WPB Water-Body = S-5A
FEB = A-2W + A-2E + A-1

Fig. 1 RSMBSN Basin Definition within the EAA: Updated Tentatively Selected Plan (ALT4R2)

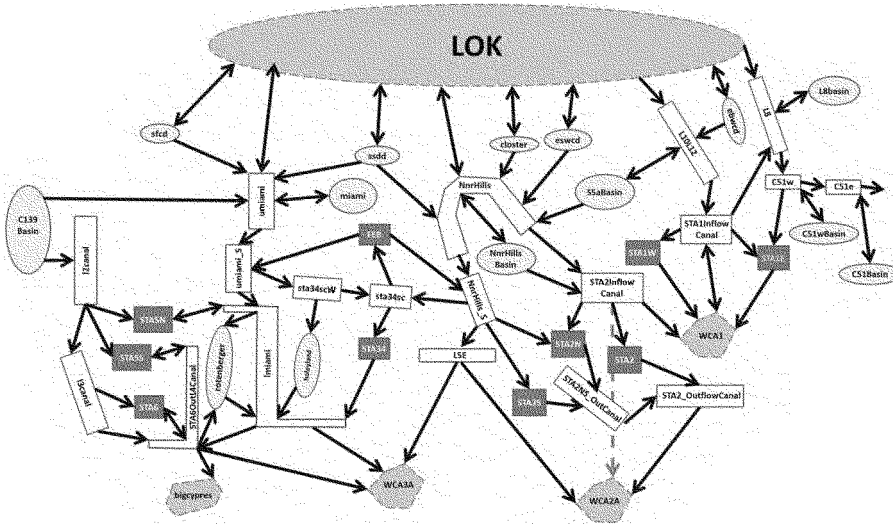


Fig. 2 RSMBSN Link-Node Routing Diagram: Updated Tentatively Selected Plan (ALT4R2)

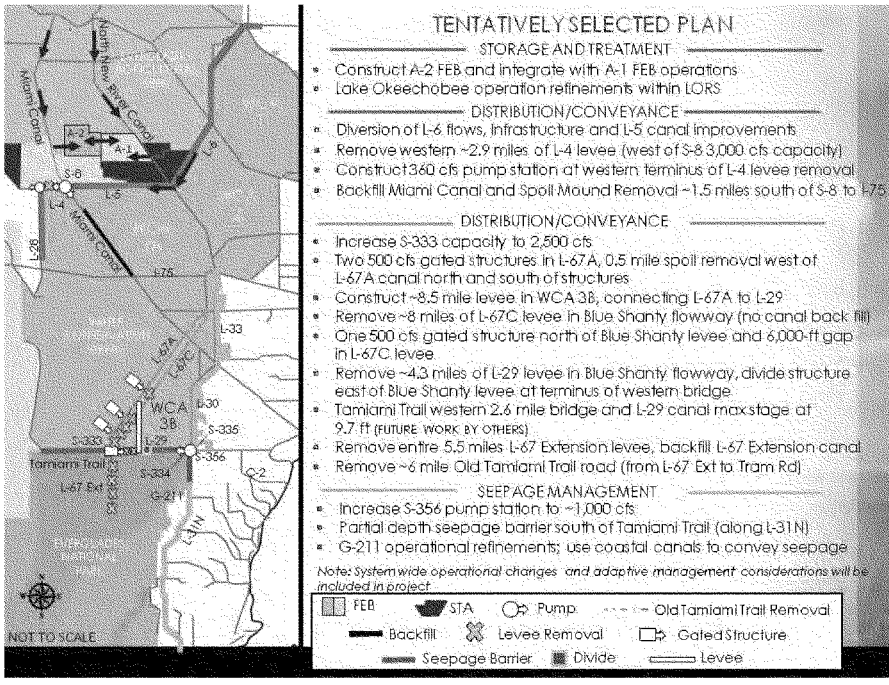


Fig. 3 CEPP ALT4R2 Features as defined by CEPP project team

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) Tentatively Selected Plan (ALT4R) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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.Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. • 2nd Generation CERP – C-111 Spreader Canal Project includes the

Feature	
	Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Diversion of L-6 flows with additional 500 cfs structure and improvements to the L-5 canal • STA-3/4 outflows routed based on Rainfall Driven Operations (RDO) – a maximum of 2500 cfs is routed to S8 and G404, with the remainder being sent to S7 • Western L-4 levee degrade (west of S-8 = 3,000 cfs capacity) • Miami Canal backfilled and spoil mound removed 1.5 miles south of S-8 to I-75 • L-28 Triangle – levee gap and canal backfill approximately 9000 ft. • Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • One 500 cfs gated structure in L-67A north of Blue Shanty levee (S345D) and associated gap in L-67C levee • Two 500 cfs gated structures in L-67A (S345F & S345G) discharging into Blue Shanty Flowway

Feature	
	• Environmental target deliveries through the S345s are determined through RDO and is spatially distributed as 40% to 345D, 35% to 345F and 25% to 345G • Blue Shanty Flowway assumed as follows: o Construction of ~8.5 mile levee in WCA 3B, connecting L-67A to L-29 o Removal of L-67C levee in Blue Shanty Flowway (no canal back fill) o Removal of L-29 levee in Blue Shanty Flowway. • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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 or CA3 canal stage fall below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. The environmental component of the schedule is defined by RDO. If hydraulic capacity exists at the 345s, then flood control discharges are made into 3B instead of at the S12s. • S-333 capacity increased to 2,500 cfs • L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft. • L29 canal can receive inflow up to 9.7 ft (applies to both E and W segments / i.e. S333 & S356) • G-3273 constraint for operation of S-333 assumed to be 9.5 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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. • Removal of the entire 5.5 miles L-67 Extension levee, with backfill of L-67 Extension canal • S-355A & S-355B are operated.

Feature	
	• Capacity of S-356 pump increased to 1000 cfs. S-356 is operated to manage seepage. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. ○ An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation. • Partial depth, approximately 4 mile long seepage barrier south of Tamiami Trail (along L-31N)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 flood control discharges are sent to STA-1E through the S-319 structure

Feature	

	• Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1
	  ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15
	  ○ Structure S-12B is closed Jan. 1 to July 15
	• Water supply deliveries from regional system (from WCA3A: S-151/S-337) are used to maintain the L30 canal with a minimum seasonal level varying from 6.25 ft in the dry season to 5.2 ft. at the beginning of the wet season
	• G-211 / S338 operational refinements; use coastal canals to convey seepage toward Biscayne Bay during drier times.

Canal Configuration	• Canal configuration same as calibration except no L-67 Extension Canal and CERP & CEPP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO simulation.

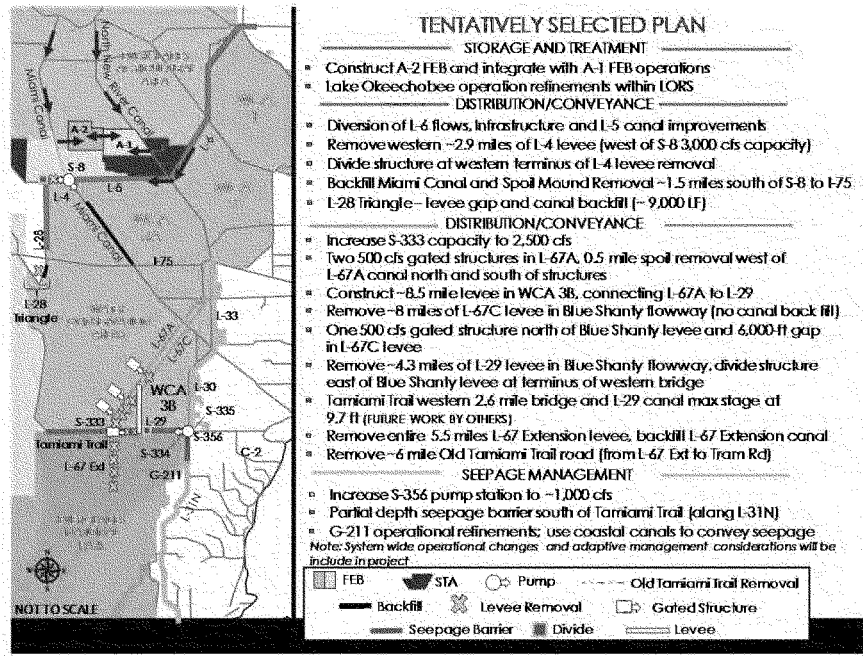


Fig. 1 CEPP ALT4R Features as defined by CEPP project team

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.

Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) Tentatively Selected Plan Other Water Related Needs Sensitivity Scenario (ALT4R1) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
Topography	• Same as calibration topographic data set except where reservoirs are introduced (STA1-E, C4 Impoundment and C-111 reservoirs). • United States Geological Survey (USGS) High-Accuracy Elevation Data Collection (HAEDC) for the Water Conservation Areas (1, 2A, 2B, 3A, and 3B), the Big Cypress National Preserve and Everglades National Park.
Tidal Data	• Tidal data from two primary (Naples and Virginia Key) and five secondary NOAA stations (Flamingo, Everglades, Palm Beach, Delray Beach and Hollywood Beach) were used to generate a historic record to be used as sea level boundary conditions for the entire simulation period.
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 2008-2009 Land Use coverage as prepared by the SFWMD, consumptive use permits as of 2011 were used to update the land use in areas where it did not reflect the permit information. • Land Use and Land Cover Classification for the 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. Modified at locations where reservoirs are introduced (STA1-E, Site 1 Impoundment, Broward WPAs, C4 Impoundment, Lakebelt Lakes and C-111 Reservoirs).
Water Control Districts (WCDs)	• Water Control Districts in Palm Beach and Broward Counties and in the Western Basins assumed. • 8.5 SMA seepage canal is modeled as a WCD in ENP area.
Lake Belt Lakes	• Based on the permitted 2020 Lake Belt Lakes coverage obtained from USACE.
CERP Projects	• 1st Generation CERP – Site 1 Impoundment project is modeled as an above ground reservoir of area 1600 acres, with a maximum depth of 8 ft. • 2nd Generation CERP – Broward County Water Preserve Areas (WPAs) comprised of C-11 and C-9 impoundments were modeled as above ground reservoirs with areas 1221 and 1971 acres and maximum depths 4.3 and 4.0 ft. respectively. Operations refined in RSM model to closer represent project intent and outcomes.

Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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	• Diversion of L-6 flows with additional 500 cfs structure and improvements to the L-5 canal • STA-3/4 outflows routed based on Rainfall Driven Operations (RDO) – a maximum of 2500 cfs is routed to S8 and G404, with the remainder being sent to S7 • Western L-4 levee degrade with 1.5 miles retained west of S8 (west of S-8 = 3,000 cfs capacity) • Miami Canal backfilled and spoil mound removed 1.5 miles south of S-8 to I-75 • Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • One 500 cfs gated structure in L-67A north of Blue Shanty levee (S345D) and associated gap in L-67C levee • Two 500 cfs gated structures in L-67A (S345F & S345G) discharging into Blue Shanty Flowway

Feature	
	• Environmental target deliveries through the S345s are determined through RDO and is spatially distributed as 40% to 345D, 35% to 345F and 25% to 345G • Blue Shanty Flowway assumed as follows: o Construction of ~8.5 mile levee in WCA 3B, connecting L-67A to L-29 o Removal of L-67C levee in Blue Shanty Flowway (no canal back fill) o Removal of L-29 levee in Blue Shanty Flowway. • Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002) • 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 or CA3 canal stage falls below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. The environmental component of the schedule is defined by RDO. If hydraulic capacity exists at the 345s, then flood control discharges are made into 3B instead of at the S12s. • S-333 capacity increased to 2,500 cfs • L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft. • L29 canal can receive inflow up to 9.7 ft (applies to both E and W segments / i.e. S333 & S356) • G-3273 constraint for operation of S-333 assumed to be 9.5 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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. • Removal of the entire 5.5 miles L-67 Extension levee, with backfill of L-67 Extension canal • S-355A & S-355B are operated.

Feature	
	• Capacity of S-356 pump increased to 1000 cfs. S-356 is operated to manage seepage. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. o An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation. • Partial depth, approximately 4 mile long seepage barrier south of Tamiami Trail (along L-31N)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Modeling of the TSP assumes an additional public water supply withdrawal of 18 MGD in Service Area 2 and 53 MGD in Service Area 3. • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary • 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 • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 ○ Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 ○ Structure S-12B is closed Jan. 1 to July 15 • Water supply deliveries from regional system (from WCA3A: S-151/S-337) are used to maintain the L30 canal with a minimum seasonal level varying from 6.25 ft in the dry season to 5.2 ft. at the beginning of the wet season • G-211 / S338 operational refinements; use coastal canals to convey seepage toward Biscayne Bay during drier times.
Canal Configuration	• Canal configuration same as calibration except no L-67 Extension Canal and CERP & CEPP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO simulation.

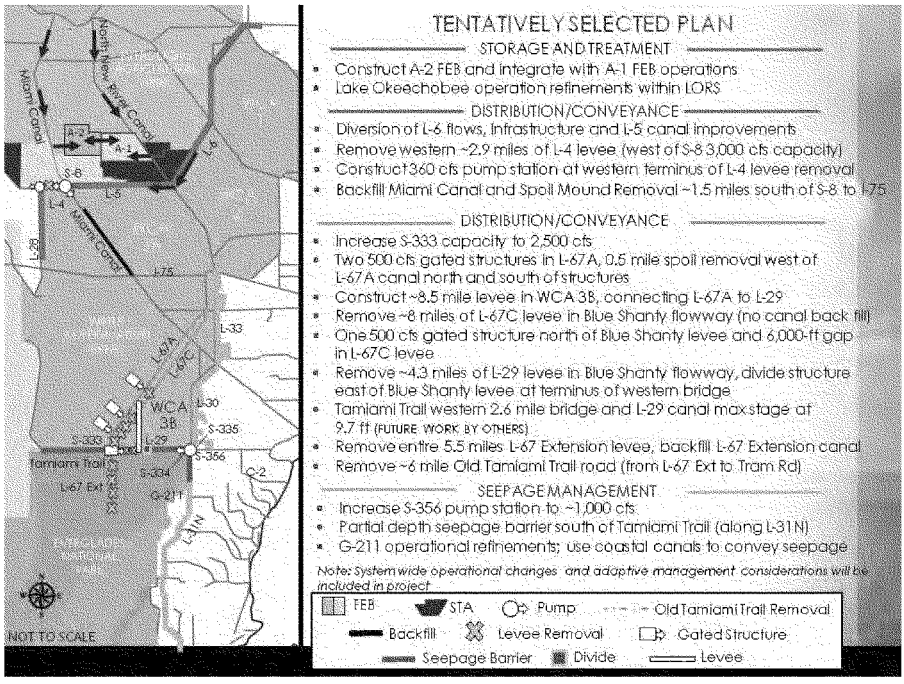


Fig. 1 CEPP ALT4R2 Features as defined by CEPP project team

Notes:

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Hydrologic and Environmental Systems Modeling & Interagency Modeling Center

Regional Simulation Model Glades-LECSA (RSMGL) Updated Tentatively Selected Plan (ALT4R2) Table of Assumptions

Feature	
Meteorological Data	• Rainfall file used: rain_v3.0_beta_tin_14_05.bin • Reference Evapotranspiration (RET) file used: RET_48_05_MULTIQUAD_v1.0.bin (ARCADIS, 2008)
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Feature	
	• 2nd Generation CERP – C-111 Spreader Canal Project includes the Frog Pond Detention Area, which is modeled as an above ground impoundment with the S200 A, B and C pumps as inflow structures. In addition, the Aerojet canal is modeled with the inflow pumps S199 A, B and C. The S199 and S200 pumps are turned off based on the stage at the remote monitoring location EVER4 for the protection of the CSS Critical Habitat Unit 3. • 2nd Generation CERP – Biscayne Bay Coastal Wetlands project features were not modeled since these features along the coast in Miami-Dade County were not considered significant for CEPP. • Areal corrections were applied to the impoundment storages to account for the discrepancies of the areas in the model of the impoundments not matching the design areas.
Water Conservation Area 1 (Arthur R. Marshall Loxahatchee National Wildlife Refuge)	• Current C&SF Regulation Schedule. 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. • 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. 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 10.5 ft in WCA-2A, defined as when WCA2-U1 marsh gauge falls below 10.5 ft or L38 canal stage falls below 10.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.
Water Conservation Area 3A & 3B	• Diversion of L-6 flows with additional 500 cfs structure and improvements to the L-5 canal • STA-3/4 outflows routed based on Rainfall Driven Operations (RDO) – a maximum of 2500 cfs is routed to S8 and G404, with the remainder being sent to S7 • Western L-4 levee degrade with 1.5 miles retained west of S8 (west of S-8 = 3,000 cfs capacity) • Miami Canal backfilled and spoil mound removed 1.5 miles south of S-8 to I-75 • Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 (USACE, 2012) • One 500 cfs gated structure in L-67A north of Blue Shanty levee (S345D) and associated gap in L-67C levee

Feature	

	• Two 500 cfs gated structures in L-67A (S345F & S345G) discharging into Blue Shanty Flowway
	• Environmental target deliveries through the S345s are determined through RDO and is spatially distributed as 40% to 345D, 35% to 345F and 25% to 345G
	• Blue Shanty Flowway assumed as follows:
	  ○ Construction of ~8.5 mile levee in WCA 3B, connecting L-67A to L-29
	  ○ Removal of L-67C levee in Blue Shanty Flowway (no canal back fill)
	  ○ Removal of L-29 levee in Blue Shanty Flowway.
	• Includes regulatory releases to tide through LEC canals. Documented in Water Control Plan (USACE, June 2002)
	• 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 or CA3 canal stage falls below 7.0 ft. Any water supply releases below the floor will be matched by an equivalent volume of inflow.

Everglades Construction Project 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.
Everglades National Park	• Water deliveries to Everglades National Park are based upon Everglades Restoration Transition Plan (ERTP), with the WCA-3A Regulation Schedule including the lowered Zone A (compared to IOP) and extended Zones D and E1. The environmental component of the schedule is defined by RDO. If hydraulic capacity exists at the 345s, then flood control discharges are made into 3B instead of at the S12s. • S-333 capacity increased to 2,500 cfs • L29 Divide structure assumed and is operated to send water from L29W to L29E to equilibrate canals when L29E falls below 7 ft. • L29 canal can receive inflow up to 9.7 ft (applies to both E and W segments / i.e. S333 & S356 as well as S345F & S345G structure on Blue Shanty Flowway) • G-3273 constraint for operation of S-333 assumed to be 9.5 ft, NGVD. • The one mile Tamiami Trail Bridge as per the 2008 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 mile 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.

Feature	
	• Removal of the entire 5.5 miles L-67 Extension levee, with backfill of L-67 Extension canal • S-355A & S-355B are operated. • Capacity of S-356 pump increased to 1000 cfs. S-356 is operated to manage seepage. • Full construction of C-111 project reservoirs consistent with the as-built information from USACE plus addition of contract 8 and contract 9 features. A uniform bottom elevation equal to the spatial average over the extent of each reservoir is assumed. • 8.5 SMA project feature as per federally authorized Alternative 6D of the MWD/8.5 SMA Project (USACE, 2000 GRR); operations per 2011 Interim Operating Criteria (USACE, June 2011) including S-331 trigger shifted from Angel's well to LPG-2. Outflow assumed from 8.5 SMA detention cell to the C-111 North Detention Area. ○ An additional length of seepage canal is assumed in the model to allow water to be collected for S357 operation. • Partial depth, approximately 4 mile long seepage barrier south of Tamiami Trail (along L-31N)
Other Natural Areas	• Flows to Biscayne Bay are simulated through Snake Creek, North Bay, the Miami River, Central Bay and South Bay
Pumpage and Irrigation	• Public Water Supply pumpage for the Lower East Coast was updated using 2010 consumptive use permit information as documented in the C-51 Reservoir Feasibility Study; permits under 0.1 MGD were not included • Modeling of the TSP assumes an additional public water supply withdrawal of 12 MGD in Service Area 2 and 5 MGD in Service Area 3. • Residential Self Supported (RSS) pumpage are based on 2030 projections of residential population from the SFWMD Water Supply Bureau. • Industrial pumpage is also based on 2030 projections of industrial use from the Water Supply Bureau. • Irrigation demands for the six irrigation land-use types are calculated internally by the model. • 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 in effect in 2012 • 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) • S-25B and S-26 backflow pumps are not modeled since they are used very rarely during high tide conditions and the model uses a long-term average daily tidal boundary

Feature	
	• 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 flood control discharges are sent to STA-1E through the S-319 structure • Releases from WCA-3A to ENP and the South Dade Conveyance System (SDCS) will follow the Everglades Restoration Transition Plan (ERTP) regulation schedule for WCA-3A, as per SFWMM modeled alternative 9E1 o Structures S-343A, S-343B, S-344 and S-12A are closed Nov. 1 to July 15 o Structure S-12B is closed Jan. 1 to July 15 • Water supply deliveries from regional system (from WCA3A: S-151/S-337) are used to maintain the L30 canal with a minimum seasonal level varying from 6.25 ft in the dry season to 5.2 ft. at the beginning of the wet season • G-211 / S338 operational refinements; use coastal canals to convey seepage toward Biscayne Bay during drier times.
Canal Configuration	• Canal configuration same as calibration except no L-67 Extension Canal and CERP & CEPP project modifications.
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. The Lower East Coast Subregional (LECsR) model is the source of this data. • Periods where the Lower East Coast is under water restriction due to low Lake Okeechobee stages were extracted from the corresponding RSMBN FWO simulation.

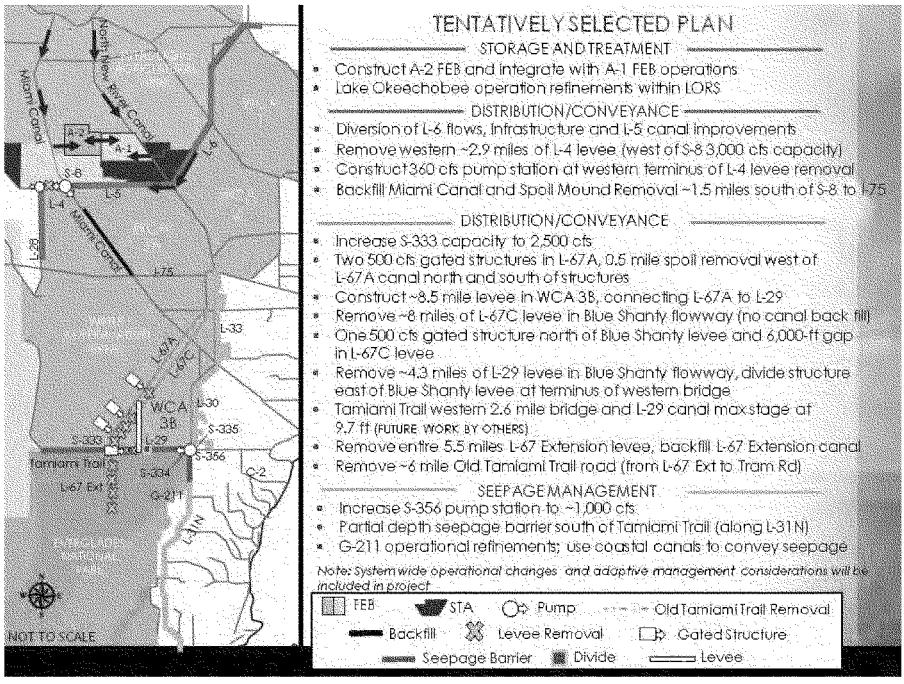

Fig. 1 CEPP ALT4R2 Features as defined by CEPP project team

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.

Appendix B – LORS08 Operations Schedule

The LORS08 schedule used for operation of Lake Okeechobee in the CEPP baselines was modified as shown in **Figure B.1** for use in the TSP. **Figures B.2 and B.3** show the pulse releases from Lake Okeechobee into the Caloosahatchee and St. Lucie Estuary, respectively.

Details of the TSP model implementation of the schedule can be found in **Figures B.4, B.5 and B.6. Figure B.4** lists the range of values used to classify the tributary hydrologic conditions. **Figure B.5** lists the range of values used to classify the net inflow seasonal outlook. **Figure B.6** lists the range of values used to classify the net inflow multi-seasonal outlook.

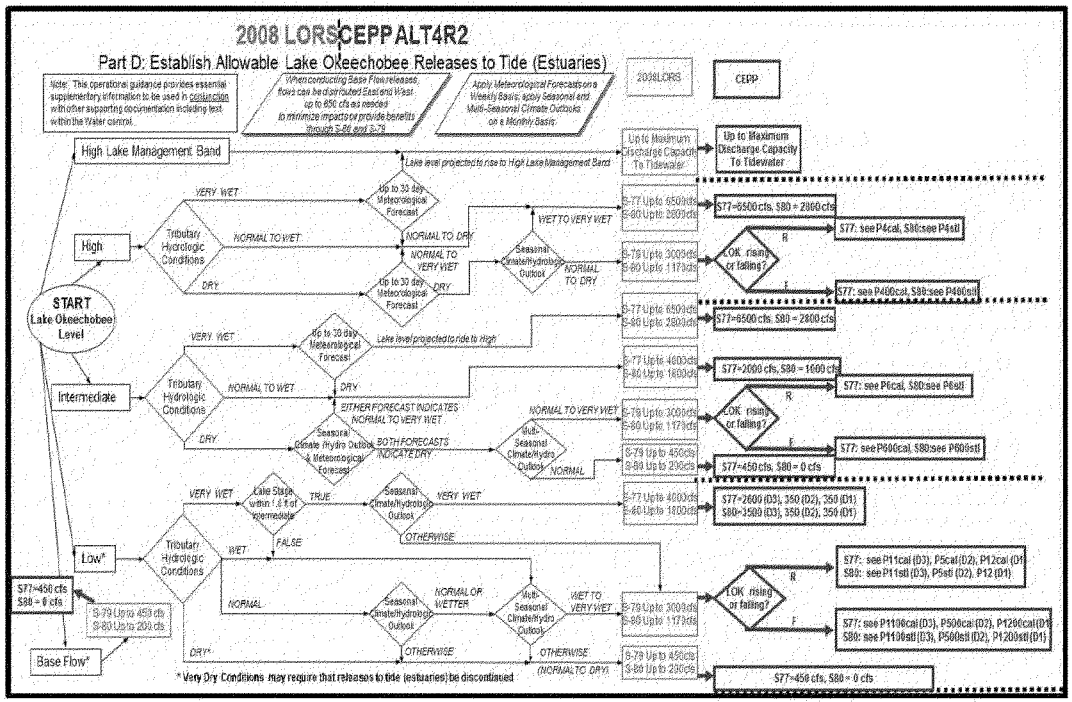

Figure B.1. LORS08 operations schedule, with CEPP TSP modifications as modeled shown in blue.

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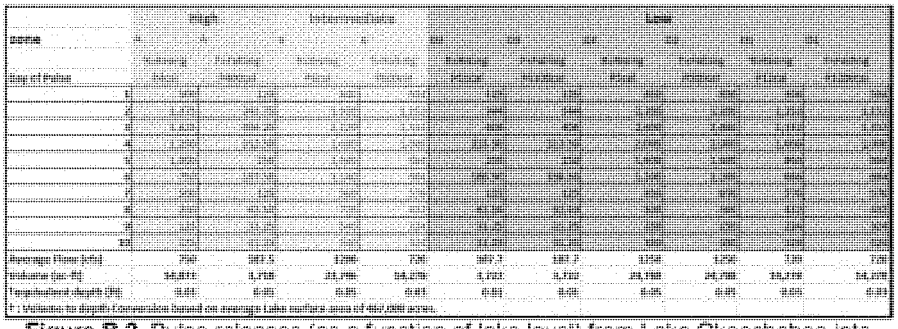

	High		Intermediate		Low					
zone	A	A	B	B	D3	D3	D2	D2	D1	D1
Day of Pulse	R=Rising P45cfs	F=Falling P400cfs	R=Rising P65cfs	F=Falling P500cfs	R=Rising P11cfs	F=Falling P1100cfs	R=Rising P36cfs	F=Falling P500cfs	R=Rising P12cfs	F=Falling P1200cfs
1	450	112.50	720	432	112.50	112.50	750	750	432	432
2	600	150	960	576	150	150	1,000	1,000	576	576
3	525	131.25	840	504	131.25	131.25	900	900	504	504
4	375	93.75	600	360	93.75	93.75	600	600	360	360
5	250	62.50	420	252	62.50	62.50	450	450	252	252
6	225	56.25	360	216	56.25	56.25	350	350	216	216
7	150	37.50	240	144	37.50	37.50	250	250	144	144
8	150	37.50	240	144	37.50	37.50	250	250	144	144
9	100	25	0	0	25	25	200	200	0	0
10	100	25	0	0	25	25	0	0	0	0
Average Flow (cfs)	292.5	73.1	438.0	262.8	73.1	73.1	475.0	475.0	262.8	262.8
Volume (ac-ft)	5,800	1,450	8,686	5,211	1,450	1,450	9,419	9,419	5,211	5,211
†equivalent depth (ft)	0.01	0.00	0.02	0.01	0.00	0.00	0.02	0.02	0.01	0.01

† : Volume to depth Conversion based on average Lake surface area of 467,000 acres.

Figure B.2. Pulse releases (as a function of lake level) from Lake Okeechobee into Caloosahatchee Estuary in cubic feet per second (cfs).

	High		Intermediate		Low					
zone	A	A	B	B	D3	D3	D2	D2	D1	D1
Day of Pulse	R=Rising P45cfs	F=Falling P400cfs	R=Rising P65cfs	F=Falling P500cfs	R=Rising P11cfs	F=Falling P1100cfs	R=Rising P36cfs	F=Falling P500cfs	R=Rising P12cfs	F=Falling P1200cfs
1	450	112.50	720	432	112.50	112.50	750	750	432	432
2	600	150	960	576	150	150	1,000	1,000	576	576
3	525	131.25	840	504	131.25	131.25	900	900	504	504
4	375	93.75	600	360	93.75	93.75	600	600	360	360
5	250	62.50	420	252	62.50	62.50	450	450	252	252
6	225	56.25	360	216	56.25	56.25	350	350	216	216
7	150	37.50	240	144	37.50	37.50	250	250	144	144
8	150	37.50	240	144	37.50	37.50	250	250	144	144
9	100	25	0	0	25	25	200	200	0	0
10	100	25	0	0	25	25	0	0	0	0
Average Flow (cfs)	292.5	73.1	438.0	262.8	73.1	73.1	475.0	475.0	262.8	262.8
Volume (ac-ft)	5,800	1,450	8,686	5,211	1,450	1,450	9,419	9,419	5,211	5,211
†equivalent depth (ft)	0.01	0.00	0.02	0.01	0.00	0.00	0.02	0.02	0.01	0.01

† : Volume to depth Conversion based on average Lake surface area of 467,000 acres.

Figure B.3. Pulse releases (as a function of lake level) from Lake Okeechobee into St. Lucie Estuary in cubic feet per second (cfs).

LORS2008

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.0	>= 6000 cfs	Very Wet
1.5 to 2.99	2500 - 5999 cfs	Wet
-1.49 to 1.49	500 - 2499 cfs	Near Normal
-2.99 to -1.5	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry

*use the wettest of the two indicators

CEPP-RSMBN

Classification of Lake Okeechobee Tributary Hydrologic Conditions

Palmer Index Class Limits	2-wk Mean LO Inflow Class Limit	Tributary Hydrologic Classification*
> 3.3	>= 8700 cfs	Very Wet
0.01 to 3.29	1000 - 8699 cfs	Wet
-0.49 to 0.0	500 - 999 cfs	Near Normal
-2.99 to -0.50	-5000 - 500 cfs	Dry
-3.0 or less	< -5000 cfs	Very Dry

*use the wettest of the two indicators

Figure B.4. LORS08 and CEPP TSP modified Tributary Hydrologic Conditions Classifications.

LORS2008

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 0.93	> 2.0	Very Wet
0.71 to 0.93	1.51 to 2.0	Wet
0.35 to 0.70	0.75 to 1.5	Normal
< 0.35	< 0.75	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

Classification of Lake Okeechobee Net Inflow Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Seasonal Outlook
> 1.43	> 3.06	Very Wet
0.91 to 1.43	1.93 to 3.06	Wet
0.46 to 0.90	0.98 to 1.92	Normal
< 0.46	< 0.98	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

Figure B.5. LORS08 and CEPP TSP modified Seasonal Outlook Classifications.

LORS2008

Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does not include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.5 to 1.17	1.1 to 2.5	Normal
< 0.5	< 1.1	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

CEPP-RSMBN

Classification of Lake Okeechobee Net Inflow Multi-Seasonal Outlook**

Lake Net Inflow Prediction (million acre-feet) (Does include ET)	Equivalent Depth (feet)	Lake Okeechobee Net Inflow Multi-Seasonal Outlook
> 2.0	> 4.3	Very Wet
1.18 to 2.0	2.51 to 4.3	Wet
0.6 to 1.17	1.3 to 2.5	Normal
< 0.6	< 1.3	Dry

**volume-depth conversion based on average lake surface area of 467,000 acres.

Figure B.6. LORS08 and CEPP TSP modified Multi-Seasonal Outlook Classifications.

Appendix C – Structure Operations in South Miami-Dade County for CEPP TSP Scenarios

In **Table C.1**, the list of structures is color-coded in three groupings:

green	Structures on the L-67, L-28, and L-29 canals. Structures included are S-345, S-349, S-344, S-343A-B, S-12A-D, S-333, S-334, S-355, and S-356
blue	Structures on the L-30 and part of the L-31 canals Structures included are S-337, S-151, S-335, S-338, G-211, S-173 & S-331P (COMBQ), S-176 and S-174
yellow	Structures on part of the L-31 canal and L-31W and C-111 canals Structures included are S-332A-D, S-357, S-332, S-175, S-200, S-199, S-177, S-18C, S-197 and S-332E

Table C.1 includes alternatives ALT4R and ALT4R2.

Table C.1. Alternatives (ALT4R, ALT4R2)

Canal	Structure	**ALT4R (RSMGL)**	**ALT4R2 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-67	S-345*	S345D, S345F & S345G 3 gated spillway at L-67A Design Q= 500 cfs each flood control only	S345D, S345F & S345G 3 gated spillway at L-67A Design Q= 500 cfs each flood control only
	S-349*	Non-existent	Non-existent
L-28	S-344*	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only	Special code Design Q=250 cfs 1) Closed Nov 1- Jul 15 2)flood control only
	S-343A-B*	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each	Special code 1) Closed Nov 1- Jul15 2) flood control only 3)S343A&B- Design Q= 200 cfs each
L-29	S-12A-D*	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only	per ERTP S12A closed Nov 1 to Jul 31; S12B closed Jan 1 to Jul 31; S12C no closure dates. S12D no closure dates. Special code 1) S12s = 8000 cfs per structure. 2) Each structure modeled individually. 3) Each Structure is a spillway 4) Flood Control only
	S-333*	Special code (S333 has higher priority over S12s) 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=2500 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only	Special code (S333 has higher priority over S12s) 1) L-29 canal max stage of 9.7 Wet/Dry 2) Design Q=2500 cfs 3) G-3273 stage constraint of 9.5 4) Flood Control only
	S-334	Non-existent No IOP wraparound operations. So, no flow through S334	Non-existent No IOP wraparound operations. So, no flow through S334
	S-355*	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5	Special code 1) S355 A and B Modeled Design Q = 1000 cfs each, 2) L-29 Max stage of 9.7 3) Flood control only 4)G-3273 stage constraint of 9.5
	S-356*	**6.0/5.5** open/closed wet season **6.0/5.8** open/closed dry season 1) Design Q = 1000 cfs 2) Flood control only	**6.0/5.5** open/closed wet season **6.0/5.8** open/closed dry season 1) Design Q = 1000 cfs 2) Flood control only

Canal	Structure	**ALT4R (RSMGL)**	**ALT4R2 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-30	S337	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)	1) Water Supply / Flood Control 2) Design Q=1100 cfs (discharge coef = 1053 cfs in msestruc*.xml)
		mse_unit inlet L30; L30 maintLevel from rc id=993110 maintLevel(01 Nov-31 May=6.45. 01 Jun-31 Oct =5.4) L30 resLevel from rc id = 993111 resLevel(01 Nov-31 May=6.25. 01 Jun-31 Oct=5.2) mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ALT4R.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml	mse_unit inlet L30; L30 maintLevel from rc id=993110 maintLevel(01 Nov-31 May=6.45. 01 Jun-31 Oct =5.4) L30 resLevel from rc id = 993111 resLevel(01 Nov-31 May=6.25. 01 Jun-31 Oct=5.2) mse_unit outlet C-304; C304 localLevel=99.0 S337_HWi & S337TWi (input variable for WCA3A_WCA3B_regulatory in Special_Assessors_ALT4R.so) S337_FracGO & S337_FracGo_high & S337_FracGo_low variable output maxfracS12s xml
	S-151*	Flow target based on WCA-3A regulation schedule	Flow target based on WCA-3A regulation schedule
	S-335	**7.6/ 7.4** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 maintLevel from rc ID 993110 maintLevel(01 Nov-31 May=6.45. 01 Jun-31 Oct=5.4) L30 resLevel from rc ID=993111 resLevel(01 Nov-31 May=6.25. 01 Jun-31 Oct=5.2) mse_unit inlet for L31NC; localLevel=99.0	**7.6/ 7.4** open/closed wet &dry season 1) Water Supply / Flood Control 2) Design Q=1170 (discharge coef. = 1468 cfs in msestruc*.xml) 3) twHeadLimit name "S335 twHeadLimit" = 6.0 mse_unit outlet for L30; L30 maintLevel from rc ID 993110 maintLevel(01 Nov-31 May=6.45. 01 Jun-31 Oct=5.4) L30 resLevel from rc ID=993111 resLevel(01 Nov-31 May=6.25. 01 Jun-31 Oct=5.2) mse_unit inlet for L31NC; localLevel=99.0

Canal	Structure	**ALT4R (RSMGL)**	**ALT4R2 (RSMGL)**
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N	S-338	**5.8 / 5.5** open/closed wet season **5.7 / 5.5** open/closed dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0	**5.8 / 5.5** open/closed wet season **5.7 / 5.5** open/closed dry season 1) Water Supply / Flood Control 2) Design Q=305 (discharge coef. = 393 cfs in msestruc*xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for C1; C1 maintLevel=3.0
	G-211	**6.0 / 5.7** open/closed wet season **5.8 / 5.5** open/closed dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0	**6.0 / 5.7** open/closed wet season **5.8 / 5.5** open/closed dry season twHeadLimit name "G211 twHeadLimit" = 5.3 1) Water Supply / Flood Control 2) Design Q=1100 (discharge coef. = 943 cfs in msestruc*.xml) mse_unit outlet for L31NC; L31NC localLevel=99.0 mse_unit inlet for L31N; L31N localLevel=99.0
	S-173 & S-331P (COMBQ) *	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.	1) Water Supply / Flood Control 2) Design Q=1161 (special code Special_Assessors_ECB_2010-11.so) mse_unit outlet for L31N; localLevel = 99.0 mse_unit inlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit inlet for L31S; "L31S res" resLevel = 3.5 mse_unit outlet for L31N; mse_unit "L31N local" localLevel = 99.0 S331_TW_lim = 6.0 Operations defined in S331_ECB_2010-11.cc: S331_HW_levels = 4.0 4.5 5.0 5.5 (LPG2 stage criteria) S331 OPERATING CRITERIA: "Discharges through S-331 can be made if the S-331 tailwater stage is below 6.0 feet and the S-176 headwater stage is below 5.5 feet. If either of those water levels of S-331 and S-176 were exceeded, discharges at S-331 would be terminated until the S-176 headwater recedes to 5.0 feet." S176_Cond is dependent on S331_TW and S176_HW -> true if either stage prohibits S331 releases.

Canal	Structure	ALT4R (RSMGL)	ALT4R2 (RSMGL)
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations
L-31N (cont)	S-173 & S-331P (COMBQ) * (cont)	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations	S331 High Range: If the water level at LPG2 well is < 5.5 ft, S331 HW will have no limit. S331 Intermediate Range: If the level at LPG2 well is > or = 5.5 and < 6.0 ft, the average daily water level upstream of the S-331 will be maintained between 5.0 ft., and 4.5 ft if permitted by d/s conditions. S331 Low Range: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. S331 Low Range Adjustment: If the level at LPG2 well is > or = 6.0 ft and S-357 constraints are not limiting the ability of maintaining C-357 avg daily WL below 6.2 ft, the average daily water level upstream of S-331 will be maintained between 4.5 ft. and 4.0 ft if permitted by d/s conditions. Use previous day LPG2 stage, S331_TW and S176_HW, C-357 WL for current day operations
	S-176	**5.0 / 4.75** open/closed wet season **5.1 / 4.8** open/closed dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)	**5.0 / 4.75** open/closed wet season **5.1 / 4.8** open/closed dry season 1) Water Supply / Flood Control 2) design Q = 1100 cfs (discharge coef. = 1135 cfs in msestruc*.xml) mse_unit outlet for L31S; "L31S maint" maintLevel = 4.0 mse_unit outlet for L31S; "L31S res" resLevel = 3.5 mse_unit inlet for C111; maintenance level and reserve level determined in high_rf_events assessor S176_HW_levels 5.0 5.5 (input variable for S331 ops in Special_Assessors_ECB_2010-11.so)
	S-174*	S174 not in model; canal is blocked near structure	S174 not in model; canal is blocked near structure

Canal	Structure	ALT4R (RSMGL)		ALT4R2 (RSMGL)	
		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations		Open/Close (ft NGVD) (Optimum stage ft NGVD) Wet Season/Dry Season Normal FC Operations	
L-31N (cont)	S-332A, B,C,D (pumps)	S332A Non-Existent S332B1 4.7/4.5 S332B2 5.0/4.7 S332BN1 4.7/4.5 S332B2 5.0/4.7 S332C1 4.7/4.5 S332C2 5.0/4.7 S332D1 4.65/4.50 S332D2 4.85/4.65	S332A Non-Existent S332B1 4.7/4.5 S332B2 5.0/4.7 S332BN1 4.7/4.5 S332B2 5.0/4.7 S332C1 4.7/4.5 S332C2 5.0/4.7 S332D1 4.65/4.50 S332D2 4.85/4.65	S332A Non-Existent S332B1 4.7/4.5 S332B2 5.0/4.7 S332BN1 4.7/4.5 S332B2 5.0/4.7 S332C1 4.7/4.5 S332C2 5.0/4.7 S332D1 4.65/4.50 S332D2 4.85/4.65	S332A Non-Existent S332B1 4.7/4.5 S332B2 5.0/4.7 S332BN1 4.7/4.5 S332B2 5.0/4.7 S332C1 4.7/4.5 S332C2 5.0/4.7 S332D1 4.65/4.50 S332D2 4.85/4.65
		S332B1=125 cfs S332B2=125 cfs S332BN1 =125cfs S332BN2=125 cfs S332C1 = 250 cfs S332C2=250 cfs S332D1 = 250 cfs S332D2 = 250 cfs Jul15-Nov30, 75cfs Dec 1-Jan31, 0cfs Feb 1-Jul14 All Flood Control		S332B1=125 cfs S332B2=125 cfs S332BN1 =125cfs S332BN2=125 cfs S332C1 = 250 cfs S332C2=250 cfs S332D1 = 250 cfs S332D2 = 250 cfs Jul15-Nov30, 75cfs Dec 1-Jan31, 0cfs Feb 1-Jul14 All Flood Control	
	S-357 (pump)	S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs		S357A (5.7' Nov 1-May31, 5.2' Jun1-Oct31)/(5.4' Nov 1-May31, 4.9' Jun1-Oct31) S357B (6.0' Nov 1-May31, 5.5' Jun1-Oct31)/(5.7' Nov 1-May31, 5.2' Jun1-Oct31) S357A = 250 cfs S357B = 250 cfs	
L-31W	S-332 (pumps)*	Non-existent		Non-existent	
	S-175	Non-existent		Non-existent	
C-111	S-200	S-200A=75cfs; **3.6/3.4** S-200B=75cfs; **3.7/3.4** S-200C=75cfs; **3.8/3.4**		S-200A=75cfs; **3.6/3.4** S-200B=75cfs; **3.7/3.4** S-200C=75cfs; **3.8/3.4**	
	S-199	S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**		S-200A=75cfs; **3.8/3.6** S-200B=75cfs; **3.9/3.6** S-200C=75cfs; **4.0/3.6**	
	S-177	**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.		**4.2/3.6** (*Open/Close determined in high rainfall event Special Code.) 1) Water Supply & Flood Control Spillway w/1 gate Design Q = 2900 cfs.	
	S-18C	**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.		**2.6 / 2.3** open/closed wet & dry season 1) Water Supply & Flood control Spillway w/2 gates Design Q=3200 cfs.	
	S-197*	****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.		****Same as IOP,See Note 1) S197 ops see below **** 2) Flood control only 13 Culverts w/gates Design Q=6000 cfs.	
	S-332E (pump)	Non-existent		Non-existent	

* SFWMM uses special code. Open/Close may or may not be used in operations.

**** S-197 Ops: Open 3 gates if S-177 full open & S-177>4.1 ft or S-18C> 2.8 ft
Open 7 gates if S-177 > 4.2 ft for 24 hrs or S-18C > 3.1 ft
Open 13 gates if S-177 > 4.3 ft or S-18C > 3.3 ft
Close when all the conditions below are met
1) S-176 < 5.2 ft and S-177 < 4.2 ft
2) Storm moved away from basin
3) After 1 and 2 are met, keep the number of S-197 culverts open necessary only to match residual flow through S-176

FOR CONTINUATION OF HOUSE DOCUMENT 114-65

COMPREHENSIVE EVERGLADES RESTORATION PLAN, CENTRAL EVERGLADES PLANNING PROJECT, INTEGRATED PROJECT IMPLEMENTATION REPORT AND ENVIRONMENTAL IMPACT STATEMENT: FINAL JULY 2014, REVISED DECEMBER 2014

SEE PART 2