Central and Southern Florida, Canal 111 (C-111) South Dade Project
PUMP STATIONS S-332B AND S-332C REPLACEMENT SECTION 902 POST AUTHORIZATION CHANGE REPORT

Final: October 2025

U.S. Army Corps of Engineers, Jacksonville District

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EXECUTIVE SUMMARY

The Central and Southern Florida Project is authorized by Section 203 of the Flood Control Act of 1948 (Public Law 80-858), as modified by Section 203 of the Flood Control Act of 1968 (Public Law 90-483), and relevant to the C-111 South Dade Project (C-111 SD Project), further modified by Section 316 of the Water Resources Development Act of 1996 (Public Law 104-303) [to implement the C-111 South Dade improvement]; Section 4013 of the Water Resources Reform and Development Act of 2014 (Public Law 113-121) [amending Section 316(b)(2) of the WRDA of 1996 to replace “shall pay” with “may pay up to”]; and Section 401(7) of the WRDA of 2020 (Public Law 116-260) [authorizing the C-111 SD Project modification per the September 15, 2020 Director’s Report at a total project cost of $133,473,000]. The primary objectives of the C-111 SD Project are to restore natural hydrologic conditions of the ecosystem in Taylor Slough and the eastern panhandle of Everglades National Park (ENP) while maintaining the authorized level of flood risk management for the agricultural areas in the C-111 Basin, an important objective for the C&SF Project due to agriculture within the basin. Although construction of permanent pump stations was authorized in 1996, the current C-111 SD Project S-332B and S-332C pump stations were designed and constructed between 2000 and 2003 as interim facilities to address quickly the Cape Sable Seaside Sparrow (CSSS) 1999 Jeopardy Biological Opinion (BO) issued by the U.S. Fish and Wildlife Service (USFWS). These pump stations are experiencing major deficiencies and are vulnerable to high velocity hurricanes. In April 2014, the Assistant Secretary of the Army for Civil Works (ASA(CW)) directed the U.S. Army Corps of Engineers (USACE), Jacksonville District to proceed with a Post Authorization Change Report (PACR) to evaluate the need to replace the pump stations, possible alternative measures, cost sharing and depreciation payments, in-kind contributions, and the overall schedule. The decision to replace current pump stations S-332B and S-332C is documented in the “Central and Southern Florida Project, Canal 111 (C-111) South Dade Project Replacement of Current Pump Stations S-332B and S-332C, Final Integrated General Re-Evaluation Report and Environmental Assessment”, dated June 2020. The 2020 General Re-Evaluation Report and Environmental Assessment (GRR/EA) was formally submitted to the ASA(CW) with a Report of the Director of Civil Works (Director’s Report) on September 15, 2020. Section 401(7)3 of the WRDA of 2020, approved modifications to the C&SF Project, C-111 SD Project in accordance with the Director of Civil Works’ Report. Replacement of the current S-332B and S-332C pump stations will maintain a hydraulic ridge along the North Detention Area (NDA) and South Detention Area (SDA) flow ways, which reduces groundwater seepage, improves hydro-periods and –patterns, and ensures retention of crucial water resources within approximately 730,000 acres of the ENP ecosystem. Additionally, the replacement pumps will maintain flood protection in the C-111 basin by reducing risk of pump failure that could result in elevated freshwater discharge into nearby areas like Barnes Sound and Manatee Bay and potentially extend flooding durations in agricultural areas.

The purpose of this Section 902 PACR is to seek approval of the proposed design changes included in this report (Table EX-1) and to increase the authorized total project cost as a result. The total project cost has increased since the 2020 GRR/EA was authorized due to required design changes that cause the project costs to exceed the Section 902 of WRDA 1986 Cost Limit. The S-332B and S-332C pump stations include a total pump capacity of approximately 900 cubic feet per second (cfs; 575 cfs design capacity), hardened outer structures, an intake canal, a long concrete-lined discharge channel, and a weir to tie into the existing SDA; expansion of the NDA by approximately 7.1 acres as a result of degrading a section of the NDA levee; an automated gated culvert connecting the concrete discharge channel with the NDA; a new microwave tower control building at S-332B and fiber optic cable; and demolition of each current pump station and connecting features. Proposed design changes are summarized in Table EX-1.

Table EX- 1. Summary of Design Changes Between the 2020 General Re-Evaluation Report (GRR/EA) Authorization and the 2025 Section 902 Post Authorization Change Report (PACR).

Design Change	2020 GRR/EA Authorized Design	2025 Section 902 PACR Design
Pump Mix Configuration	650 cubic feet per second (cfs; four 125 cfs diesel pumps, two 75 cfs electric pumps)	900 cfs [three 250 cfs (one unit for redundancy), two 75 cfs electric pumps]
Discharge Channel Length	Alternative 3 - Short concrete-lined Channel (S-332B: 1,900 ft and S-332C:1,900 ft)	Alternative 2 - Long concrete-lined Channel (S-332B: 3,600 ft and S-332C: 3,200 ft)
Updated Design Guidelines	2008 South Florida Water Management District (SFWMD) Major Pump Station Engineering Guidelines	2021 SFWMD Pump Station Engineering Guidelines - control room complex, diesel tanks within building, maintenance access, pump cooling and lubrication, day tank storage rooms (2), enclosed room for diesel tanks, energy dissipation pool, and fire suppression system.

The pump mix configuration was changed based on a 2022 Value Engineering Study (Appendix E) that identified beneficial changes to the 2020 General Re-Evaluation Report and Environmental Assessment (GRR/EA) design which would result in cost savings and more efficient project features. Of these changes, Proposal No. PW-24A (pump mix modification) was recommended as the most beneficial change. The original design utilizes four 125-cfs diesel pumps and one 75-cfs electric pump, all running at 100 percent capacity to reach the 575 cfs design requirements. Further, a second electric pump is required to provide backup in case of engine failure and to provide further operational flexibility to manage the NDA and SDA stages. The 2020 GRR/EA authorized design does not provide backup for the diesel pumps, which are the largest pump units. Running any mechanical equipment at 100 percent capacity reduces life expectancy and increases operational costs by decreasing operational efficiency and increasing the required maintenance frequency. For the 2020 GRR/EA authorized pump mix, if one of the diesel-driven pumps breaks down, there is no backup other than running both electric pumps, effectively limiting the design capacity from 575 cfs to 525 cfs. Additionally, electric pumps would require supplementary upsized back-up generators to provide the required power when commercial power outages occur during large storm events. Projects authorized with a flood control component require pump redundancy in accordance with EM 1110-2-3105, Mechanical and Electrical Design of Pump Stations, Paragraph 3.9.c.(6). Due to unreliable power supply during storm events and the increased requirements of electric pumps, diesel pumps will be used to meet the redundancy requirement.

As part of the analysis of proposed design changes, this Section 902 PACR re-evaluated the alternatives developed for the 2020 GRR/EA. Both action alternatives (Alternative 2 – 1,900 ft concrete lined channel and Alternative 3 – 3,600 ft and 3,200 ft concrete lined channel for S-332B and S-332C, respectively) would produce the same habitat benefits and flood protection conditions because they have the same design capacity and operational plan, either the 2020 Combined Operational Plan (COP) or a future update to Volume 4 of the System Operating Manual (SOM Volume 4) for Water Conservation Areas, Everglades National Park and the ENP-South Dade Conveyance System [inclusive of planned future updates to the Central Everglades Planning Project (CEPP) Project Operating Manual (POM)]. Additionally, both action alternatives will perform in maintaining a hydraulic ridge along the western flow way to disperse water into the NDA and SDA detention areas and continue improved hydroperiods in eastern ENP to meet the ecosystem restoration objective. Although Alternative 2 is not the least-cost alternative in terms of average annual cost, its selection remains technically justified based on the difference in additional Operations and Maintenance (O&M) cost identified during the seepage and hydraulic analysis completed during Preconstruction Engineering and Design (PED).

The 2020 GRR/EA authorized design of the S-332B and S-332C replacement pump stations was based on the 2005 as-built design of the S-357 Pump Station. The subsequently updated 2021 South Florida Water Management District (SFWMD) Pump Station Engineering Guidelines (PSEG) necessitated several S-332B and S-332C replacement pump station design changes, such as an increased operating footprint. Use of future PSEG updates was addressed in the 2020 GRR/EA and, accordingly, proposed changes were reviewed by the USACE Jacksonville District and were determined to be justified based on legitimate engineering reasons detailed in this Section 902 PACR. Compliance with the 2021 SFWMD PSEG contributed to a total increase of square footage for the pump stations by approximately 7,000-8,000 ft^2. The changes to the pump station features led to an increase in the overall cost of each replacement pump station.

Restoration targets are not expected to change from the 1994 Central and Southern Florida Project Final Integrated General Re-Evaluation Report and Environmental Impact Statement (GRR/EIS) Canal 111 (C-111) South Dade County, Florida, consistent with the 2016 Canal 111 (C-111) South Dade County, Florida Final Limited Reevaluation Report and the 2020 COP. Although the No Action Alternative has the lowest total project cost, the current S-332B and S-332C pumps are not effective in meeting ecological restoration and flood risk management objectives. The current pumps have recently failed and required emergency repair; do not meet design requirements for permanent structures; lack pump redundancy as required for flood protection; and continue to deteriorate, presenting a significant risk of failure.

This Section 902 PACR presents an updated certified cost estimate for the authorized project and requests a project first cost of $954,561,000 Fiscal Year (FY) 2026 price levels.

The increase in project cost is due to the following factors:

- Design changes for components of the 2020 authorized design.
- Application of new design requirements.
- Increases in material costs, labor rates, and equipment costs; higher escalation percentages based on construction schedule changes and volatile rates; and differences in percentages of applied markups.
- Pump station design maturity in the 2020 GRR/EA did not meet acceptable Corps standards (Engineer Regulation 1110-2-1302).

The Project Cooperation Agreement (PCA) between the Department of the Army and SFWMD for Construction of Modifications to the C-111 SD Project was executed on January 13, 1995. Amendment No. 1 to the PCA was executed on August 14, 2014, to adjust project cost sharing and crediting. The PCA has not yet been further amended to incorporate the replacement of pump stations S-332B and S-332C as authorized by WRDA 2020.

In 2024, the USACE Jacksonville District updated the projected costs for the C-111 SD Project replacement of current pump stations S-332B and S-332C based on the final design for the S-332B replacement pump station submitted by SFWMD in December 2024. The cost certification is in Appendix A. The cost update shows that the project first cost has increased by $777,396,000 over the authorized project first cost ($177,165,000) as established pursuant to Section 902 of WRDA 1986 for a project first cost of $954,561,000 (FY26 price levels; Table EX-2). The fully funded total project cost is $1,014,679,000.

Table EX-2. Project Costs, Fiscal Year 2026 Price Levels.

Authorized Project First Cost	Current Project First Cost
$177,165,000	$954,561,000

1 INTRODUCTION AND DESCRIPTION OF AUTHORIZED PROJECT

The Central and Southern Florida Project is authorized by Section 203 of the Flood Control Act of 1948 (Public Law 80-858), as modified by Section 203 of the Flood Control Act of 1968 (Public Law 90-483), and relevant to the C-111 South Dade Project, further modified by Section 316 of the Water Resources Development Act of 1996 (Public Law 104-303) [to implement the C-111 South Dade improvement]; Section 4013 of the Water Resources Reform and Development Act of 2014 (Public Law 113-121) [amending Section 316(b)(2) of the WRDA of 1996 to replace "shall pay" with "may pay up to"]; and Section 401(7) of the WRDA of 2020 (Public Law 116-260) [authorizing the C-111 SD Project modification per the September 15, 2020 Director's Report at a total project cost of $133,473,000].

The C-111 SD Project was authorized to restore natural hydrologic conditions on approximately 730,000 acres within Taylor Slough and the eastern panhandle of ENP while maintaining the authorized level of flood risk management for the agricultural areas in the C-111 Basin. The C-111 SD Project replacement of current pump stations S-332B and S-332C will provide the dual benefit of reducing the average annual operating costs and annual probability of pump station failure. Ecosystem restoration and flood risk management objectives will continue to be met by the project along with the same benefits the project currently provides, but at a lower annual cost and reduced risk of pump station failure than the current S-332B and S-332C pump stations. The C-111 SD Project will continue to meet objectives by maintaining a hydraulic ridge along the NDA and SDA flow ways, which reduces groundwater seepage losses, improves hydro-periods and –patterns, and ensures retention of crucial water resources within the ENP ecosystem as detailed in the 1994 GRR/EIS. The 2020 COP EIS and Water Control Plan, which prescribes the current operational criteria for the C-111 SD Project features (including S-332B and S-332C), conducted a socioeconomic evaluation that demonstrated adherence to the project objective to maintain the level of flood reduction associated with the 1994 C-111 SD GRR/EIS flood damage reduction project recommended plan (refer to Appendix I of the 2020 COP EIS).

The S-332B and S-332C pump stations are project features of the C-111 SD Project detailed in the report "Central and Southern Florida Project Final Integrated General Reevaluation Report and Environmental Impact Statement Canal 111 (C-111) South Dade County, Florida," dated May 1994. The USACE Jacksonville District expedited construction of the current S-332B and S-332C pump stations in response to the 1999 USFWS Jeopardy BO to support the immediate needs of the endangered CSSS. As a result, these pump stations were designed and constructed, between 2000 and 2003, as interim features to address quickly the USFWS Jeopardy BO as part of the Emergency Interim Structural and Operational Plan (ISOP) and Emergency Interim Operation Plan contracts. The USACE Jacksonville District transferred the current pump stations to the SFWMD in 2010 for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R). Although the two pump stations are C-111 SD Project features, authorized in WRDA 1996, they were constructed as interim solutions and intended to be temporary with the expectation of being replaced in the future.

The ASA(CW) in April 2014 directed the USACE Jacksonville District to generate a PACR to evaluate the need to replace the pump stations, possible alternative measures, cost sharing and depreciation payments, in-kind contributions, and the overall schedule. The decision to replace current pump stations S-332B and S-332C is documented in the "Central and Southern Florida Project, Canal 111 (C-111) Replacement of Current Pump Stations S-332B and S-332C, Final Integrated General Re-Evaluation Report and Environmental Assessment," dated June 2020. On September 15, 2020, the GRR/EA was submitted to the ASA(CW) with a Report of the Director of Civil Works (Director's Report). Section 401(7)3 of the WRDA 2020 authorized the modifications (replacement pumps) in accordance with the Director's Report with a total cost of $133,473,000 (which made Section 902 of the WRDA of 1986, as amended, applicable although these are features of a project).

The C-111 SD Project S-332B and S-332C pump stations replacement, with the revised design, cannot be completed at a cost below the Section 902 Limit. If the project is not completed, the current pump stations are at high risk of catastrophic damage that could cause failure and significantly diminish or eliminate the ecosystem restoration and flood risk management benefits that the project currently provides to meet federal objectives.

The 2020 GRR/EA states the following regarding future pump station design considerations:

> The design of the pump stations shall be based on USACE engineering and design manuals, technical letters, the Design Criteria Memorandum #5 (DCM5) SFWMD Pump Station Engineering Guidelines (as revised, in progress 2020), and SFWMD design guidelines and standards. SFWMD standards shall be used in cases where legitimate engineering reasons exist (i.e. in the event USACE standards are incompatible with SFWMD's infrastructure operations), in the absence of USACE standards, and/or if SFWMD has a strong preference towards a specific standard. If preferential use of a standard other than USACE results in a higher cost, a betterment shall be evaluated for cost responsibility of the non-federal sponsor.

Due to requirements detailed in Engineer Manual (EM) 1110-2-3105 and the 2021 SFWMD Pump Station Engineering Guidelines (PSEG) the project cannot be re-scoped to bring the cost under the Section 902 Limit. The proposed design changes are needed to meet existing objectives and purposes of the authorized project.

The SFWMD is the non-Federal sponsor (NFS) for the C-111 SD Project, including the pump station replacement effort. An In-Kind Memorandum of Understanding (MOU) Between the Department of the Army and the SFWMD for Construction Work Prior to Execution of Amendment No. 2 to the PCA for the C-111 SD Project was executed on September 29, 2020. This preserves the eligibility of the non-Federal sponsor to receive credit for work performed as in-kind contributions for the construction of the replacement pump stations prior to execution of the PCA amendment. SFWMD will be performing design and construction work described in the In-Kind MOU. Amendment No. 1 to the In-Kind MOU was executed on May 28, 2025, to reflect changes required for the pump states and to clarify the inclusion of the necessary new microwave tower control building at S-332B and fiber optic cable in construction work.

1.1 Purpose and Need

This Section 902 PACR presents a revised cost estimate for the 2020 authorized C-111 SD Project replacement of current pump stations S-332B and S-332C. Additionally, this Section 902 PACR evaluates the cost increase associated with design changes during PED and requests authorization for a project first cost of $954,561,000 (FY26). The current Section 902 Cost Limit is $215,018,000 (FY26; Table 1-1).

Table 1-1. C-111 South Dade Project Pump Stations S-332B and S-332C Replacement Budget Update- 902 Tool Output (Table G-4 from ER 1105-2-100, Appendix G) (in FY26 thousands of dollars).*

Table G-4 (ER 1105-2-100 Appendix G)

MAXIMUM COST INCLUDING INFLATION THROUGH CONSTRUCTION FY26

		Thousand Dollars (000's)
Line 1		
a.	Current project estimate at current price levels:	$954,561
b.	Current project estimate, inflated through construction:	$1,014,679
c.	Ratio: Line 1b / line 1a	1.0630
d.	Authorized cost at current price levels:	$177,165
	(Column (h) plus (i) from table G-3)	
e.	Authorized cost, inflated through construction:	$188,323
	(Line c x Line d)	
Line 2	Cost of modifications required by law:	$0
Line 3	20 percent of authorized cost:	$26,695
	.20 x (table G-3, columns (f) + (g)	
Line 4	Maximum cost limited by section 902:	$215,018
	Line 1e + line 2 + line 3	

*Calculated using Work Breakdown Structure feature code 13 (Pumping Plant)

The current C-111 SD Project S-332B and S-332C pump stations are showing signs of stress, require extensive repairs, and are not reliable. The pumps have exhibited problems in the current structures, such as vibration issues and strong vortices and swirls induced by imbalanced approaching inflows at pump intake. For example, the corrugated metal pipe (CMP) discharge culverts have a history of corrosion induced washouts, sinkholes and cave-ins that require recurring costly repairs. Recently, the CMP culverts for S-332C failed (Figure 1-1) requiring an Emergency Section 408 approval to remove the culverts and replace them with a riprap armored earthen channel bordered by a berm along each side. The construction of the emergency channel was completed in July 2024 (Figure 1-2). Under a follow-on Section 408 approval, SFWMD is currently replacing the culverts for S-332B with a riprap armored earthen channel bordered by a berm along each side.

Figure 1-1. Current S-332C Pump Station Failed Culverts and Erosion of Levee

Figure 1-2. Current S-332C Pump Station Emergency Repair of Discharge Culverts to Discharge Channel

Additionally, the current pump stations and equipment are not housed in storm hardened structures, making them vulnerable to prevailing weather (e.g., rain, wind, and solar) and high velocity hurricane events. If a severe weather event were to occur, catastrophic damage may cause pump station failure and diminish or halt the ecosystem restoration and flood risk management benefits that the project currently provides to meet federal objectives.

While never formally estimated using a potential failure mode analysis, the annual probability of pump station failure is assumed to increase each year due to gradual loss of structural integrity (corrosion, fatigue, etc.). Unlike mechanical or electric system repairs, structural repairs can be complicated and expensive, potentially making them unjustified due to the temporary nature of the features. Additionally, annual OMRR&R costs are expected to increase as the current S-332B and S-332C pump stations continue to deteriorate. Therefore, replacement of the pump stations will provide the dual benefit of reducing the average annual operating costs and reducing the annual probability of pump station failure.

1.2 Project Location

The C-111 SD Project is a modification to (a part of) the larger C&SF Project and is located west of the L-31N Canal in southern Miami-Dade County in southeast Florida (Figure 1-3). The area of primary focus for this Section 902 PACR is where the S-332B and S-332C pump stations are located (Figure 1-4).

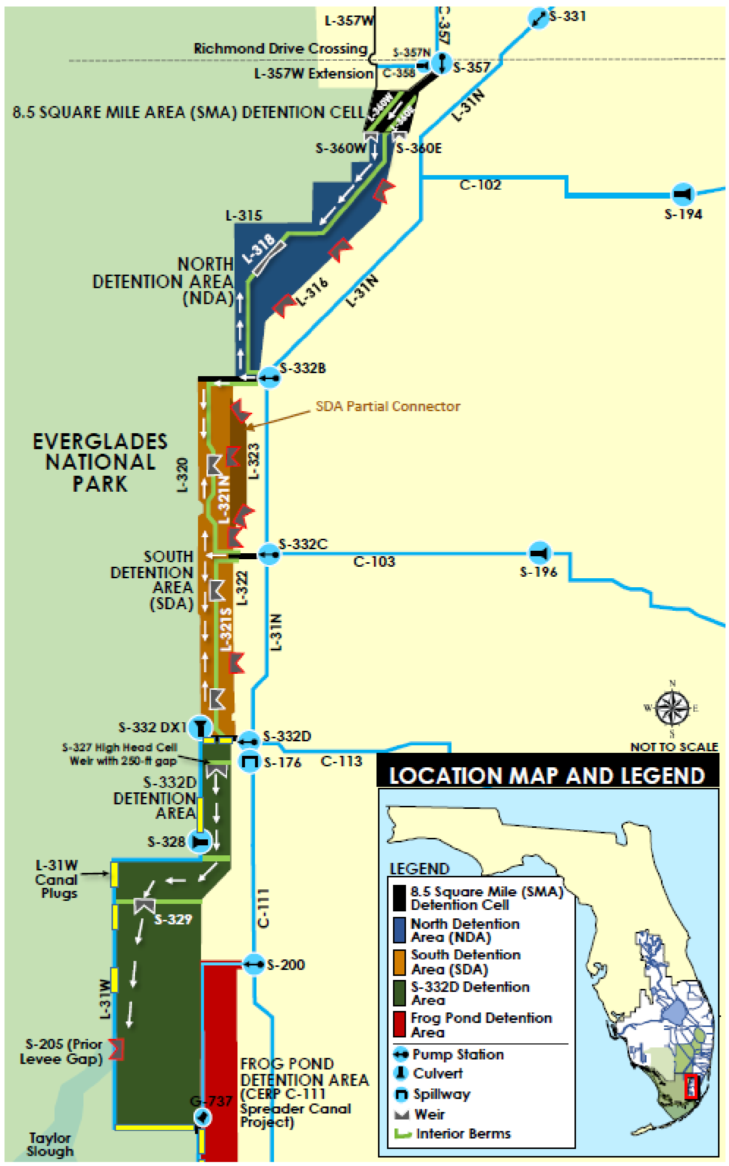


Figure 1-3. C-111 South Dade Project Area, Miami-Dade County, Florida

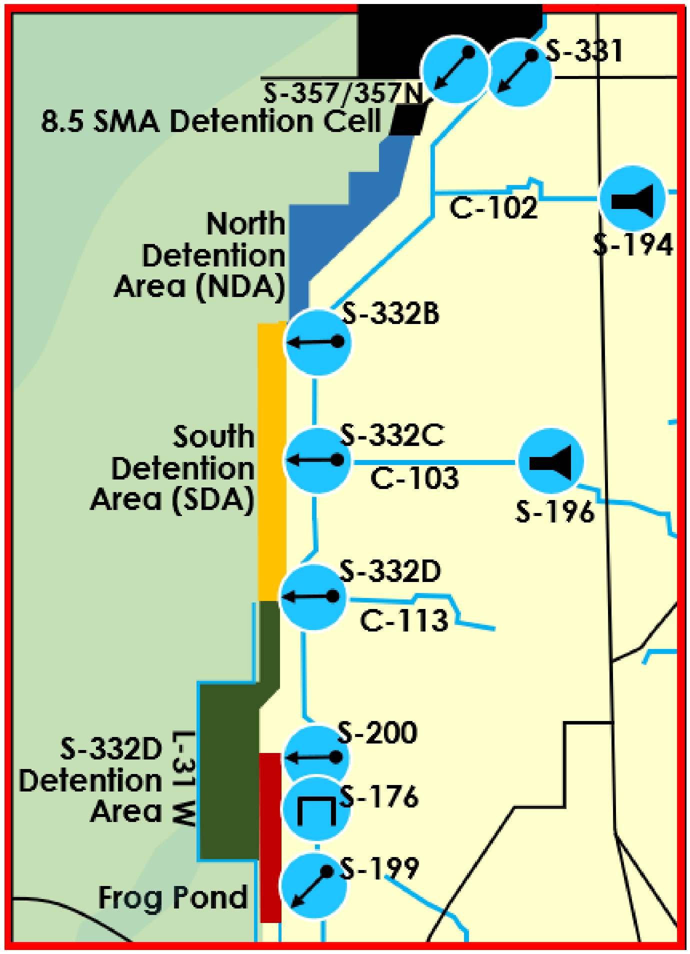


Figure 1-4. C-111 South Dade Project Replacement of Current Pump Stations S-332B and S-332C Location, Miami-Dade County Florida

1.3 Project Status

The C-111 SD Project is divided into 11 contracts and the status of all project features is provided below.

- Features that have been completed by the C-111 SD Project, prior to the 2020 GRR, include:
  - S-332D Pump Station – Contract 1 (construction completed 1996)
  - C-111 Spoil Mound Removal – Contract 2 (construction completed 1996)
  - Taylor Slough Bridge – Contract 3 (construction completed 1999)
  - S-332B Interim Pump Station – Contract 4 (construction completed 2000)
    - S-332B Western Detention Area and Weir (part of SDA; construction completed 2000)
  - S-332D Engine Replacement – Contract 4A (construction completed 2001)
  - Contract 5 (construction completed 2003):
    - S-332C Interim Pump Station
    - S-332C Detention Area (part of SDA)
    - S-332B Detention Area (215 acres of NDA)

        - Partial connector between the two detention areas
        - Tie-back levee from L-31W to portion of the SDA
        - S-332D High Head Cell and Weir
    - S-331 Command and Control Facility – Contract 6 (construction completed 2009)
    - Contract 7 (construction completed 2009):
        - Final SDA Configuration
        - S-332DX1
    - NDA and Related Features – Contract 8 (construction completed 2018)
    - SDA, Richmond Drive Crossing, Internal Flow way Berms – Contract 8A (construction completed 2018)
    - Modify S-327 High Head Cell Weir and decommission/removal of obsolete structures S-332, S-332i, S-174, and S-175 – Implemented by USACE Jacksonville District/SFWMD (construction completed 2018)
    - L-31W Canal Modifications – Contract 9, by SFWMD (construction completed 2017)
- Features currently under design include:
    - S-332B Replacement Pump Station – (SFWMD, contract award anticipated in 2025)
    - S-332C Replacement Pump Station – (USACE, contract award anticipated in 2027)

2 AUTHORIZATION

Section 216 of the Flood Control Act of 1970 authorizes the Secretary of the Army, acting through the Chief of Engineers, to review projects constructed by the USACE and make recommendations to Congress for modifications. In accordance with the April 29, 2014, memorandum issued by the ASA(CW), the USACE Jacksonville District was directed to develop a PACR to examine replacing the pumps, possible measures, cost sharing, depreciation payments, in-kind contributions, and the overall schedule. The April 29, 2014, memorandum also instructed that a PCA amendment must be executed to complete construction of the project. On August 14, 2014, the USACE Jacksonville District and SFWMD executed an amendment to the 1995 PCA to address cost sharing and crediting. The PCA amendment added Article II.M. to the PCA, which provided further clarification on the associated requirements of the PACR:

> The Government and the Non-Federal Sponsor agree to enter into an agreement for equal cost sharing for preparation of a post authorization change report (PACR) to evaluate various alternatives to replace pump stations S-332B and S-332C and associated discharge pipes including an alternative with pump stations with hardened outer structures for additional protection during hurricanes and concrete-lined conveyance canals. The PACR shall consider seeking authorization for cost sharing of recommended features in accordance with Section 316 of the Water Resources Development Act of 1996; appropriate cost sharing for the operation, maintenance, repair, replacement and rehabilitation of project features; and the provision of credit for proportional depreciation payments made by the Government to the Non-Federal Sponsor under Article Vll.A.1.a of this Agreement for Pump Stations S-332B and S-332C toward the Federal share of the replacement costs for S-332B and S-332C.

2.1 C-111 SD Project Background

The Central and Southern Florida Project is authorized by Section 203 of the Flood Control Act of 1948 (Public Law 80-858), as modified by Section 203 of the Flood Control Act of 1968 (Public Law 90-483), and relevant to the C-111 South Dade Project, further modified by Section 316 of the Water Resources Development Act of 1996 (Public Law 104-303) [to implement the C-111 South Dade improvement]; Section 4013 of the Water Resources Reform and Development Act of 2014 (Public Law 113-121) [amending Section 316(b)(2) of the WRDA of 1996 to replace “shall pay” with “may pay up to”]; and Section 401(7) of the WRDA of 2020 (Public Law 116-260) [authorizing the C-111 SD Project modification per the September 15, 2020 Director’s Report at a total project cost of $133,473,000].

The C-111 SD Project is part of the larger C&SF Project. The purposes of the C&SF Project, first authorized by section 203 of the Flood Control Act of 1948 (Public Law 80-858) include flood control, agricultural water supply, municipal and industrial water supply, preservation of fish and wildlife, water supply to ENP, preservation of ENP, prevention of saltwater intrusion, drainage and water control, groundwater recharge, recreation, and navigation. Modifications to the C&SF Project in southern Dade County were authorized by Section 203 of the Flood Control Act of 1962, Public Law 87-874. Congress recognized the need to improve the supply, distribution and conservation of water resources in Central and Southern Florida to meet growing urban and agricultural needs and to provide sufficient flow to preserve ENP. This authorization was further modified by the C&SF authorization in Section 203 of the Flood Control Act of 1968, Public Law 90-483, as the ENP-South Dade Canal System (SDCS) Project (House Document 369, 90th Congress). The Act authorized modifications to the existing C&SF Project in the interest of improved conservation and distribution of available water and extended flood protection.

The ENP Protection and Expansion Act of 1989, Public Law 101-229, added 107,600 acres of wetlands and former agricultural lands to ENP and expanded the former eastern boundaries from approximately the location of the L-67 extension canal eastward to the current ENP boundary. Under Section 104(j) of the 1989 ENP Protection and Expansion Act (Protection of Natural Values):

> The Secretary of the Army is directed in analysis, design and engineering associated with the development of a general design memorandum for works and operations in the “C-111 basin” area of the East Everglades, to take all measures which are feasible and consistent with the purposes of the project to protect natural values associated with Everglades National Park.

Accordingly, the 1989 ENP Protection and Expansion Act authorized the construction of modifications to the C&SF Project to improve water deliveries into the ENP, and to the extent practicable, take steps to restore the natural hydrologic conditions within ENP. These modifications are “justified by the environmental benefits to be derived by the Everglades ecosystem in general and by the park in particular… .”

The USACE Jacksonville District completed the “Central and Southern Florida Project for Flood Control and Other Purposes Part I, Agricultural and Conservation Areas Supplement 54 General Design Memorandum and Environmental Impact Statement (EIS) Modified Water Deliveries (MWD) to Everglades National Park” in 1992. The report described structural changes to improve water conveyance from the Water Conservation Areas and across Tamiami Trail into ENP. The report also included protective measures for the 8.5 Square Mile Area (SMA). MWD implementation has been subsequently revised through amendments to the MWD Project, including the “General Reevaluation Report and Final Supplemental Environmental Impact Statement, 8.5 Square Mile Area” (USACE 2000); the “Modified Water Deliveries to Everglades National Park Tamiami Trail Modifications Final Limited Reevaluation Report (LRR) and Environmental Assessment” (USACE 2008); the “Environmental Assessment; Design Refinement for the 8.5 Square Mile Acres” (USACE 2012); and the “Environmental Assessment and Finding of No Significant

Impact; Modified Water Deliveries to Everglades National Park Project: Removal of Unconstructed Conveyance and Seepage Control Features" (USACE 2017a).

When Congress authorized expansion of ENP lands, the C-111 Canal needed modifications so that it would no longer draw groundwater out of the new additions to ENP. Accordingly, the USACE Jacksonville District and SFWMD developed the 1994 "Central and Southern Florida Project Final Integrated General Reevaluation Report and Environmental Impact Statement, Canal 111 (C-111) South Dade County, Florida." The 1994 GRR/EIS addressed restoration of the ecosystem in Taylor Slough and the eastern panhandle of ENP which were affected by the C&SF Project in the C-111 Basin. The 1994 GRR/EIS also focused on maintaining flood protection for the agricultural activities on adjacent lands. The 1994 GRR/EIS described a conceptual plan for five pump stations and levee-bounded water retention areas to be built west of the L-31N Borrow Canal between the 8.5 SMA and the Frog Pond Detention Area to its south. These features were designed to reduce seepage out of ENP by operating the inflow pump stations to maintain target L-31N Canal stages to maintain the authorized flood protection (40% removal of standard project flood flows) to agricultural lands east of the L-31N Canal. The 1994 GRR/EIS plan provided the operational capability and flexibility to assist in restoring the ecological integrity of Taylor Slough and the eastern panhandle area of the Everglades and flood protection to the agricultural interests adjacent to the C-111 Canal.

Modifications in the 1994 GRR/EIS were authorized by Section 316 of the WRDA of 1996, Public Law 104-303.

> SEC. 316. CENTRAL AND SOUTHERN FLORIDA, CANAL 111.
>
> (a) IN GENERAL. - The project for Central and Southern Florida, authorized by section 203 of the Flood Control Act of 1948 (62 Stat. 1176) and modified by section 203 of the Flood Control Act of 1968 (82 Stat. 740-741), is modified to authorize the Secretary to implement the recommended plan of improvement contained in a report entitled "Central and Southern Florida Project, Final Integrated General Reevaluation Report and Environmental Impact Statement, Canal 111 (C-111), South Dade County, Florida", dated May 1994, including acquisition by non-Federal interests of such portions of the Frog Pond and Rocky Glades area as are needed for the project.
>
> (b) COST SHARING. -
>
> > (1) FEDERAL SHARE. - The Federal share of the cost of implementing the plan of improvement shall be 50 percent.
> >
> > (2) SECRETARY OF INTERIOR RESPONSIBILITY. - The Secretary of the Interior shall pay 25 percent of the cost of acquiring such portions of the Frog Pond and Rocky Glades areas as are needed for the project. The amount paid by the Secretary of the Interior shall be included as part of the Federal share of the cost of implementing the plan.
> >
> > (3) OPERATION AND MAINTENANCE. - The non-Federal share of operation and maintenance costs of the improvements undertaken pursuant to this section shall be 100 percent; except that the Federal Government shall reimburse the non-Federal interest with respect to the project 60 percent of the costs of operating and maintaining pump stations that pump water into Taylor Slough in the Everglades National Park.'

To provide a timely solution to address environmental problems in Taylor Slough and the eastern panhandle of ENP, the features described in the 1994 GRR/EIS would be implemented in two stages: (1) the facilities planning stage; and (2) the operation planning stage. The facilities planning stage included identifying locations and capacities of pumps, canals, levees and required appurtenances as described in the 1994 GRR/EIS. The C-111 Project operations planning stage was intended to be combined with the development of the operational plan for the MWD to ENP Project. This strategy would optimize environmental benefits of the recommended plans identified for both projects.

2.2 Regional Operations Background

Section 2 of the River Basin Monetary Authorization and Miscellaneous Civil Works Amendments Act of 1970, Public Law 91-282, passed in June 1970, assured the ENP a minimum supply of water from the C&SF Project. These minimum deliveries were suspended for the "Experimental Program" which modified water deliveries to ENP. (See Section 1302 of the Supplemental Appropriations Act, 1984, Public Law 98-181; Section 115 of Public Law 99-190; Section 40 of Public Law 100-676; Section 107, Public Law 102-104).

Section 104(a)(1) of the Everglades National Park Protection and Expansion Act of 1989, Public Law 101-229, authorized the Secretary of the Army (in consultation with the Secretary of the Interior), upon completion of a final report by the Chief of the USACE, to modify the C&SF Project to improve water deliveries to ENP and to take steps to restore ENP's natural hydrological conditions. In response, the USACE Jacksonville District developed a plan in the 1992 MWD General Design Memorandum and Environmental Impact Statement (GDM), which stated that deliveries to the ENP would be based on rainfall with a regulatory component using three stations in Water Conservation Area 3A (MWD GDM at pp. 60). It also stated, "The minimum delivery requirements of PL 91-282 will no longer be the basis of delivery but will be superseded by the schedules developed by the Secretary of the Army."

While a preliminary operational plan for the then-proposed C-111 Project was included in the 1994 GRR/EIS, it further identified the need for a refined operation plan to be developed in coordination with ENP, the USFWS, the SFWMD and other agencies prior to completion of project construction.

For operational planning, the purposes of the MWD and C-111 Projects are complementary. The purpose of the MWD Project is to improve water deliveries into ENP and, to the extent practicable, restore the natural hydrological conditions within ENP. The purposes of the C-111 Project include ecosystem restoration in Taylor Slough and the eastern panhandle of ENP, while preserving the authorized level of flood protection for agricultural areas in the C-111 Basin. Combined with the MWD Project, NDA, SDA, and the S-332D Detention Area, features of the C-111 Project currently form a hydraulic ridge that extends from the 8.5 SMA to Taylor Slough for the combined purposes of reducing groundwater seepage losses from ENP while maintaining flood protection for adjacent agricultural lands.

The construction of the MWD Project is complete and an operational plan for both the C-111 Project and MWD Project was developed under the COP, which was implemented in August 2020. Because the COP is the full implementation plan contemplated under Public Law 102-104, it does not call for continuation of Minimum Deliveries as identified in Public Law 91-282 but is aimed at more natural deliveries to ENP that are tied to rainfall and are based on the operations developed under the Experimental Program. Nevertheless, as further detailed in the COP Final EIS, regional operations under the COP should far exceed the Minimum Deliveries required under Public Law 91-282 on an average annual basis.

The "Canal 111 (C-111) South Dade County, Florida Final Limited Reevaluation Report" (LRR), dated November 2016, served as the PACR that documented prior design refinements to the 1994 C-111 SD Project GRR/EIS plan that were incorporated into project construction (Contracts 1 through 8) as well as features proposed for future construction (Contract 9), as coordinated with the USACE South Atlantic Division (SAD). C-111 Project features already constructed were addressed in previous National Environmental Policy Act (NEPA) documents. The "Canal 111 (C-111) Basin South Dade County, Florida Environmental Assessment and Finding of No Significant Impact; Modifications to the C-111 South Dade North and South Detention Areas and Associated Features", dated June 2016, evaluated features proposed in the 2016 LRR including options for connecting the MWD Project 8.5 SMA to the C-111 Project, and flow ways through the 8.5 SMA Detention Cell and the NDA and SDA of the C-111 Project, to better maintain a continuous hydraulic ridge along the eastern boundary of ENP that extends from the 8.5 SMA to Taylor Slough. As of July 2019, construction of the C-111 Project was functionally complete.

2.3 S-332B and S-332C Pump Replacement

In 1999, as the C-111 SD Project was beginning to be implemented, the USFWS concluded in a Jeopardy BO that the operation of the Experimental Program, MWD and C-111 SD Projects would jeopardize the continued existence of the endangered CSSS. In response to this Jeopardy BO, construction was expedited on the current S-332B pump station in 2000. The current S-332C pump station was constructed in 2002, also in response to the 1999 Jeopardy BO and subsequent development of the 2002 Interim Operational Plan (IOP) for protection of the CSSS. The pump station capacities were increased, compared to the 1994 C-111 GRR/EIS, primarily to provide additional capacity in conjunction with elimination of the S-332A pump station following the MWD 8.5 SMA modifications approved in the 2000 8.5 SMA GRR and to create more favorable hydroperiods for CSSS habitat in ENP as part of the IOP. The 2016 LRR approved the increase in pump station capacity and codified all the design modifications after the 1994 GRR/EIS.

In April 2014, the ASA(CW) directed the USACE Jacksonville District to proceed with a PACR to evaluate the need to replace the pump stations, possible alternative measures, cost sharing and depreciation payments, in-kind contributions, and the overall schedule. The C-111 SD Project replacement of current pump stations S-332B and S-332C is documented in the "Central and Southern Florida Project, Canal 111 (C-111) South Dade Project Replacement of Current Pump Stations S-332B and S-332C, Final Integrated General Re-Evaluation Report and Environmental Assessment", dated June 2020. The GRR/EA was submitted to the ASA(CW) with a Director's Report on September 15, 2020. Section 401(7)3 of the WRDA 2020, authorized modifications to the C-111 SD Project in accordance with the Director's Report.

3 FUNDING SINCE AUTHORIZATION

The C-111 SD Project replacement of current pump stations S-332B and S-332C has received the following funding allocations since authorization, as detailed in Table 3-1.

Table 3-1. C-111 South Dade Project Pump Stations S-332B and S-332C Replacement Funding Since Project Authorization.

Fiscal Year	Construction	Real Estate	Total Obligation
2021	$278,000		
2022	$300,000		
2023	$299,000		
2024	$1,953,000		
Total(s)	$2,830,000		$2,830,000

4 CHANGES IN SCOPE OF AUTHORIZED PROJECT

Design changes, as detailed in Section 9 and Appendix E, contribute to an increase in the total project costs beyond what was authorized in Section 401 of the WRDA of 2020, substantially in accordance with the 2020 GRR/EA to replace the current S-332B and S-332C pump stations with permanent, hardened structures and the permanent reconfiguration of intake and discharge structures (See Section 10 for description). The environmental benefits of the project features as described in the 1994 GRR/EIS and 2020 GRR/EA will be sustained by completion of the authorized project.

5 CHANGES IN PROJECT PURPOSE

There are no changes to the project purposes of ecosystem restoration and flood mitigation as described in the approved 1994 GRR/EIS and 2020 GRR/EA documents.

6 LOCAL COOPERATION REQUIREMENTS

The replacement of the S-332B and S-332C pump stations is part of the overall C&SF C-111 SD Project. The PCA between the Department of the Army and SFWMD for Construction of Modifications to the C-111 SD Project was executed on January 13, 1995. Amendment No. 1 to the PCA was executed on August 14, 2014. As set forth in the PCA, as amended, the non-Federal sponsor is responsible for specified items of local cooperation for the project, including contributing 50 percent of total project costs, providing all lands, easements, rights-of-way, and suitable borrow and dredged or excavated material disposal areas that the Government determines the non-Federal sponsor must provide for the construction, operation, maintenance of the project, as well as agreement to operate, maintain, repair, replace, and rehabilitate the entire project or the functional portion of the project once it is determined by the District Commander to be complete. An In-Kind Memorandum of Understanding (MOU) Between the Department of the Army and the SFWMD for Construction Work Prior to Execution of Amendment No. 2 to the Project Cooperation Agreement (PCA) for the C-111 Project was executed on September 29, 2020. An Amendment No. 1 to the In-Kind MOU was executed on May 28, 2025.

7 CHANGE IN LOCATION OF PROJECT

Overall authorized project boundaries as shown in Figure 1-3 and Figure 1-4 remain unchanged.

8 REAL ESTATE

All project lands required for replacement construction of the permanent S-332B and S-332C pump stations have been certified to the Government and are readily available for the project. The footprint of the pump stations falls within the limits and right-of-way of lands certified for the C&SF L-31N structure feature, which allows for the project to construct structures considered incidental to the overall C&SF project. Additionally, project lands to the west of L-31N required for construction (including staging, borrow, and stockpile) are available and provided under lands certifications by SFWMD on March 1, 2002, as part of the current S-332B and S-332C pump stations. No additional lands are anticipated to be required for replacement construction of the S-332B and S-332C pump stations.

9 DESIGN AND COST CHANGES

The design of the S-332B and S-332C Pump Stations has advanced from the feasibility level design (less than 10% Design Maturity for the 2020 GRR) to the current design (95% Design Maturity). The final design of the S-332B and S-332C Pump Stations follows the GRR/EA requirements with two modifications to what was authorized. The length of the discharge channel increased and the pump mix for the pump stations was modified. The below paragraph from the 2020 GRR/EA describes the authorized project features that are incorporated into designs for the S-332B and S-332C replacement pump stations.

> Proposed features for the two new pump stations are anticipated to include pump station buildings designed to withstand Hurricane Category 5 force winds, inclusive of pipe gallery, pump equipment room, fan room, workshop, break room, truck bay, access bridge, service bridge, bridge crane, fuel tank area, telemetry, turning vanes, trash rake, backup generator, headwater/tail water stilling well platforms, intake bay from L-31N, discharging to a concrete lined channel and weir. The diesel pumps will be compliant to latest air permit requirements. A shelter building with replacement microwave equipment at the S-332B microwave tower and new fiber optic cable at S-332B and S-332C pump stations will be necessary. The permanent S-332B pump station will also include a 250 cfs vertical lift gate box culvert structure with telemetry including headwater/tail water stilling well platforms. The old pump stations will be demolished upon construction completion and commencement of operation of the new S-332B and S-332C pump stations. The design of the two new pump stations will require a full geotechnical investigation to include the following: shallow and deep borings at each pump station and discharge channel, core borings, percolation tests, seepage testing, piezometers, and seepage modeling. The two pump stations will be designed per SFWMD and USACE design guidelines. USACE design guidelines will supersede SFWMD standards. SFWMD standards may be used in cases where legitimate engineering reasons exist (i.e. in the event USACE standards are incompatible with SFWMD's infrastructure operations), in the absence of USACE standards, and/or if SFWMD has a strong preference towards a specific standard. If preferential use of a standard other than USACE results in a higher cost, a betterment shall be evaluated for cost responsibility of the non-federal sponsor. There will be more detailed hydraulic modeling of the pump stations, intake canals, and the concrete lined discharge channels. A physical model will be required for each pump station to evaluate the proposed hydraulic design, including the intake canal, and to adjust it as necessary.

Additional considerations during preconstruction engineering and design (PED), such as design guidelines updates, building code changes and additional modeling and analysis, have led to cost growths. During design of the S-332B and S-332C replacement pump stations, the USACE Jacksonville District and SFWMD identified three design changes subsequent to the 2020 GRR/EA required for project implementation based on additional modeling and updated design requirements:

1. Discharge channel length (Section 9.1);
2. Pump mix modifications (Section 9.2); and
3. Pump station features to meet updated design guidelines, manuals and building codes (Section 9.3).

This section describes below the design (Sections 9.1, 9.2, and 9.3) and cost changes (Section 9.4) for the S-332B and S-332C replacement pump stations since the 2020 GRR/EA.

9.1 Discharge Channel Modification

This Section 902 PACR describes proposed design modifications to implement Alternative 2 instead of the recommended plan (Alternative 3) identified in the 2020 GRR/EA due to reductions in long-term project OMRR&R costs. A comparison of the two alternative layouts and associated environmental effects are extensively described in the 2020 GRR/EA and Section 11.1 of this Section 902 PACR. Briefly, Alternative 3 releases flows from the S-332B and S-332C replacement pump stations into 1,900-foot discharge channels and alternative 2 releases flows from the

S-332B and S-332C replacement pump stations in 3,600- and 3,200-foot discharge channels, respectively. Discharge channels for the two alternatives were evaluated for a constant pumped discharge of 575 cfs (nominal capacity), 650 cfs (maximum capacity) and 900 cfs (maximum capacity of all pumps, including redundant unit). Subsequent to the 2020 GRR/EA, the two alternatives were developed in detail, including hydraulic modeling, seepage modeling, design, and cost estimates, in addition to detailed life-cycle cost analyses. The seepage analysis served to better understand the movement of groundwater back towards the L-31N Borrow Canal from the SDA and the NDA, and its effect on the project life cycle for pumping and pump maintenance costs.

9.1.1 Seepage Analysis

Section 5.1 of the 2020 GRR/EA identified requirements to complete a full geotechnical investigation during the PED phase to include the following: shallow and deep borings at each pump station and discharge channel, core borings, percolation tests, seepage testing, piezometers, and updated seepage modeling analyses. A cross-sectional groundwater flow model of the Biscayne Aquifer for the SDA, along with surrounding areas to the east and within the ENP, were applied during development of the 2020 GRR/EA to simulate several seepage scenarios involving an estimated range of stages for the SDA, ENP, and L-31N Borrow Canal. Seepage rates computed by the model were highly variable due to uncertainties inherent in both the conceptual hydrostratigraphic model and the model parameters. Accordingly, the model was only suitable for providing order-of-magnitude estimates of seepage needed for cost estimating purposes.

To support PED efforts, the SFWMD's contractor (Royal Consulting Services, Inc.) used the U.S. Geological Survey modular finite-difference flow model (MODFLOW) to develop two discrete seepage models sufficient to compare relative differences in seepage flow back to the L-31N Canal for both alternative configurations of the S-332B and S-332C replacement pump stations. The seepage model development work plan, including the groundwater monitoring network, modeling assumptions, and modeling results, were reviewed in accordance with the approved project review plan (ER 1165-2-217) and closely coordinated with the USACE Jacksonville District during PED efforts. To calibrate and validate the seepage models, additional water level data was collected in the model domain through installation of a groundwater observation well network from December 2021 through March 2022. Seepage modeling (included in Appendix E) summarizes the modeling effort, including conceptual model, model development, results of the evaluation, and recommendations. Consistent with the preliminary seepage analyses described in the 2020 GRR/EA, the results of the seepage modeling indicate that for both the S-332B and S-332C replacement pump models, the Alternative 2 configuration provides the greatest reduction in return flow from the detention areas to the L-31N Canal and reduces recirculation of water into L-31N Canal. The estimated reduction of baseflow to the L-31N Canal attributable to the Alternative 2 discharge channel modification Alternative 2 was approximately 28 million gallons per day (mgd) and 31 mgd for the S-332B and S-332C replacement pump stations, respectively. The S-332B pumpage lost to return seepage through the L-31N Canal is reduced from 38% with Alternative 3 to 27% with Alternative 2. Similarly, the S-332C pumpage lost to return seepage to the L-31N Canal is reduced from 20% with Alternative 3 to 7% with Alternative 2. The reduced seepage return translates to lower long-term pumping and maintenance costs (Table 11-1) than OMRR&R estimates in the 2020 GRR/EA (Appendix F).

The preliminary design was completed by the SFWMD in June 2022, including the hydraulic design analysis (refer to Section 9.1.2) and seepage modeling described above, along with more detailed cost estimates and life-cycle cost analyses.

Following the preliminary design review by the USACE Jacksonville District and SFWMD, a Technical Review Briefing (TRB) occurred on June 15, 2022. At the TRB, the findings from the seepage analysis and the discharge channel life cycle cost evaluation (Appendix E) were presented. At the end of the briefing, USACE Jacksonville District and SFWMD leadership agreed to pursue incorporation of Alternative 2 into the designs of the S-332B and S-332C replacement pump stations. This recommendation was recorded in the TRB Consensus Sheet (Appendix E).

9.1.2 Hydraulic Analysis

The hydraulic modeling served to refine the proposed design of the channels and their associated features. The hydraulic modeling developed for the S-332B and S-332C replacement pump station discharge channels was conducted using Hydrologic Engineering Center-River Analysis System (HEC-RAS) (Version 6.3.1) two-dimensional modeling. Figures 9-1 and 9-2 show the HEC-RAS model extents. The concrete discharge channel lengths for Alternative 2 are approximately 3,600 and 3,200 feet (ft) for the S-332B and S-332C replacement pump stations, respectively. The hydraulic analysis was used to compute Water Surface Elevation (WSE) profiles within the discharge channels for evaluating whether freeboard and velocity design criteria are met, per the following in Appendix E.2:

> The maximum water surface elevation should not exceed an elevation of 10.42 ft for S-332B and should not exceed an elevation of 10.49 ft for S-332C at any location or discharge while using the higher Manning's roughness coefficient for the concrete lining. In each case, the initial geometry grading provides for a minimum of 1.5 ft of freeboard [relative to the levee crest elevation] to the maximum water surface elevation.
>
> The channel velocity evaluation criterion for the initial geometry is as follows. The maximum velocity within the discharge channel should not exceed 4.5 ft/s. This criterion is based on the GRR and follow-up discussions as part of this project.

Each alternative discharge channel length was evaluated for a constant pumped discharge of 575 cfs (nominal capacity), 650 cfs (maximum capacity) and 900 cfs (maximum capacity of all pumps, including redundant unit). For the S-332B replacement pump station, a 250 cfs diversion into the NDA was also included in the modeling scenarios. The maximum allowable WSE in the S-332B and S-332C replacement pump station discharge channels is 10.42 and 10.49 ft North American Vertical Datum of 1988 (NAVD88), respectively. The modeling results indicate the computed WSE for the 900 cfs discharge exceeds the maximum allowable WSE at both S-332B and S-332C. However, the pump stations are not anticipated to be operated at the full 900 cfs capacity due to operational constraints prescribed in the governing Water Control Plan and the associated operational permits issued by Florida Department of Environmental Protection (FDEP) to the SFWMD. Accordingly, the hydraulic analysis has not resulted in design changes and confirms that freeboard specified in the 2020 GRR/EA is sufficient to accommodate the pump mix change. Tables 9-1 and 9-2 summarize results from the hydraulic analysis for the Alternative 2 channel design configuration. More detail on the hydraulic modeling can be found in Appendix E.

A scouring analysis was performed to determine areas where significant local scouring may occur and identify control methods. The analysis can be found in Appendix C.4 ("Scour and RipRap Design Report") of the S-332B replacement pump station Detailed Design Report located in Appendix E of this Section 902 PACR. The most significant scouring was found to occur at the pump station outlet and diversion culvert. These results are evident in both the HEC-RAS and CFD analysis. Riprap placement was based on the results of this analysis, with consideration of locally available limestone rock (145 pounds per cubic foot). The need for riprap downstream of the diversion culvert is exhibited by the velocity contours; see example below in Figure 9-3.

Figure 9-1. Alternative 2 S-332B Replacement Pump Station Hydrologic Engineering Center-River Analysis System Model Extents

Figure 9-2. Alternative 2 S-332C Replacement Pump Station Hydrologic Engineering Center-River Analysis System Model Extents

Table 9-1. Summary of Hydraulic Modeling.

Geometry	Discharge (cubic feet per second)	Maximum Water Surface Elevation (WSE; feet NAVD88[1])	Freeboard between design levee crest elevation and Maximum Allowable WSE (feet NAVD88)
S-332B (Alternative 2)	575	9.99	0.43
	575 (NDA[2] Diversion)	9.28	1.14
	650	10.21	0.21
	650 (NDA Diversion)	9.51	0.91
	900	10.87	-0.45
	900 (NDA Diversion)	10.21	0.21
S-332 C (Alternative 2)	575	9.94	0.55
	650	10.15	0.34
	900	10.8	-0.31

[1] North American Vertical Datum of 1988
[2] North Detention Area

Table 9-2: Summary of Maximum Discharge Channel Velocity (Initial Geometry).

Geometry	Discharge (cubic feet per second)	Maximum Discharge Channel Velocity (feet/second)	Difference to Maximum Allowable Velocity (feet/second)
S-332B Alternative 2	575	4.12	-0.38
	575 (with NDA[1] Diversion)	4.81	0.31
	650	4.48	-0.02
S-332C Alternative 2	575	4.08	-0.42
	650	4.44	-0.06
S-332B Alternative 3	575	3.97	-0.53
	575 (with NDA Diversion)	4.52	0.02
	650	4.38	-0.12
S-332C Alternative 3	575	4.01	-0.49
	650	4.41	-0.09

[1]North Detention Area

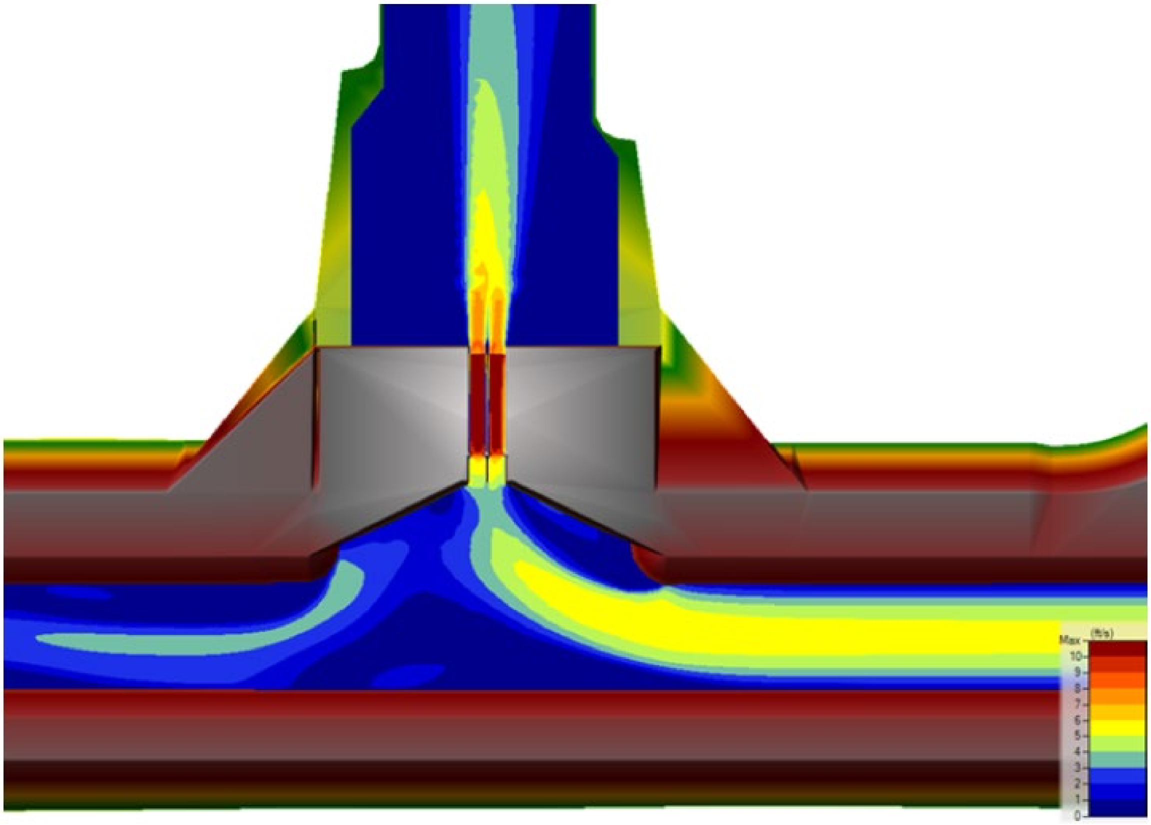


Figure 9-3. North Detention Area (NDA) Discharge Channel Diversion Culvert Velocity Contours

9.1.3 Levee Modifications

The concrete discharge channel lengths for Alternative 2 are approximately 3,600 and 3,200 feet for the S-332B and S-332C replacement pump stations, respectively. For Alternative 3, the channels extended approximately 1,900 feet from each replacement pump station. Due to the extended discharge channels in Alternative 2, the existing levees will require additional modifications than what was required for Alternative 3. For the S-332B replacement pump station, the existing L-321N Levee will require an additional 1,500 feet of degrades (Figure 9-4). Additionally, for the S-332C replacement pump station, the existing L-321S levee will require approximately 1,400 feet of degrades and approximately 250 feet of new levee embankment (Figure 9-5).

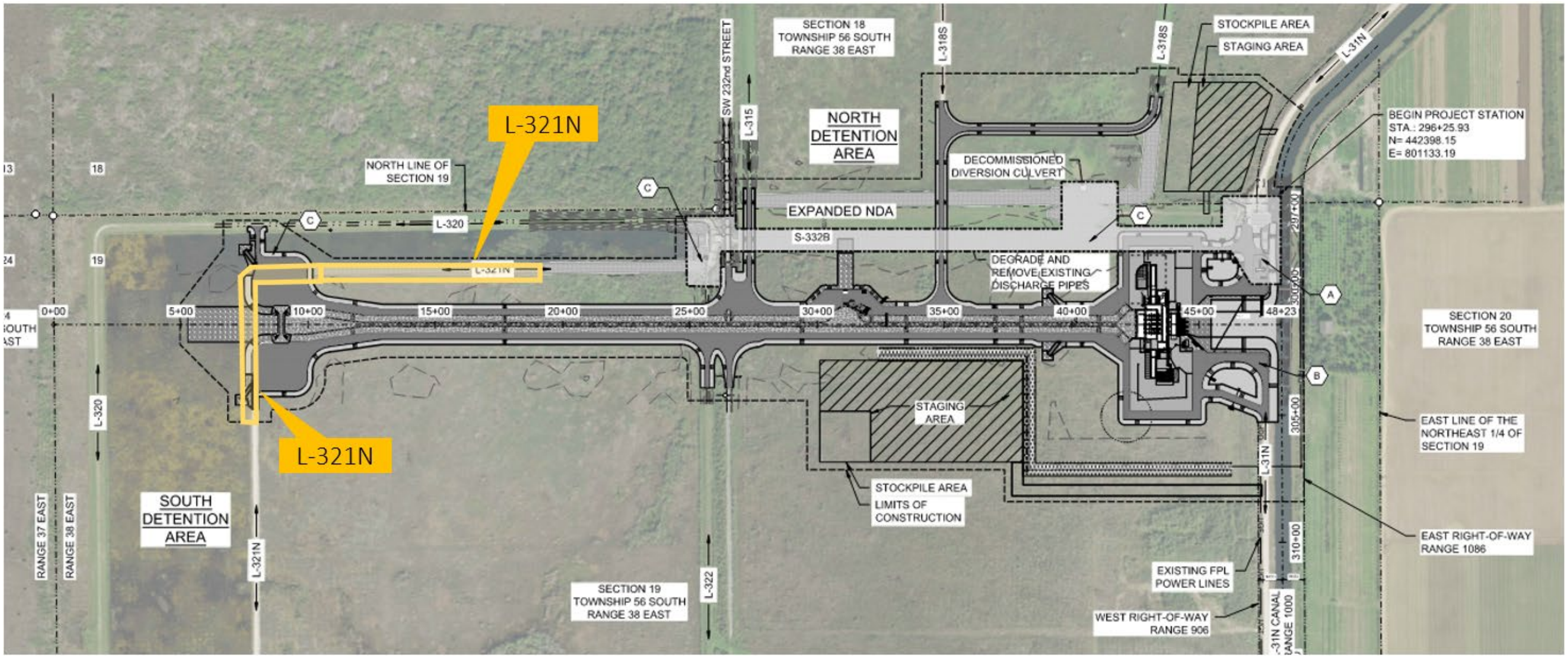


Figure 9-4. S-332B Replacement Pump Station: Additional Levee Modifications Due to Implementation of Alternative 2

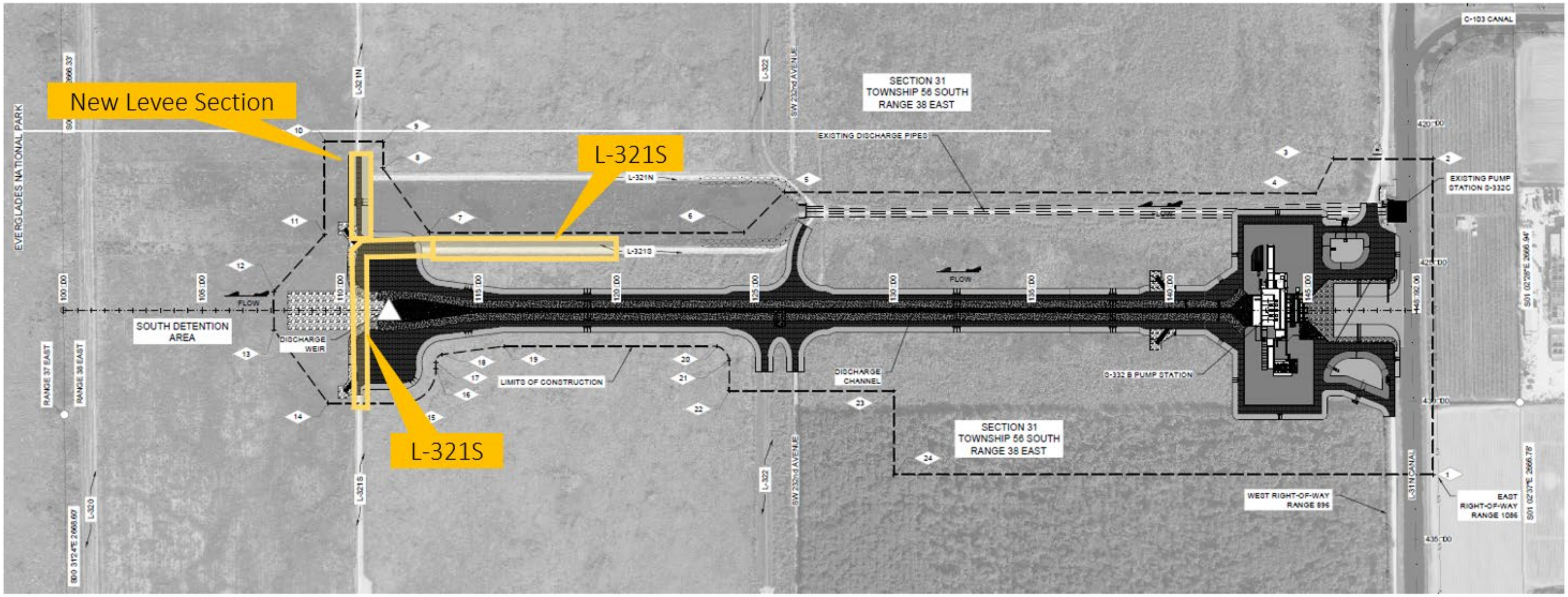


Figure 9-5. S-332C Replacement Pump Station: Additional Levee Modifications Due to Implementation of Alternative 2

9.2 Pump Mix Modifications

9.2.1 2022 Value Engineering Study

The 2022 Value Engineering Study (Appendix E) identified beneficial changes to the 2020 GRR/EA design which would result in cost savings and more efficient project features. Of these changes, Proposal No. PW-24A (pump mix modification) was recommended as the most beneficial change. The original design utilizes four 125-cfs diesel pumps and one 75-cfs electric pump, all running at 100 percent capacity to reach the 575 cfs design requirements. Further, a second electric pump is required to provide backup in case of engine failure and to provide further operational flexibility to manage the NDA and SDA stages. The 2020 GRR/EA authorized design does not provide backup for the diesel pumps, which are the largest pump units. Running any mechanical equipment at 100 percent capacity reduces life expectancy and increases operational costs by decreasing operational efficiency and increasing the required maintenance frequency. For the 2020 GRR/EA authorized pump mix, if one of the diesel-driven pumps breaks down, there is no backup other than running both electric pumps, which effectively limits the design capacity from 575 cfs to 525 cfs. Additionally, electric pumps would require supplementary upsized back-up generators to provide the required power when commercial power outages occur during large storm events. Projects authorized with a flood control component require pump redundancy in accordance with EM 1110-2-3105, Mechanical and Electrical Design of Pump Stations, Paragraph 3.9.c.(6). Due to unreliable power supply during storm events and the increased requirements of electric pumps, diesel pumps will be used to meet the redundancy requirement.

Proposal No. PW-24A from the Value Engineering Study was implemented in the S-332B and S-332C replacement pump station designs. PW-24A changed the pump mix to three 250-cfs diesel pumps and two 75-cfs electric pumps. This change will increase pump life expectancy, reduce maintenance costs, add redundancy in case of a single pump failure, and eliminate one diesel pump. The Value Engineering Study, conducted during intermediate design phase, concluded that proposal PW-24A would save $1,873,000 in construction cost for each pump station. Due to cost growths, the team revisited the Value Engineering Study cost saving for PW-24A during final design. The team found that PW-24A would likely save $4,420,000 in construction costs per pump station based on the same design assumptions but updated with more current estimates.

9.2.2 2021 Pump Station Engineering Guidelines

The SFWMD PSEG dated January 2021 and EM 1110-2-3105 were utilized in both the S-332B and S-332C replacement pump station designs. Section 2.2.1.3 (Environmental Restoration Pump Stations) of the 2021 PSEG states:

> Environmental restoration pump stations are built primarily for environmental restoration needs but may also provide a flood control function. If that is the case, a backup pump with capacity equal to the largest unit shall be provided.

As discussed in Section 2.1, the objectives of the C&SF Project, as modified, are to remove 40 percent of the standard project flood runoff from the drainage area, to reduce depth and duration of larger floods, and to provide water control to prevent over-drainage of the area. The 2020 GRR/EA and Pump Station S-357, which was used as the conceptual design for the S-332B and S-332C replacement pump stations, preceded the 2021 SFWMD PSEG and EM 1110-2-3105 updates. During the subsequent Value Engineering Study, discussed in Section 9.2.1, SFWMD requested that the proposed pump mixes be evaluated for consistency with the 2021 PSEG

The SFWMD Major Pumping Station Engineering Guidelines (MPSEG), 4th Edition dated May 2008 was also reviewed to ensure that redundancy requirements for the authorized pump mixes were met. There are differences between the 2021 PSEG and the preceding 2008 MPSEG, and Section 1.4 (General Design Practices) of the 2008 MPSEG states the following:

> All critical ancillary equipment elements utilized in the pumping station shall have one redundant unit to allow continuous station operation in the event one unit fails or is being maintained. Critical equipment is defined as the 'non-shelf item,' piece of equipment that would shut down pump operations if it failed.

Additionally, Section 2.4 (Pump Selection) of the 2008 MPSEG states:

> The selection of pump machines is based upon the minimum number and size of units required to satisfy the station function and pumping conditions. The pumping stations utilizing large pumps are configured to have a submerged intake and discharge tube system. In selecting the size of units, the number and size of units should be utilized to achieve the total capacity and allow for standardized drivers and reduction gears as well as ancillary equipment. A minimum of three, preferably equal sized, units shall be considered to satisfy the total stormwater flow capacity for station. The risk and effect of lost pump capacity due to an out-of-service unit shall be analyzed, including the proximity of the station to populated areas and whether the station is intended to provide flood damage reduction. If full capacity of the station is a critical requirement with one unit not operable, then a minimum of three units shall be utilized such that 100% of station capacity can be achieved with only two units operable, and one unit shall be redundant.

The Value Engineering Study recommendation to change the pump mix is consistent with the 2021 PSEG and the 2008 MPSEG.

Furthermore, EM 1110-2-3105, Mechanical and Electrical Design of Pump Stations, Paragraphs 3.9.c.(5) and 3.9.c.(6) corroborates redundancy needs for pump stations.

> (5) … Further, the MPSEG requires that all critical items (e.g., cooling water pumps, generators, etc.) used in large flood-control pumping stations have one redundant unit to allow the station to operate continuously in the event a unit fails or is being maintained.
>
> (6) Further, the criterion requires a redundant pump if the pumping systems are for flood risk management.

9.3 Revised Design Criteria Manual

The design of the authorized S-332B and S-332C replacement pump stations was based on the 2005 as-built design of the S-357 Pump Station. S-357 was sponsored by the National Park Service and was not required to follow the same design standards as a SFWMD sponsored project. S-357 was designed more than 20 years before S-332B and S-332C replacements were authorized. Though the C-111 South Dade projects are not CERP pump stations, S-332B and S-332C are designed in accordance with DCM-5 as detailed in the 2020 GRR/EA. The S-357 design did not consider requirements for flood risk management resiliency; the lack of a redundant largest pump to allow continuous station operation or operations and maintenance optimization; and lack of additional space for maintenance while keeping the pump station operational. Additionally, S-357 is a much smaller pump station than the S-332B and S-332C pump stations and does not include many of the pump station features that were described in the 2020 GRR/EA and referenced in the 2020 GRR/EA excerpt discussed in Section 9 of this report. The S-357 pump station was funded by the National Park Service (NPS) in accordance with the Modified Water Deliveries authorization and the plan identified in the 2000 General Re-Evaluation Report and Supplemental Environmental Impact Statement (GRR/SEIS) for 8.5 SMA.

The subsequently updated 2021 SFWMD PSEG contributed to several S-332B and S-332C replacement pump station design changes, such as an increased operating footprint. Use of future PSEG updates was addressed in the 2020 GRR/EA and, accordingly, proposed changes were reviewed by the USACE Jacksonville District and were determined to be justified based on legitimate engineering reasons detailed in this Section 902 PACR. Specific 2021 SFWMD PSEG requirements include the following:

> **Section 2.2.1.3**: requires a backup pump with capacity equal to the largest unit. To reduce the overall number of pumps and associated cost, it was determined that instead of using 4+1 diesel pumps sized for 125 cfs each, which would only allow 500 cfs diesel capacity without redundancy for flood risk resiliency, that 2+1 diesel pumps sized for 250 cfs each would be provided. This configuration would allow 500 cfs diesel capacity and maintain one 250 cfs diesel pump for backup capacity. The larger size of the diesel pumps requires additional footprint of the main pump station building, totaling an increase of approximately 2,670 ft^2 of extra floor space. If the original pump mix was utilized in the design using the 4+1 diesel pumps sized for 125 cfs each, an additional intake bay would have been required. This additional pump would likely have increased the main pump station building by approximately 700 ft^2 of extra floor space as well as added an additional 1,500 ft^2 of extra concrete intake bay.
>
> **Section 6.3.2.4**: requires a driving lane in the main operating floor to be provided at pump stations with large pumps to allow for efficient operations and maintenance activities by allowing a low boy to drive through and load/unload the heavy equipment (primarily pumps and engines). This feature was not prevalent in the S-357 model and therefore not part of the original GRR/EA design; it added an approximately 1,800 ft^2 to the main operating floor.
>
> **Section 7.3.1.1**: SFWMD staffs pump stations with flood risk function during storms. Personnel protections during adverse weather is paramount and therefore requires a pump station control room complex, including the addition of a kitchen, breakroom/office, toilet, as well as an IT room, janitor room, showers, a workshop, and a control room that faces the pumps/engines. Due to the pump station control room complex requirement, as well as other supporting equipment not included in the authorized design, the footprint was increased by approximately 1,800 ft^2.
>
> **Section 8.2.3.3**: requires the diesel day tanks be situated within the pump station building. These day tanks were not considered when basing the design on S-357, which does not account for this feature.

Section 8.2.10: provision for an opening in the main floor slab, which allows the use of the main operating floor bridge crane, to move equipment between the pipe gallery and the main operating floor for operations and maintenance. The footprint required for this feature is approximately 200 ft^2.

Sections 8.1.3 and 8.1.4.1.b.1: The pumps selected require water for both cooling and lubrication. To provide water with the adequate pressure and cleanness (max particle size content) a set of pumps and screens needed to be added to the project, Cooling and lubrication water systems internal to the pump station are not used on S-357 and therefore were not considered in the original GRR/EA design estimate. As a result of this requirement, the operating floor increased in footprint to accommodate the pumps, screens, and storage tank by approximately 600 ft^2, when compared to the original GRR/EA design.

The larger number of pumps and building footprint, along with the requirement to provide a small generator for basic building loads and a standby generator to support pump station operation with a single electric pump in service, required additional and larger motors. This also includes motors associated with the building ventilation equipment, which required larger and also additional generators. As a result, the required additional footprint of the main operating floor was approximately 1,100 ft^2.

UFC 3-600-01 Sections 9-7.2.1.2 and 9-7.2.1.5 require automatic sprinkler protection (1) for multistory facilities, regardless of floor area or construction type, and (2) as required by the International Building Code (IBC) for area, height, or construction type modifications. The IBC and Fire Building Code (FBC) Sections 903.2.4 require automatic sprinkler protection for group F-1 fire areas exceeding 12,000 ft^2. Automatic sprinkler protection is required throughout the entire facility. The requirement for an automatic sprinkler protection in pump stations is a new requirement and not included as part of the original GRR/EA design. The USACE Jacksonville District reviewed the proposed fire protection system on 15 May 2024 and determined that there is a relevant reason and need for the design change.

To comply with 2021 SFWMD PSEG, all items described above have contributed to the total increase of the square footage of the pump stations by approximately 7,000-8,000 ft^2. This increase in pump station features and overall square footage resulted in an increase in the overall cost of each replacement pump station. The design changes affect the size of the cofferdam, foundation, and structure as well as increase the total volumes of concrete and steel in the structure.

9.4 Cost Drivers

A review of the assumptions made during development of the 2020 GRR/EA cost estimate was conducted. Assumptions for the project requirements included demolition of the current pump stations, construction of the replacement pump stations, new intake channels, new discharge channels (both Alternative 2 and 3), discharge channel outfall weirs, new culverts to the NDA for S-332B, and new levees and levee degrades. These assumptions align closely with what is designed. However, the level of design in the 2020 GRR/EA was conceptual and does not meet current best practice design maturity requirements with a Class 3 estimate described in ER 1110-2-1302.

The 2020 GRR/EA lacked sufficient design maturity and applied portions of other similar pump stations, primarily S-357, to complete the planning level cost estimate for the S-332B and S-332C replacement pump stations (Table 9-3).

Table 9-3. Differences Between Authorized Project First Cost and Current Project First Cost (FY26 price level).

Cost	Authorized Project First Cost (FY26 Price Level)	Current Project First Cost (FY26 Price Level)	Difference
Total Project Cost	$174,463,000*	$954,561,000	$780,098,000

*Calculation methodology used by Cost Engineering differs from the approach used in Table EX-1's Section 902 Authorized Project First Cost (FY26 Price Level) calculation.

The primary work breakdown structure categories driving cost increases associated with S-332B and S-332C replacement pump station design changes are:

- Channels and Canals (WBS 09), and
- Pumping Plant (WBS 13).

The project design has progressed from planning to implementation consistent with normal design practices. The increased number of pump station features and overall footprint that were required to accommodate changes to the pump configuration are the design changes that have the most significant effect on the total project cost (Table 9-4).

Table 9-4. Differences in Costs Drivers by Work Breakdown Structure without Contingency (FY26 price level)

Cost Driver by Work Breakdown Structure (WBS)	Breakdown of 2020 Authorized Project First Cost (FY21 Price Level)	Breakdown of 2020 Authorized Project First Cost (FY26 Price Level)	Current Project First Cost (FY26 Price Level)	Difference
09 CHANNELS & CANALS	$13,686,000 [1]	$17,889,000	$92,969,000	$75,080,000
13 PUMPING PLANT	$63,665,000	$83,217,000	$442,282,000	$359,065,000
Subtotal Construction Cost (w/o Contingency)	**$ 77,351,000**	**$101,106,000**	**$535,251,000** [2]	**$434,145,000**
01 LANDS AND DAMAGES	-	-	-	-
30 PLANNING ENGINEERING & DESIGN	$13,647,000	$17,838,000	$87,652,000 [3]	$69,814,000
31 CONSTRUCTION MANAGEMENT	$9,358,000	$12,232,000	$64,626,000	$52,394,000

CONTINGENCY - CONSTRUCTION, PED (30), S&A (31)	$33,117,000	$43,287,000	$267,032,000	$223,745,000
Totals:	**$133,473,000**	**$174,463,000**	**$954,561,000**	**$780,098,000**

[1]Account 09 Channels & Canals for the FY21 Certified First Costs (**$13,686,000** = $12,426,000 + $1,260,000) includes cost associated with the Outfall Parallel Weir previously accounted on Feature 15 - FLOODWAY CONTROLS & DIVERSION STRUCTURES ($1,260,000).

[2]Slight difference (+$1,000) from Total Project Cost Summary due to truncation impacts on rounding. The final total of $954,561,000 matches.

[3]Feature 30 – Preconstruction Engineering & Design shown for the FY26 First Costs includes $2,830,000 Spent Thru ($84,822,000 + $2,830,000 = $**87,652**,**000**).

Table 9-5. Line-Item Breakdown of Work Breakdown Structures.

Work Breakdown Structure Number	Civil Works Work Breakdown Structure	Scope Change Cost Growth (FY26 Price Level)
09	**CHANNELS & CANALS**	**$75,080,000**
	Canal Excavation / Levee Degradation	*$8,247,000*
	Canal: Embankment Construction/Outfall Weir Construction	*$54,440,000*
	Discharge Channel Concrete Lining	*$7,331,000*
	Stilling Well/Monitoring Platform Plan	*$1,951,000*
	General Sitework (Site Prep, Sodding)	*$3,111,000*
13	**PUMPING PLANT**	**$359,065,000**
	General (Pre-Construction, Temp Access/Services, etc.) and Dewatering	*$22,562,000*
	Cofferdam, Piles, Seal Slab	*$30,856,000*
	Intake Structure, Wingwalls, Energy Dissipation Pool	*$46,432,000*
	Structural Components: Superstructure & Substructure	*$44,541,000*
	Architectural (including Miscellaneous Metals)	*$7,480,000*
	Side Buildings (Make-Up Pump Building, Control Building, IT / Microwave Tower Building & Underground Tank	*$5,941,000*

	Process Mechanical (Pump Mix, Bar Screen Assembly, Overhead Cranes, Fuel Systems, Other Equipment, Etc.)	*$112,179,000*
	Electrical	*$21,740,000*
	HVAC/Plumbing	*$2,041,000*
	Instrumentation & Controls	*$11,637,000*
	Fire Protection, including Fire Building	*$3,962,000*
	Earthwork and Exterior Improvements	*$19,554,000*
	Site Utilities	*$10,457,000*
	S-332B & S-332C Demolition	*$19,683,000*

9.4.1 Channels & Canals (WBS 09)

The Channels & Canals Work Breakdown Structure (WBS) (Table 9-4) gives a detailed breakdown of the 2020 GRR/EA cost estimate and the certified cost in Appendix A. The Channels & Canals WBS is broken out into five subcategories: Canal Excavation / Levee Degradation, Canal: Embankment Construction/Outfall Weir Construction, Discharge Channel Concrete Lining, Stilling Well/Monitoring Platform Plan, and General Sitework (Site Prep, Sodding) (Section 9.4.1.1). The first three are related to cost increases associated with construction of the discharge channel. Some of these costs are a result of the increased discharge channel length (Alternative 2) and others are associated with the increased embankment cross sections that were made during the detailed design process. The Stilling Well/Monitoring Platform Plan section is a singular item that is discussed in Section 9.4.1.2. Site preparation would see increases (or decreases) depending on expansion or detraction of expected site needs, mobilization assumptions, feature sizing, etc. Sodding is required along levees and outside of the discharge channel. Changes to feature lengths would change this cost. No subsection will be created to further discuss General Sitework.

9.4.1.1 Canal Excavation / Levee Degradation, Canal: Embankment Construction/Outfall Weir Construction, Discharge Channel Concrete Lining

The cost for the discharge channels has increased due to the discharge channel cross sectional area width and height increases from planning phase to final design. The assumed cross-sectional area in the 2020 GRR/EA was less than the cross-sectional area of the final design. The 2020 GRR/EA estimate assumed an embankment crown width of 12 ft, a height of 6 ft and side slopes of 4H:1V. These measurements were taken from a document in the GRR estimate titled "Assumptions in Alternatives Cost Estimate (dated July 25, 2019)." The final design has an embankment crown width of 20 ft, a height of approximately 8 ft, interior side slopes of 4H:1V and exterior side slopes of 3H:1V. The crown width increase from 12 ft to 20 ft is to allow for maintenance vehicles to pass each other without stopping ongoing activities, such as a crane or excavator loading trucks. The cross sections from the 2020 GRR/EA to the final design increased from 216 ft^2 to 384 ft^2. This equates to a 78% increase in the embankment cross-sectional area.

Dimensions of the final design discharge channel cross-section are provided in Figure 9-6. A comparison of the 2020 GRR/EA dimensions and final design discharge channel cross-sections are provided in Figure 9-7.

During final design submittal review, a reduction of the cross-sectional area was investigated as a cost saving measure. Design Criteria Memorandum 4, DCM-4, states that the minimum levee crown width is 12 ft. During review, SFWMD Operations requested that the crown width be 20 ft to improve maintenance access because the channel embankments will not include a 50 ft maintenance berm at the embankment toe. The lack of a maintenance berm is due to minimizing effects to adjacent wetlands, which is common for SFWMD levees. Reduction of crown width from 20 ft to 12 ft was ultimately rejected due to maintenance access requirements. The crown width of 20 ft was deemed a necessary requirement so that future maintenance vehicles can pass each other after being loaded without having to reverse thousands of feet down the embankment.

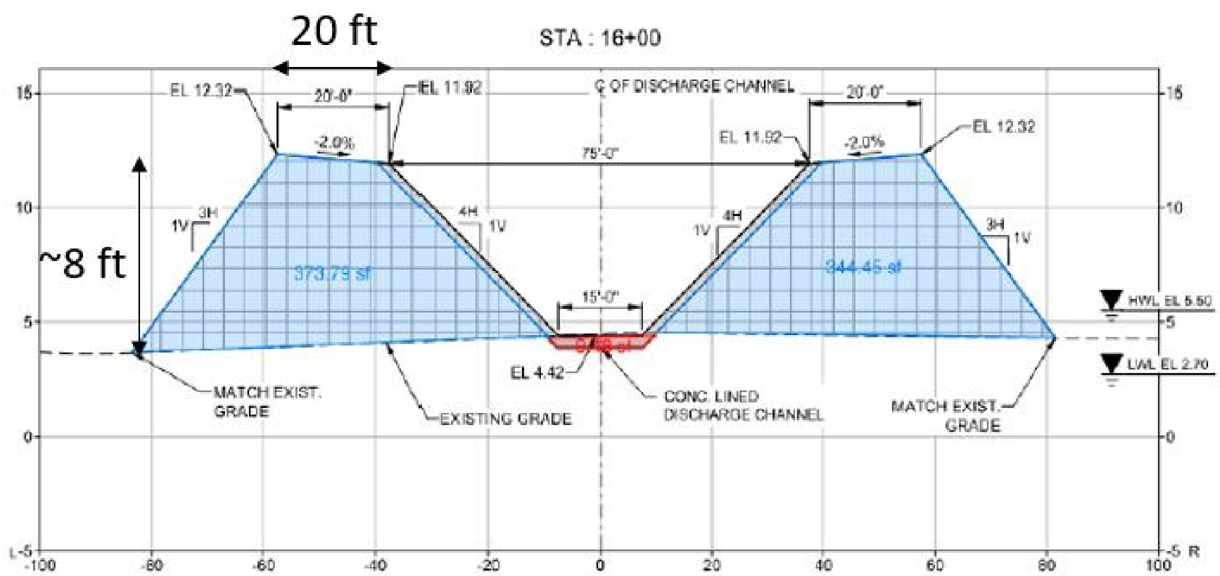


Figure 9-6. S-332B Replacement Pump Final Design Cross Sectional Area

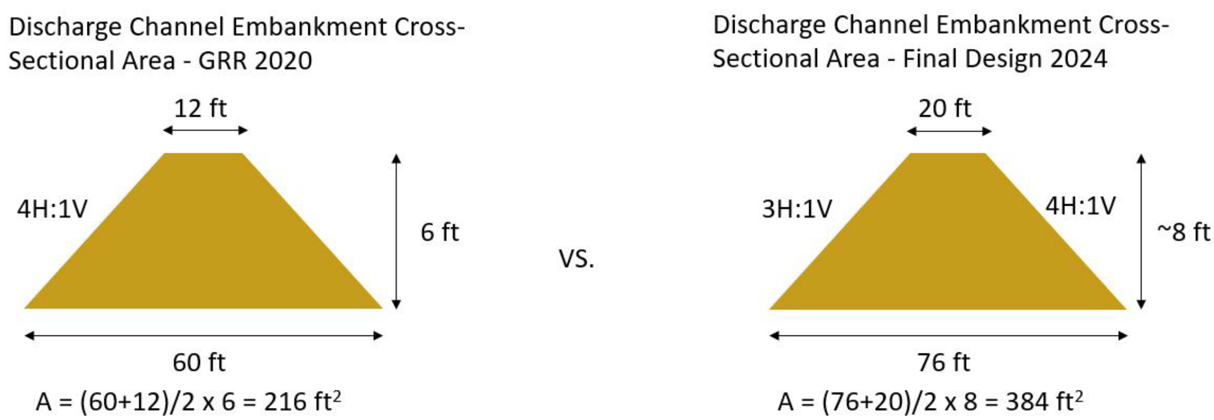
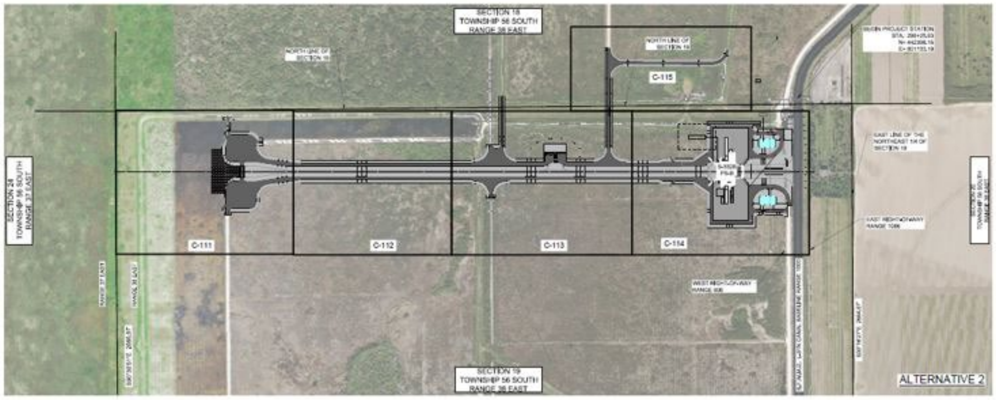


Figure 9-7. 2020 General Re-Evaluation Report and Environmental Assessment compared to S-332B Replacement Pump Final Design Discharge Channel Cross-Sectional Areas

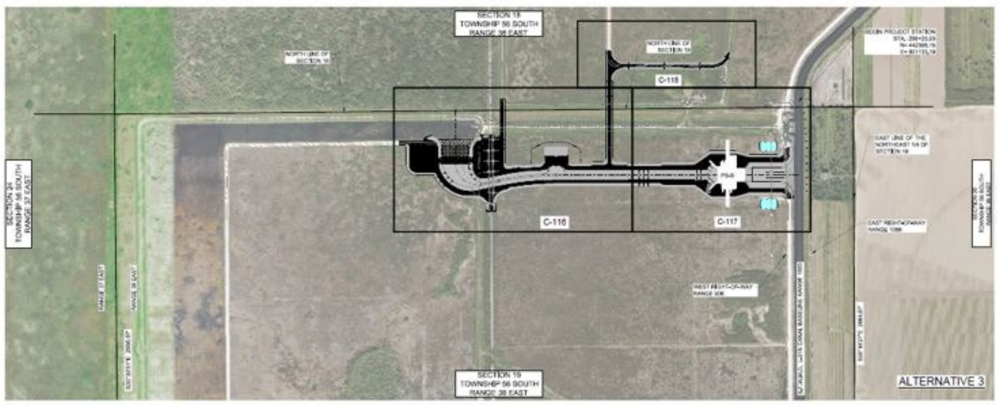
Cumulatively, the three WBS subsections, Canal Excavation / Levee Degradation, Canal: Embankment Construction/Outfall Weir Construction, Discharge Channel Concrete Lining, have a cost increase of approximately \$75M. Of that, approximately \$16.5M is related to extension of the discharge channels from the Alternative 3 to Alternative 2 options (Table 9-6). Earthwork requirements for pump stations and discharge channels construction are described below. The 2020 GRR/EA estimate determined that the discharge channels and levee modifications would require 77,191 yds^3 of fill material (see Section 9.4.1.1.2). The design volumes required for the discharge channels and levee modifications for both S-332B and S-332C are a combined 244,413 yds^3 of fill material. This equates to a difference of 167,222 yds^3 of fill material needed. The 2020 GRR/EA underestimated the total cost of site preparation/clearing requirements, embankment material requirements, and the total modifications required to the existing levees. The 2020 GRR/EA estimate also did not account for the cost associated with maintenance features for the channels, such as wider crown width for maintenance vehicle access, boat ramps, maintenance access to the NDA culvert structure, and turn around requirements adjacent to the weirs. The increase in Discharge Channel Concrete Lining cost is primarily related to additional concrete and bedding stone requirements related to the discharge channel lengthening.

9.4.1.1.1 Discharge Channel Extension Cost

The 2020 GRR/EA assumptions and cost estimate were reviewed and compared to the S-332B and S-332C replacement pump stations final designs and cost estimate to document any cost changes. The 2020 GRR/EA cost estimate included the shorter discharge channels (Alternative 3) whereas the final designs include the long channels (Alternative 2). The decision to change from Alternative 3 to Alternative 2 is described in Section 9.1.1. Both Alternative 2 and Alternative 3 include the discharge weirs and gated culvert for the S-332B replacement pump station. Both Alternative 2 and Alternative 3 have similar earthwork requirements (Figures 9-8 and 9-9). The main difference is the extended cross section through the center of the discharge channel. Alternative 2 lengthens the discharge channels by approximately 1,700 ft for the S-332B replacement pump station and 1,500 ft for the S-332C replacement pump station.



S-332B Long Discharge Channel Layout



S-332B Short Discharge Channel Layout

Figure 9-8. S-332B Long (Alternative 2) and Short (Alternative 3) Discharge Channel Layouts (figures taken from Preliminary submittals and do not match the Final pump station layout)

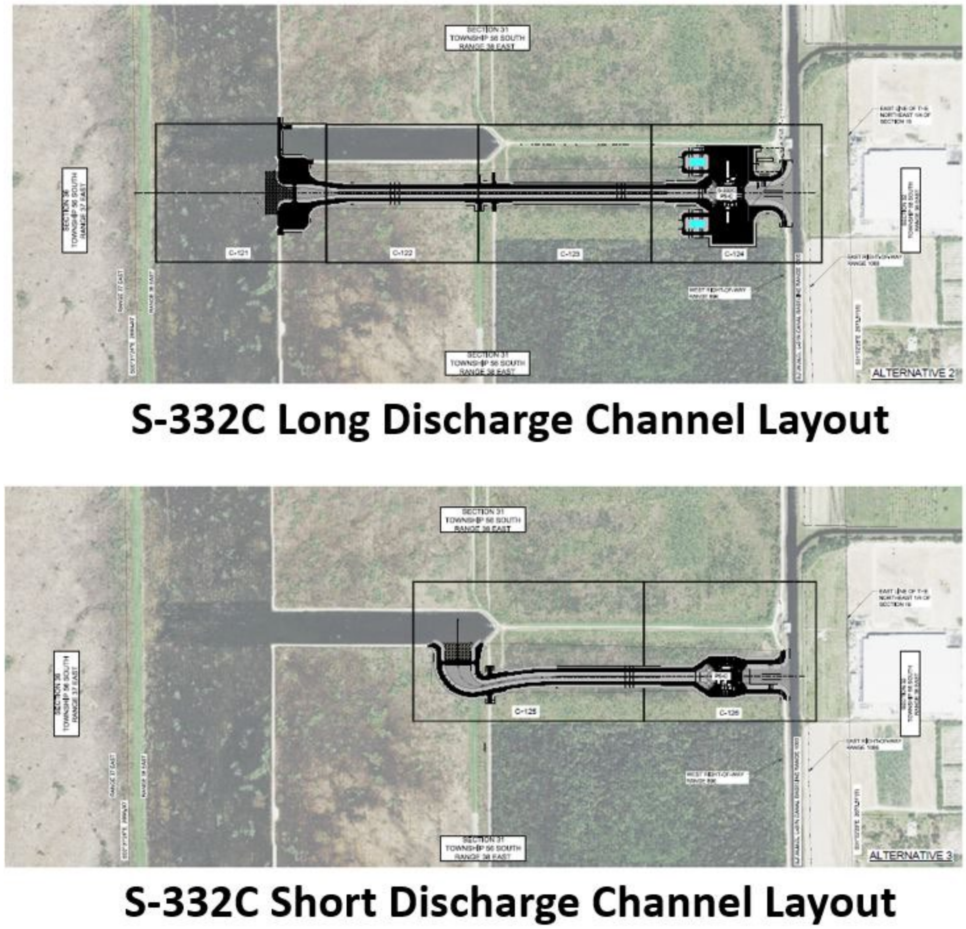


Figure 9-9. S-332C Long (Alternative 2) and Short (Alternative 3) Discharge Channel Layouts (figures taken from Preliminary submittals and do not match the Final pump station layout)

Lengthening of the discharge channel increases the cumulative cost due to increases in land clearing requirements, volume of embankment placements, volume of bedding stone placement and increases in volume of reinforced concrete placement. Table 9-6 below itemizes the additional costs associated with Alternative 2. Table 9-6 does not include any additional levee modifications that differ from the 2020 GRR/EA estimate. Lengthening the discharge channels was found to increase the project cost by $8,931,827 for the S-332B replacement pump station and $7,539,595 for the S-332C replacement pump station (Table 9-7).

Table 9-6. Additional Cost of Alternative 2 Option.

Item	Description	Calculation	Cost per Unit	Cost
S-332B Additional Clearing	North Embankment, South Embankment and Channel Bottom	[(76 + 15 + 76) x 1,700] /43,560 = 6.52 Acres	$29,409 per acre	$191,747

S-332B Channel Embankments	North and South Embankments	2 x (384 x 1,700) / 27 = 48,356 cubic yard (cy)	$106 per cy	$5,125,736
S-332B Bedding Stone (9 inches)	North and South Embankments and Channel Bottom	[(33 + 15 +33) x 9/12 x 1,700] /27 = 3,825 cy	$248.26 per cy	$949,595
S-332B Channel Concrete and Reinforcement (6 inches)	North and South Embankments and Channel Bottom	[(33 + 15 +33) x 6/12 x 1,700]/27 = 2,550 cy	$1,045 per cy	$2,664,750
S-332C Additional Clearing	North Embankment, South Embankment and Channel Bottom	[(76 + 15 + 76) x 1,500] /43,560 = 5.75 Acres	$29,409 per acre	$169,102
S-332C Channel Embankments	North and South Embankments	2 x (384 x 1,500) / 27 = 42,667 cy	$98 per cy	$4,181,366
S-332C Bedding Stone (9 inches)	North and South Embankments and Channel Bottom	[(33 + 15 +33) x 9/12 x 1,500] /27 = 3,375 cy	$248.26 per cy	$837,878
S-332C Channel Concrete and Reinforcement (6 inches)	North and South Embankments and Channel Bottom	[(33 + 15 +33) x 6/12 x 1,500]/27 = 2,250 cy	$1,045 per cy	$2,351,250
S-332B Cumulative Increase for Alternative 2				**$8,931,827**
S-332C Cumulative Increase for Alternative 2				**$7,539,595**
• Embankment material is provided by nearby stockpiles. • Bedding stone material is not provided.				

9.4.1.1.2 Earthwork Cost

A major component of the C-111 Project Replacement of Current Pump Station S-332B and S-332C includes the large quantity of earthwork required to construct the discharge channel embankments and for various project sites around the pump station, diversion culvert, and intake channel. Due to a lack of design maturity, the subsequent accounting of the cut and fill requirements in the 2020 GRR/EA underestimated the earthwork needed. The 2020 GRR/EA estimate included the discharge channel embankments, levee modifications, and some of the backfilling around the S-332B and S-332C replacement pump stations (Table 9-8). The 2020 GRR/EA estimate does not include excavation for the intake canal and significantly underestimated fill requirements around the S-332B and S-332C replacement pump stations (Table 9-9). Site surveys show that existing grade near the S-332B replacement pump station varies between 4.0-5.3 ft NAVD88 and the S-332C replacement pump station varies between 3.5-4.5 ft NAVD88. The final grades for the S-332B replacement pump station varies between 10.8-14.0 ft NAVD88 and the S-332C replacement pump station varies between 11.0-13.1 ft NAVD88. This increased elevation around the pump stations is required to be above flooding elevations and to connect to the L-31N levee. During design of the S-332B and S-332C replacement pump stations, seven available stockpiles were surveyed and geotechnically tested to confirm their use as construction fill material. The stockpiles will supply most of the earthwork for construction of both pump stations (Figure 9-10). A borrow pit location has been selected for any additional earthwork material required. The proposed 940x570 ft borrow pit is limited to 10-ft deep to avoid hitting a highly permeable zone of the aquifer and includes 3H:1V side slopes for safety. The recommended geometry yields approximately 178,600 CY of material (including a 10% waste factor). The difference between the required fill for both pump stations and the onsite fill plus the nearby stockpiles is approximately 38,000 CY. The proposed borrow pit location provides well over the required amount of available fill material in addition to the seven stockpiles.

Table 9-7. Earthwork in 2020 General Re-Evaluation Cost and Environmental Assessment Cost Estimate.

	S-332B (Cubic Yards)	**S-332C (Cubic Yards)**
Discharge Channel Embankments	35,200	33,440
Levee Modifications	5,700	2,851
Pump Station- Excavation of Organic Material	800	800
Pump Station- Excavation of Cap Rock	6,000	6000
Pump Station- Excavation of Soil	8,530	8530
Pump Station- Backfill Around Pump Station	853	964
Total:	57,083	52,585
Cumulative Total	**109,668**	

Table 9-8. Design Earthwork Volumes

	Required Fill (Cubic Yards)	**Onsite Fill (Cubic Yards)**	**Nearby Stockpiles (Cubic Yards)**	
S-332B Discharge Channel and Associated	127,514	7,576	119,938	Stockpile 6 (100%)

Structure (S-332BX1) Replacements				Stockpile 5 (100%) Stockpile 4 (87%)
S-332B Pump Station Replacement	121,255	78,552	42,703	Stockpile 4 (13%) Stockpile 2 (46%)
Total:	**248,769**	**86,127**	**162,641**	
S-332C Discharge Channel Replacement	116,899	33,027	83,872	Stockpile 2 (55%) Stockpile 3 (89.7%)
S-332C Pump Station Replacement	87,304	50,475	27,645	Stockpile 3 (89.7%) Stockpile 7 (100%) Stockpile 1 (100%)
Total:	**232,978**	**83,502**	**111,517**	
Cumulative Total	**481,747**	**169,629**	**274,158**	

- Stockpile values listed include a 15% waste factor
- Volumes in table are from Intermediate Submittals. Volumes may fluctuate +/- 10% during Final Design

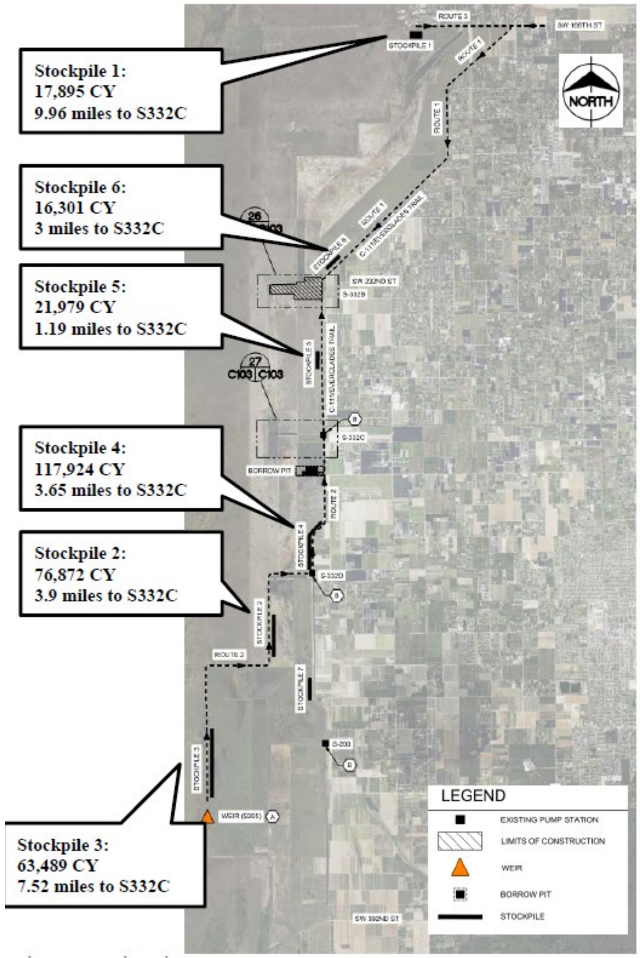


Figure 9-10. Available Stockpile Locations for the C-111 SD Project Pump Stations S332-B and S-332C Replacement, Miami-Dade County, Florida

9.4.1.2 Stilling Well/Monitoring Platform Plan

In accordance with the 2021 SFWMD PSEG:

> Stilling wells shall be located off the canal embankments upstream and downstream of the pump station. Walkways from embankments to stilling wells shall be provided. The stilling wells are to be installed a minimum 150-ft away from new diversion culvert to avoid disturbance in readings, the same approach was implemented for the first stilling well downstream of the pump station.

The final design of the S-332B replacement pump station included a total of four stilling wells with associated monitoring platforms. The intake channel and discharge channel, just downstream of the pump station, each include one stilling well. The diversion culvert includes two stilling wells, one upstream and one downstream. The S-332C replacement pump station will likely require only two stilling wells due to the discharge channel not including a culvert.

There is an expected total of six stilling wells and associated monitoring platforms for the discharge channels. The 2020 GRR/EA estimate did not include stilling wells. There are additional stilling wells that will be in the pump station bays, but these are included in the pumping plant WBS 13.

9.4.2 Pumping Plant (WBS 13)

The Pumping Plant WBS (Table 9-4) gives a detailed breakdown of the 2020 GRR/EA cost estimate and the final cost estimate. The Pumping Plant WBS is broken out into fourteen subcategories: General (Pre Construction, Temp Access/Services, etc.) and Dewatering; Cofferdam, Piles, Seal Slab; Intake Structure, Wingwalls, Energy Dissipation Pool; Structural Components: Superstructure & Substructure, Architectural (including Miscellaneous Metals), Side Buildings (Make-Up Pump Building, Control Building, IT / Microwave Tower Bldg & Underground Tank; Process Mechanical (Pump Mix, Bar Screen Assembly, Overhead Cranes, Fuel Systems, Other Equipment, Etc.); Electrical; HVAC/Plumbing; Instrumentation & Controls; Fire Protection, including Fire Building; Earthwork and Exterior Improvements; Site Utilities; and current pump stations S-332B and S-332C Demolition. Electrical, Instrumentation & Controls, and Site Utilities are discussed in section 9.4.2.7.

9.4.2.1 General (Pre-Construction, Temp Access/Services, etc.) and Dewatering

The WBS subcategory of General was created to account for requirements to the contract that did not fit into the specific subcategories. Examples include site maintenance cost for the project duration, contractor administration and submittal preparation, training for operations personnel following construction and commissioning of the pump stations, baseline survey cost, erosion control, site safety program, on-site management, temporary utilities and the quality control/quality assurance program.

Dewatering well and pumping operation costs have increased from the 2020 GRR/EA estimate. Due to the increased size of the cofferdam (section 9.4.2.2) and dewatering requirements for other project features, dewatering cost has grown to $1.8M per pump station.

9.4.2.2 Cofferdam, Piles, Seal Slab

The 2020 GRR/EA cost estimate utilized the S-357 pump station for the structural portions of the estimate. The S-357 pump station is comprised of five pumps, four 125 cfs pumps and one 75 cfs pump. The S-332B and S-332C replacement pump stations were authorized with six pumps, four 125 cfs pumps and two 75 cfs pumps. To account for the additional pump, the estimate was increased by a factor of 6/5. The S-357 pump station included a cofferdam, but the square footage for the pump station cofferdam was 5,624 ft^2 (80 ft x 70 ft 3 5/8 inches). The S-357 pump station cofferdam tremie seal was comprised of a 6 ft thick slab, from elevation -13.5 ft to -19.5 ft NAVD88, with a total of 56 anchors comprised of 6-inch auger cast piles encasing 1 in diameter steel anchors (Figure 9-11).

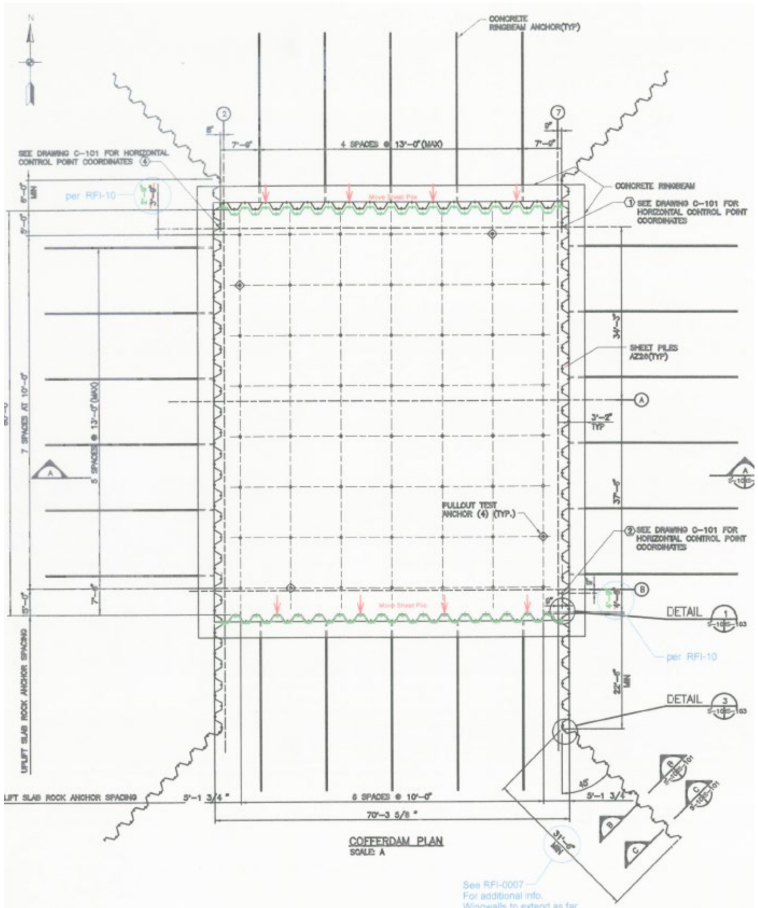


Figure 9-11. S-357 Cofferdam Plan

The final design of the S-332B replacement pump station cofferdam is much larger than the S-357 cofferdam. The S-332B replacement pump station cofferdam is approximately 20,300 ft^2 and includes a second cofferdam for the Energy Dissipation Pool foundation to be completed later in the construction process. The Energy Dissipation Pool cofferdam is approximately 8,000 ft^2. The S-332B replacement pump station cofferdam tremie seal is comprised of a 6.5 ft thick slab, from elevation -20.6 ft to -27.1 ft NAVD88, with a total of 347 anchors comprised of 60.2 ft long HP12x53 H-pile anchors. The S-332B replacement pump station Energy Dissipation Pool cofferdam tremie seal is comprised of a 10 ft thick slab, from elevation -6 ft to -16 ft NAVD88 (Figures 9-12 and 9-13).

The cumulative $30.9M cost increase for the S-332B replacement pump station is evident when compared to the S-357 pump station cofferdam. The cofferdam for S-332B is deeper and larger in area with a thicker tremie seal and more and longer anchor piles.

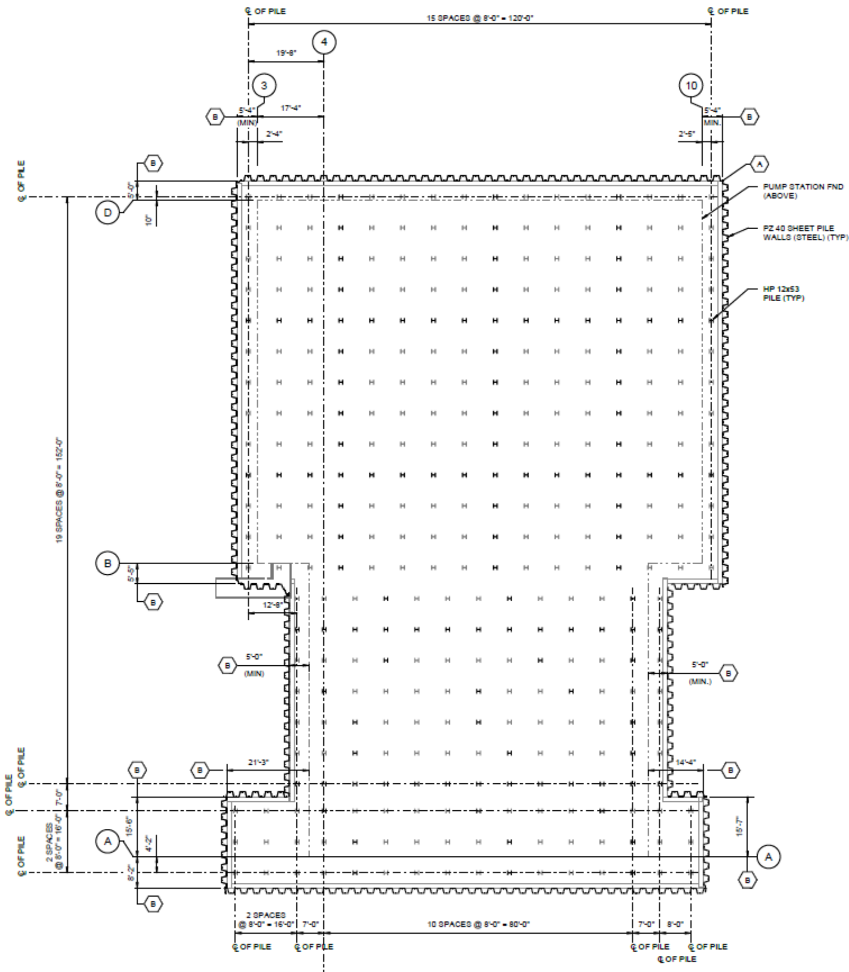


Figure 9-12. S-332B Replacement Pump Station Cofferdam Plan

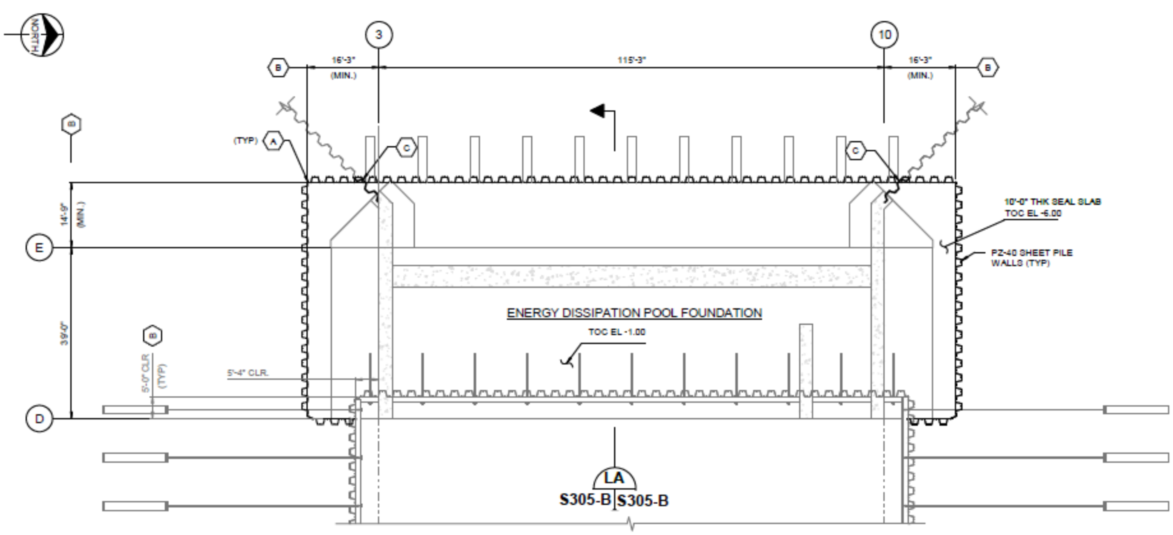


Figure 9-13. S-332B Replacement Pump Station Energy Dissipation Pool Coffer Dam

9.4.2.3 Intake Structure, Wingwalls, Energy Dissipation Pool

Although the 2020 GRR/EA discussed the S-332B and S-332C replacement pump stations being located 300 ft downstream along L-31 canal and 300 ft further west from their respective current locations, no description of the width and depth of the intake canal was detailed. The 2020 GRR/EA cost estimate was reviewed for earthwork requirements, and it was found not to include any cost associated with construction of the intake canal for either the S-332B or S-332C replacement pump station. There was also no cost estimate in the 2020 GRR/EA for concrete lining of the intake canal or for the three concrete vanes.

During the Physical Hydraulic Model Study, the intake canal/structure was modeled with and without the vanes, which the model report references as guide walls and vanes. The Physical Hydraulic Model Study concluded,

> The forebay guide walls are not required to meet the Hydraulic Institute and USACE acceptance criteria and can be removed if desired.

Following the physical model study, the vanes were removed from the design.

The final design of the intake canal/structure was largely in accordance with SFWMD's Computational Fluid Dynamics (CFD) modeling that was provided. The intake canal was designed with internal slopes of 2.5H:1V to meet the slope stability requirements. The bottom width of the intake canal is 100 ft wide and will tie into the existing L-31N canal banks with a 20-ft radius curve. The intake channel slopes will be armored with rip-rap but velocities in the intake channels do not require canal bottom armoring.

The driving factor for the intake channel cost increases is that the 2020 GRR/EA estimate did not include costs for canal excavation, vanes, and concrete lining. Although these items were proposed in the 2020 GRR/EA, the vanes and concrete lining were determined not to be required.

The intake canal cost also includes sheetpile for both the intake canal adjacent to each pump station and along the energy dissipation pool and weir on the pump station discharge side. The canal bottom is not concrete lined, but the intake bays and energy dissipation pool on the discharge side include sheet pile / concrete walls as well as concrete bottoms. This results in a significant increase in cost when compared to the S-357 pump station that was used to determine the 2020 GRR/EA cost estimate.

9.4.2.4 Structural Components: Superstructure & Substructure

The roughly 7000 ft^2 increase for each replacement pump station, primarily caused by design requirements updated since authorization of the 2020 GRR/EA and lack of design maturity consistent with current best practice, resulted in a concomitant increase in volume of structural components. The amount of Cast-In-Place and Precast concrete are the main drivers of this increase, resulting from a larger seal slab, increased substructure volume, an additional superstructure for the attached electrical/control building, and taller pump station superstructure to accommodate the bridge crane.

9.4.2.5 Architectural (including Miscellaneous Metals)

The addition of a control room, day tank room, operations room, safe room, electrical/control rooms, and support facilities, as required by the SFWMD 2021 PSEG for operations and maintenance and flood risk management resiliency, raises cost of the building's architectural components. These rooms require specific designs, materials, and construction methods to meet facilities requirements. For instance, the pump station includes elevated design wind velocities and safe room requirements to ensure operators' safety during hurricane storm events. This leads to increased costs for furniture, plumbing fixtures, windows, climate control, and flooring. Metal building components have also increased throughout the S-332B and S-332C replacement pump station designs due to the size increase and project requirements. Items such as handrails, stairs, steel bracing, windows, louvers, doors, and roll-up doors have increased as the design matured. The cost of these items was not considered in the 2020 GRR/EA because there were minimal support facilities included on the S-357 pump station.

9.4.2.6 Process Mechanical (Pump Mix, Bar Screen Assembly, Overhead Cranes, Fuel Systems, Other Equipment, Etc.)

Mechanical components for the S-332B and S-332C replacement pump stations have significantly increased throughout design. As part of the submittal packages, multiple estimates for the pumps and trash racks were provided from the manufactures. The bare cost for a 125 cfs pump has increased by a factor of 4.5 over a 5-year period (Table 9-9). The trash racks have increased by a factor of 3.8 over a 4-year period (Table 9-9).

Table 9-9. Historical Mechanical Component Costs from Manufacturers.*

Date of Estimate	Pump Size		
	75 cubic feet per second (cfs)	**125 cfs**	**250 cfs**
July 2019	$478,765	$462,620	
August 2021		$815,625	
September 2023	$1,389,100		$3,256,466
February 2024		$2,073,200	
November 2024	$1,389,100	$2,073,610	$3,256,466
September 2025	$1,923,369	$2,871,152	$4,508,953
	Trash Racks		
July 2019	$991,246		
June 2023	$3,800,000		
September 2025	$5,021,000		

* Costs do not include mark ups, installation, or transportation

9.4.2.6.1 Pump Mix Cost

During planning phase, the S-332B and S-332C pump stations were assumed to have a total capacity of 650 cfs. However, as discussed in Section 9.2, total pump station capacity was increased to 900 cfs (maximum capacity of all pumps, including redundant unit) during design to account for flood risk management resiliency. The parametric estimate completed for the 2020 GRR/EA cost estimate assumed that a 650 cfs pump station would cost $40.5M ($57M FY26 Price Level) each. If the redundant pump mix was used during the planning phase, the parametric estimate for a 900 cfs pump station would have increased the cost for each pump station to $56.1M ($78.5M FY26 Price Level). This would have increased the total estimate for both the S-332B and S-332C replacement pump stations by $31.2M ($43.6M FY26 Price Level).

As discussed in Section 9.2, the Value Engineering Study recommended to modify the pump mix from the authorized four 125-cfs diesel pumps and two 75-cfs electric pumps to the current design of three 250-cfs diesel pumps and two 75-cfs electric pumps. The Value Engineering Study concluded that the proposed pump mix change would increase the overall flood risk management resiliency, increase pump life expectancy, reduce maintenance costs, reduce design in backup capacity in case of a single pump failure, and eliminate one diesel pump, resulting in potential cost savings of $1,873,000 per pump station. Following the Value Engineering Study, the pump mix recommendation was implemented during the beginning of Intermediate Design Phase. As the design progressed, sequential estimates have proven that the cost saving assumed in the Value Engineering Study was not accurate due to historic inflation increases; not only broad-based inflation, but specific to the pump manufacturers pricing which escalated significantly from previous quotes. The team revisited the Value Engineering Study findings to determine what the updated cost ramifications are for implementation of the new pump mix. The team investigated the three cases, the authorized pump mix (four 125 cfs diesel pump and two 75 cfs electric pumps; Figure 9-14), the current design pump mix (three 250 cfs diesel pump and two 75 cfs electric pumps; Figure 9-15), and the authorized pump mix plus one redundant diesel pump (five 125 cfs diesel pump and two 75 cfs electric pumps; Figure 9-16). The estimated cost of implementing the Value Engineering Study recommendation found that the current design will cost $3,045,647 more per pump station for a cumulative increased project total of $6,091,294. Adopting this recommendation adds value to the project by increasing flood risk management resiliency through the addition of the redundant pump. The option of keeping the authorized pump mix with the addition of one redundant 125 cfs diesel pump would have increased the project cost by $4,420,396 when comparing the current pump mix to the authorized pump mix plus one redundant diesel pump. This was largely due to the increase of building square footage required to accommodate the additional pump and intake bay. The current design has five pumps while the authorized pump mix plus one redundant diesel pump would have seven total pumps.

Original Config. - 4 x 125cfs + 2x75cfs				
Equipment:	*Equipment Bare Cost*	Equipment Project Cost	Labor	**Total**
Old Config (new quote) - 4x125cfs, 2x75cfs	$ *11,071,100*	$ 21,060,009	$ 423,003	$ 21,483,012
Old Config. - Screens (escalated)	$ *3,591,120*	$ 6,356,282	$ 539,394	$ 6,895,677
				$ 28,378,689
Civil/Structural:	Qty	UOM	Unit $ (Project Cost)	**Total**
Additional Intake Wall Concrete	252	CY	$ 730	$ 183,960
Additional Pumphouse Wall Concrete	44	CY	$ 1,335	$ 58,740
				$ 242,700
Project Cost for Original Config. (like items)				**$ 28,621,389**

Figure 9-14. Updated Value Engineering Study Estimate for Authorized Pump Mix

Current Config. - 3x250cfs, 2x75cfs				
	Equipment Bare Cost	Equipment Project Cost	Labor	**Total**
Current Config. - 3x250cfs, 2x75 cfs	$ *12,547,600*	$ 23,868,682	$ 509,949	**$ 24,378,631**
Current Config. - Screens	$ *3,813,000*	$ 6,749,010	$ 539,394	**$ 7,288,404**
Project Cost for Current Config. (like items)				**$ 31,667,036**

Figure 9-15. Updated Value Engineering Study Estimate for New Pump Mix

Original Config. - 5 x 125cfs + 2x75cfs				
Equipment:	Equipment Bare Cost	Equipment Project Cost	Labor	**Total**
Old Config (new quote) - 5x125cfs, 2x75cfs	$ 13,146,250	$ 25,007,465	$ 500,149	$ 25,507,615
Old Config. - Screens (escalated)	$ 4,189,640	$ 7,415,663	$ 539,394	$ 7,955,057
				$ 33,462,672
Civil/Structural:	Qty	UOM	Unit $ (Project Cost)	**Total**
Additional Intake Wall Concrete	252	CY	$ 730	$ 183,960
Additional Pumphouse Wall Concrete	44	CY	$ 1,335	$ 58,740
Additional Square Footage for 125cfs pump	508.5	SF	$ 4,800	$ 2,440,800
				$ 2,624,760
Project Cost for Original Config. (like items)				**$ 36,087,432**

Figure 9-16. Updated Value Engineering Study Estimate for Authorized Pump Mix Plus One Redundant 125 cubic feet per second Pump

9.4.2.7 Electrical, Instrumentation & Controls, and Site Utilities

Due to lack of a detailed design for the 2020 GRR/EA, the cost estimate utilized the Picayune Strand pump station S-626 as the basis for Electrical and Controls. A comparison review of the S-626 pump station and the S-332B replacement pump station final design found that components of the two pump stations are similar (Table 9-10).

Table 9-10. *Electrical and Communication Equipment Comparison Between the S-332B Replacement Pump Station and S-626 Pump Station.*

S-332B Replacement Pump Station (C-111 South Dade Project)		**S-626 Pump Station (Picayune Strand)**	
QTY	**Item**	**QTY**	**Item**
2 EA	800 Kilowatt (KW) GENERATOR	2 EA	800 KW GENERATOR
1 EA	200 KW STANDBY GENERATOR	-	-
1EA	TRANSFORMER 2000 kilovolt-amperes (KVA)	1EA	TRANSFORMER 2000 KVA
-	-	1 EA	MAIN SWITCHBOARD w/ 2* 1200A BREAKERS
1 EA	MTS-1, 1600A	2 EA	ATS 1200 A
1 EA	ATS-1 2000A	1 EA	ATS 400 A
1 EA	ATS-2 400A	-	-
1 EA	ATS-3 200A	-	-
1 EA	MAIN MCC, 2000A	2 EA	SWITCHBOARD 1200A
1 EA	MCC-1, 600AF/400AT	4 EA	MCC, 600AF/300AT
1 EA	MCC-2, 600AF/200AT	-	-
2 EA	250 Horsepower (HP) ELECTRIC PUMPS, 75 cubic feet per second (CFS)	2 EA	200 HP ELECTRIC PUMPS, 75 CFS
1 EA	CRANE, 100AT	1 EA	CRANE, 100AT
3 EA	LUBE WATER PUMP, 7.5 HP	3 EA	LUBE WATER PUMP, VERTICLE TURBINE, 5HP

5 EA	COOLING WATER PUMP, 20 HP	8 EA	COOLING WATER PUMP, VERTICLE TURBINE, 20HP

The 2020 GRR/EA did not fully assess the pump station requirements. The GRR/EA assumed a similarly sized pump station (S-357) to the existing temporary installation (existing S-332B and S-332C) and applied proportional electrical and communication equipment costs as compared to recent builds at Picayune Strand (S-626). During PED, due to the lack of design maturity for the S-332B and S-332C replacement pump stations, the pump stations requirements were further developed. As the design matured from feasibility phase through PED phase, the flood risk management component was incorporated into the design. It was determined that the S-357 footprint, which was the basis for the GRR design assumptions, would not be able to accommodate all flood risk management and Operations and Maintenance (O&M) requirements needed to satisfy flood risk management resiliency requirements. As a result, the appropriate features to accommodate the flood risk management purpose of the pump stations were added during PED, increasing the facility footprint and estimated costs accordingly. The Electrical, Instrumentation & Controls, and Site Utilities cost have increased by approximately $43.8 million (Table 9-5). Though the two pump stations, S-332B compared to S-626, are similar in electrical and communication equipment components (Table 9-10), the cost for these components have increased significantly.

9.4.2.8 Fire Protection, including Fire Building

When the 2020 GRR/EA cost estimate was being developed, fire protection codes were less restrictive. In subsequent years, fire protection codes have become more restrictive, and recently, ECB 2024-7 established requirements to utilize Unified Facilities Criteria (UFC) for USACE civil works projects. As a result, pump stations require, with few exceptions, sprinkler systems in accordance with UFC 3-600-01 paragraph 4-15 *Electronic Equipment Areas.*

9.4.2.9 Earthwork and Exterior Improvements

As discussed in section 9.4.1.1, earthwork cost for the C-111 SD Project replacement of current pump station S-332B and S-332C has grown. The 2020 GRR/EA underestimated fill requirements around the replacement pump stations due to a lack of design maturity. The 2020 GRR/EA earthworks volume assumed that soil volume needed around the replacement pump stations would be limited to 10% of the soil volume excavated for construction of the replacement pump stations. The 2020 GRR/EA estimated that the S-332B replacement pump station would require 853 cy of fill while the S-332C replacement pump station would require 964 cy of fill (Table 9-7). The design estimates that the S-332B replacement pump station would require 121,255 cy of fill while the S-332C replacement pump station would require 87,304 cy of fill (Table 9-8).

The site surveys indicate that the existing grade near the S-332B replacement pump station varies between 4.0-5.3 ft NAVD88 and the S-332C replacement pump station varies between 3.5-4.5 ft NAVD88. The final grade for the S-332B replacement pump station varies between 10.8-14.0 ft NAVD88 and the S-332C replacement pump station varies between 11.0-13.1 ft NAVD88. This is to raise the pump stations above flood elevations and facilitate connection to the L-31N levee. Figure 9-17 shows the AutoTURN results for fuel truck deliveries and lowboy trailers access to replacement pump station S-332B. The increased earthwork volume around the pump stations is needed due to access, stormwater treatment, and finished floor elevation requirements.

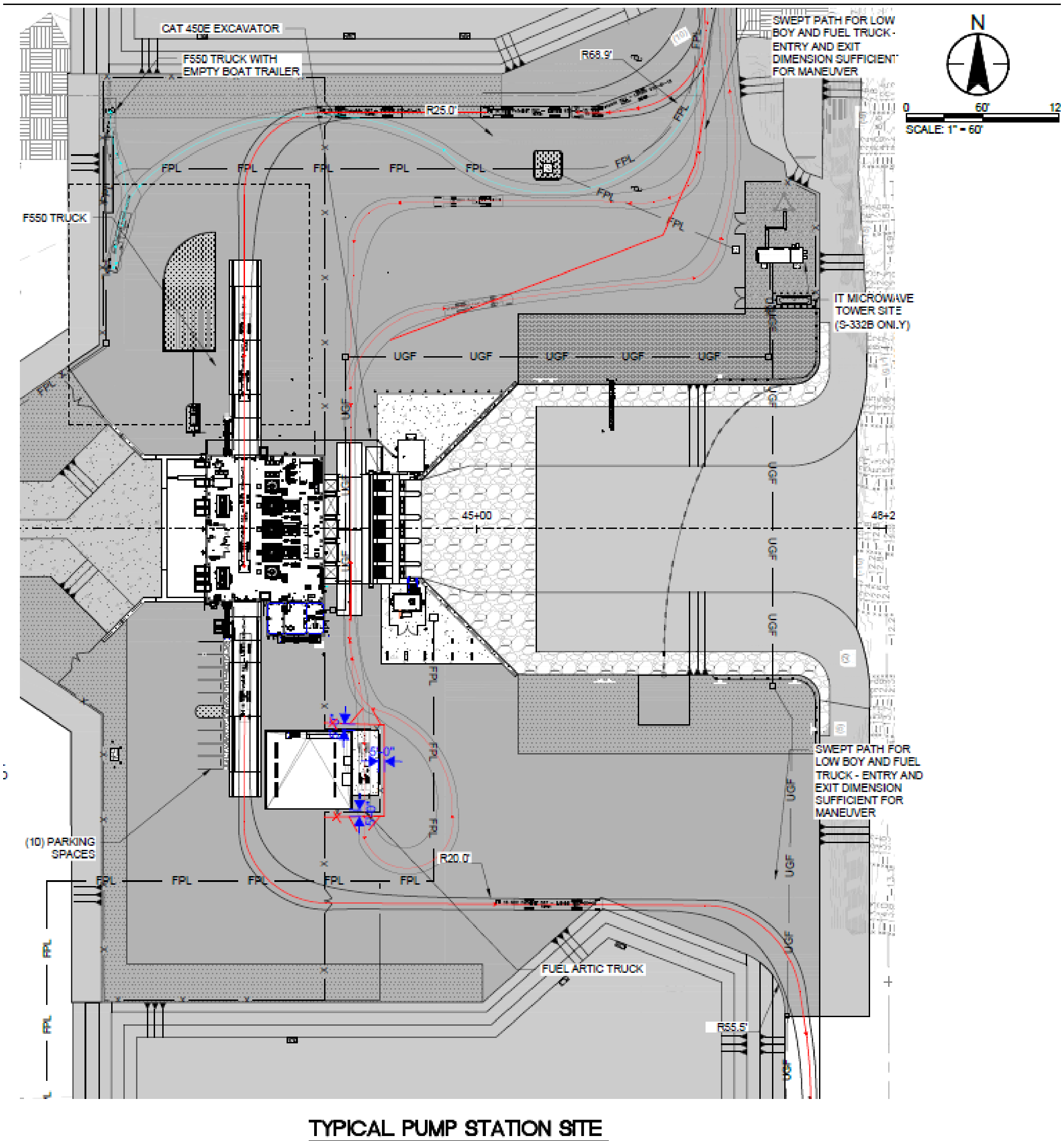


Figure 9-17. Example of AutoTURN Analyzed Path For Fuel Truck and Lowboy Trailers at the S-332B Replacement Pump Station

9.4.2.10 S-332B and S-332C Demolition

Both the 2020 GRR/EA and final cost estimates include demolition for the current S-332B and S-332C pump stations, discharge channels, and embankment degrades. The cost estimates also include silt fencing and disposal. The final cost estimate includes greater volumes and includes sub-contractor mark-up. These changes make up a $19.7M difference, or approximately $9.85M per pump station.

10 VALIDATION OF PROJECT BENEFITS

10.1 Benefits Detailed in the 1994 GRR/EIS

The purpose of the 1994 GRR/EIS was ecosystem restoration in Taylor Slough and the eastern panhandle of ENP that were affected by construction of the flood risk management project (CS&F) in the C-111 Basin. The study also focused on preserving the current level of flood risk management for the agricultural activities in the C-111 Basin. The report provided a recommended solution to these problems which provided both flood risk management and improved management options for the benefit of the environment and the economy. Because the 1994 GRR/EIS focused on restoration of habitat conditions, a National Economic Development (NED) plan, which is normally required for a flood risk management project, was not developed. Instead, an ecosystem restoration plan which maintains the flood damage reduction for the study area was determined. The recommended plan provided the greatest flexibility to restore the ecological resources within the study area and minimize economic impact to adjacent agricultural land use activities by reducing flood risk. Additionally, the recommended plan addresses structural modifications to the water management system that enables greater operational flexibility. Evaluation of the structural plans within the 1994 GRR/EIS were based on continued use of the existing operating guidelines. Subsequent operating plans, such as the COP, further optimized environmental benefits of the recommended plan.

The following planning objectives were established in the 1994 GRR/EIS to address the problems and realize the opportunities identified in the C-111 basin and to serve as guidelines for the formulation and evaluation of alternative plans:

1. Restoration of historic hydrologic conditions in the C-111 basin;

2. Protection of natural values associated with the Everglades National Park;

3. Elimination of damaging freshwater inflows to Manatee Bay /Barnes Sound; and

4. Maintain flood risk reduction for the C-111 basin, east of L-31N and C-111.

Because the flood risk objective was to maintain the level of risk reduction provided by the original C&SF Project, the flood reduction benefits for all alternatives analyzed in the 1994 GRR/EIS are similar. Additionally, environmental benefits of the project were not quantified for comparison among alternatives. Instead, a qualitative assessment was completed (Table 10-1).

Table 10-1. Planning Criteria Comparison Among Alternatives in the 1994 General Re-Evaluation Report and Environmental Impact Statement. Alternative 6A (ALT 6A) is the Recommended Plan.

PLANNING CRITERIA	"WITHOUT PROJECT" CONDITION (NO ACTION)	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6 and 6A	ALT 1A
OBJECTIVES:								
Restoration of historic hydrologic conditions	0	+	+	+	+	+	+	+
Protection of natural values associated with ENP	0	+	+	+	+	+	+	+
Elimination of excess freshwater inflow to Manatee Bay/Barnes Sound	0	+	+	++	++	+	+	+
Maintain flood protection for agriculture	0	+	+	+	+	+	+	+
EVALUATION FACTORS:								
Operational Flexibility	0	+	+	+	+	+	++	+
Cost Effective	0	+	+	+	+	+	+	+
Environmental Outputs	0	+	+	++	++	+	++	+
Flood Control Impacts	0	+	+	+	+	+	+	+
P&G FOUR CRITERIA								
Completeness	Not applicable	High	High	High	High	High	High	High
Effectiveness	Not applicable	Low	Low	Moderate	High	Moderate	High	Low
Efficiency	Not applicable	Low	Low	Moderate	Moderate	Moderate	High	Low
Acceptability	Not applicable	Low	Low	Low	High	Low	High	Low

Plans effects are estimates of net overall changes from the "without project" condition:

++ very beneficial change — very adverse change
+ beneficial change - adverse change
0 no change

The following evaluation criteria were utilized to demonstrate each alternative's effectiveness at providing environmental benefits:

a. Recreate hydrohabitat units that are closer to historic levels. Hydrohabitat units are a measure of hydrologically modeled outputs of alternatives relative to historic conditions deduced from marl measurements. They depict how well an alternative's hydrology supports the natural values associated with the sawgrass-on-marl ecosystem.

b. Recreate species compatibility indices that are closer to historic levels. These indices are founded on hydrologic habitat criteria defined by ENP staff as favorable to selected indicator species.

The wide aerial extent of the water distribution capability of the Recommended Plan restores the hydrology in 1,155 mi^2 (approximately 730,000 acres) of habitat within the ENP. The hydroperiod and depths in 1027 mi^2 of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough and 128 mi^2 of the Taylor Slough and its headwaters in the Rocky Glades. During flood periods, the 1200 cfs of additional pump capacity will retain over 2,300-acre ft per day of water in ENP that was previously diverted to tide water.

Ecological benefits for specific locations within the project area are detailed in Table 10-2. Benefits specifically relevant to the S-332B and S-332C replacement pump stations as detailed in the 2020 GRR/EA are discussed in Sections 11.1.3 (Ecosystem Restoration) and 11.1.4 (Flood Risk).

Table 10-2. Ecological Benefits within the C-111 South Dade (SD) Project Area from the 1994 General Re-Evaluation Report and Environmental Impact Statement.

	Ecological Benefit
Everglades National Park	Five- to seven-month hydroperiod during which water covers the land surface to depths of 2-20 inches and seldom drops as much as 29-30 inches below ground surface. These conditions are those that produce abundant freshwater shrimp, crayfish and warm water fishes that proliferate during the wet season and become concentrated in drying pools during the dry season. These groups serve as prey for roseate spoonbills, wood storks, herons and egrets that may become re-established on their historic nesting and feeding grounds in and around ENP.
Shark River Slough East and West Basins	Augmented water supply providing for the environmentally beneficial hydroperiods (periods when water levels are at or above ground level) that are interrelated in eastern and western Shark River Slough, the Rocky Glades, Taylor Slough (including the southeastern Frog Pond), and the western and eastern C-111 basins. A 100 percent improvement over the base condition and maintains a slightly higher elevation of dry season, sub-surface water in both east and west basins. Increased water supply to the expanded portion of ENP in the north part of the west basin.
The Rocky Glades	Restored water supply and capacity for distributing water into the Rocky Glades restores the Rocky Glades' function as a hydrologic barrier between Shark Slough waters and the headwaters of Taylor Slough. The Rocky Glades would continue to represent a transition area between the deep slough areas and seldom flooded uplands.
Taylor Slough	Distributing restored water supplies with the natural timing associated with historical wet and dry seasons, can provide for sheetflows throughout Taylor Slough and into the downstream areas of Florida Bay.
The Frog Pond	Portions of the Frog Pond that are removed from agriculture as a result of the C-111 SD Project will likely be invaded by Brazilian pepper. The artificial "soil" created by the practice of rock plowing and fertilization apparently is inhospitable to most native plant species, even many years after agricultural abandonment

The Marl Glades	Potential for delivering water high in the Rocky Glades, into Taylor Slough and south of lower C-111 in quantities and with the timing that contribute to 100 percent-improved habitat quality. This alternative maintains dry season, sub-surface water at higher elevations in both east and west basins and increases water supply to the north part of the west basin. In dry season, water levels drop at least 12 inches below the ground surface, where water is held in solution cavities, in water control structure receiving basins, and, perhaps, in alligator holes. Even with a more natural water supply, the marl glades would dry out in winter months. Natural dry season events would result in a concentration of small fishes, frogs, and invertebrates that would attract concentrations of wading birds, including the endangered wood stork.
Florida Bay, Barnes Sound, and the Coastal Mangrove Fringe	Reduce or eliminate the need for damaging freshwater discharges to Manatee Bay/Barnes Sound. Water would be re-directed to northeast Florida Bay. With the availability of an adequate supply of water, the natural timing and distribution of sheetflows throughout Taylor Slough would benefit Florida Bay. Elevated groundwater levels in the Taylor Slough basin would contribute to reduction toward hypersaline conditions in northern Florida Bay. Restoration of a more natural hydrology will correct one of the major problems in the Bay. It is not known whether this alone will restore Florida Bay, but it is unlikely that restoration will occur without the natural freshwater increment from the Everglades.

10.2 Changes in Benefits

Ecosystem benefits currently provided by the C-111 SD Project, as identified in the 1994 GRR/EIS and reiterated in the 2020 GRR/EA, will continue to be maintained with replacement of the S-332B and S-332C pump stations. The 2020 GRR/EA recognized that the C-111 Project features will be operated as established by the 2020 COP. The COP, which was completed with an EIS and Record of Decision in August 2020, was a parallel effort to provide guidance on how to operate the project while achieving the C-111 Project benefits identified in the 1994 GRR/EIS. The anticipated benefits of restoring the ecosystem in Taylor Slough and the eastern panhandle of ENP that were affected by construction of the C&SF flood control project in the C-111 Basin and preserving the current level of flood protection for agricultural activities, as depicted in the 1994 GRR/EIS, were not re-evaluated for the purpose of the 2020 GRR/EA. No new benefits will be achieved, nor will any benefits previously identified be reduced (Table 10-3).

Table 10-3. Comparison of Benefits among the 1994 General Re-Evaluation Report (GRR/EIS), 2020 General Re-Evaluation Report and Environmental Assessment (GRR/EA), and the 2025 Section 902 Post Authorization Change Report (PACR).

Project Component	Status	Purpose	1994 GRR/EIS Description of Benefits	2020 GRR/EA Confirmation of Benefits	2025 VR Confirmation of Benefits
S-332B and S-332C Pump Station	Completed (2000 and 2003, respectively)	Water conveyance, Ecological Restoration, Flood Damage Prevention	100% improvement over base conditions for 1,155 square miles (mi^2) (approximately 730,000 acres) of Everglades National Park (ENP) habitat; Maintain 40% standard project flood flows	• 100% improvement over base conditions for 1,155 mi^2 of ENP habitat; Maintain 40% standard project flood flows • C-111 South Dade features will be operated as established by the Combined Operational Plan (COP) and future updates to SOM Volume 4 [inclusive of planned future updates to the Central Everglades Planning Project (CEPP) Project Operating Manual].	• 100% improvement over base conditions for 1,155 mi^2 of ENP habitat; Maintain 40% standard project flood flows • C-111 SD features will be operated as established by the COP and future updates to SOM Volume 4 [inclusive of planned future updates to the CEPP Project Operating Manual.

10.3 Intended Benefits of Project Components

The C-111 SD Project reduces flooding in south Miami-Dade County, prevents over drainage and saltwater intrusion, and conveys water to ENP when runoff is available. A hydraulic ridge is formed by combination of the MWD to the ENP Project, along with C-111 SD Project components including the NDA, SDA, and the S-332D Detention Area that extend from the MWD 8.5 SMA to Taylor Slough, reducing groundwater seepage losses from ENP, while maintaining the authorized level of flood damage reduction for the C-111 Basin. The C-111 SD Project features are operated according to the 2020 COP, which provides guidance on how to operate the C-111 SD Project while achieving the C-111 SD Project benefits identified in the 1994 GRR/EIS.

The objectives of the 1994 GRR/EIS include protection of the natural values associated with the ENP and maintenance of flood reduction within the C-111 basin. The recommended plan provided a 100% improvement over base conditions for 1,155 mi^2 (approximately 730,000 acres) of habitat (additional details provided in Table 10-2) and maintained removal of 40% standard project flood flows. Under the pre-project base condition, the majority of outflows from the L-31N basin pass eastward through the C-102 and C-103 canals. This represented a significant loss of water from the regional system. However, the recommended plan from the 1994 GRR/EIS redirected these flows westward into Taylor Slough. The 1994 GRR/EIS recommended plan accomplished the project objectives through construction of five new pump stations that maintain a hydraulic ridge primarily by pumping water from the L-31N borrow canal westward toward the ENP. As detailed in the 2016 LRR, prior to construction of the pumps, one of the proposed pumps (S-332A) was eliminated and pump capacity for S-332B and S-332C increased from 300 cfs to 575 cfs to compensate, thereby increasing the importance of these features for achieving project benefits. Because the 1994 GRR/EIS only addressed structural modifications to the water management system that would enable greater operational flexibility, the ecological benefits were based on the proposed set of infrastructure and existing C-111 basin operational criteria at that time.

Subsequent operations plans, such as the 2020 COP, have maintained, and likely increased, benefits identified in the 1994 GRR/EIS. The purpose of the 2020 COP is to define the water management operations for the Water Conservation Area (WCA) 3A, WCA 3B, structures in the L-31N and the C-111 basins constructed as part of the C&SF Project and the constructed components of the MWD and C-111 SD Projects. The 2020 COP water management operations are consistent with the respective MWD and C-111 SD Project purposes as defined by the authorizing legislation and further refined by subsequent General Design Memoranda, General Reevaluation Reports, and Limited Reevaluation Reports. The 2020 COP operations are also consistent with the original purposes of the C&SF project to provide flood control, water supply for agricultural, municipal, and industrial uses, regional groundwater control and prevention of saltwater intrusion, enhancement of fish and wildlife, and recreation.

The benefits of restoring the ecosystem in Taylor Slough and the eastern panhandle of ENP that were affected by construction of the C&SF Project in the C-111 Basin and preserving the current level of flood protection for agricultural activities, as detailed in the 1994 GRR/EIS, will not be reevaluated in this Section 902 PACR. By continuing the pump station function to rehydrate and reduce groundwater seepage losses from ENP, the S-332B and S-332C replacement pump stations will continue to provide appropriate hydrology to maintain the hydraulic ridge, while also preserving habitat conditions for the CSSS in accordance with the 2020 COP and future CERP operational plans. Although the cost for replacing the S-332B and S-332C pump stations has increased since the 2020 authorization, these features continue to provide the only solution to meet the objectives and constraints outlined in the 2020 GRR/EA (see Section 11.1 below) and to meet objectives of the 1994 GRR/EIS.

11 COST EFFECTIVENESS OF SELECTED PLAN

This section provides a summary of alternatives considered in the 2020 GRR/EA and discusses the cost-effectiveness of the selected plan based on a comparison to other alternatives. No project reformulation was conducted as part of this analysis because replacing the current S-332B and S-332C pump stations is the only viable way to maintain the C-111 SD Project objectives as detailed in the 1994 GRR/EIS and 2020 GRR/EA, and to satisfy legal requirements of the Endangered Species Act. The purpose of this section is to provide background and context about how the Recommended Plan was selected. The cost increase of the replacement pump stations would be commensurate across the range of alternatives evaluated in the 2020 GRR/EA. The replacement pump station requirements between the two action alternatives are identical with only the discharge channel length differing between the two alternatives.

11.1 Validation of Plan Formulation Methodology in the 2020 GRR/EA

The 2020 GRR/EA produced an array of alternative plans for permanent replacement of the S-322B and S-332C pump stations.

Objectives of the 2020 GRR/EA include:

- Reduce costs of pump stations S-332B and S-332C while maintaining the authorized ecosystem restoration outputs and flood risk management performance for the C-111 SD Project area throughout the 50-year period of analysis (2025-2075).
- Reduce the likelihood of storm induced damage to pump stations S-332B and S-332C throughout the 50-year period of analysis.

No reformulation was completed as part of the 2020 GRR/EA, and engineering design performance evaluations of the proposed alternatives affirm that the facilities previously authorized are consistent with current project needs and obtain the benefits anticipated in the 1994 GRR/EIS, with focus on verification that the 575 cfs design capacities are sufficient. The 2020 COP has demonstrated that the pump station capacities meet C-111 SD Project needs.

In addition to the “No Action” alternative (Alternative 1), the 2020 GRR/EA contributed to the development of two action alternatives based on four constraints:

- Maintain the continuous hydraulic ridge to disperse flows into the NDA and SDA, and thereby meet the CSSS habitat and nesting requirements.
- Maintain ecosystem restoration by keeping water in ENP.
- Maintain the same flood risk management performance in the C-111 Basin as the project currently provides.
- Allow the existing pump stations to remain operable during construction and testing of any new features.

Accordingly, each action alternative includes replacing both S-332B and S-332C pump stations with permanent, hardened structures in an offset location approximately 300 ft south and 300 ft west along the L-31N Canal and with the same 575 cfs design capacity as the two current pumps. Alternatives were evaluated based on the existing conditions, project goals, objectives, and constraints. Potential effects to the human environment were also evaluated.

Alternative plans were developed from management measures that achieve one or more planning objectives. The following measures were evaluated in the 2020 GRR/EA:

- Pump station discharge capacity,
- Pump station offset location,
- Pump station intake canal,
- Bypass culvert connection to NDA,

- Levee/degrade relocation, and
- Pump station discharge channels.

All action alternatives included replacing current pump stations S-332B and S-332C with permanent pump stations containing hardened, outer structures. In addition to the No Action Alternative, two Alternatives were developed.

11.1.1 Alternative 2 – Extended Concrete Channel

This alternative consists of replacing the current S-332B and S-332C pump stations with new permanent pump stations at an offset of approximately 300 ft south and 300 ft west from their current location along L-31N Canal and an extended concrete lined discharge channel with an extension and connection to the existing NDA (Figure 11-1). The S-332B replacement pump station features include demolition of the current pump station and connecting features, pump offset of approximately 300 ft south and 300 ft west from the current location along L-31N Canal, concrete intake canal, concrete lined discharge channel to the eastern SDA perimeter levee, extended concrete lined discharge channel with the interior of the SDA bypass culvert, and an expansion of the NDA of approximately 7.1 acres by degrading a section of NDA levee. Based on the preliminary hydraulic design, the discharge culvert to the NDA will be a vertical lift gate box culvert with two barrels, with 5.8 ft span by 6-ft rise, and approximately 100 ft in length. The S-332C replacement pump station features include demolition of the current pump station and connecting features, pump offset, concrete intake canal, concrete lined discharge channel to the eastern SDA perimeter levee and extended concrete lined discharge channel within the interior of the SDA.

The S-332B and S-332C replacement pump stations will have a maximum design capacity of 575 cfs, consisting of four diesel units (125 cfs each) and one electric unit (75 cfs). In addition to the normal pump station operational capacity of 575 cfs, both pump stations will have one additional 75 cfs electric pump as a backup unit to maintain operational flexibility during periods when one or more pump units are offline for maintenance or repairs. This additional 75 cfs electric pump will also provide further operational flexibility to manage the NDA and SDA stages by allowing for additional combinations of pump capacities. The diesel pumps will be located in the center and electric pumps will be placed on each end. The S-332B replacement pump station discharge channel design will allow the full pump capacity of 575 cfs to be directed to the SDA (the existing current pump station culvert discharges limit the maximum discharge to the SDA to 325 cfs). Consistent with the existing NDA design for the current S-332B pump station, the S-332B replacement pump station discharge channel design will allow up to 250 cfs to be redirected to the NDA. The S-332C replacement pump station discharge channel design will allow the full pump capacity of 575 cfs to be directed to the SDA.

A new above-ground channel will replace the existing underground corrugated metal pipes to connect the pump station releases to the SDA. This new above-ground channel will be lined with concrete to reduce seepage losses, minimize the maintenance of an unlined channel, and ensure water connection to the SDA. These proposed channels extend approximately 3600 ft and 3400 ft from replacement pump stations S-332B and S-332C, respectively, to the SDA in the east-west direction. The design head water stage for each channel at its eastern end is 10.0 ft NAVD88 while the design tail water stage at the SDA is 7 ft NAVD88. The existing underground corrugated metal pipes and overburden material will be removed and will be leveled to grade.

The operations of the current pump stations would continue through construction while decreasing the amount of over-drying within this region (without operation of the hydraulic ridge) and providing appropriate hydrology for CSSS habitat in accordance with the 1999 USFWS Jeopardy BO and 2020 COP. Once the replacement pump stations are operational, the current pump stations would be removed.

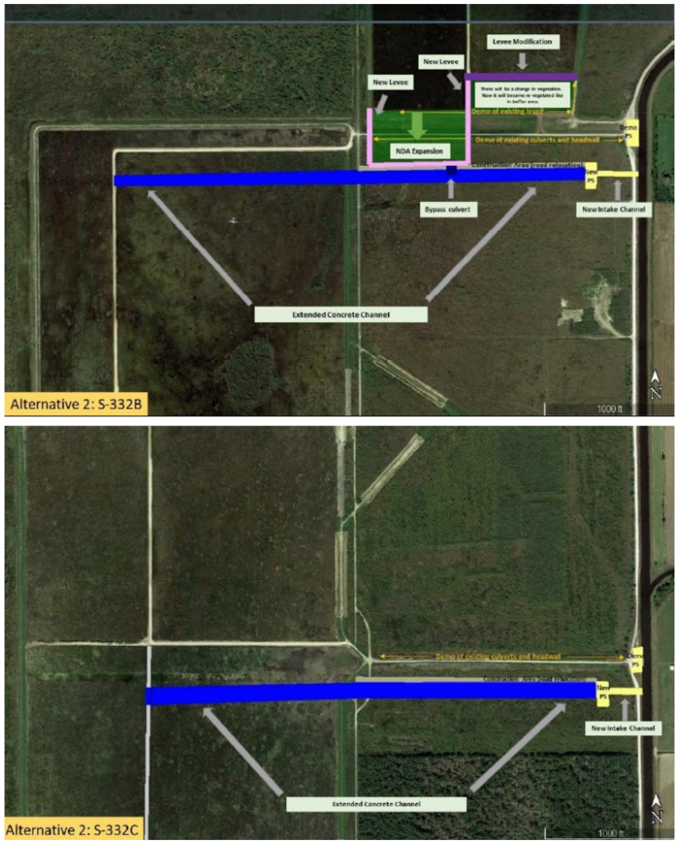


Figure 11-1. Alternative 2 Extended Concrete Channel Project Footprint

11.1.2 Alternative 3 – Short Concrete Channel

This alternative consists of replacing the current S-332B and S-332C pump stations with new permanent pump stations at an offset of approximately 300 ft south and 300 ft west from their current location along L-31N Canal and a short concrete lined discharge channel with a NDA connect (Figure 11-2). The S-332B replacement pump station features include demolition of the current pump station and connecting features, pump offset, concrete intake canal, short concrete lined discharge channel (extending slightly west of the eastern SDA perimeter levee), parallel weir to tie into the existing S-332B SDA inflow corridor, bypass culvert, and expansion of the NDA by approximately 7.1 acres by degrading a section of NDA levee. Based on the preliminary hydraulic design, the discharge culvert to the NDA will be a vertical lift gate box culvert with 2 barrels, with a 5.8 ft span by 6-ft rise, and approximately 100 ft in length. The S-332C replacement pump station features include demolition of the current pump station and connecting features, pump offset, concrete intake channel, short concrete lined discharge channel (extending slightly west of the eastern SDA perimeter levee), and a parallel weir to tie into the existing S-332C SDA inflow corridor. Each of the permanent pump stations will have a maximum design capacity of 575 cfs, consisting of four diesel units (125 cfs each) and one electric unit (75 cfs). In addition to the normal pump station operational capacity of 575 cfs, both the S-332B and S-332C replacement pump stations will have one additional 75 cfs electric pump as a backup unit to maintain operational flexibility during periods when one or more pump units are offline for maintenance or repairs. This additional 75 cfs electric pump will also provide further operational flexibility to manage the NDA and SDA stages by allowing for additional combinations of pump capacities. The diesel pumps will be located in the center and the electric pumps will be placed on each end. The S-332B replacement pump station discharge channel design will allow the full pump capacity of 575 cfs to be directed to the SDA (the current pump station culvert discharges limit the maximum discharge to the SDA to 325 cfs). Consistent with the existing NDA design for the current S-332B pump station, the S-332B replacement pump station discharge channel design will allow up to 250 cfs to be redirected to the NDA. The S-332C replacement pump station discharge channel design will allow the full pump capacity of 575 cfs to be directed to the SDA.

A new above-ground channel will replace the existing underground corrugated metal pipes to connect pump station discharges to the SDA by a parallel weir. This new above-ground channel will be lined with concrete to reduce seepage losses, minimize the maintenance of an unlined channel, and ensure water connection to the SDA. Each of the proposed channels extends approximately 1900 ft from the pump station to the existing flow-way. The design head water stage for each channel at its eastern end (i.e. the west end of the pump station tail water pool) is 10.0 ft NAVD88. The existing underground corrugated metal pipes and overburden material will be removed and will be leveled to grade.

Once the replacement pump stations are operational, the current pump stations would be removed. The operations of the current pump stations would continue through construction while decreasing the amount of over-drying within this region (without operation of the hydraulic ridge) and providing appropriate hydrology for CSSS habitat in accordance with the 1999 Jeopardy BO.

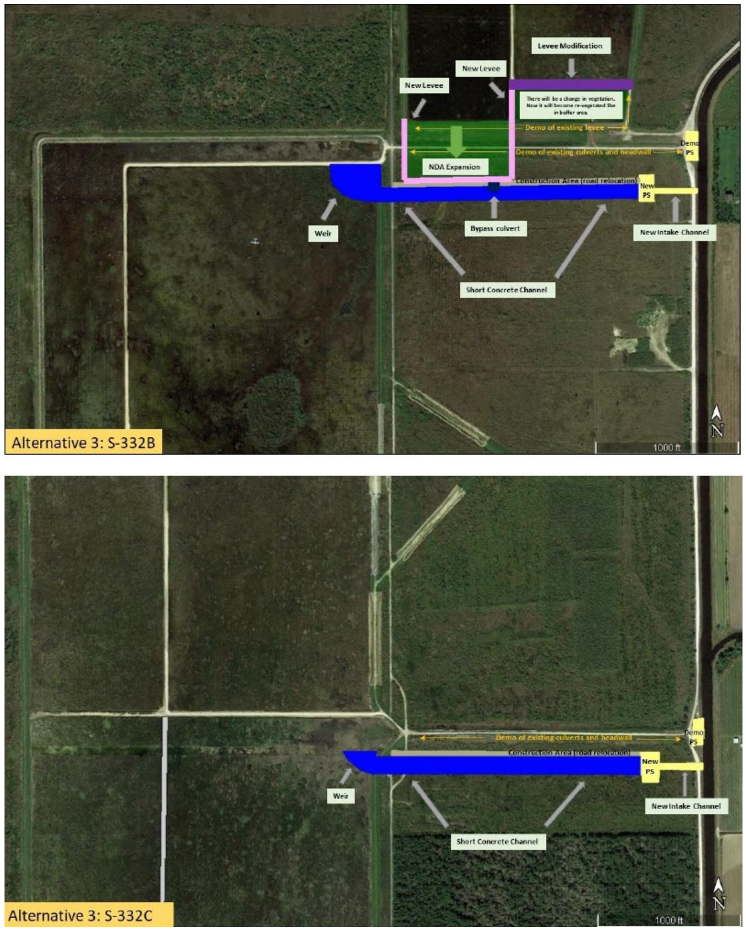


Figure 11-2. Alternative 3 Short Concrete Channel Project Footprint

Ecosystem restoration benefits and flood risk management performance, along with cost, were evaluated and were the basis for selecting the plan recommended in the 1994 GRR/EIS. The alternatives in the 2020 GRR/EA were also evaluated based on ecosystem benefits, flood risk management, cost, and environmental effects.

11.1.3 Ecosystem Restoration

Pump station design capacity, pump mix (individual pump unit capacities), and operations are the most important factors that allow the S-332B and S-332C pump stations to maintain the hydraulic ridge along the NDA and SDA flow way to reduce groundwater seepage losses from eastern ENP, and to provide operational flexibility to improve hydroperiods and hydropatterns within the adjacent eastern ENP CSSS habitat. The current pump stations that would remain under Alternative 1 and the new permanent pump stations that would be constructed under Alternatives 2 or 3 all have the same 575 cfs design capacity. All three alternatives would produce the same habitat conditions because they would have the same design capacity and the same operational plan, either 2020 COP or a future update to Volume 4 of the System Operating Manual (SOM Volume 4) for Water Conservation Areas, Everglades National Park and the ENP-South Dade Conveyance System [inclusive of planned future updates to the CEPP Project Operating Manual (POM). Both Alternatives 2 and 3 will perform in maintaining a hydraulic ridge along the flow way to disperse water into the NDA and SDA and continue restoration of hydro periods in eastern ENP to meet the ecosystem restoration objective. Restoration targets are not expected to change from the 1994 GRR/EIS, consistent with the 2016 LRR. If one or more of the current pump stations in Alternative 1 (No Action) were to be deemed inoperable, such as if they were damaged during an extreme weather event, then ecosystem benefits would be adversely affected. The hydraulic ridge would be less effective in reducing seepage out of eastern ENP, with negative effects to CSSS habitat. Loss of the pump station capacity would require increased releases to the C-111 Canal through the S-176 spillway, which would result in increased freshwater discharges from the S-197 gated culvert into Manatee Bay and Barnes Sound.

11.1.4 Flood Risk Management

The C-111 Project was authorized to remove 40 percent of the standard project flood flows. This purpose remains an important objective for the C&SF Project because of the remaining agriculture within the basin. The South-Dade County Basin (south of the S-331 pump station) provides flood risk management by operation of the S-332B, S-332C, and S-332D pump stations completed under the C-111 Project and through the operation of the L-31N and C-111 canal control structures (S-176, S-177, S-18C, and S-197) to maintain the L-31N Canal reach within the operational range prescribed by the governing Water Control Plan (WCP) [the 2020 COP, or a future update to SOM Volume 4 (inclusive of planned future updates to the CEPP POM)]. The South-Dade County Basin may also receive inflows from upstream basin drainage through the S-331 pump station and the adjacent S-173 gated culvert structure. With the C-111 Project, the pump stations are also utilized to maintain the hydraulic ridge to reduce groundwater seepage losses from eastern ENP and to improve hydroperiods and hydropatterns within the adjacent eastern ENP CSSS habitat. The risk of flooding during normal operations is minimal for this project as it is primarily focused on ecosystem restoration and is constrained to maintain the authorized level of flood protection. The project features covered in the 2020 GRR/EA focused on routing flow along the western edge of the C-111 Basin. There will be no major impacts to nearby communities since the current pump station 575 cfs capacity will be maintained with the replacement pump stations, and the current pump stations S-332B and S-332C will continue to operate until construction is completed for the replacement pump stations. Alternatives 2 and 3 would have the same flood risk performance because each alternative would have the same pump station design capacities and would be operated under the same operational plan, either the 2020 COP or a future update to SOM Volume 4. Under the No Action Alternative (Alternative 1), significant adverse impacts to flood risk management may be realized if the current pump stations were to be deemed inoperable prior to completion of the replacement pump stations, for example, if one or both of the current pump stations were damaged during an extreme weather event. Temporary loss of the pump station capacity would require increased releases to the C-111 Canal through the S-176 spillway, which would result in increased freshwater discharges from the S-197 gated culvert into Barnes Sound and Manatee Bay. The drainage rate along the L-31N Canal reach is more limited with reliance on the gravity drainage along the C-111 Canal (S- 176, S-177, S-18C, and S-197) compared to the S-332B and S-332C pump stations. Temporary loss of all or a significant portion of the S-332B and S-332C collective pump station capacity would diminish the capability to maintain the L-31N Canal reach within the range prescribed by the governing Water Control Plan, resulting in potential extended flood event durations with the canal stages above the upper limit of the target prescribed operational range. Agricultural tree and row crops located within the areas east and south of the project area (downstream of S-176) are susceptible to elevated groundwater levels if levels reach between two inches and 24 inches below ground (depending on the crop type and bedding heights used), and crops may receive damage within 24 hours if groundwater levels cross the crop-dependent root zone depth threshold. Additional inflow volumes to the L-31N Canal resultant from the future planned implementation of the CEPP, which has been estimated at 85 cfs with the preliminary seepage modeling results, would have the potential to further expand these durations for periods with restricted pump availability coincident with the higher water stages within the adjacent eastern ENP.

11.2 Cost-Effectiveness of Final Array and the Recommended Plan

An alternative is cost effective if its cost per unit of output is lower than the cost per unit of output of another alternative. As described above, Alternatives 2 and 3 are expected to provide the same ecosystem and flood risk management benefits. Alternative 1 has unquantified but incrementally lower ecosystem and flood risk benefits than Alternatives 2 and 3 due to its higher likelihood of operational failure and the vulnerability of pump units, particularly when down for repair or if they suffer major damage from a large storm. When outputs are the same for all the alternatives, the alternative with the lowest cost will be cost effective compared to the other alternatives. Although Alternative 1 has the lowest average annual cost (Table 11-1), Alternative 1 does not meet the Principles and Guidelines evaluation criteria and current pump station redundancy requirements. Table 11-2 summarizes the effectiveness, efficiency, completeness, and acceptability analyses of the C- 111 Project replacement of current pump stations S-332B and S-332C described within this chapter and based on additional modeling and analysis since the 2020 GRR/EA.

At the time of the Technical Review Briefing (TRB) held on June 15, 2022, updated seepage modeling and discharge channel life-cycle cost evaluations were presented to USACE and South Florida Water Management District (SFWMD) Leadership. Alternative 2 (Extended Concrete Channel) was shown to provide a greater reduction in seepage return from the detention areas to the L-31 Canal, thereby lowering long-term pumping and maintenance activities. The estimated reduction of baseflow to the L-31N Canal attributable to the Alternative 2 discharge channel modification was approximately 28 million mgd for the S-332B pump station and 31 mgd for the S-332C pump station. The decision to transition from Alternative 3 (Short Channel) to Alternative 2 was documented in the TRB Consensus Sheet (Appendix E) and described in Section 9.1.1.

Project cost estimates were updated to reflect increases in construction costs, labor rates, diesel fuel prices and design refinements. As shown in Table 11-1, the total annual cost is $45,209,000 for Alternative 2 and $41,492,000 for Alternative 3, a difference of $3,717,000 in average annual terms. This cost difference represents approximately 8 percent of the total annual cost of Alternative 2. Operations and Maintenance base costs for the replacement of the pump stations were provided by SFWMD. Additional O&M costs associated with differences in seepage return were estimated at $963,000 for Alternative 2 and $1,777,000 for Alternative 3, resulting in annual O&M savings of $814,000 under Alternative 2.

Although Alternative 2 is not the least-cost alternative in terms of average annual cost, its selection remains technically justified based on the difference in additional O&M cost, as presented in Table 11.1, Row 5. This difference was the basis for the decision made on June 15, 2022. The extended discharge channel results in lower OMRR&R costs, reduced seepage return and improved pumping efficiency, all of which align with project objectives and USACE decision criteria.

Table 11-1. Total Construction and Annual Cost Comparison (FY26 price level) for the Alternatives[1] .

Cost	Alternative 1 – No Action	Alternative 2 – Extended Concrete Channel	Alternative 3 – Short Concrete Channel
Project First Cost	$0	$954,561,000	$859,920,000
Interest during Construction	$0	$83,398,000	$66,795,000
Annualized First Cost	$0	$42,276,000	$37,745,000
O&M Cost, annual (SFWMD O&M estimates for new pump stations) [2]	$3,418,000[2]	$1,970,000	$1,970,000
Additional O&M Cost for seepage difference, annual	$0	$963,000	$1,777,000
Total Annual Cost	$3,418,000	$45,209,000	$41,492,000

[1] Costs were annualized at the October 01, 2025 (FY26) Water Resources Discount rate of 3.25 percent per EGM 26-01 over a 50-year period of analysis, in accordance with ER 1105-2-100 Appendix E.

[2] Estimated Operations and Maintenance (O&M) cost for Alternative 1 is an average based on the 5-year summary of Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Estimates for Non-CERP Projects contained in the Five-Year Operation, Maintenance, Repair, Replacement, and Rehabilitation Plan FY2024-FY2028

Table 11-2. Summary of Principles and Guidelines Criteria for the 2020 General Re-Evaluation and Environmental Assessment and the 2025 Section 902 Post Authorization Change Report (PACR).

	Alternative 1 - No Action	Alternative 2 - Extended Concrete Channel	Alternative 3 - Short Concrete Channel
Effectiveness in Meeting Objective 1: Maintain hydrologic ridge to	**2020 GRR/EA**: Maintains hydraulic ridge until pump stations fail	**2020 GRR/EA**: Maintains hydraulic ridge	**2020 GRR/EA**: Maintains hydraulic ridge

aid in ecosystem restoration and flood risk management	**2025 Section 902 PACR**: High failure risk. Two emergency Section 408 requests to repair failed culverts for S-332B and S-332C. Do not meet pump redundancy requirements for flood risk management.	**2025 Section 902 PACR**: Maintains hydraulic ridge and provides pump redundancy for flood risk management	**2025 Section 902 PACR**: Maintains hydraulic ridge and provides pump redundancy for flood risk management
Effectiveness in Meeting Objective 2: Reliability of pump stations	**2020 GRR/EA**: Current pump stations with non-hardened structures, reliability is a concern, prone to storm damages	**2020 GRR/EA**: Permanent pump stations with hardened outer structures, increased reliability, protected from storm damage	**2020 GRR/EA**: Permanent pump stations with hardened outer structures, increased reliability, protected from storm damage
	2025 Section 902 PACR: High failure risk. Two emergency Section 408 requests to repair failed culverts for S-332B and S-332C. Do not meet requirements for permanent pump stations	**2025 Section 902 PACR**: Same as above and provides pump redundancy	**2025 Section 902 PACR**: Same as above and provides pump redundancy
Efficiency - Cost to obtain ecosystem restoration and flood risk management benefits	**2020 GRR/EA**: Lowest cost; cost effective	**2020 GRR/EA**: Highest cost; not effective	**2020 GRR/EA**: Intermediate cost; cost effective; most efficient
	2025 Section 902 PACR: Lowest cost	**2025 Section 902 PACR:** Highest annual cost, most effective with respect to seepage prevention	**2025 Section 902 PACR**: Intermediate cost; cost effective; Higher residual risk of seepage
Completeness	**2020 GRR/EA**: Maintains ecosystem and flood risk management protection benefits until pump stations fail	**2020 GRR/EA**: Maintains ecosystem and flood risk management benefits	**2020 GRR/EA**: Maintains ecosystem and flood risk management benefits
	2025 Section 902 PACR: Same as above; do not meet pump redundancy requirements for flood risk management	**2025 Section 902 PACR:** Same as above	**2025 Section 902 PACR**: Same as above

Acceptability	**2020 GRR/EA**: Not acceptable due to risk of failure and accruing high annual Operations and Maintenance (O&M) cost	**2020 GRR/EA**: Acceptable, not expected to fail, reduced annual O&M cost. Less acceptable than Alt 3 as project footprint has more wetland acreage impacts than Alt 3	**2020 GRR/EA**: Acceptable, not expected to fail, reduced annual O&M cost. More acceptable than Alt 2 as project footprint has fewer wetland acreage impacts than Alt 2
	2025 Section 902 PACR: Not acceptable due to realized failures, future risk of failure, and accruing high annual O&M cost	**2025 Section 902 PACR:** Same as above	**2025 Section 902 PACR**: Same as above

12 CHANGES IN COST SHARE

Cost share has not changed since authorization of the 2020 GRR/EA. The cost share for replacement of the current S-332B and S-332C pump stations is 50 percent Federal and 50 percent non-Federal, consistent with the existing construction cost share authority in Section 316 of WRDA 1996. Depreciation calculations/payments were eliminated to be consistent with current policy for civil works projects OMRR&R. The OMRR&R will be cost shared on the following: pump stations; intake canals; concrete conveyance channels, including the parallel weirs; and NDA diversion culvert for S-332B which delivers pump station discharges into the NDA and the SDA. The non-Federal sponsor's cost share for OMRR&R for the S-332B and S-332C replacement pump stations, their associated conveyance features, and S-332D is 40 percent and the Federal Government's cost share is 60 percent.

13 CHANGES IN COST APPORTIONMENT

Comparison of cost apportionment between Federal and non-Federal for the authorized and recommended project (using FY26 price levels) is shown in Table 13-1. The non-Federal sponsor is aware that the project costs have increased.

Detailed design of the S-332B and S-332C replacement pump stations will be accomplished by the SFWMD. Detailed design will be coordinated and reviewed by the USACE Jacksonville District in accordance with ER 1165-2-217. All features will be designed in accordance with USACE regulations and standards and comply with State of Florida laws.

Table 13-1. FY26 Project Cost Apportionment.

	Federal	**Non-Federal**	**Total**
Authorized Project (FY21)	$66,736,500	$66,736,500	133,473,000

Authorized Project (FY26)	$88,582,500	$88,582,500	$177,165,000
Revised Project First Cost Estimate (FY26)	$477,280,500	$477,280,500	$954,561,000

14 ENVIRONMENTAL CONSIDERATIONS IN RECOMMENDED CHANGES

NEPA compliance was originally completed for the project with an integrated GRR/EA in 2020 which analyzed all environmental impacts associated with the C-111 SD Project replacement of current pump stations S-332B and S-332C for both Alternative 1 and 2. No additional impacts from those already analyzed in the 2020 GRR/EA will occur. A Revised FONSI (Appendix D) was prepared for the change from Alternative 3 to Alternative 2 and completed a 30-day public review process ending on October 27, 2023. No comments were received during public review. Concurrence with the Florida Coastal Zone Management Program pursuant to the Coastal Zone Management Act (CZMA) of 1972 was received on November 28, 2023, from the Florida State Clearinghouse.

Informal consultation with USFWS and concurrence of the species effect determinations was completed for the 2020 GRR/EA in a letter dated April 6, 2020. On July 27, 2023, the USACE Jacksonville District requested concurrence from the USFWS on a “No Effect” determination for listed species not considered during prior consultation and, therefore, reaffirms the prior effects determinations. Concurrence was received on August 10, 2023 (Appendix D).

The project complies with the requirements of NEPA and Section 7 of the Endangered Species Act (ESA). The environmental effects of the proposed changes were analyzed alongside the effects of other alternatives within a the 2020 GRR/EA, as legally required under the NEPA, and the Revised FONSI documents the change in the recommended alternative (Appendix D).

15 CULTURAL RESOURCE CONSIDERATIONS IN RECOMMENDED CHANGES

Cultural resources investigations have been completed for all project components and have identified no cultural resources eligible for inclusion in the National Register of Historic Places (NRHP).

Two modern water control structures (S-332B and S-332C pump stations) are located within the project area. These structures were constructed following standardized construction design plans, and do not embody distinctive characteristics of a type, period, or method of construction, and are not historic properties considered eligible for inclusion in the NRHP. Consultation in accordance with Section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulations in 36 CFR Part 800: Protection of Historic Properties has been coordinated with the Florida State Historic Preservation Office (SHPO) within the Division of Historical Resources, Florida Department of State, regarding these project components. The current project footprint has been surveyed for cultural resources (DHR# 2006-04979). No recorded archaeological sites exist along or within the L-31N Canal. The entire project footprint has been previously disturbed by construction of the SDCS. The USACE Jacksonville District has determined that project design modifications to the C-111 Project S-332B and S-332C current pump stations and associated features would have no effect on historic properties. The SHPO has concurred with the determination of no effect in a letter dated August 5, 2019 (DHR# 2019-0299).

16 PUBLIC INVOLVEMENT

In accordance with NEPA requirements, all interested parties had opportunity to comment on the contents of the 2020 GRR/EA. The public comment period was 30 days, beginning January 28, 2020, and ending February 27, 2020. Comments received during the review of the draft were addressed and documented in the final 2020 GRR/EA.

The Notice of Availability of the Proposed Revised FONSI was published for public comment on September 28, 2023. The public review period was 30 days, from September 28, 2023, until October 27, 2023. No public comments were received on the Proposed Revised FONSI.

17 LONG-TERM HYDROMETEOROLOGICAL CONDITION ASSESSMENT

USACE policy requires a Long-Term Hydrometeorological Condition Assessment (LHCA) for all phases of the USACE project life cycle for both existing and proposed projects where decision documents are required. The vulnerability of the C-111 SD Project was assessed in the 2020 GRR/EA according to the applicable USACE guidance at the time, including an assessment of how changes in sea level and inland hydrology could affect the overall project performance. Since the 2020 GRR/EA underwent an Agency Technical Review (ATR) for compliance with technical and policy guidance, a new LHCA has not been necessary for this Section 902 PACR due to following reasons:

- Project features and objectives remained essentially unchanged.
- USACE guidance on relevant LHCA considerations remained unchanged.
- Hydrometeorological conditions for both inland and coastal hydrology have not significantly changed.

While a new LHCA is not deemed necessary at this time, the conclusions in 2020 GRR/EA are validated by evaluating the impacts of recently observed sea level change trends in projections and by applying the latest CPR Inland Hydrology tools to be compliant with CPR ATR state of the practice. In addition, the 2020 LHCA (previously Climate Change Vulnerability Assessment) is included in Appendix F for reference. There are other nearby USACE Jacksonville District projects incorporating LHCA as a part of study formulation and engineering design, providing a larger scale evaluation of impacts to project performance.

17.1 Previous Long-Term Hydrometeorological Condition Assessment (vice Climate Change Vulnerability Assessment) in 2020 GRR/EA

The 2020 GRR/EA included a LHCA in accordance with USACE guidance to determine the risk and resilience of the project to projected hydrometeorological trends. The C-111 SD Project is located inland from the eastern and southern coasts of Florida. However, it is potentially vulnerable to rising sea levels in Florida Bay to the south, as there are currently no existing water management features located between Florida Bay and the project area. The C-111 SD Project is protected from sea level change (SLC) to the east at the Atlantic Ocean because of the SDCS water control structures located between the C-111 SD Project and the east coast of Florida. Because of this protection, existing or future sea levels to the east are not expected to impact the hydrologic boundaries, including coastal surge and groundwater impacts. The risk and resilience of the project was evaluated for both inland hydrology and SLC in the previous assessment. The inland hydrology aspect was evaluated qualitatively, with a focus on describing the risks to the project from potential changes in precipitation, air temperature, and stream flow. Observed SLC trend at the National Oceanic and Atmospheric Administration's (NOAA) Key West gauge was used to develop three SLC scenarios. Potential impacts from the SLC on the operation of project features and seepage rates in the project area were evaluated. In addition to risks to project performance, adaptation measures that may be incorporated over the project life cycle were also discussed. It was concluded that while SLC does not impact the C-111 SD Project directly, future resilience for the C-111 SD Project may be considered as a part of the other nearby large-scale studies. Operational considerations for the Combined Operational Plan (COP), of which the C-111 SD Project is a component, may preliminarily be considered with high SLC projections potentially impacting water control structures to the east.

17.2 Sea Level Change

The 2020 GRR/EA included a LHCA to evaluate the projected impacts of relative sea level change (RSLC) on the project features and estimated benefits. A range of operational and design modifications were also recommended as additional resilience measures. The USACE SLC guidance has remained essentially the same since the last publication in 2011, with minor edits in 2019. Since there hasn't been a significant change in approach to developing SLC scenarios since the 2020 report, the rate of change of mean sea level (MSL) is expected to be the major variable that needs to be validated in this Section 902 PACR. In this section, the recent sea level observations at the NOAA Key West, FL - Station ID: 8724580 (https://tidesandcurrents.noaa.gov/stationhome.html?id=8724580) are used to evaluate the validity of the sea level change rate used in the previous 2020 assessment. A comparison of these rates is provided in Table 17-1. The RSLC scenarios developed using the USACE Climate Preparedness and Resilience (CPR) Sea Level Analysis Tool (SLAT) are compared against the 2020 GRR/EA projections.

Table 17-1. Key West, Florida - Station ID: 8724580 – Relative Sea Level Change (RSLC) trend used in 2020 General Re-Evaluation and Environmental Assessment vs current National Oceanic and Atmospheric Administration (NOAA) estimate.

Document	Basis	RSLC Trend (millimeters per year)
2020 GRR/EA	NOAA 2006 published rate	2.24
2025 Section 902 PACR	Jan 1912 – Dec 2023 observations	2.61
	Difference:	0.37

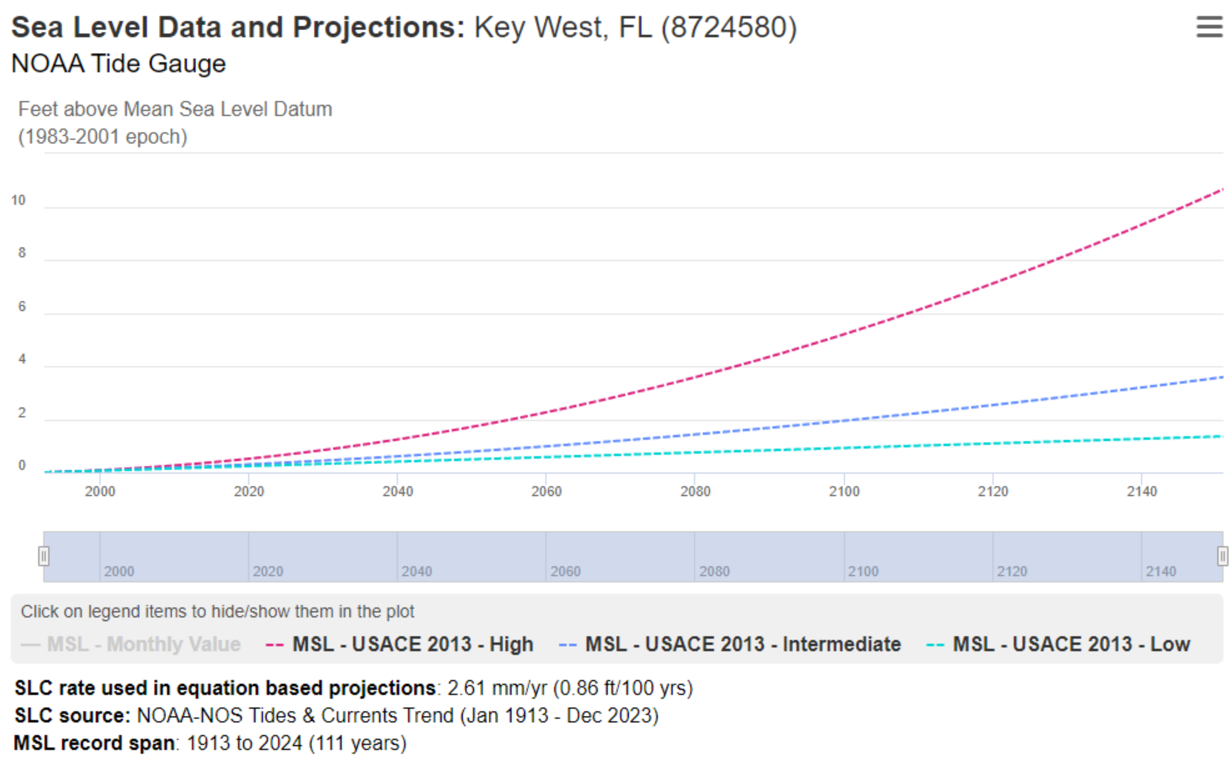


Figure 17-1. Sea Level Change (SLC) Projections for Key West, Florida, Using the Most Recently Published Relative Sea Level Change (RSLC) Trend (0.0086 feet per year)

Following the guidance provided in ER 1100-2-8162, three RSLC curves are developed for the Key West NOAA gauge based on the most recent RSLC rate (Figure 17-1). Table 17-2 compares the projected RSLC elevations for the low, intermediate, and high SLC scenarios in 2075 using RSLC trends for the 2020 GRR/EA trend and most recently published value. The year 2075 was selected as the end of 50-year life cycle of S-332B and S-332C replacement pumpstations assuming replacement is completed in 2025.

Table 17-2. Key West, Florida - Station ID: 8724580 - Projected Relative Sea Level Change (RSLC) Elevations for 2075 Developed in 2020 General Re-Evaluation Report and Environmental Assessment (GRR/EA) Compared to Current Estimates.

Scenario	2020 GRR/EA	Current Report	Difference (feet)
USACE Low	-0.26 ft NAVD88[1]	-0.17 ft NAVD88	+0.09
USACE Int	0.35 ft NAVD88	0.45 ft NAVD88	+0.1
USACE High	2.29 ft NAVD88	2.39 ft NAVD88	+0.1

[1]North American Vertical Datum of 1988

Despite the shifts in corresponding years, the values in the table indicate that the difference between the projected RSLC curves is expected to be less than 0.1 ft. Since this value is within the precision of the topographic data (+/- 0.5 ft), it is decided that there isn't enough reason to produce a new LHCA.

The vulnerability of the project due to SLC remains unchanged from the 2020 LHCA. The inundation of the SLC projection in 2075 (50-yr life cycle) is very unlikely to impact the C-111 Project for the USACE low, intermediate, and high SLC projections. It is not expected that groundwater seepage flow rates will be impacted by SLC based on the proximity of the project to the SLC inundation of the high curve in 2075. As a result, the risk of seepage impacting future pump station operations and O&M is low. The risk of high tide Mean Higher High Water (MHHW) impacts were also evaluated by assessing the SLC inundation footprint with a MHHW of 0.04 ft.

17.3 Inland Hydrology

The inland hydrology assessment follows the USACE guidance of Engineering and Construction Bulletin (ECB) 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. A literature review, non-stationarity analyses, Climate Hydrology Assessment Tool (CHAT) evaluation, and Vulnerability Assessment were conducted as required by ECB 2018-14. A concise summary of the inland hydrology evaluation is provided below and is consistent with USACE CPR practice to scale the LHCA to the project purpose, complexity, and phase of the project.

17.3.1 Review of Literature for Observed and Projected Hydrometeorological Trends

As required by ECB 2018-14, a literature review was conducted to summarize published studies on observed and projected hydrometeorological trends in the study area.

The sources reviewed are listed below:

1) US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – South Atlantic-Gulf Region 03 (USACE, 2015)
2) Climate Science Special Report: Fourth National Climate Assessment, Volume I (USGCRP, 2017) and II (USGCRP, 2018)
3) NOAA State Climate Summaries (Sweet et al., 2022)

A summary of observed and projected trends is included in the tables below:

Table 17-3. Observed Trends of the Hydrometeorological Variables Reviewed in the Literature.

Literature Source	Temperature (annual/seasonal)	Temperature Minimums	Temperature Maximums	Precipitation (annual/seasonal)	Precipitation Extremes	Streamflow
Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – South Atlantic-Gulf Region 03 (USACE, 2015)	No trend	Increase	Increase	No Trend	Increase	No Trend
Climate Science Special Report: Fourth National Climate Assessment, Volume I and II (USGCRP, 2017; USGCRP, 2018)	Increase	Increase	Increase	No Trend	Increase	No Trend
National Oceanic and Atmospheric Administration (NOAA) State Climate Summaries (NOAA, 2022)	Increase	Increase	No Trend	No Trend	No Trend	No literature

Table 17-4. Projected Trends of the Hydrometeorological Variables Reviewed in the Literature.

Literature Source	Temperature (annual/seasonal)	Temperature Minimums	Temperature Maximums	Precipitation (annual/seasonal)	Precipitation Extremes	Streamflow
Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – South Atlantic-Gulf Region 03 (USACE, 2015)	Increase	Increase	Increase	No Trend	Increase	No Trend
Climate Science Special Report: Fourth National Climate Assessment, Volume I and II (USGCRP, 2017; USGCRP, 2018)	Increase	Increase	Increase	No Trend	Increase	No Trend
National Oceanic and Atmospheric Administration (NOAA) State Climate Summaries (NOAA, 2022)	Increase	No literature	Increase	No Trend	Increase	No literature

17.3.2 Nonstationarities in Observed Stream Flow and Precipitation

Many traditional hydrologic analyses depend on the assumption of stationarity (i.e. statistical properties of the data do not change over time). In addition to the significant impacts to the hydrologic analyses, the detected nonstationarities can provide valuable insights into understanding the potential hydrometeorological impacts on natural streamflow and precipitation patterns of a region. Techniques to detect nonstationarities are outlined in Engineering Technical Letter (ETL) 1100-2-3 (USACE, 2017b). USACE's Time Series Toolbox (TST) performs these tests on streamflow records collected at U.S. Geological Survey (USGS) stream gage stations (USACE, 2023a). The tool can be accessed at:

https://climate.sec.usace.army.mil/tst_app/.

The water management system in South Florida is highly managed with hundreds of operable water control structures. To avoid the impacts of operations on the nonstationarity signal, the nearest uncontrolled watershed (USGS Fisheating Creek at Palmdale Station (Id: 02256500)) with gravity-driven stream is selected to investigate the nonstationarities in the study area. Based on the trend and nonstationarity detection analyses for streamflow records, it is concluded that no statistically significant trends or strong nonstationarities were detected in the hydrological records. While this gage is located some distance from the project site, it represents one of the few unregulated basins in the region, providing the most suitable data for assessing potential hydrometeorological impacts on natural streamflow patterns without the confounding effects of human-controlled water management structures.

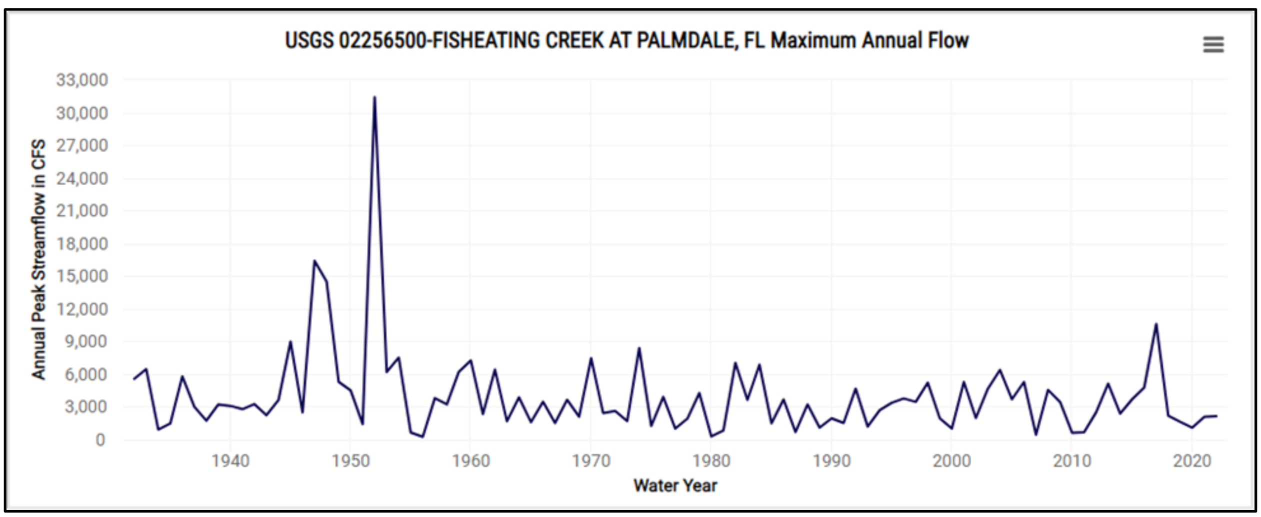


Figure 17-2. Annual Peak Streamflow for Fisheating Creek at Palmdale Gage (USGS Station 02256500)

17.3.3 Climate Hydrology Assessment Tool (CHAT)

The USACE Climate Hydrology Assessment Tool (CHAT) is used to assess projected, future changes to streamflow and precipitation in the watershed (USACE, 2023b). The tool is available at -

https://climate.sec.usace.army.mil/chat/. The streamflow, precipitation, and annual mean temperatures for the Hydrologic Unit Code (HUC) 0309 subregion were analyzed using CHAT. The HUC located in southeast Florida (HUC 03090202, Everglades) was selected to examine the projected impacts to the relevant hydrologic variables.

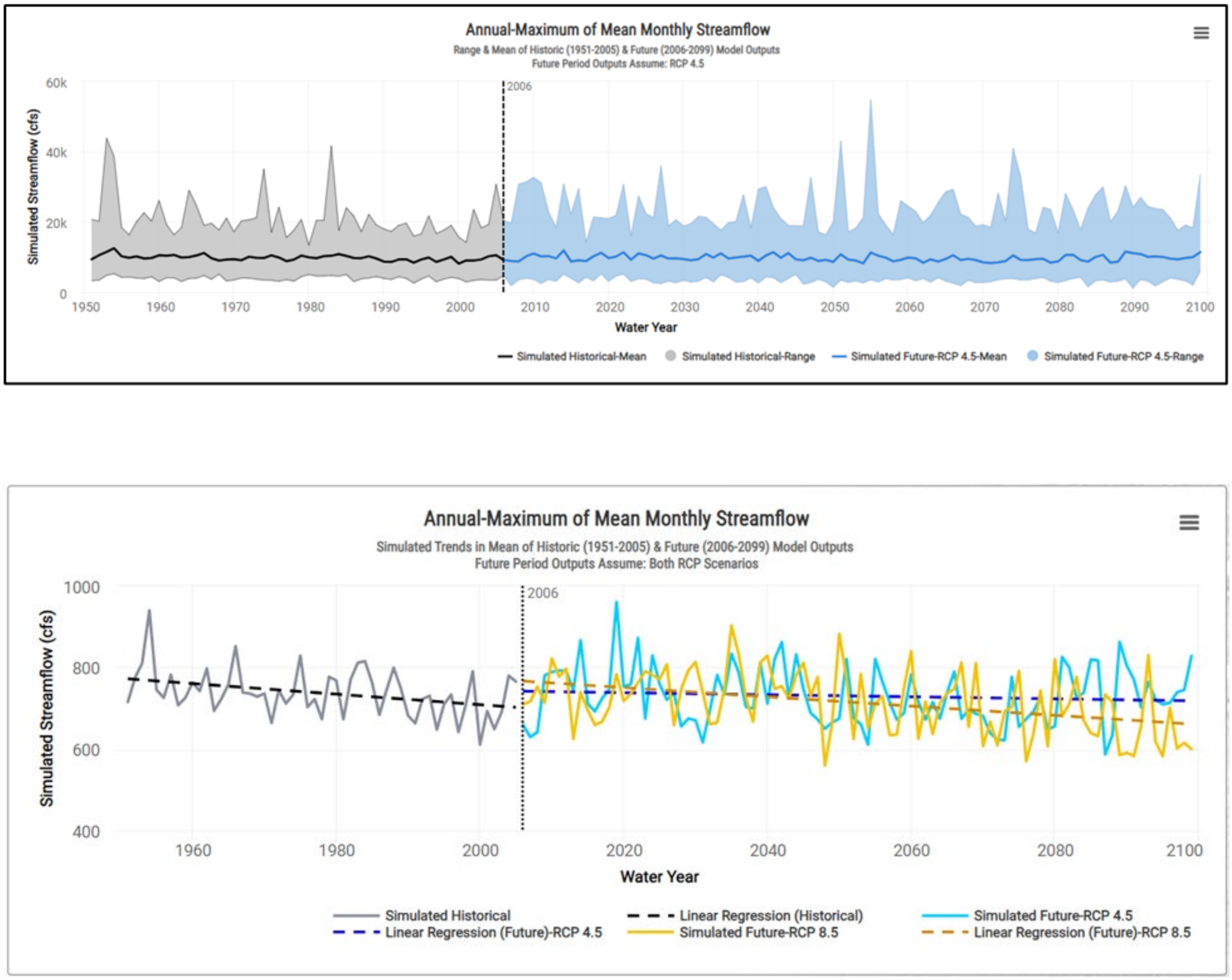


Figure 17-3. Climate Hydrology Assessment Tool *(CHAT) simulated historical and future annual maximum of mean monthly streamflow for Everglades Inflow Unit (Hydrologic Unit Code 03090202)*

CHAT results indicated evidence of decreasing trends in simulated “historical” (1951-2005) and “future” (2006-2099) annual maximum of mean monthly streamflow with p-values at 0.00693 and 0.355 (RCP 4.5) and 7.34e-05 (RCP 8.5). Even though the future RCP 4.5 scenario trend doesn’t meet the statistical significance criteria at $p<0.05$, the historical and RCP 8.5 scenarios indicate a statistically significant trend. Despite the approximations and uncertainties in the models used to develop CHAT results, these trends indicate that a reduction in this variable can be expected during the project horizons. Similar analysis was applied to the historic and future mean stream flow (Figure 17-4) and 3-day maximum precipitation (Figure 17-5) and no statistically significant trend at $p<0.05$ level was observed. However, increases in both historical and future mean temperatures were observed in the simulation results (Figure 17-6).

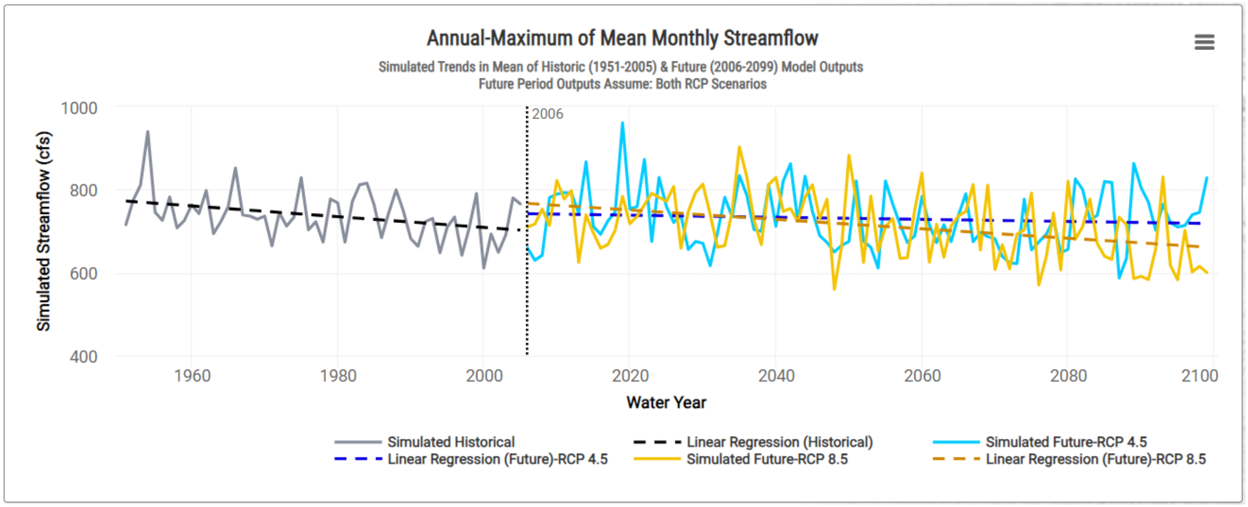


Figure 17-4. Climate Hydrology Assessment Tool *(CHAT) Simulated Historical and Future Annual Maximum of Mean Monthly Streamflow for Western Okeechobee Inflow Unit (Hydrologic Unit Code 03090103)*

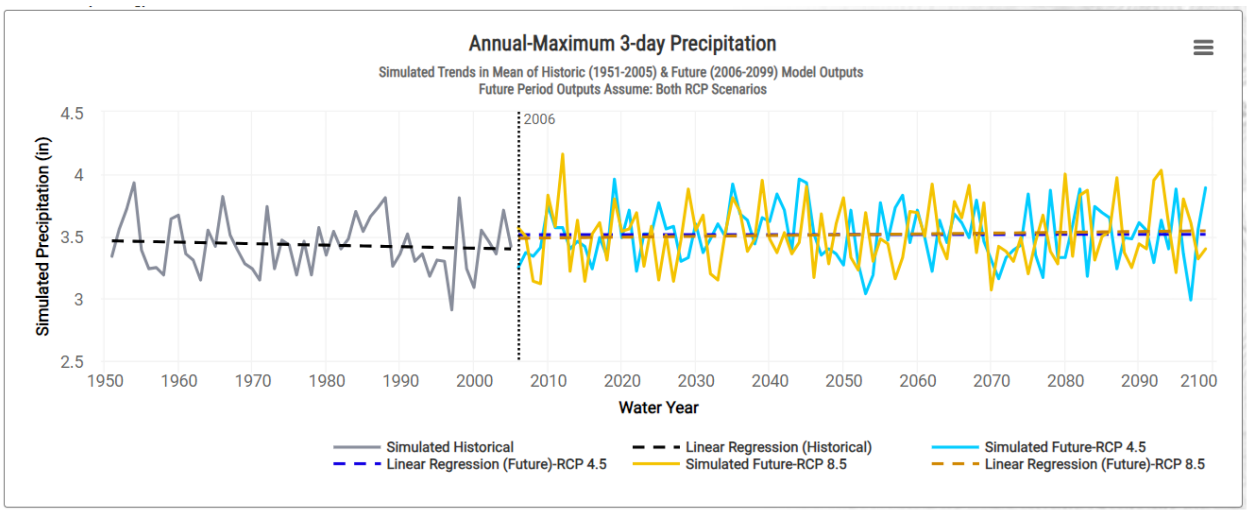


Figure 17-5. Climate Hydrology Assessment Tool *(CHAT) Simulated Historical and Future Annual-Maximum 3-Day Precipitation for Western Okeechobee Inflow (Hydrologic Unit Code 03090103) Unit*

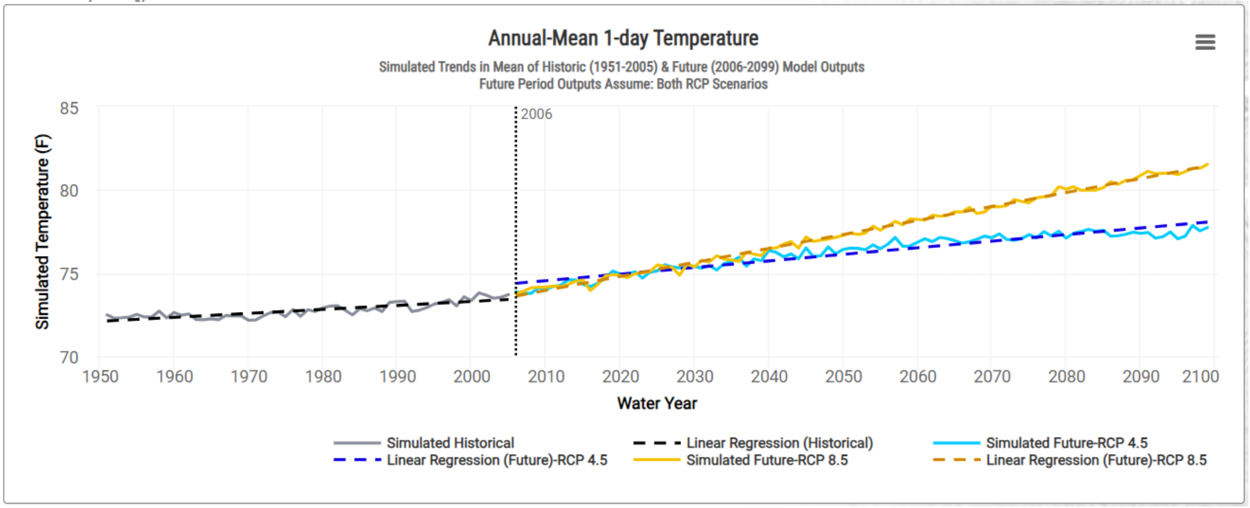


Figure 17-6. Climate Hydrology Assessment Tool *(CHAT) Simulated Historical and Future Annual-Mean Temperature for Western Okeechobee Inflow (Hydrologic Unit Code 03090103) Unit*

17.3.4 Vulnerability Assessment

The USACE Watershed Climate Vulnerability Assessment (VA) Tool (USACE, 2023c) facilitates a screening-level, comparative assessment of the vulnerability of a given business line and HUC-4 watershed to projected hydrometeorological impacts, relative to the other HUC-4 watersheds within the continental United States (CONUS). The VA Tool analysis was conducted using national standard settings without modifications, as recommended by USACE guidance (USACE, 2023c).

As shown in Figure 17-7, the South Florida (HUC 0309) watershed is considered relatively vulnerable to projected hydrometeorological impacts for the flood risk reduction business line, being among the 20% most vulnerable watersheds for this business line in the CONUS (202 HUC04s). This is true for both the wet and dry scenarios and both the 2050 and 2085 epochs. The primary driver of this flood risk vulnerability for all scenarios and epochs is indicator 590: acres of urban area within the 500-year floodplain. Other important contributors at this location include runoff elasticity and flood magnification.

Based on these results, the Broward County Water Preserve Area (BCWPA) project is considered relatively vulnerable to projected hydrometeorological impacts for both the flood risk reduction and ecosystem restoration business lines, ranking among the 20% most vulnerable watersheds in the continental United States. This vulnerability is consistent across wet and dry scenarios and for both 2050 and 2085 epochs. The primary driver of flood risk vulnerability is the acres of urban area within the 500-year floodplain. Other significant contributors include runoff elasticity and flood magnification. While sea level rise inundation is not expected to directly impact the project features upstream of the S-13 tidal structure, the structure's discharge capacity may be adversely affected by increased tailwater elevation during the project lifecycle. The ongoing C&SF Flood Resiliency Study will evaluate the performance of tidal structures due to sea level rise along Florida's east coast, which will help ensure the BCWPA project's long-term performance.

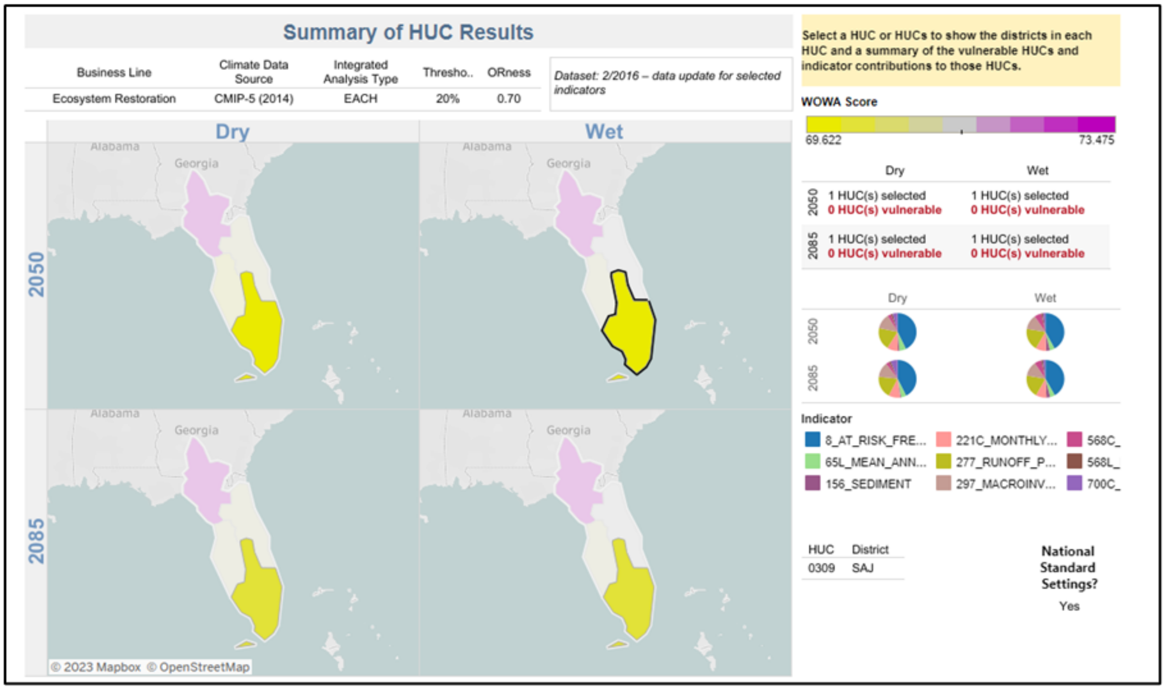


Figure 17-7. Output of the USACE Watershed Climate Vulnerability Assessment *(VA) Tool Indicates the South Florida Watershed is Among the 20% Most Vulnerable Contiguous United States (CONUS) Watersheds for the Ecosystem Restoration Business Line*

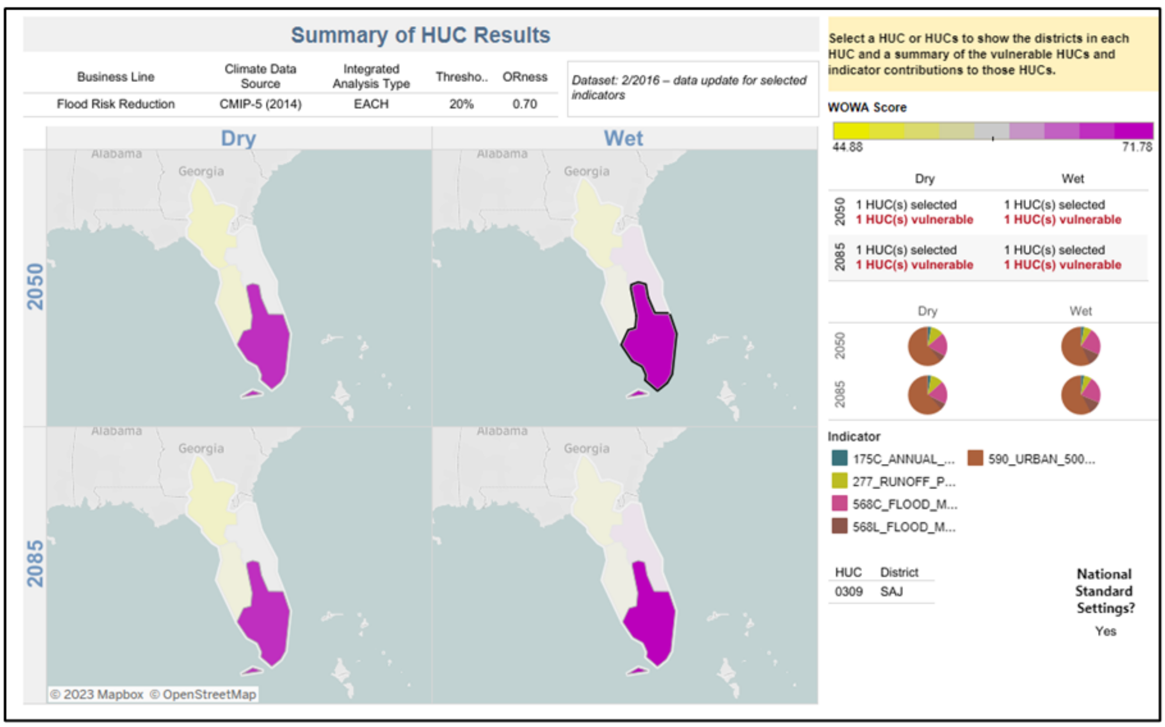


Figure 17-8. Output of the USACE Watershed Climate Vulnerability Assessment *(VA) Tool Indicates the South Florida watershed is Among the 20% Most Vulnerable Contiguous United States (CONUS) Watersheds for the Flood Risk Reduction Business Line*

17.4 Long-Term Hydrometeorological Condition Risk Assessment

The projected increases in extreme storm frequency and intensity and increases in temperatures indicated by the literature review present risks to the project features. Despite the projected increases in extreme rainfall, the potential changes in soil moisture deficiency and land use may not result in noticeable change in the future stream flow volumes. Further investigation is needed to determine the impacts of projected hydrometeorological trends on future rainfall and streamflow patterns for the project area, which is beyond the scope of this report.

The results of the risk assessment indicate that the project is located in a relatively vulnerable watershed for the flood risk management business line. The watershed is most vulnerable to increases in extreme storm frequency and intensity and increases in air temperature. An assessment of residual risks resulting from projected hydrometeorological trends, as described in ECB 2018-14, is included in Table 17-1. The table shows the major project features, the trigger events (hydrometeorological variable that causes the risk), the hazard (resulting undesirable environmental condition), the harms (potential damage to the project or changed project performance), and qualitative assessment of the likelihood and uncertainty of this harm. Note that not all impacts of projected hydrometeorological trends will result in increased risk, as there may be increased project benefits.

Though initially justified over a 50-year project life cycle, USACE projects can remain in service much longer. The hydrometeorological conditions for which the project was designed can change over the full lifetime of a project to the extent that stability,maintenance, and operation may be impacted, possibly with serious consequences, but also potentially with beneficial consequences. In addition to the risk assessment factors described in Table 17-5 for the 50-year project life cycle, Table 17-6 provides supplemental risk assessment information for the project planning horizon of 100 years to support characterization of expected resilience or robustness of the project features beyond the 50-year project life cycle. Due to the lack of substantial evidence indicating increasing streamflows for the project area, projected hydrometeorological trends and resilience should be accounted for by incorporation into the project's risk register. The impacts of projected hydrometeorological trends are already reflected in the uncertainty bounds included in the preliminary project design outlined in the 2020 GRR/EA.

If sea levels, the frequency and intensity of extreme storm events, or drought conditions increase beyond the current projections, the future resilience to the area served by the project could include:

1) Continue hydrologic monitoring to track changes in wetland water levels and flow patterns and assess project performance and benefits.
2) Adjust operations of structures especially during abnormally wet or dry periods.
3) Install additional water control structures to increase project's overall conveyance capacity.
4) Consider SLC for the hydrologic modeling conducted during PED to further assess the potential spatial and temporal effects on the groundwater flow rates from ENP towards the L-31N Canal.

Table 17-5. Risk Assessment for the 50-year Project Planning Horizon.

Feature or Measure	Trigger	Hazard	Harm	Qualitative Likelihood
North Detention Area (NDA)/South Detention Area (SDA) Storage Reservoir, C-111	Increased extreme precipitation may occur from increased tropical storm activity.	Future flood volumes may be larger than present.	Flood waters may remain on the levee for longer durations, and more frequently, potentially damaging the NDA or SDA perimeter levees. Larger flood volumes may not be adequately captured and have to bypass to the downstream South Florida Water Management District (SFWMD) C-111 Spreader Canal detention areas and/or the Estuary.	Somewhat Likely
NDA/SDA Storage Reservoir,C-111	Increased temperatures	Increased evapotranspiration or drought	Decrease in flows may result in lower reservoir stages, resulting in reduced effectiveness for seepage management, resulting in loss of habitat and vegetation and reducing project benefits.	Likely
Water Control Structures and Pump Stations	Increased extreme precipitation may occur from increased tropical storm activity.	Future flood volumes may be larger than present.	Increase in flows resulting in structure under-performing during high flow events	Somewhat Likely
Water Control Structures and Pump Stations	Increased Sea Level	Future sea level elevation may be larger than present.	Increased Sea Level Change (SLC) may limit discharge capacities of water control structures near the coast with current headwater conditions, increasing the frequency of C-111 South Dade Project pump operations.	Unlikely within the 50-year pump station life cycle
Water Control Structures and Pump Stations	Increased Sea Level	Groundwater seepage rates from Everglades National Park (ENP) towardsthe Atlantic Ocean may change	Increased SLC may change groundwater seepage rates, resulting in impacts to pump station operations and Operations and Maintenance (O&M).	Unlikely within 50-year pump station life cycle.

Table 17-6. Risk Assessment for 100-year Project Planning Horizon for Long-Term Hydrometeorological Condition Assessment

Feature or Measure	Trigger	Hazard	Harm	Qualitative Likelihood
Water Control Structures and Pump Stations	Increased Sea Level	Future sea level elevation may be larger than present.	Increased SLC may limit discharge capacities of gravity water control structures both near the coast and inland to the primary L-31N/C-111 Canals with current headwater conditions, increasing the frequency of C-111 South Dade Project pump operations for Flood Risk Management.	Likely within the 100-year life cycle
Water Control Structures and Pump Stations	Increased Sea Level	Groundwater seepage rates from ENP towards the Atlantic Ocean may change.	Increased SLC may change groundwater seepage rates, resulting in impacts to pump station operations and O&M. In the absence of tidal and/or storm surge barriers within ENP, the continued northward movement of the tidal boundary within ENP may result in saltwater contamination of Miami-Dade wellfields, surface water canals, and surficial aquifers used for basin agriculture.	Likely within 100-year planning horizon, beyond the 50-yearlife cycle of the pump stations.

18 RISK AND UNCERTAINTY

The study team has updated the Cost Summary Risk Analysis, detailed in Appendix B.

18.1 Project Benefit Uncertainty

Replacement of the current pump stations will provide the dual benefit of reducing the average annual operating costs and reducing the annual probability of pump station failure. Ecosystem restoration and flood risk management objectives will continue to be met by the project along with the same benefits the project currently provides, but at a lower annual cost.

18.2 Risks to Project Implementation

The C-111 SD Project, with the revised design, cannot be completed at a cost below the existing Section 902 limit. The two interim existing pump stations, S-332B and S-332C, were constructed in an expedited manner in response to a 1999 USFWS BO to support the immediate needs of the endangered CSSS. These pump stations were constructed on platforms without hardened outer structures. The current pump stations have been used successfully for almost 20 years. However, inspections performed by the USACE Jacksonville District and SFWMD have indicated that these current pump stations are now requiring extensive repairs. Additionally, the current pump stations and equipment are not housed in storm hardened structures, causing them to be vulnerable to prevailing weather (rain, wind, and solar) and high velocity hurricane events. If a severe weather event were to occur, catastrophic damage could cause failure of these pump stations, diminishing or halting the ecosystem restoration and flood risk management benefits that the project currently provides to meet federal objectives.

While never formally estimated using a potential failure mode analysis, the annual probability of pump station failure is assumed to increase each year due to a gradual loss of structural integrity (corrosion, fatigue, etc.). Unlike mechanical and electrical system repairs, making structural repairs can be complicated and expensive, and potentially unjustified due to the temporary nature of the features. Therefore, replacement of the current pump stations has the dual benefit of reducing the average annual operating costs and reducing the annual probability of pump station failure.

19 AUTHORITY FOR THE PROPOSED CHANGES

An analysis was conducted to determine whether the proposed design changes for the S-332B and S-332C pump stations are within the Chief of Engineer's discretionary authority and may be approved by the Division Commander. The design changes reflected in this report are the first changes proposed for the S-332B and S-332C pump stations that were authorized in WRDA 2020.

The authority of the Chief of Engineers to modify projects is acknowledged by Congress and reflected in ER 1105-2-100 and case law. A change in scope greater than 20 percent particularly serves as an alert that the change may exceed the Chief's discretionary authority. The guidance in Appendix G of the Planning Guidance Notebook (PGN) was applied to determine whether the proposed changes are within the Chief's discretionary authority and, if yes, the approval authority.

The analysis first analyzed the changes that always require congressional authorization. The proposed design changes meet the sixth change always requiring congressional authorization: the total project cost exceeds the Section 902 Cost Limit because of the design changes, and so Congress will be requested to authorize a new total project cost.

The analysis then applied the following four criteria to determine whether the proposed changes may be approved by the Division Commander: (1) increase in total project cost no greater than increases in price level changes and cost of modifications required by subsequent legislation; (2) increase or decrease in scope no greater than 20 percent; (3) change in the location or the design of the project to the extent that the location and magnitude of the impacts of the change are determined to be insignificant compared to the impacts assessed for the authorized project; and (4) no addition or deletion of a project purpose.

Regarding the first criteria (cost), the conclusion was made that the total project cost has increased above price level changes and exceeds the Section 902 Cost Limit and that the increase in total project cost is due to the cost of design changes for components of the 2020 authorized design and application of new design requirements (that is, requirements detailed in the 2021 SFWMD PSEG). Thus, the first criteria for determining whether project changes can be approved by the Division Commander is not met. The analysis continued to evaluate whether, aside from the Section 902 Cost Limit exceedance, the design changes are otherwise within the Chief's discretionary authority.

Regarding the second criteria (scope), the identified relevant parameters are design capacity, environmental impacts, and benefits. The proposed design changes for the S-332B and S-332C pump stations do not contribute to an increase or decrease in design capacity. The design capacity of the pump stations remains the same as the design capacity of the pump stations authorized in WRDA 2020 (575 cfs). The proposed design changes will not result in any new or additional environmental impacts than those evaluated in the 2020 GRR/EA. Furthermore, the design changes will not result in any new or additional ecosystem benefits than those provided in the 1994 GRR/EIS, and reiterated in the 2020 GRR/EA.

Regarding the third and fourth criteria, (project location and purpose), there are no changes to the location of the S-332B and S-332C pump stations, and the overall project boundaries from the 2020 WRDA authorization remain unchanged. Similarly, the design changes do not propose addition or deletion of a project purpose.

Based on the analysis, the design changes for the S-332B and S-332C pump stations, aside from the Section 902 Cost Limit exceedance, are within the Chief's discretionary authority. The Corps will seek authorization from Congress for a new total project cost.

20 RECOMMENDATIONS

The proposed design changes for the C-111 SD Project Pump Stations S-332B and S-332C Replacement are needed for the project, are environmentally acceptable, are technical feasible, and will result in cost savings over time while providing reliable backup power when needed. There are legitimate engineering reasons, discussed above, to apply some design standards that are different than those of the USACE. The proposed pump station replacements will increase the overall cost to the project, which will exceed the Section 902 Cost Limit.

Based on the analysis and findings in this report, to include the conclusion that the Division Commander may approve the proposed design changes, I recommend the Division Commander approve the proposed changes to (that is, replacement of) the C-111 SD replacement pump stations S-332B and S-332C. Due to the increased project costs resulting from the proposed pump station design changes, I recommend that Congress be requested to authorize a new project first cost of $954,561,000. The Corps may not initiate construction of the changes, to include award of a contract, unless Congress authorizes a new project cost.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing design changes and a Section 902 Cost Limit exceedance. They do not reflect program and budgeting priorities inherent in the national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendation regarding a new authorized project cost may be modified before it is transmitted to the Congress.

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Brandon L. Bowman
Colonel, U.S. Army
District Commander

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