ANNEX C
ANALYSES REQUIRED BY WRDA 2000 AND STATE LAW

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C.0 ANALYSES REQUIRED BY THE WATER RESOURCES DEVELOPMENT ACT OF 2000

This document explains the legal basis and requirements of WRDA 2000 savings clause and project-specific assurances (Section C.1), methods used to analyze WRDA 2000 requirements for the C-111 SC Western project (Section C.2), and results of the analyses (Section C.3).

C.1 LEGAL BASIS - BACKGROUND

Federal law and regulation implementing the Comprehensive Everglades Restoration Plan (CERP) require Project Implementation Reports (PIRs) to address certain assurances as part of the project recommendation for approval and implementation. This section addresses provisions of Section 601(h) of the Water Resources Development Act of 2000 (WRDA 2000) and the Programmatic Regulations for the CERP (33 CFR Part 385) for Savings Clause requirements and Project-Specific Assurances.

The following sections describe the specific requirements from WRDA 2000 and the CERP Programmatic Regulations and present the methods and results of the analyses necessary to meet those requirements.

C.1.1 WATER RESOURCES DEVELOPMENT ACT (WRDA 2000)

Congress enacted the Water Resources Development Act of 2000, Title VI, Section 601, Comprehensive Everglades Restoration Plan (WRDA 2000) which approved the 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." Section 601(h) of WRDA 2000, entitled “Assurance of Project Benefits” establishes project-specific assurances to be addressed as part of CERP implementation.

Section 601 (h) (1) of WRDA 2000 provides:

> *IN GENERAL - The 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. The Plan shall be implemented to ensure the protection of water quality in, the reduction of the loss of fresh water from, the improvement of the environment of the South Florida Ecosystem and to achieve and maintain the benefits to the natural system and human environment described in the Plan, and required pursuant to this section, for as long as the project is authorized.*

In this document, sections C.1.1.1 and C.1.1.2 discuss the savings clause and project assurances required by WRDA 2000 to be addressed in each PIR. ***Section C.1.2*** lists the savings clause and project assurances provisions of the CERP programmatic regulations, which provide supplemental information for implementing the WRDA 2000. ***Section C.1.3*** discusses the role of the Draft Guidance Memoranda in the analyses.

C.1.1.1 Savings Clause Analyses

The Savings Clause analysis was required by the WRDA 2000 as a means to protect users of legal sources of water supply and flood protection that were in place at the time of enactment. Briefly, Section 601(h)(5) of WRDA 2000, entitled "Savings Clause", requires an analysis of each project's effects on legal sources of water supply that were in existence on the date of enactment of WRDA 2000 (*i.e.*, December 2000), and effects on levels of service for flood protection in existence on the date of enactment of WRDA 2000. Section 601(h) (5) of WRDA 2000 states:

> *(A) NO ELIMINATION OR TRANSFER. – Until a new source of water supply of comparable quantity and quality as that available on the date of enactment of this Act is available to replace the water to be lost as a result of implementation of the Plan, the Secretary and the non-Federal sponsor shall not eliminate or transfer existing legal sources of water, including those for –*
>
> > *(i) an agricultural or urban water supply;*
> > *(ii) allocation or entitlement to the Seminole Indian Tribe of Florida under section 7 of the Seminole Indian Land Claims Settlement Act of 1987 (25 U.S.C. 1772e);*
> > *(iii) the Miccosukee Tribe of Indians of Florida;*
> > *(iv) water supply for Everglades National Park; or*
> > *(v) water supply for fish and wildlife.*
>
> *(B) MAINTENANCE OF FLOOD PROTECTION. – Implementation of the Plan shall not reduce levels of service for flood protection that are –*
>
> > *(i) in existence on the date of enactment of this Act; and*
> > *(ii) in accordance with applicable law.*
>
> *(C) NO EFFECT ON TRIBAL COMPACT. – Nothing in this section amends, alters, prevents, or otherwise abrogates rights of the Seminole Indian Tribe of Florida under the compact among the Seminole Tribe of Florida, the State, and the South Florida Water Management District, defining the scope and use of water rights of the Seminole Tribe of Florida, as codified in section 7 of the Seminole Indian Land Claims Act of 1987 (25 U.S.C. 1772e).*

C.1.1.2 Project-Specific Assurances

Subsection 601(h)(4) of WRDA 2000, entitled "Project-Specific Assurances", contains the following requirements for project implementation reports:

(A) PROJECT IMPLEMENTATION REPORTS. –

(i) IN GENERAL. – The Secretary (of the Army) and the non-Federal sponsor shall develop project implementation reports in accordance with Section 10.3.1 of the Plan.

(ii) COORDINATION. – In developing a project implementation report, the Secretary and the non-Federal sponsor shall coordinate with appropriate Federal, State, tribal, and local governments.

(iii) REQUIREMENTS. – A project implementation report shall –

(I) be consistent with the Plan and the programmatic regulations promulgated under paragraph (3);

(II) describe how each of the requirements stated in paragraph (3)(B)[sic] is satisfied;

(III) comply with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.);

(IV) identify the appropriate quantity, timing, and distribution of water dedicated and managed for the natural system;

(V) identify the amount of water to be reserved or allocated for the natural system necessary to implement under State law, subclauses (IV) and (VI);

(VI) comply with applicable water quality standards and applicable water quality permitting requirements under subsection (b)(2)(A)(ii);

(VII) be based on the best available science; and

(VIII) include an analysis concerning the cost-effectiveness and engineering feasibility of the project.

C.1.2 Programmatic Regulations (33 CFR PART 385)

The following summary of requirements of the Programmatic Regulations provides supplemental information for implementing the Savings Clause and Project Specific Assurances of WRDA 2000.

C.1.2.1 Pre-CERP Baseline

Section 385.35(a) of the Programmatic Regulations requires the development of a pre-CERP baseline to aid the U.S. Army Corps of Engineers and the South Florida Water Management District (SFWMD) when implementing the Savings Clause to determine if existing legal sources of water will be eliminated or transferred and to demonstrate that the levels of service of flood protection in existence on the date of enactment of WRDA 2000 and in accordance with applicable law will not be reduced by implementation of a project.

The final draft Pre-CERP Baseline document was issued by the U.S. Army Corps of Engineers and the SFWMD in April 2005. In accordance with the programmatic regulations, the final draft Pre-CERP Baseline document will be submitted to the Secretary of the Army for approval and concurrence by the Secretary of the Interior and the Governor.

C.1.2.2 Savings Clause - Flood Protection

Section 385.37 of the Programmatic Regulations requires that PIRs include an analysis of the project's impacts on levels of service for flood protection that existed on the date of enactment of WRDA 2000, December 2000, and in accordance with applicable law. These conditions will be included in the Pre-CERP Baseline (see section C.1.2.1).

C.1.2.3 Savings Clause -Elimination or Transfer of Existing Legal Sources of Water

Section 385.36 of the Programmatic Regulations requires that project implementation reports determine if existing legal sources of water are to 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.

C.1.2.4 Project Assurances - Identification of Water for the Natural System

Section 385.35(b) of the Programmatic Regulations requires that each project implementation report identify the quantity, timing, and distribution of water to be dedicated and managed for the natural system necessary to meet the restoration goals of CERP. This evaluation considers the availability of the Pre-CERP Baseline water and previously reserved water, and whether improvements in water quality are necessary. The existing conditions for this project do not include any previously reserved water within the project area.

C.1.2.5 Project Assurances - Identification of Water for Other Water-Related Needs

Section 385.35(b) of the Programmatic Regulations also requires that procedures be developed for identifying water generated by CERP for use in the human environment and that the quantity, timing, and distribution of water for other water-related needs be identified in project implementation reports.

C.1.3 Guidance Memoranda

The Programmatic Regulations require the development of six guidance memoranda jointly by the USACE and SFWMD. Draft Guidance Memoranda

dated July 2007 (http://www.evergladesplan.org/pm/program_docs/cerp-guidance-memo.aspx) provided additional information necessary to complete the analyses initially described in WRDA 2000. Because the guidance memoranda are still in draft form, the Programmatic Regulations allow for PIRs completed prior to their approval to use any method that is deemed appropriate and consistent with applicable law, policy and regulations.

Section C.2.2 of this report contains a description of the assumptions, concepts and methodologies based on the procedures and guidance described in draft Programmatic Regulations Guidance Memorandum 3 (GM 3), "Savings Clause Requirements", at the time this PIR was being developed for identifying project effects on:

1. Existing legal sources of water as of the date of enactment of WRDA 2000 on the user categories listed in Section 601(h)(5)(A) of WRDA 2000.
2. Levels of service for flood protection as required by WRDA 2000.

Section C.2.3 of this report contains a description of the assumptions, concepts and methodologies for identifying water made available by the project for the natural system and for other water related needs of the region. The methodologies are based on the procedures and guidance described in draft Programmatic Regulations Guidance Memorandum 4 (GM 4), "Identifying Water Made Available for the Natural System and for Other Water Related Needs", available at the time this PIR was being developed.

Section C.3 of this report summarizes the results of these analyses, including identifying the amount of water made available by the project for the natural system to be reserved or allocated by the State of Florida and the amount of water made available for other water-related needs.

C.2 METHODS

The primary goal of the C-111 SC Western project is to improve of water flows to Florida Bay via Taylor Slough, as well as restore the Southern Glades and Model Land. The C-111 SC Western project objectives are as follows:

- Restore the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough to levels nearest as possible to the pre-drainage model runs;
- Improve hydroperiods and hydropatterns in the Southern Glades and Model Lands. The hydroperiods will be improved to optimal levels to support historical vegetation patterns nearest as possible to the pre-drainage model runs; Hydropatterns will be restored to historical sloughs and associated tributaries.

- Return coastal zone salinities in western Florida Bay to levels as close as possible to pre-drainage scenario model runs by restoring upstream water levels in eastern Everglades National Park.

C.2.1 Key project assumptions

The process of identifying water is integral to the specific assurances of section 601 of WRDA 2000, and ultimately to ensuring that the overarching objectives of the Comprehensive Everglades Restoration Plan, namely restoration, preservation, and protection of the south Florida ecosystem while providing for other water-related needs of the region, including flood protection and water supply. It is assumed that both the project objectives and WRDA 2000 requirements are compatible, and that the final design of the project will achieve its objectives.

Project Extent and Assumptions. These analyses and results apply only to the Recommended Plan for the recommended project, including the features associated with Alternative 2D Short and its effects described in ***Section 5***, which includes benefits to the natural system. The recommended plan intends to primarily improve the quantity, timing, and distribution of water delivered to Florida Bay via Taylor Slough. It is anticipated that these improvements can be realized through the establishment of a hydraulic ridge between Taylor Slough and the C-111 Canal, to reduce seepage losses from Taylor Slough and its headwaters. The hydraulic ridge will be established by: (1) combining operational changes within the lower C-111 Canal (south of S-177), and (2) the diversion of water that is currently being discharged through S-177, S-18C and S-197 to the existing Aerojet Canal and an above ground detention area to be constructed on Frog Pond lands owned by SFWMD. Marsh stage triggers in Taylor Slough and the adjacent basin will be used to manage pumping rates and to increase the net water distributed west of the existing C-111 Canal system.

The recommended plan also includes the installation of additional intermediate water control structures on the lower C-111 Canal to increase the effective water control elevation of the lower C-111 Canal. These changes will facilitate reducing the seepage losses from Taylor Slough and increase the net water distributed west of the existing C-111 Canal system.

The plan also intends to improve wetland hydroperiods for Southern Glades and Model Land tracts. This will largely be accomplished by proposed modifications to current operations at structure S-20, installation of an earthen plug in the L-31E Canal near S-20A and installation of earthen plugs in the C-110 Canal.

Absence of Regional or System-wide Effects. Because the C-111 SC Western project is located at or near the coastline, does not alter regional operations and only affects water deliveries to the southernmost canals in the Central and

Southern Project or coastal structures, it is assumed to produce no system-wide effects. Therefore, only project-level effects were evaluated for elimination or transfer of existing legal sources, effects on level of service for flood protection, and identification of water made available.

Basins to be Evaluated. Draft Guidance Memorandum 4 (GM #4) requires the identification of the inflow basins that will be affected by a project. Drainage basins located in southern Miami-Dade County that will be affected by the project include ENP and the C-111 Basin including the Model Lands and Southern Glades.

Key Components of water budget. Water flows across key transects, which are located in the Southern Glades and Model Lands, are utilized to quantify water flows to the natural system. This includes surface water or overland flows as well as groundwater flows in the Biscayne aquifer. Although groundwater stages may increase as a result of the project due to the interconnectivity of the surface and groundwater, groundwater flows remain relatively unaffected. Therefore, groundwater will not be quantified for project assurances. However, at times when there is seemingly no water being delivered from S-176, because the structure is closed, there may be some small amount of water that could be pumped by either S-200 or S-199 that is not capture in the S-177 flows. These flows can be quantified at transects located further downstream used to quantify surface water flowing towards Florida Bay.

C.2.1.1 Information used for all analyses: Pre-CERP Baseline, Existing Conditions Baseline and Initial Operating Regime, Next Added Increment, Next Added Increment Baseline

Savings clause and project assurances analyses require consideration of five different sets of assumptions at three different points in time. The three different points in time include 1) the date of enactment of WRDA 2000, 2) the existing conditions at the time of adoption of the C-111 SC Western Project Recommended Plan, and 3) the 2050 future conditions as described below:

- PCB- The Pre-CERP Baseline represents the conditions existing on the date of enactment of WRDA 2000, December 2000;
- ECB- The Existing Conditions Baseline represents conditions in 2007;
- IOR– The Initial Operating Regime represents the same conditions as the ECB plus the recommended project and consumptive uses for each year simulated. The model runs are labeled IOR_2DS;
- NAI Baseline - This condition represents the 2050 conditions with no CERP projects included;
- NAI – This condition represents the 2050 conditions with the recommended project in place.

Draft Guidance Memoranda Nos. 3 and 4 indicate that analyses of the above conditions should be based on hydrological simulations using something like the South Florida Water Management Model (SFWMM). In this case the Regional Simulation Model (RSM) is the preferred regional hydrologic model, which was developed by the SFWMD principally for application in south Florida. The RSM is developed on a sound conceptual and mathematical framework that allows it to be applied generically to a wide range of hydrologic situations. The RSM simulates the coupled movement and distribution of groundwater and surface water throughout the model domain using a Hydrologic Simulation Engine to simulate the natural hydrology and a Management Simulation Engine to provide a wide range of operational capability. Since the RSM model simulates the whole south Florida area, it is not detailed enough to be utilized to analyze the specific condition of the FPDA, however, RSM results were used to calibrate hydrologic/hydraulic model inputs when applicable.

The PDT had initial sought to use the WASH-123D model and conduct multi-year simulations. Instead MODBRANCH was selected to conduct single-year simulations (i.e, three individual single-year simulations representative of "wet," "average," and "dry" conditions) of water management infrastructure in the study area. Because of differences in the simulation periods of record, model simulation capabilities, and model configurations, the PDT adapted its suite of performance measures to fit the framework of the newly-selected model. This included adapting the application of the Draft Guidance Memoranda as well.

MODBRANCH is a hybrid code that couples MODFLOW, a three-dimensional groundwater flow model with Branch, a one-dimensional canal routing model. The model code was originally developed by the United States Geological Survey (USGS). E. D. Swain and E. J. Wexler of the USGS coupled the models. More information on the creation of MODBRANCH may be found in “A Coupled Surface-Water and Ground-Water Flow Model for Simulation of Stream-Aquifer Interaction,” (Swain and Wexler, USGS Open File Report 92-138). The U.S. Army Corps of Engineers further modified the model to more accurately represent the characteristics of the South Florida area.

The CERP Programmatic Regulations require evaluation of the Recommended Plan as the next added increment (NAI). The NAI is defined in the CERP Programmatic Regulations as “the next project to be added to a system of projects that includes only those projects that have been approved according to general provision of law or specific authorization of Congress and likely to be implemented by the time the project being evaluated is completed.” The NAI analysis evaluates the effects, or outputs, of the Recommended Plan as the next project to be added to the group of already approved CERP projects. Analysis of the NAI illustrates the amount of benefits the selected alternative plan

contributes without regard to future CERP projects. It also helps to ascertain whether sufficient benefits would accrue to the selected alternative plan to justify the cost if no additional CERP projects (other than those already existing or authorized) were implemented.

In the case of this analysis, no other CERP projects affecting the C-111 SC Western project area were assumed to exist for the purposes of the NAI analysis. In comparing SFWMM model flows at S-177 (critical structure used to determine flows to the spreader canal) for the future without CERP to the Future with all of CERP constructed, the flows are similar. This means that whether or not CERP boundary conditions (system evaluation) or future without CERP boundary conditions are used, similar results should be obtained in the overall evaluation and comparison of alternatives. Thus all plan comparison and evaluation were completed in a NAI method. Therefore there are no NAI specific analysis. Consistent with the plan formulation approach, this project assurances analysis relies upon Future without CERP scenarios to analyze the water made available with and without the C-111 SC Western project in place. The model simulations are called:

- Future without CERP - This condition represents the 2050 conditions with no CERP projects included;
- Future without CERP plus the Project – This condition represents the 2050 conditions with only the Recommended project in place.

C.2.2 Savings Clause – Flood Protection and Elimination or Transfer of Existing Legal Sources

The purpose of the Savings Clause is to protect existing legal sources of water from elimination or transfer and levels of service for flood protection existing as of December 2000. The expected performance refers to the performance of the system in place when modeled against the period of record. It does not refer to specific design flood targets such as the 10-year flood. The analysis for assessing the impacts to the level of service for flood protection was based on model output from the MODBRANCH model. The PDT determined that modeling the full period of record was impractical and that modeling a subset of the full period of record was an adequate substitute. For the C-111 Spreader Canal project a dry year, an average year, and a wet year were simulated with the MODBRANCH model. The dry year simulated was 1989, the average year simulated was 1978, and the wet year simulated was 1995.

C.2.2.1 Analysis for Flood Protection

The takings analysis in Appendix D compared modeling data from the conditions in existence in December 2000 (Pre-CERP Baseline) to Alternative 2DS. This is consistent with the Savings Clause methods described in Guidance

Memorandum #3. The comparison accounted for both groundwater and surface water impacts to different land classes due to C-111 SC Western project implementation. The takings analysis determined the lands impacted based on the following criteria:

Criteria 1: Non-Agricultural Lands (40days + 30 percent).

> Alternative Annual Hydroperiod (at surface) is greater than 40 days longer than the Base run and this value is greater than 30 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

Criteria 2: Agricultural Lands for Dry Season (Any increase of Hydroperiod at -0.5 ft).

> Alternative Dry Season Hydroperiod (at -0.5 ft) is greater than 5 days longer than the Base Dry Season Hydroperiod (at -0.5ft) for any of the three years (Average year, Dry year, Wet year).

Criteria 3: Agricultural Lands for Wet Season (30 days + 20 percent).

> Alternative Wet Season Hydroperiod (at -0.5 ft) is greater than 30 days longer than the Base wet season Hydroperiod (at -0.5 ft) AND this value is greater than 20 percent longer than the Base for any of the three years (Average year, Dry year, Wet year).

GIS data provided showed the percentage of each individual parcel impacted and a separate data sheet for the agricultural lands, which showed the hydroperiod differences in the dry season and wet season between alternative 2DS and the Pre-CERP Baseline for each of the years analyzed. The takings analysis was conducted for the agricultural lands to determine what were significant and adverse conditions warranting acquisition of a real estate interest. Any increase in any dry season (November through April) of over 5 days was considered as requiring acquisition of a real estate interest (Criteria 2 above). For the wet seasons, the increase had to meet not only Criteria 3 above, but it had to increase the entire hydroperiod to greater than 80 days. Once all this data was analyzed each parcel or percentage of the parcel was reviewed to determine if only a portion (and what portion) or all of the parcel would have to be acquired.

C.2.2.2 Analysis of Elimination or Transfer of Existing Legal Sources Analysis

Existing legal sources in the project area include water for three public utility wellfields, private wells, industrial facilities and agricultural irrigation wells within the drainage basins. The three public water suppliers include Florida Keys Aqueduct Authority, City of Homestead and Florida City (See ***Figure C-1***). Industrial uses include two quarries and the City of Homestead's power plant.

Agricultural uses include approximately 20 permittees, including both food production and landscape nurseries.

All project features such as pumps that divert water are located downstream of these sources. Operation of the project features are designed to restore the quantity, timing and distribution of water delivered to Florida Bay via Taylor Slough by increasing existing water levels and overall flows. Project features divert a portion of the water that would normally be discharged to tide through the seawater control structures before reaching Florida Bay. Therefore, no elimination or transfer of water from existing legal sources such as public utility wellfields, private wells industrial facilities or agricultural irrigation wells will occur.

Water that flows into Florida Bay through the canals may also be considered an existing legal source that maintains fish and wildlife. While project features are designed to intercept some of this water, it will be used to restore water flow through Taylor Slough before reaching Florida Bay, but not transfer it for another use. Therefore, no elimination or transfer of water from Florida Bay will occur.

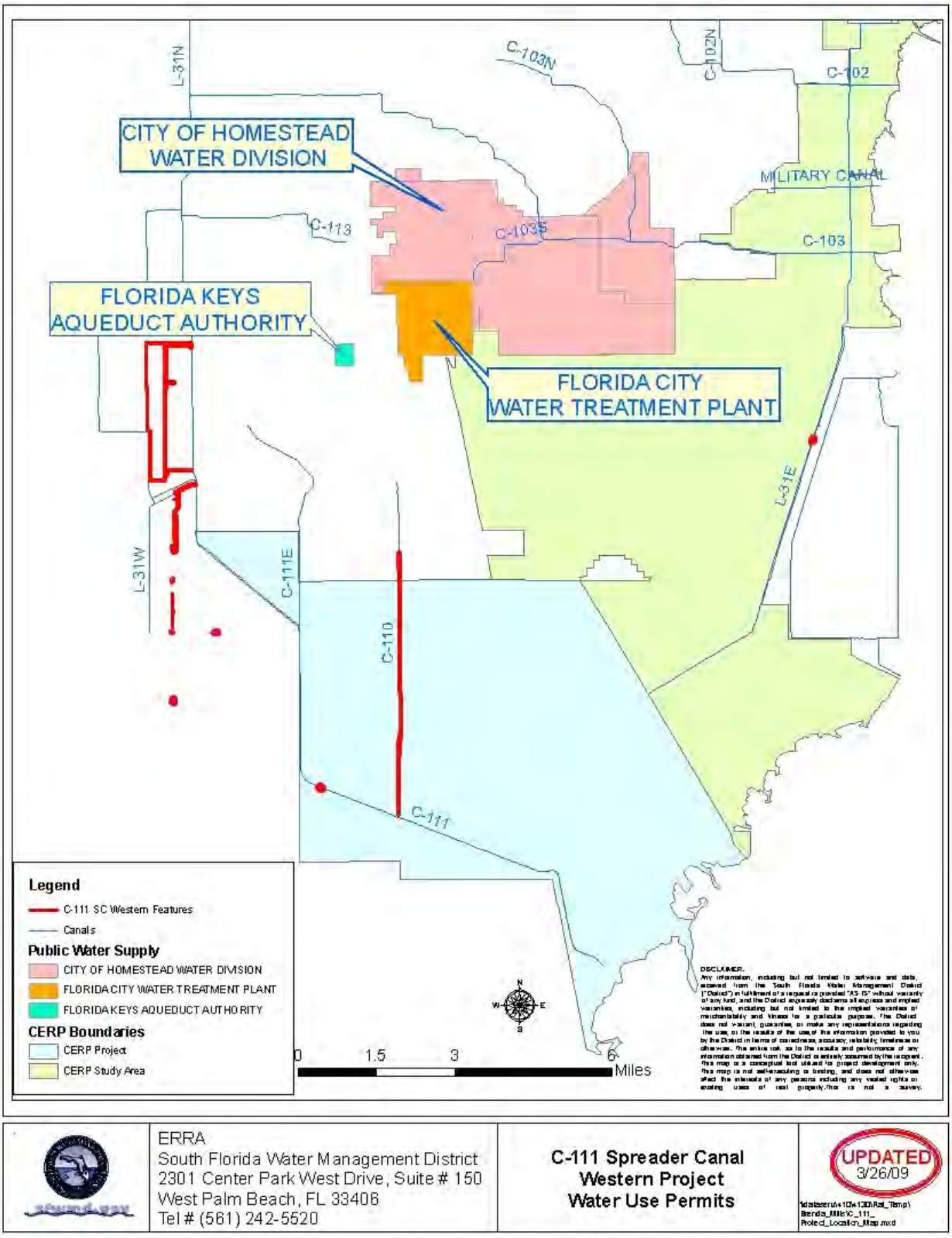

FIGURE C-1: PUBLIC WATER SUPPLIERS INCLUDE FLORIDA KEYS AQUEDUCT AUTHORITY, CITY OF HOMESTEAD AND FLORIDA CITY

C.2.3 Project Assurances - Identifying Water Made Available for the Natural System and for Other Water Related Needs by the Project

Identification of water for the natural system is based on the concept that a quantity of water is needed to achieve the benefits of the project, and the overarching objective of restoration, preservation and protection of the South Florida Ecosystem. The water made available for the natural system is the water used for the protection of fish and wildlife within natural systems, including water that contributes to meeting hydrologic, water quality, and ecologic targets for restoration of natural systems.

The C-111 SC Western project study area is situated at the southern extent of the CERP study area. As such, the potential functions provided by the C-111 SC Western project are largely limited to managing seepage from natural areas to drained areas, and detaining/distributing volumes of water made available by upstream water management infrastructure to features of the Project. The targeted quantity redistributed to Florida Bay via Taylor Slough was estimated based on the volume available to be diverted to Taylor Slough at the S-177 and the overland flows across the Southern Glades and Model Lands.

C.2.3.1 Volume Probability Curves

For purposes of identifying the volume of water made available by the project, volume probability curves were produced depicting the range of daily quantities (mean daily flow) of water delivered to the natural system. As discussed above, three years were simulated by the MODBRANCH model, 1978, 1989, and 1995, which represent the "average", "dry" and "wet" conditions, respectively for South Miami-Dade County. Probability curves indicate the probability (percentage of time equaled or exceeded, on the x-axis) that a certain quantity of water is available as a function of simulated structure flows or calculated at transect in the model domain. Once sorted, the values are ranked from highest to lowest.

C.2.3.2 Analytical Method to Identify Water Made Available for the Natural System

The basic approach used to identify water made available to the natural system was to calculate the quantity of water available to be pumped or diverted into Frog Pond Detention Area or the Aerojet Canal via S-199 and S-200 on a daily basis. Each component of the project relies on pumps to divert water out of the primary drainage system of canals, including the C-111 Canal at S-177 and is intended to allow for improved management of water in the natural areas via reducing the drainage effects of local canals on adjacent wetlands (i.e., Taylor Slough) project features. In addition to the referenced pre-drainage condition, a future without-project condition (set in the year 2050, in the absence of all other CERP features) was used as a baseline against which the ecological performance of each alternative would be compared. Because initial regional hydrologic

simulations indicated that the C-111 SC study area would likely receive similar deliveries of water from the regional system with or without the remaining CERP projects, the project sponsors and the PDT elected to evaluate each alternative with respect to the future without-project condition as referenced above.

Structure flows were quantified at S-177 for the three years simulated and represent the total volume of water available to be redistributed by the project features; specifically S-199 and S-200 pump stations. Since the S-177 is an existing spillway which can pass up to 1400 cfs, its flows in the Existing Condition Baseline (ECB) and Initial Operating Regime (IOR) can be compared to determine how much is being diverted towards Taylor Slough with and without the project in place. This volume of water diverted is also captured in the volume probability curves for S-200, a 225 cfs pump station, which routes water to the Frog Pond Detention Area and S-199, a 225 cfs pump station which discharges to the Aerojet Canal. Only the S-177 flows will be quantified to display the volume of water made available to the natural system from these features.

For each year simulated, a graphic will display two volume probability curves. One curve indicates the total quantity discharged from S-177 in the existing condition (ECB), which represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. In addition, the 10^{th}, 50^{th} and 90^{th} percentile is identified for the ECB, which represents the total water available and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in a table.

Surface water flows across key transects located in the Southern Glades and Model Land were also utilized to quantify the increased flows resulting from the proposed S-198 structure and changed operations at S-20 and S-20A to the natural system, See ***Figure C-2***. Multiple transects were applied to assess the environmental effects using the model simulations, namely TA-1, TA-2, TA-3, TA-4, and TA-5 during plan evaluation, See ***Appendix C***. Although surface water stages and duration (hydroperiods) may be affected by the Pecommended Plan and are described in ***Section 5***, there is not a corresponding change in overland flows significant enough to quantify. This is true for the eastern-most transects TA-3, TA-4, and TA-5, which will not be applied to quantify water. Only a subset of these transects were applied to quantify the volume of water made available. In addition, although groundwater stages may increase as a result of the project, groundwater flows do not change significantly and will not be quantified for project assurances.

Of the remaining key transects, TA-2 was divided into a west and east transect to easily capture the changes to flows towards Florida Bay via Taylor Slough. The new transects, TA-2w(est) and TA-2e(ast) when combined with TA-1 quantify the water made available for the natural system by these features (see ***Figure C-3***). To capture increases in water made available for the natural system, the flows across the transects in the Existing Baseline Condition, ECB, are compared to with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the surface water made available for the natural system by these features. In addition, the 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in a table.

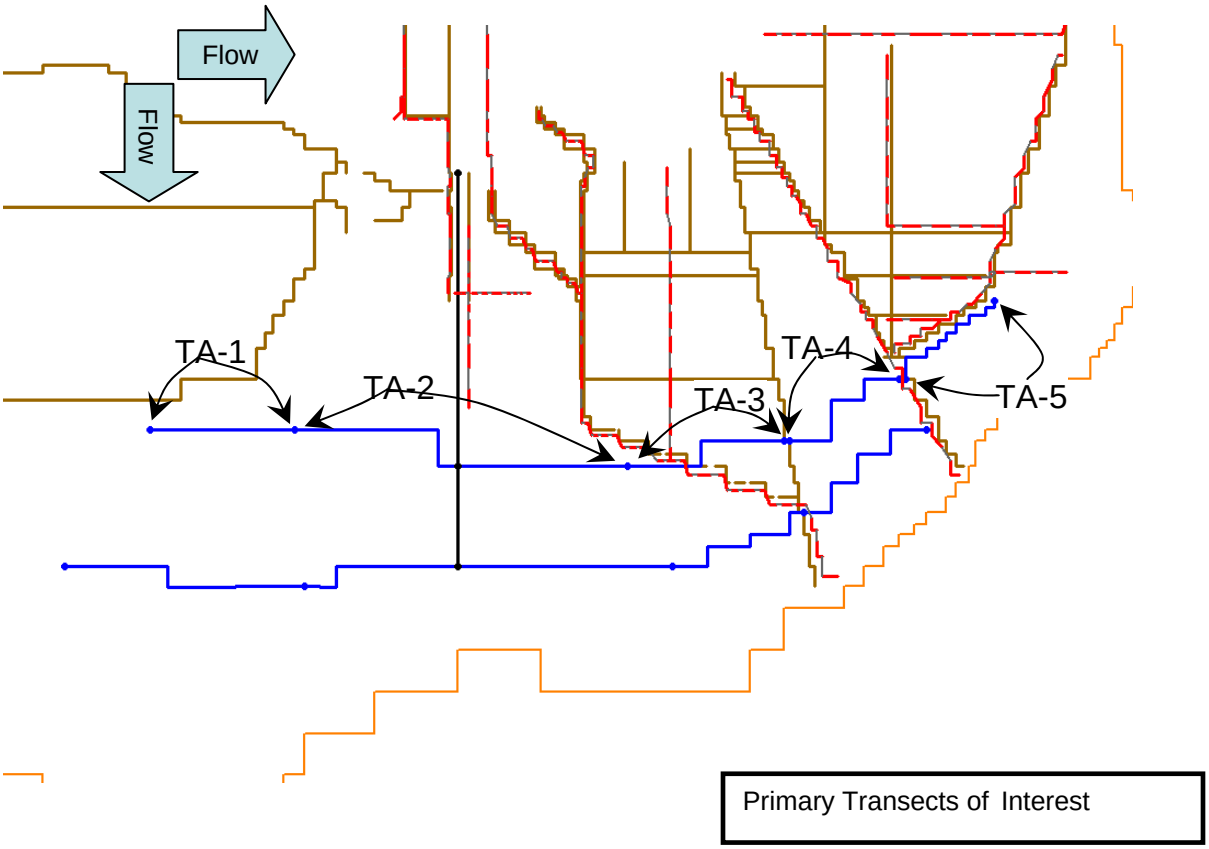

FIGURE C-2: LOCATION OF TRANSECTS TO CALCULATE WATER FLOWS TO THE NATURAL SYSTEM

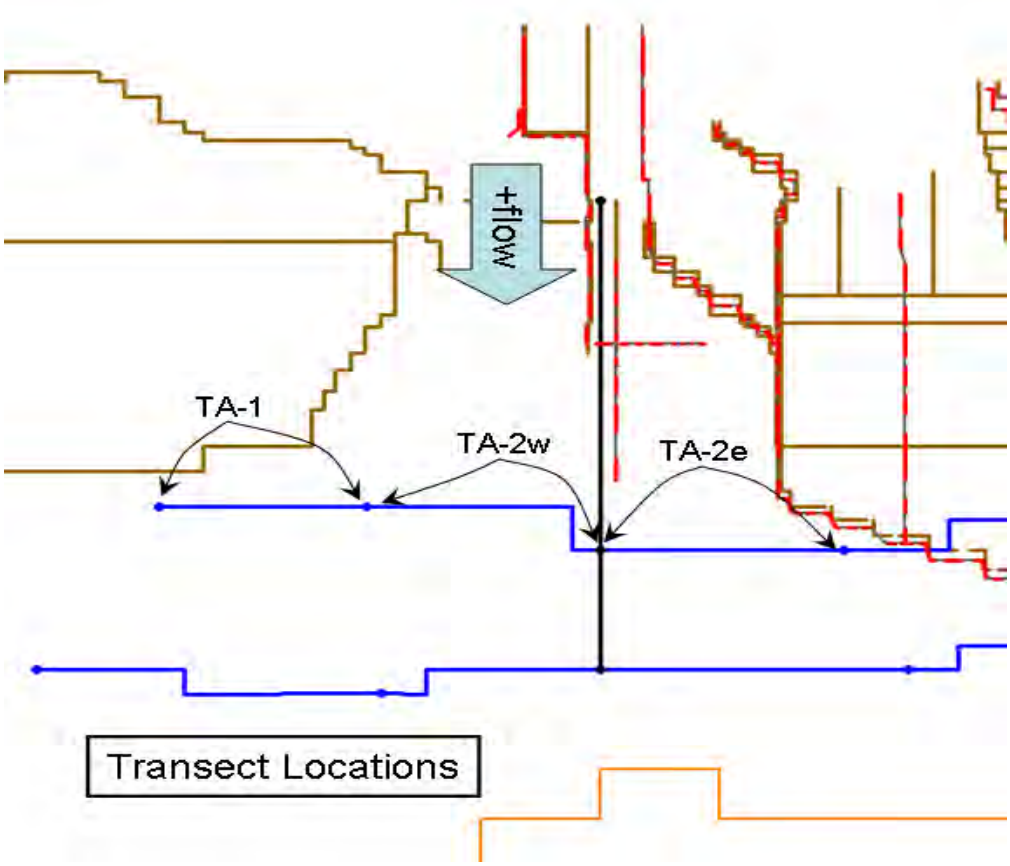

FIGURE C-3: LOCATION OF TRANSECTS APPLIED TO QUANTIFY SURFACE WATER FLOWS FOR THE NATURAL SYSTEM

C.2.3.2.1 Identifying Water Made Available for Other Water Related Needs

No analysis of water made available for other water related needs was calculated since the recommended project does provide water for other water related needs. This is consistent with the project objectives.

C.2.3.3 Quality, Timing, and Distribution of Water and Water Quality

Viewed from a programmatic perspective, identification of water for the natural system associated with the CERP involves an analysis of four different aspects of ecological responses to hydrologic changes: 1) responses to the change in the quantity of water received by the natural system; 2) responses to the timing of those deliveries; 3) responses to the distribution of water delivered to the natural system; and, 4) responses to the quality of the water received by the natural system. n a project specific sense, however, the relative importance of each of these aspects (quantity, timing, distribution, and quality) will vary from project to project depending upon the specific objectives established for the project.

For example, some CERP projects may focus formulation efforts on simply changing the timing (seasonality) or distribution (inflow and outflow points, internal movement) of water delivered to the natural system. Other projects may focus primarily on increasing or decreasing the amount of water delivered to the natural system, while still other projects may focus on improving the quality of the water delivered to the natural system to maintain desirable ecological community structure. All of these aspects (depending upon their applicability to specific projects) are addressed during plan formulation through performance measures and evaluation criteria used to evaluate alternative plans.

To identify the quantity, timing, and distribution of water for the natural system, a probabilistic approach was selected utilizing volume probability curves to depict the distribution of volumes of water that provide natural system benefits as a result of project features through the range of climatic conditions. These volumes of water may include water that is available to meet natural system needs without project features, and the water made available from project features to meet natural system needs.

According to CERP Guidance Memorandum 23.01 "Water Quality Considerations for the Project Implementation Report Phase", water quality is also to be taken into account during plan formulation and evaluation as a project constraint (i.e. projects cannot cause or contribute to violations of water quality standards). Projects such as the C-111 SC Western project should also include features to reduce nutrients and suspended solids through passive means. Accordingly, the project was formulated to improve water quality by diverting canal discharges into wetlands.

When the project is operated, water that normally discharges into the C-111 Canal (via S-177) will be routed into the Frog Pond Detention Area and Aerojet Canal to reduce seepage from ENP. When conditions allow, relatively continuous pumping will be used to maintain the required hydraulic ridge. The potentially continuous pumping is required because when pumping ceases the hydraulic ridge quickly dissipates allowing the diverted water to return to the C-111 Canal.

While a reduction in seepage from ENP would otherwise be expected to have a deleterious effect on water quality within the Lower C-111 Canal, the net effect of the incidental water quality treatment provided within the Frog Pond Detention Area and Aerojet Canal features and by water flowing through ½ mile of limestone aquifer prior to returning to the canal, is anticipated to exceed any reduction in water quality achieved by a reduction in dilution by ENP seepage water. Although it may limit use of the project, adaptive management will be

employed, particularly in the early wet season, if in-situ monitoring indicates otherwise.

C.3 RESULTS

C.3.1 Savings Clause - Flood Protection and Elimination or Transfer of Existing Legal Sources

C.3.1.1 C-111 Basin Flood Protection Analysis

One way to address significant and adverse effects on the level of service of flood protection due to CERP Implementation is to consider acquisition of affected property. The Real Estate Takings Analysis in Appendix D accounted for changes in hydrology that were significant enough to require land acquisition. The Real Estate Takings Analysis identified that total impacted lands were approximately 11,655 acres for Alternative 2D Short, of which approximately 776 acres were in private ownership. SFWMD has agreed to acquire in fee privately owned lands which are determined to be, or to have been, impacted by operation of the project.

The planning level modeling, which was completed for purposes of cost estimating, indicated that approximately 11,565 acres could be impacted by the operation of the project. SFWMD owns fee to approximately 9,688 acres which can be provided in fee. Miami-Dade County owns approximately 131 acres in fee which can be provided by perpetual flowage/conservation easements. The State of Florida owns approximately 15 acres which can be provided by easements for the life of the project in accordance with State statutes and the Florida Administrative Code. Florida Power and Light Company owns approximately 955 acres which can be provided by perpetual flowage/conservation easements. The modeling predicted that an additional 776 acres, which are owned by private parties, could be impacted by the operation of the project. SFWMD has agreed to acquire in fee privately owned lands which are jointly determined to have been impacted by operation of the project. The project and lands that may be impacted are shown on ***Figure D-3*** in ***Appendix D***.

C.3.1.2 Elimination or Transfer of Existing Legal Sources

The project results in no elimination or transfer of water from existing legal sources because canal flows and levels upstream of the project, which are the southernmost canals and control structures in the C&SF Project, will not be affected by project. Therefore, no elimination or transfer of water from existing legal sources such as public utility wellfields, private wells or agricultural irrigation wells will occur.

Water that flows into Florida Bay through the canals may also be considered an existing legal source that maintains fish and wildlife. While project features are designed to intercept some of this water, it will be used to restore water flow through Taylor Slough before reaching Florida Bay, but not transfer it for another use. Therefore, no elimination or transfer of water from Florida Bay will occur.

C.3.2 Project Assurances - Identifying Water Made Available by the Project for the Natural System and Other Water Related Needs

Volume probability curves quantify the water made available by the project for the natural system at two locations. First, the project will divert water to the S-199 and S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. Second, surface water levels in Southern Glades and Model Lands increase by installing and operating a new plug on the C-111 canal and operating the S-20 and S-20A structures differently.

The recommended project does provide water for other water related needs, therefore, there was no quantification.

C.3.2.1 Identifying Water Made Available by the Project for the Natural System

Water is diverted to the Aerojet Canal by the S-199 and Frog Pond Detention Area by S-200 pump stations that currently discharges through S-177 to maintain a hydrologic head between Taylor Slough and the C-111 Canal. The quantity of water diverted to these project features on a daily basis is calculated for the three years simulated. In general, ***Figure C-4***, ***Figure C-5***, and ***Figure C-6*** provide an estimate of the quantity of water the project is expected to be diverted to improve the quantity, timing and distribution of water to Florida Bay via Taylor Slough.

For each year simulated, 1978, 1989, and 1995, two volume probability curves describe flows through S-177. One curve indicates the total quantity discharged from S-177 in the existing condition (ECB), which represents the total water available to the natural system. The second curve, IOR_2DS, quantifies the water that still reaches S-177 after some portion is diverted to the Frog Pond Detention Area or the Aerojet Canal. The same set of graphics is shown for the simulated flows in 2050, the future without CERP (FwoCERP) compared to the future without CERP plus the Recommended Project (FwoCERP_2Ds) see ***Figure C-7, Figure C-8***, and ***Figure C-9***.

In 1978, the average year, almost all of the water available is diverted towards either the Frog Pond Detention Area or the Aerojet Canal. Water is available to be diverted to Taylor Slough 10% of the time. In 1989, the dry year water is

available for diversion at times when there is seemingly no water being delivered from S-176, because the structure is closed. These flows can be quantified in the transects used to quantify surface water further downstream. In 1995, the wet year, water is available for diversion by the project features 30% of the time (ECB) and is actually diverted up 10% of the time (IOR_2DS minus ECB).

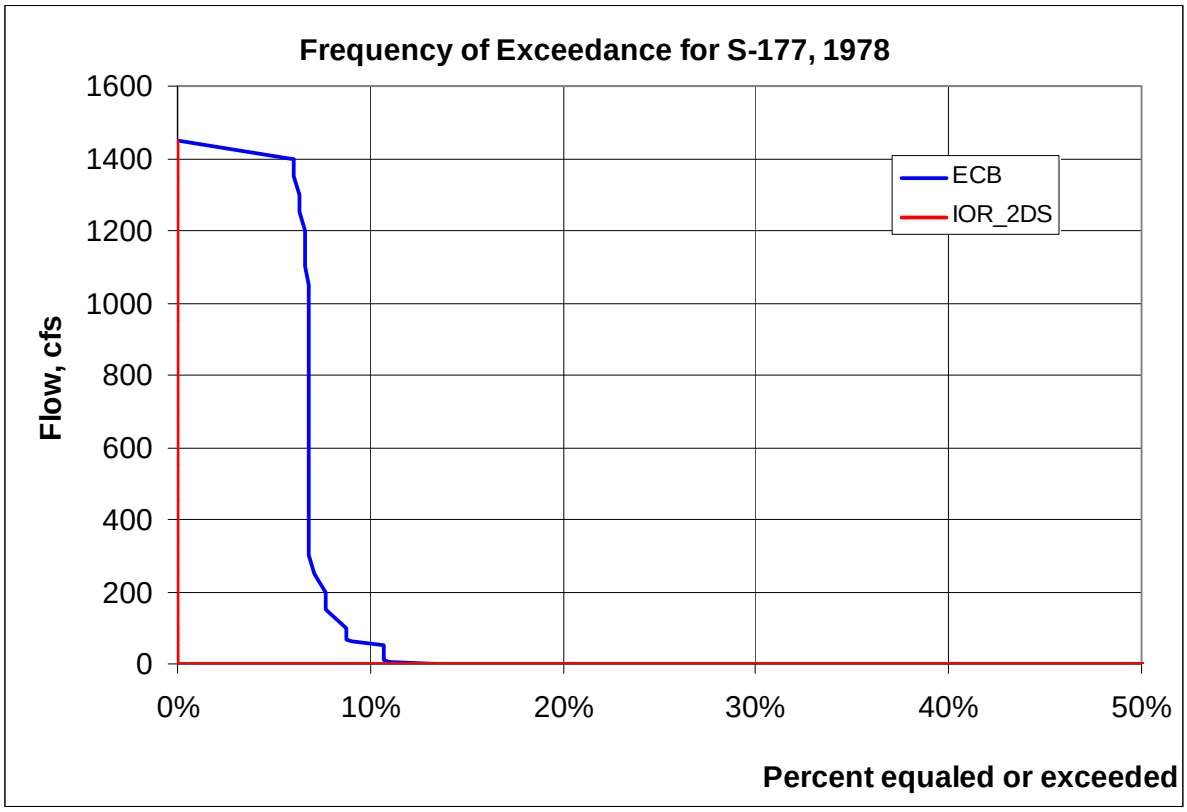

FIGURE C-4: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1978

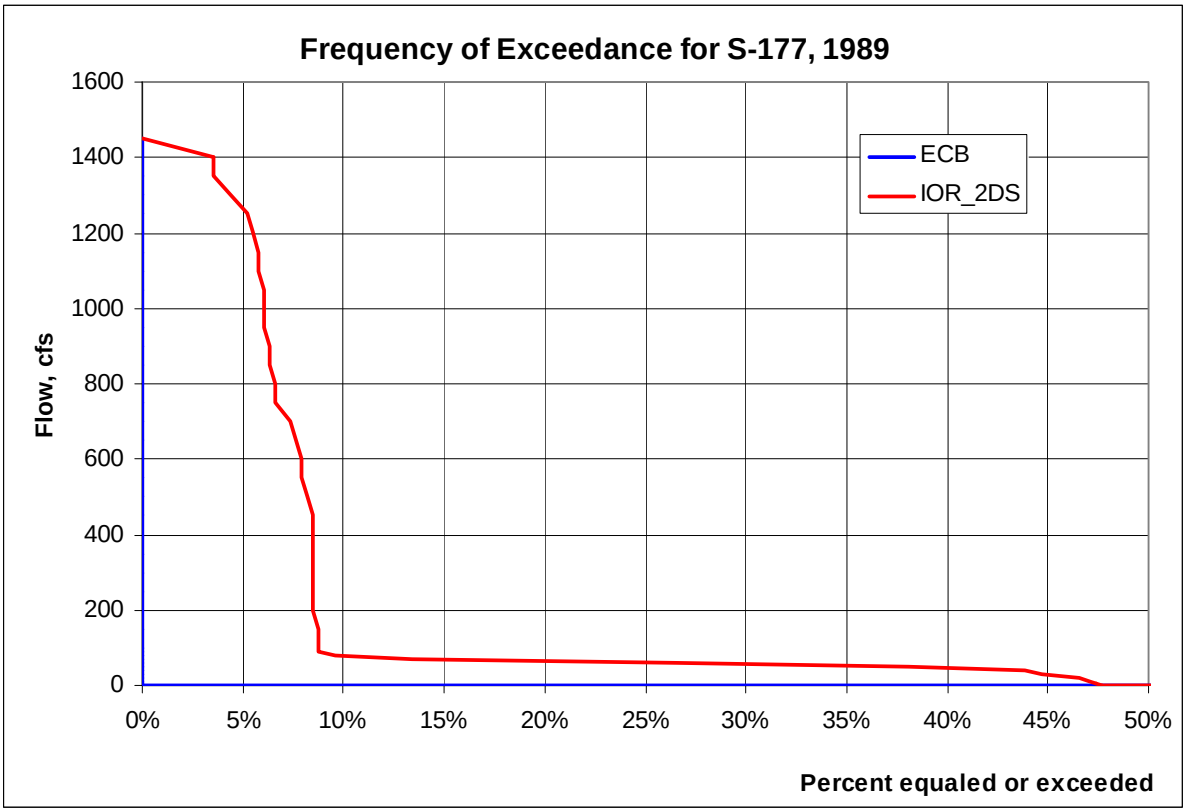

FIGURE C-5: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1989

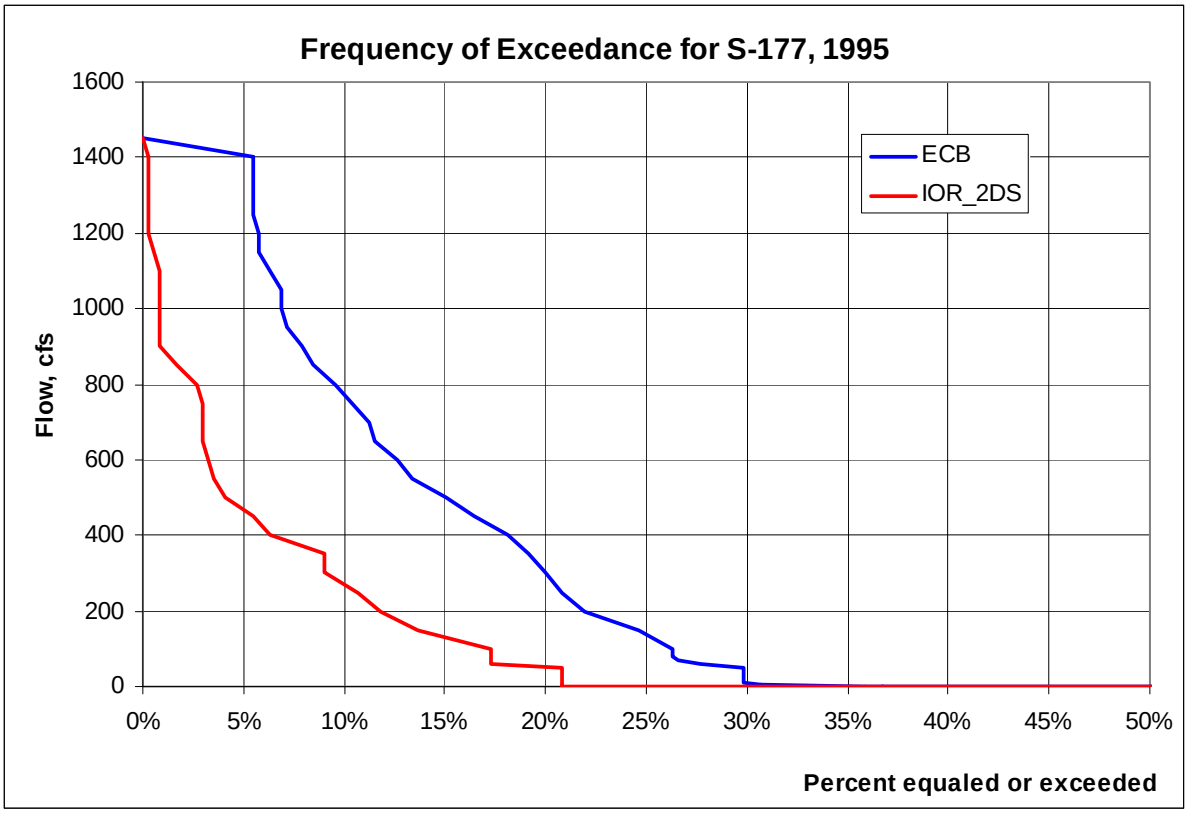

FIGURE C-6: TOTAL FLOW AVAILABLE (ECB) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES THAT STILL FLOW THROUGH S-177 (IOR_2DS) IN 1995

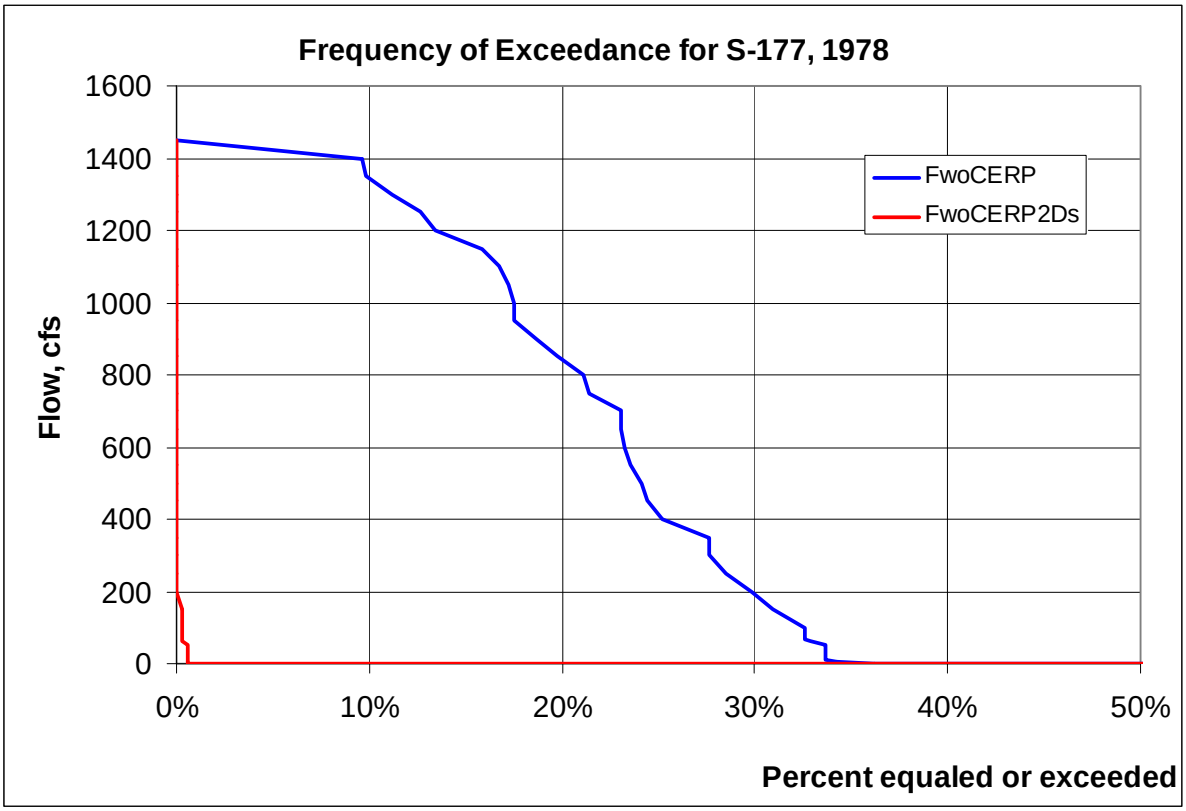

FIGURE C-7: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1978

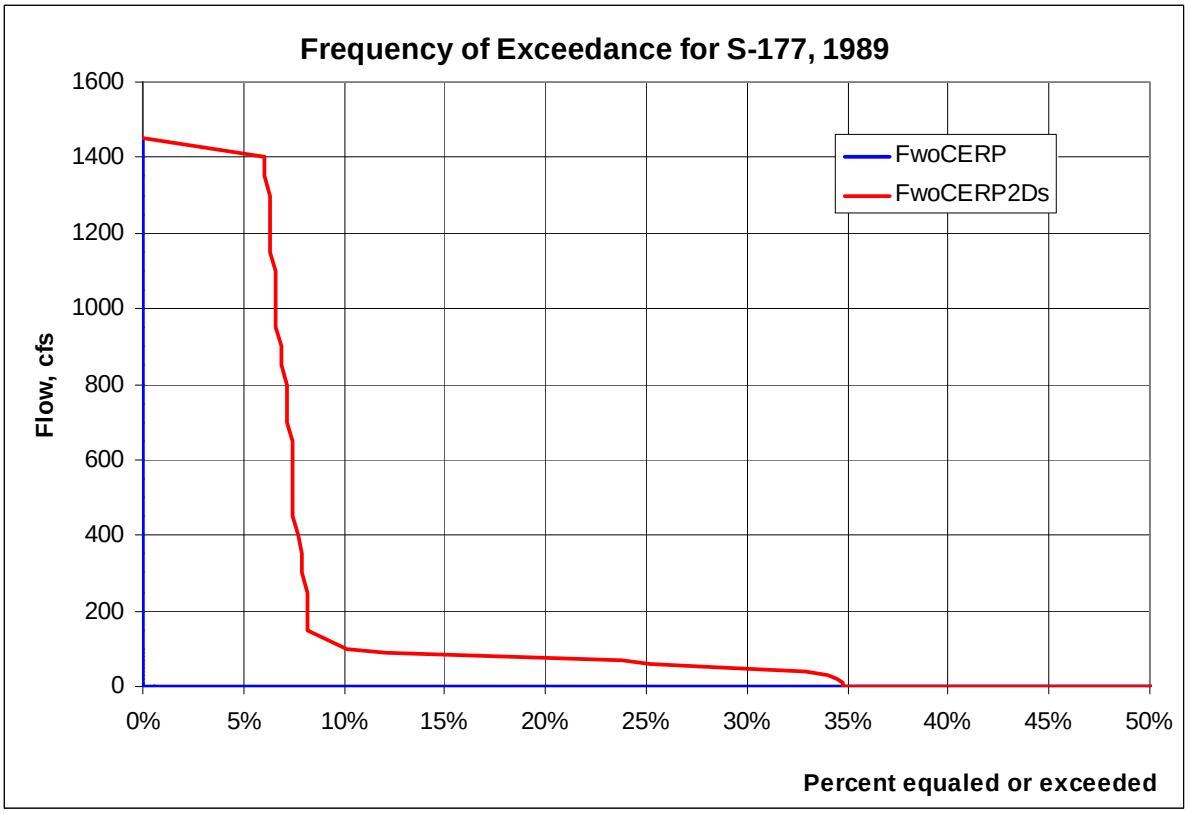

FIGURE C-8: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1989

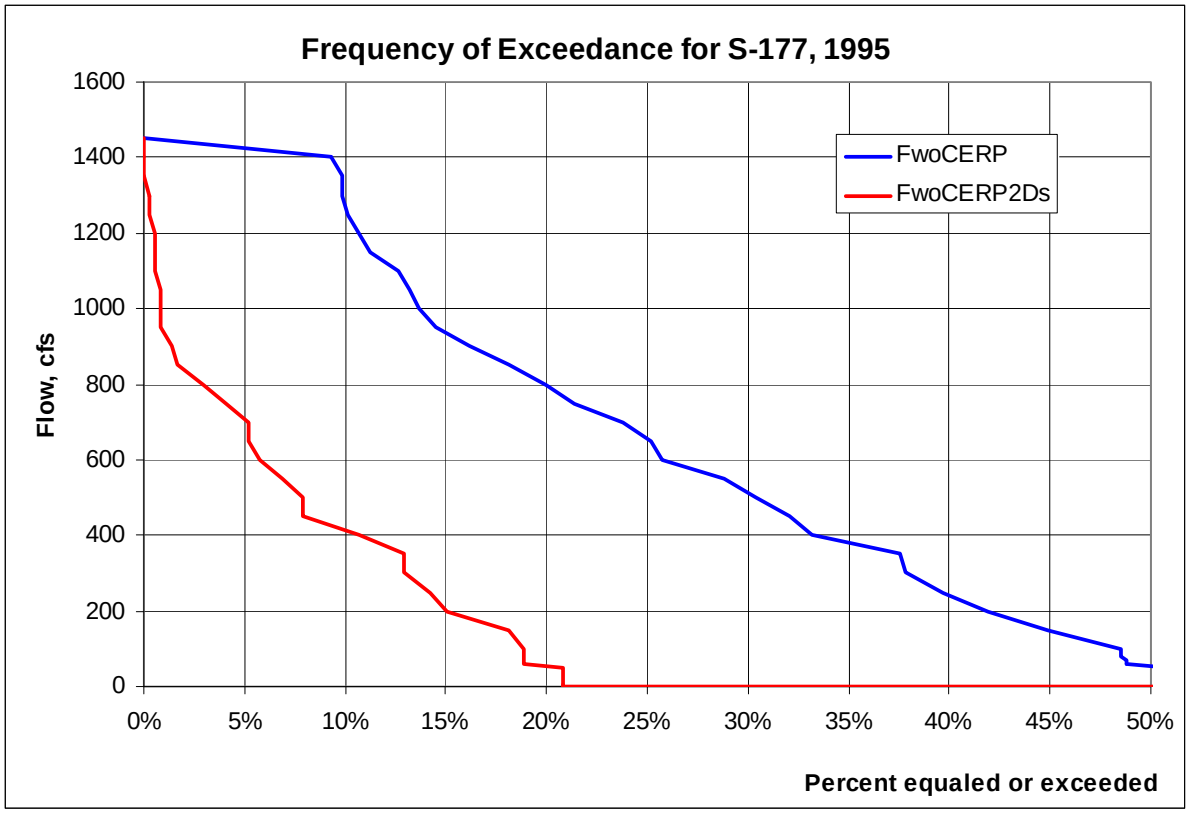

FIGURE C-9: TOTAL FLOW AVAILABLE IN 2050 (FWOCERP) AT S-177 AND PORTION NOT DIVERTED BY S-199 AND S-200, C-111 SC WESTERN PROJECT FEATURES (FWOCERP_2DS) IN 1995

Surface water flows across key transects, which are located in the Southern Glades and Model Lands, are utilized to quantify flows to the natural system. The key transects include TA-1, TA-2 West and TA-2 East as shown in ***Figure C-10*** through ***Figure C-15*** below. Model simulations are available for all three years simulated, 1978, 1989, and 1995; however, not all simulations are shown. In 1989, which is the year selected to represent dry conditions, no water flows overland to be quantified. In addition, although groundwater stages may increase as a result of the project, groundwater flows in the Biscayne aquifer do not change and will not be quantified for project assurances.

To capture increases in water made available for the natural system, the flows across the transects in the Existing Baseline Condition, ECB, are compared to with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the water made available for the natural system by these features. The Natural System Model, NSM, describes the natural system restoration target and typically is used to determine when too much water is reaching the natural system. However, ***Appendix C***; ***Environmental Information*** did not describe

anticipate harm occurring. Therefore, water flowing towards Florida Bay in the IOR_2Ds simulation will be considered necessary for the natural system. In addition, the 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in a table. The same set of graphics is shown for the simulated flows in 2050, the future without CERP (FwoCERP) compared to the future without CERP plus the Recommended Project (FwoCERP_2Ds) in ***Figure C-16*** through ***Figure C-21***. Graphics depicting simulated surface water flows in 1989, the year representing dry conditions, are not included since no surface flows are calculated at the selected transects.

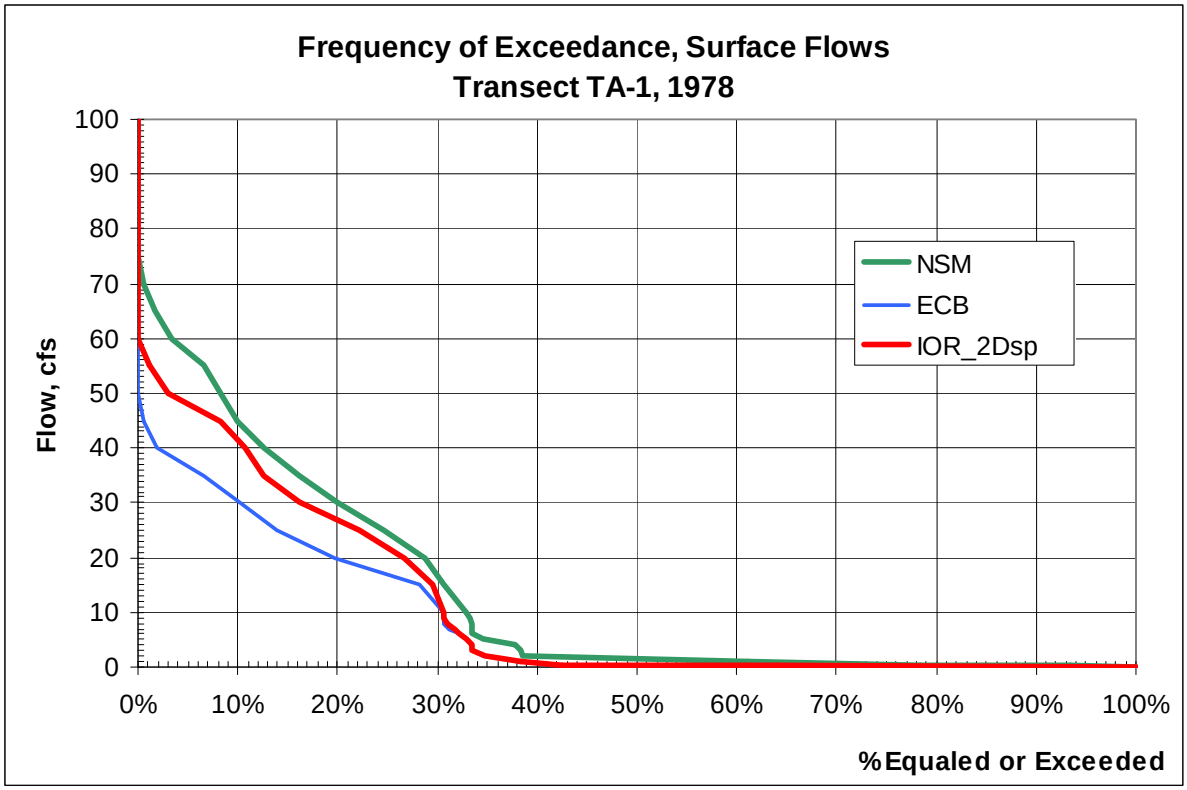

FIGURE C-10: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-1 FOR 1978

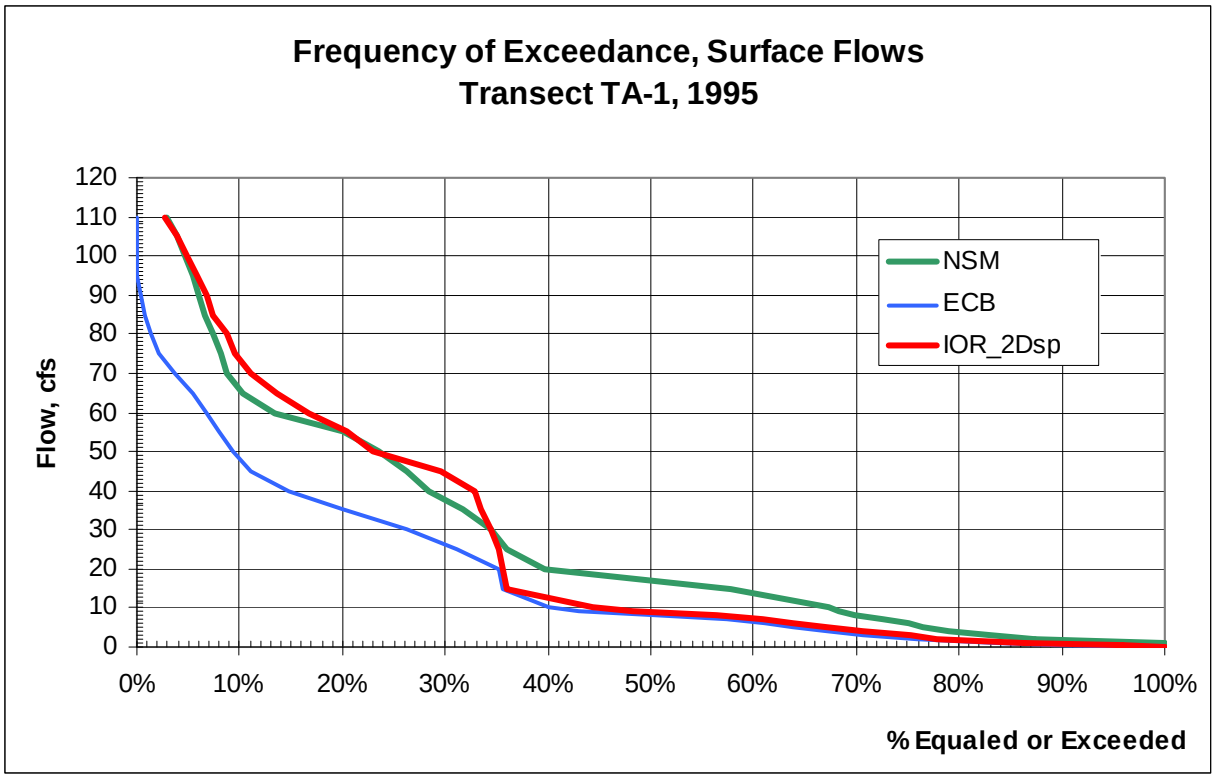

FIGURE C-11: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-1 FOR 1995

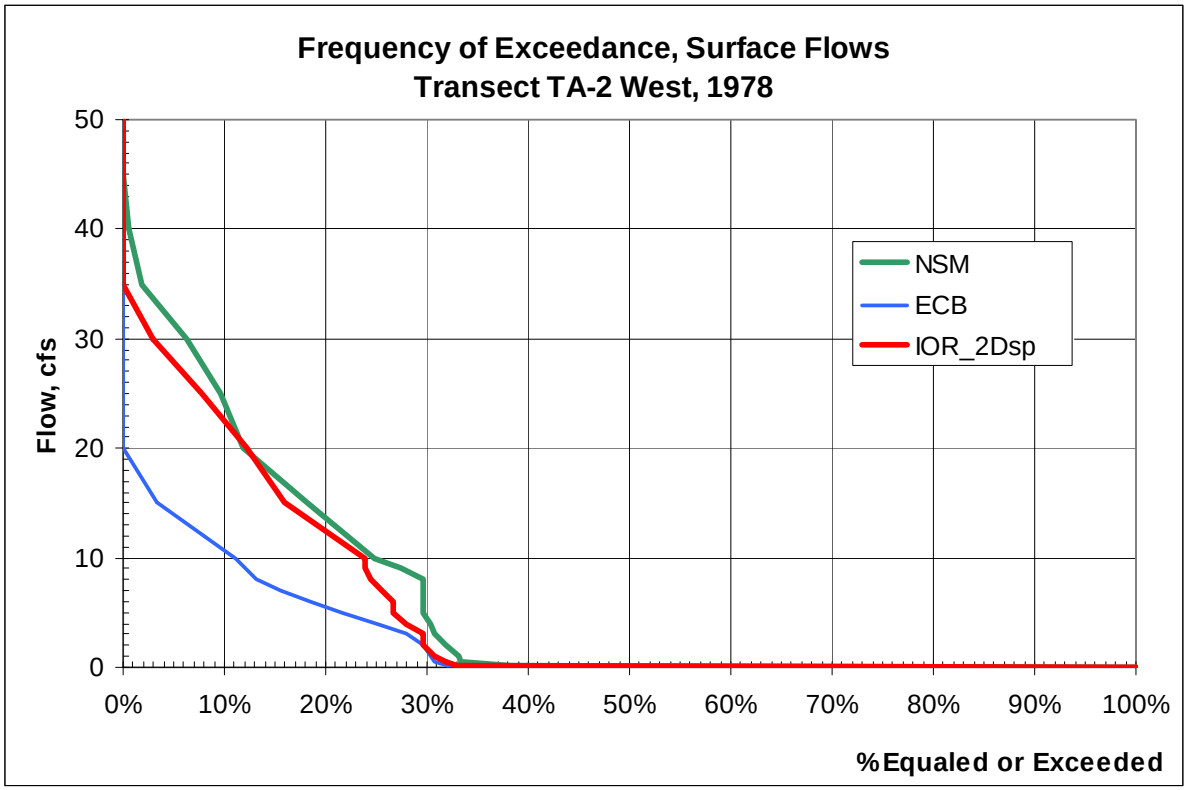

FIGURE C-12: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-2 WEST FOR 1978

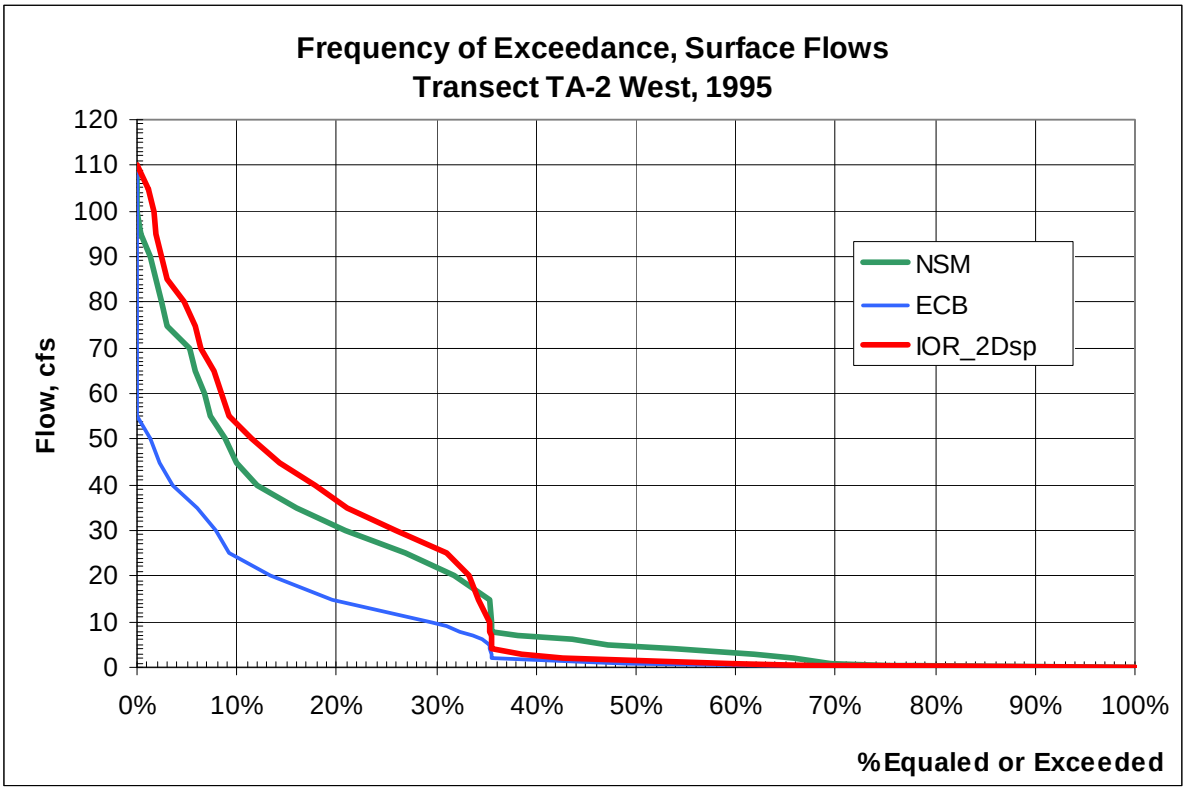

FIGURE C-13: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECT TA-2 WEST FOR 1995

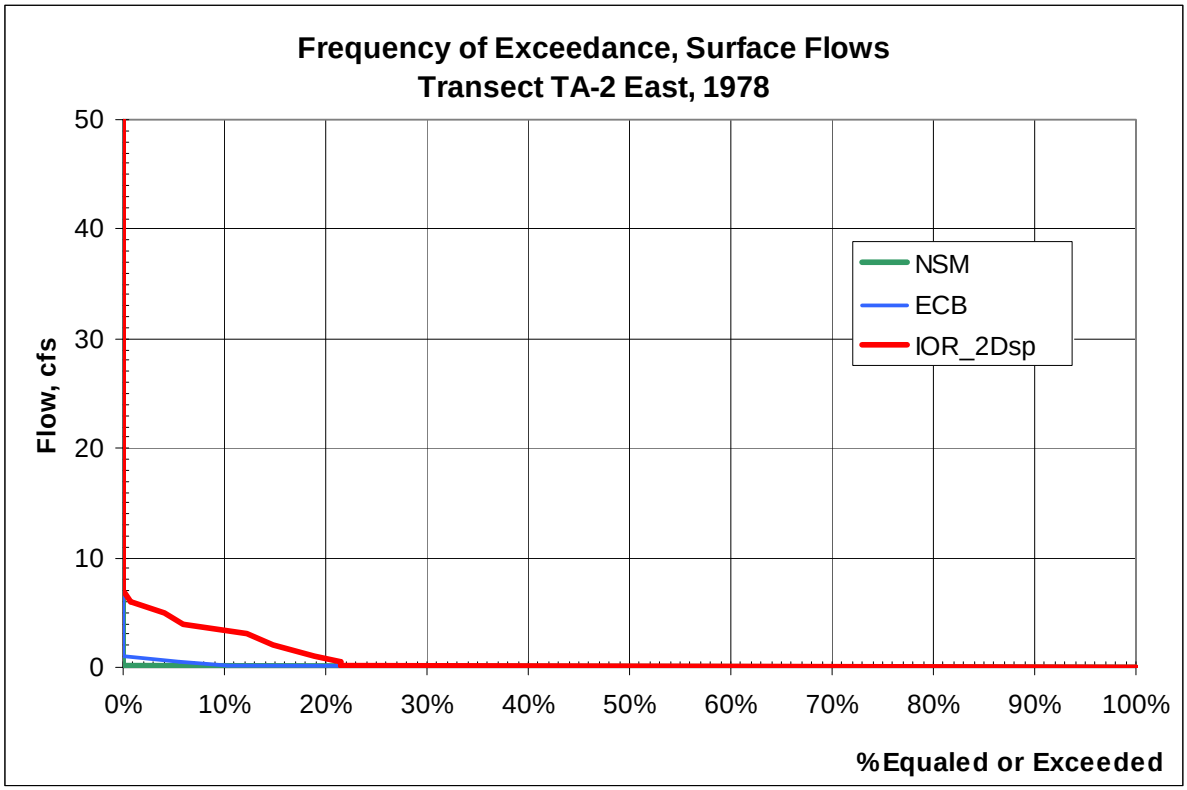

FIGURE C-14: TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) ACROSS TRANSECTS TA-2 EAST FOR 1978

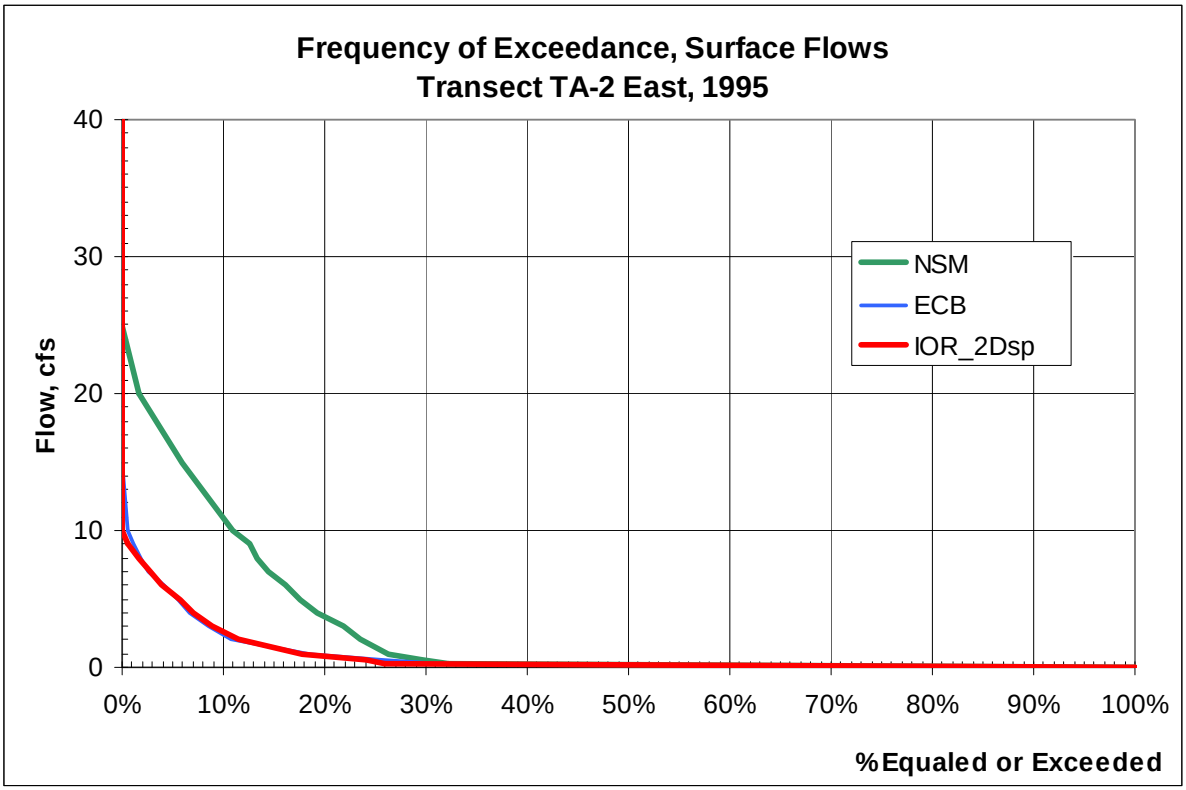

FIGURE C-15: C.X TOTAL SURFACE WATER FLOW FOR THE INITIAL OPERATING REGIME (IOR_2DS) AND EXISTING CONDITIONS BASELINE (ECB) WATER FLOW ACROSS TRANSECTS TA-2 EAST FOR 1995

For 1978, the average year, surface water flows across TA-1 increase with the recommended project in place. For the IOR_2DS there are surface water flows up to 30% of the time and increase up to 60 cfs in the IOR_2DS compared to 50 cfs for ECB. In 1995, the simulated surface water flows across TA-1 increase with the recommended project, IOR_2DS, with flows occurring up to approximately 85% of the time.

Surface water flows across TA-2 West increase in the 1978 and 1995 model simulations with the project in place, IOR_2DS, compared to the ECB, with flows occurring approximately 30% and 40% of the time.

Surface water flows across TA-2 East increase in the 1978 and 1995 model simulations with the project in place, IOR_2DS compared to the ECB, however, the increases are minimal. Surface water flows occur approximately 20% of the time.

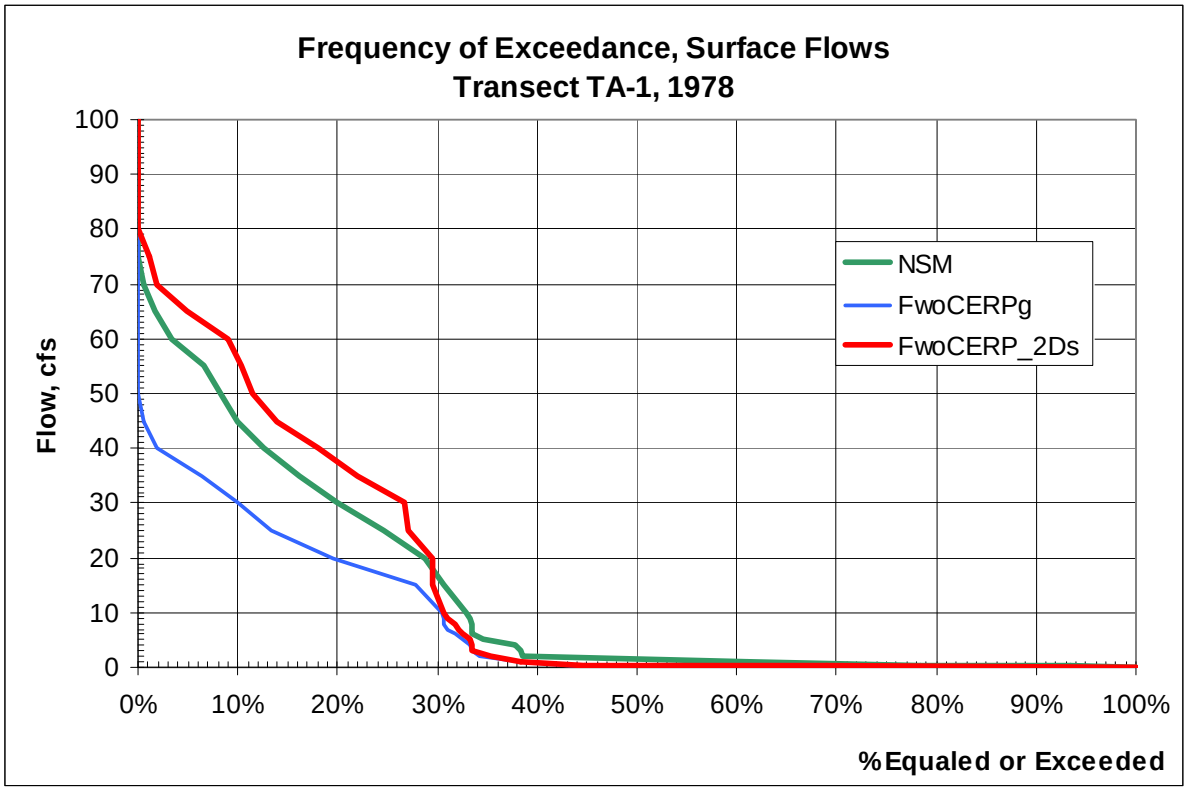

FIGURE C-16 TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-1 FOR 1978

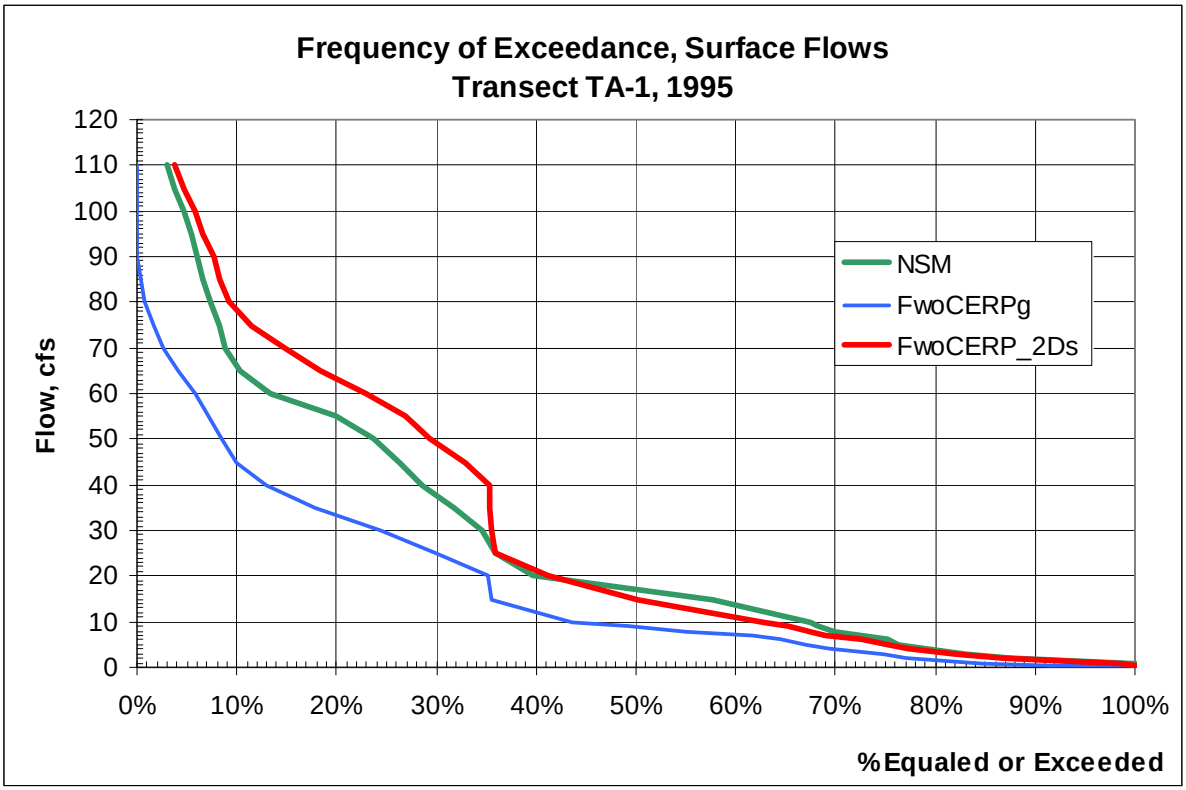

FIGURE C-17: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-1 FOR 1995

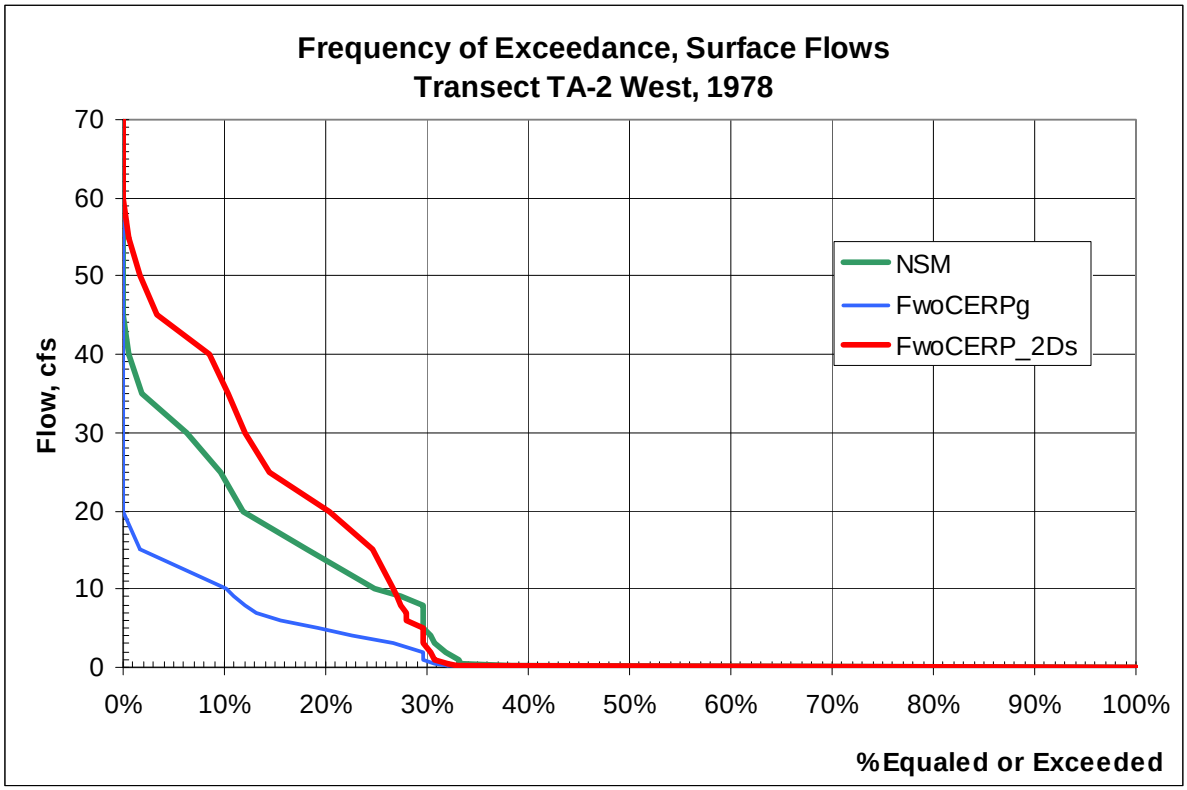

FIGURE C-18: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1978

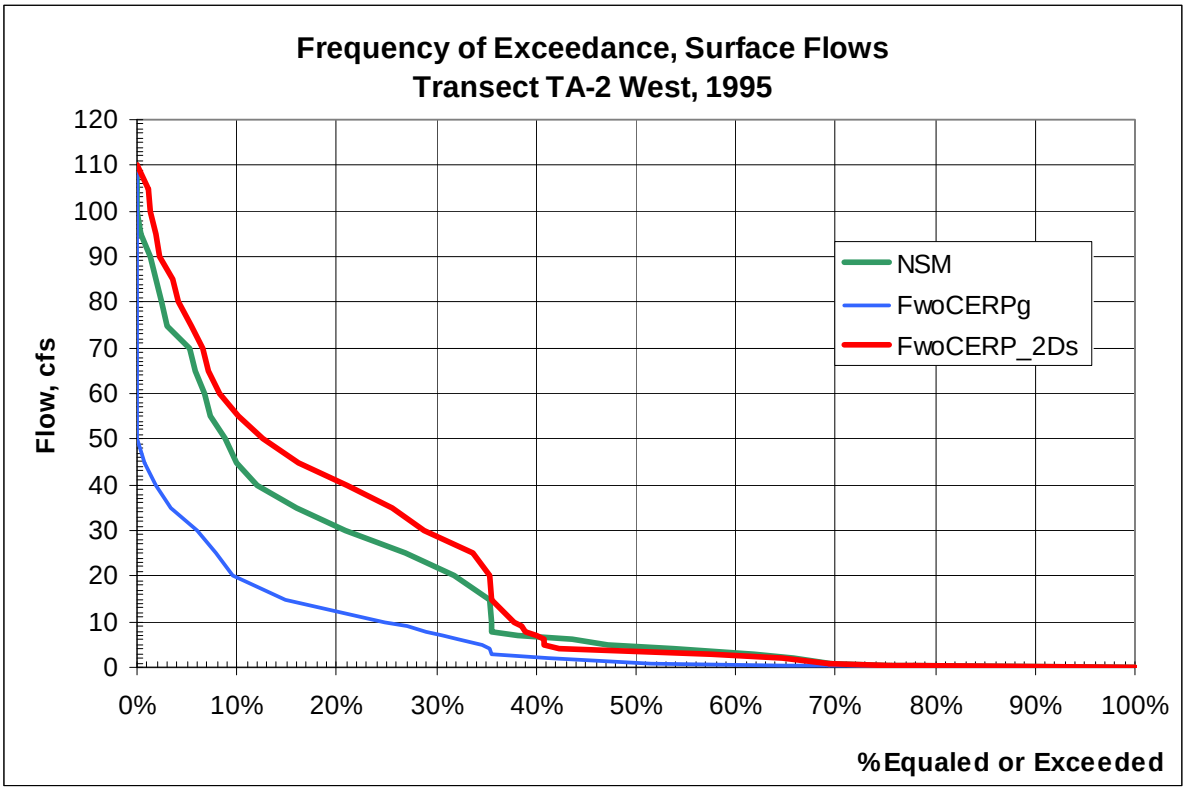

FIGURE C-19: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1995

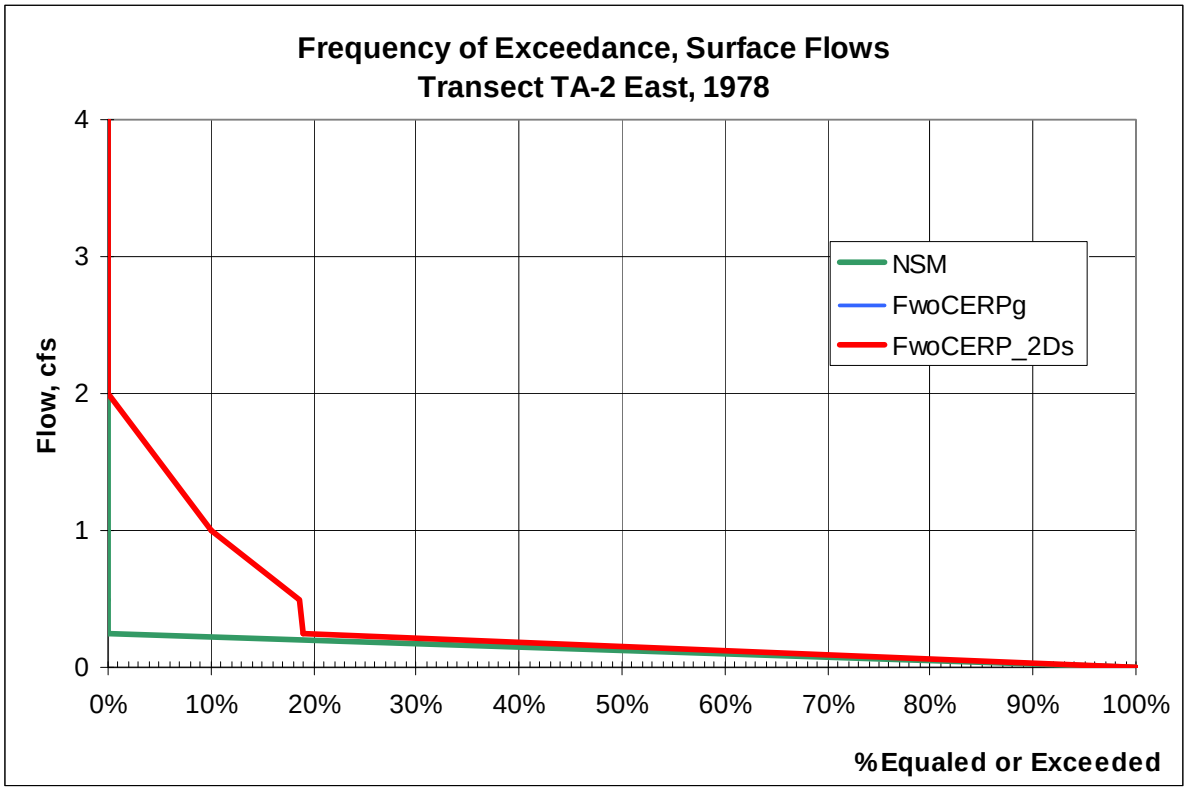

FIGURE C-20: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECT TA-2 WEST FOR 1978

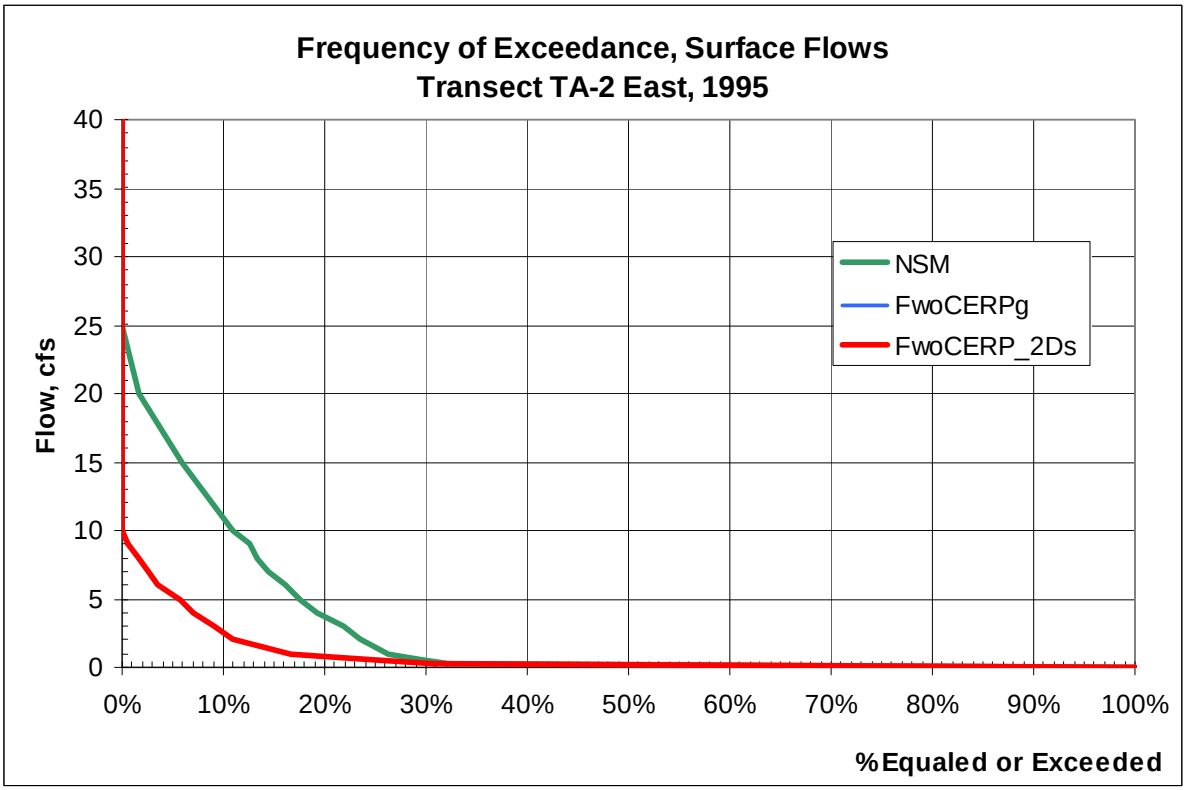

FIGURE C-21: TOTAL SURFACE WATER FLOW FOR FUTURE WITHOUT CERP (FWOCERP) AND FUTURE WITHOUT CERP PLUS THE PROJECT (FWOCERP_2DS) ACROSS TRANSECTS TA-2 EAST FOR 1995

C.3.2.2 Identifying Water to be Reserved or Allocated for the Natural System

The 10th, 50th and 90th percentile identified for the ECB, which represents the total water available for the natural system, the IOR_2DS, which represents the water directed towards C-111 Canal, and the difference between the ECB and IOR_2DS, which represents the total water made available by the project for the natural system are displayed in ***Table C-1***. The total water available to be diverted by the C-111 SC Western project ranges from about 775 cfs to 0 cfs. The portion diverted to either the Frog Pond Detention Area or the Aerojet Canal (ECB minus IOR_2DS) is the surface water made available by the C-111 SC Western project and ranges from 504 cfs (10th percentile) to 0 cfs (50th percentile). Water is not available at the median (50% percentile) or higher (90th percentile) or for the representative dry year, 1989.

TABLE C-1: TOTAL WATER AND WATER DIVERTED BY THE PROJECT FOR THE NATURAL SYSTEM QUANTIFIED AT S-177 (CUBIC FEET/SECOND)

Percentile:	10th	50th	90th
1978 Total Water (ECB)	54	0	0
1978 Water Directed towards C-111 Canal (IOR_2DS)	0	0	0
1978 Total Water Made Available by Project, (ECB minus IOR_2DS)	54	0	0
1995 Total Water (ECB)	775	0	0
1995 Water Directed towards C-111 Canal (IOR_2DS)	271	0	0
1995 Total Water Made Available by Project (ECB minus IOR_2DS)	504	0	0

To capture increases in water made available for the natural system, three transects located in South Miami-Dade, quantify surface flows in the Existing Baseline Condition, ECB. These flows are compared to the Initial Operating Regime with the project in place, IOR_2DS, which represents the total water available. The difference between these conditions for each year simulated represent the water made available for the natural system by the Recommended Project. The 10th, 50th and 90th percentile identified for the IOR_2DS, which represents the total water available, the ECB, the existing water, and the difference between the IOR_2DS and ECB, which represents the total water made available by the project for the natural system are displayed in ***Table C-2***. The surface water made available by the C-111 SC Western project ranges from 25.6 cfs (10th percentile) to 0 cfs (90th percentile).

TABLE C-2: TOTAL SURFACE WATER AND WATER MADE AVAILABLE BY THE PROJECT FOR THE NATURAL SYSTEM QUANTIFIED AT TRANSECTS TA-1, TA-2W AND TA-2E (CUBIC FEET/SECOND).

Percentile:	10th			50th			90th		
	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e	TA-1	TA-2w	TA-2e
1978 Total Water (IOR_2DS)	41.4	22.5	3.4	0.4	0.2	0.2	0.1	0	0
1978 Existing Water (ECB)	30.2	10.8	0.3	0.4	0.2	0.1	0.1	0	0
1978 Total Water Made Available by Project (IOR_2DS minus ECB)	11.2	11.7	3.1	0	0	0.1	0	0	0
1995 Total Water (IOR_2DS)	73.5	53.4	2.6	8.8	1.6	0.2	0.8	0.1	0
1995 Existing Water (ECB)	47.9	24.2	2.3	8.1	1	0.2	0.5	0.1	0
1995 Total Water Made Available by Project (IOR_2DS minus ECB)	25.6	29.2	0.3	0.7	0.6	0	0.3	0	0

The State will use its water reservation or allocation authority to protect the water made available by the project for the natural system as required by section 601 of WRDA 2000. The State has elected to protect the existing water in the natural system that the Project Implementation Report identifies as necessary to achieve the benefits of the project, using water reservation or allocation authority under Florida law. To this end, the South Florida Water Management District will protect the existing water needed for the natural system as indicated in ***Table C-1*** and ***Table C-2***.

C.3.3 Application of Project Assurances

The overarching objective of the Comprehensive Everglades Restoration Plan ("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. The Federal Government and the State of Florida are committed to the protection of the appropriate quantity, quality, timing, and distribution of water to achieve and maintain the benefits to the natural system described in the Plan. As envisioned in WRDA 2000 and the Programmatic Regulations, each PIR will identify this appropriate quantity, quality, timing, and distribution of water for the natural system.

The following language sets forth these commitments:

"The 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. The Federal Government and the non-Federal sponsor are committed to the protection of the appropriate quantity, quality, timing, and distribution of water to ensure the restoration, preservation, and protection of the natural system as defined in WRDA 2000, for so long as the project remains authorized. This quantity, quality, timing, and distribution of water shall meet applicable water quality standards and be consistent with the natural system restoration goals and purposes of CERP, as the Plan is defined in the programmatic regulations. The non-Federal sponsor will protect the water for the natural system by taking the following actions to achieve the overarching natural system objectives of the Plan:

1. Ensure, through appropriate and legally enforceable means under Federal law, that the quantity, quality, timing, and distribution of existing water that the Federal Government and the non-Federal sponsor have determined in this Project Implementation Report is available to the natural system, will be available at the time the Project Cooperation Agreement for the project is executed and will remain available for so long as the Project remains authorized.

2a. Prior to the execution of the Project Cooperation Agreement, reserve or allocate for the natural system the necessary amount of water that will be made available by the project that the Federal Government and the non-Federal sponsor have determined in this Project Implementation Report.

2b. After the Project Cooperation Agreement is signed and the project becomes operational, make such revisions under Florida law to this reservation or allocation of water that the Federal Government and the non-Federal sponsor determines, as a result of changed circumstances or new information, is beneficial for the natural system.

3. For so long as the Project remains authorized, notify and consult with the Secretary of the Army should any revision in the reservation of water or other legally enforceable means of protecting water be proposed by the non-Federal sponsor, so that the Federal Government can assure itself that the changed reservation or legally enforceable means of protecting

water conform with the non-Federal sponsor's commitments under paragraphs 1 and 2. Any change to a reservation or allocation of water made available by the project shall require an amendment to the Project Cooperation Agreement.

C.4 LITERATURE CITED

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Froelich, D. C., 1989, HW031.D – *Finite Element Surface-Water Modeling System: Two-Dimensional Flow in a Horizontal Plane—Users Manual (FESWMS)*, Federal Highway Administration Report FHWA-RD-88-177, p. 285.

U.S. Army Corps of Engineers (USACE). 2005. *Hydrologic Engineering Center River Analysis System* (HECRAS), Version 3.1.3, 2005.