US Army Corps
of Engineers®

Pahokee, Florida

CAP Section 1135 – Restoration Project

Project Cost and Abbreviated Risk Analysis Report

April 2018

Prepared by:

U.S. Army Corps of Engineers
Jacksonville District

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EXECUTIVE SUMMARY

This Project Cost and Abbreviated Risk Analysis (ARA) Report has been completed by the US Army Corps of Engineers (USACE), Jacksonville District. The ARA was developed with tools provided by the Cost Engineering Mandatory Center of Expertise (MCX) for Civil Works. The ARA was reviewed internally by Jacksonville District Cost Engineering before being presented for Agency Technical Review (ATR). This report presents a recommendation for the total project cost contingency for cost certification of the Pahokee Restoration Project. In compliance with Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated June 30, 2016, an abbreviated risk analysis study was conducted for the development of the contingency to be applied to the total project cost. The purpose of this risk analysis was to establish a project contingency by identifying and measuring the cost impact of project uncertainties with respect to the estimated total project cost.

Specific to Pahokee, the most likely total project cost (at project first cost) is at approximately $12,005K. Based on the results of the analysis, the Jacksonville District recommends a contingency value of approximately $2,326K or 29.9% for construction costs; $135K or 13.2% for Planning, Engineering, and Design costs; and $123K or 20.7% for Construction Management costs for a combine contingency of 27.5%. An ARA was developed to model the remaining work concerning scope growth, potential for mods and claims, and other concerns as seen in the risk register.

The Jacksonville District Cost Engineering Section performed the risk analysis for this project and it has been internally reviewed, as required, via the ATR process.

MAIN REPORT

1.0 PURPOSE

This report presents a recommendation for the total project cost contingencies for the cost certification of the Pahokee Restoration Project.

2.0 BACKGROUND

This estimate is primarily based upon the December 2017 Engineering Appendix, Pahokee Restoration Project located in Pahokee, Florida.

The study area is located in Palm Beach County, Florida and is 4,000 feet wide, spanning approximately 31,000 feet of shoreline along Lake Okeechobee within the City of Pahokee.

Herbert Hoover Dike, which surrounds Lake Okeechobee, has altered the ecosystem of the shoreline within the project area. The vegetation which historically existed within the gentle sloping shoreline has diminished. The shoreline is now a steep slope into deep water providing an environment of limited habitat.

During the feasibility study the project delivery team (PDT) evaluated six alternatives in an attempt to meet the study objectives. Following economic and benefits analysis, the alternatives were screen out leaving alternative 5 as the tentative selected plan. Refer to the Engineer Appendix for more information regarding the complete array of alternatives analyzed.

A. Previous alternative overview:

1. Alternative 1 – Low Profile Island. This includes construction of an island with an elevation of 11.0 feet NAVD 88. The island would be constructed of a mix of sand and finer silt sediment, surrounded by a sand berm for stability. This would enable improvement of turbidity in the project area by dredging and sequestering some of the fine silt sediments. The outer slopes would be armored with riprap.

2. Alternative 2 – Low Profile Littoral Shelf. This includes construction of a littoral shelf with an elevation of 11.0 feet NAVD 88. The shelf would be constructed of a mix of sand and finer silt sediment, surrounded on the three lake-ward sides by a sand berm for stability and armored with riprap. The fourth side would tie into the shore.

3. Alternative 3 – High Profile Island. This includes construction of a terraced island with a lower elevation of 11.0 feet NAVD 88 and a higher elevation of 13.0 feet NAVD 88. The island would be constructed of a mix of sand and finer silt sediment, surrounded by a sand berm for stability. The outer slopes would be armored with riprap.

   Alternative 3A – High Profile Island. This includes construction of an island with an elevation of 13.0 feet NAVD 88. The island would be constructed of a mix of sand and finer silt sediment, surrounded by a sand berm for stability. The outer slopes would be armored with riprap.

4. Alternative 4 – High Profile Littoral Shelf. This includes construction of a terraced littoral shelf with a lower elevation of 11.0 feet NAVD 88 and a higher elevation of 13.0 feet NAVD 88. The shelf would be constructed of a mix of sand and finer silt sediment, surrounded on the three lake-ward sides by a sand berm for stability and armored with riprap. The fourth side would tie into the shore.

5. Alternative 5 – Low Profile Island and High Profile Island. This includes construction of two structures; a low profile island and a high profile island. Section view shown in Figure 1.

6. Alternative 6 – Low Profile Island and Low Profile Littoral Shelf. This includes construction of two structures; a low profile island and a low profile littoral shelf.

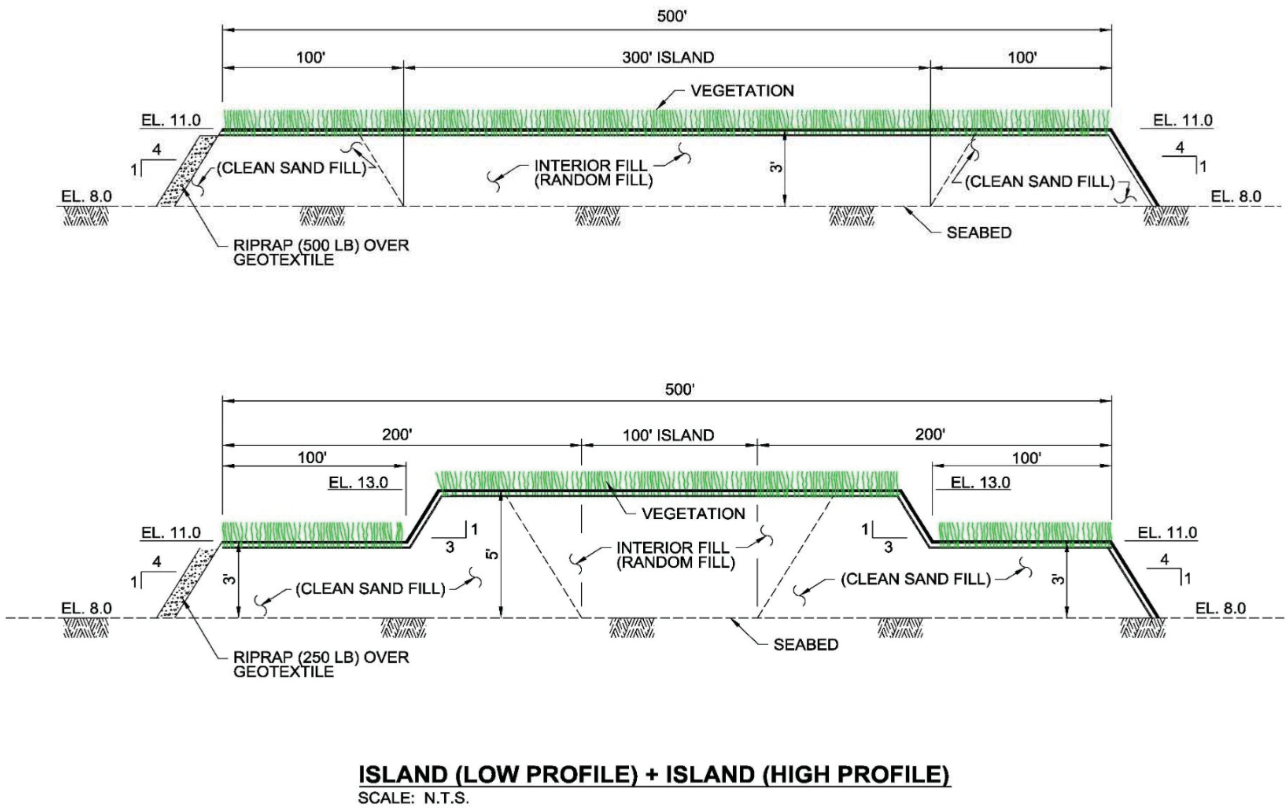
Table 1: Alternative Cost Comparison

Alternative	Rough Order of Magnitude – OCT 17	Refined Cost with risk based contingency – FEB 2018 (First Cost)
Alternative 1	$16,100,000	-
Alternative 2	$15,525,000	-
Alternative 3	$11,940,000	-
Alternative 3A	$11,030,000**	-
Alternative 4	$13,245,000	-
Alternative 5	$11,255,000	$12,005,000*
Alternative 6	$22,885,000	-

1. Value with * represent the Construction and Non-construction (Project First) Cost. Values without * are construction cost only at FY18 level for screening purposes.
2. Value with ** was priced in JAN 2018 as a new alternative.
3. All values include contingency.

The estimate is based on Alternative 5; includes construction of two structures; a low profile island and a high profile island. The low-profile island would be constructed of a mix of sand and finer silt sediment, surrounded by a 100-foot sand berm for stability and armored with 500-lb limestone riprap (rock). The high-profile island would be a terraced island with a lower elevation of 11.0 feet NAVD 88 and a higher elevation of 13.0 feet NAVD 88. The terraced island would be constructed of a mix of sand and finer silt sediment, surrounded by a 100-foot sand berm for stability and armored with 250-lb limestone riprap (stone).

Figure 1: Low Profile Island and High Profile Island – Cross section



* **Low Profile Island = 300 feet x 1500 feet**
* **High Profile Island = 100 feet x 1000 feet**

3.0 REPORT SCOPE

The scope of this report is to facilitate a technical overview of the selected plan. Part of the report includes the risk analysis report used to calculate and present the cost contingency at the 80% confidence level using the risk analysis processes, as mandated by U.S Army Corps of Engineers (USACE) Engineer Regulation (ER) 1110-2-1150, Engineering and Design for Civil Works, ER 1110-2-1302, Civil Works Cost Engineering, and Engineer Technical Letter 1110-2-573, Construction Cost Estimating Guide for Civil Works. The study and presentation does not include consideration for life cycle costs.

3.1 Project Scope

The recommended plan is to construct two islands with imported sand fill from an upland sand source. Sand and stone armoring will be used on the perimeters and material will be dredged from Lake Okeechobee to fill the interior of the islands. The two islands will be parallel to shore, positioned as shown in Figure 3, with the lakeward island being the low-profile island, and the leeward island being the high-profile island. The material will be used to create an area suitable for vegetation, with associated habitat, as well as meet other study objectives.

A. Island Construction:

1. 122,000 cubic yards of sand imported from a local source to construct the perimeter of each island
2. Transport material by truck up to 20 miles one way
3. Transport material to project site by scow barge via conveyor and offload, shape and grade (Example loading operation shown in Figure 2)
4. Construct perimeter erosion control stone armor system (geotextile, bedding and armor stone)
5. 7,000 linear feet of turbidity barrier
6. Fill interior of islands with material obtained by means of dredging from Lake Okeechobee within one mile of project site via pipeline dredge

B. Planting:

1. 29 acres of emergent and upland vegetation
2. Grass plant density – 4,800/acre
3. Tree seedling density – 1,742/acre

Figure 2: Material Loading and Transport

The photo represents the how the upland trucked material from the mine source will be loaded onto a scow barge by use of conveyor.

C. Project Assumption used for the cost estimate:

1. Estimate assumes dredging work to be subcontracted.
2. Construction will be executed during day light hours and only five days a week with the exception of the dredging work and associated tasks resulting from dredging.
3. Contractor will maintain the turbidity barrier system and water quality monitoring during construction.
4. The contractor will provide daily water transportation.
5. The imported fill and stone will be loaded onto a barge with a conveyor.
6. The imported fill material will be off-loaded at the project site with an excavator clamshell and a flat barge.
7. Vegetative Monitoring and Adaptive Management is included in the estimate for the 5 years following construction completion.
8. Any deviations from these assumptions will impact costs. The magnitude of those impacts will vary.

Figure 3: Location of Selected Alternative

The most cost-effective location for the selected alternative is shown in Figure 3.

D. Major Project Features include:

1. Two islands to support marine ecosystem habitat.

E. Monitoring and Adaptive Management:

1. The estimated cost includes vegetative monitoring for the first five years following construction completion. In the event that the plantings do not live, it is assumed that the effort of replanting up to 80% of the required vegetation could potentially be required. Adaptive Management beyond the first five years following construction completion may be required, however, is not included in this total project cost. Refer to Table 1 for Monitoring and Adaptive Management Costs Appendix E in the main report for further detail.
2. The estimated cost of the project includes vegetative monitoring and the potential cost of replanting to five-year period following the con

The estimated construction duration is 386 Calendar Days.

Table 2: Monitoring and Adaptive Management Costs

	First 5 Years, Total (Included in Project Costs)	**Post 5 Years, Annually** (NOT Included in Project Costs)
Vegetation Monitoring	$85,000	$17,000
Vegetation Replacement	$320,000	$64,000
Thin-Layer Placement		*$45

*Note: Thin-Layer Placement assumes increasing island elevation by 0.5’. Cost is per cubic yard of material placed.

4.0 ABBREVIATED RISK ANALYSIS METHODOLOGY/PROCESS

The risk analysis process for this estimate is intended to determine the probability of various cost outcomes and to quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence. In simple terms, contingency is an amount added to an estimate to allow for items, conditions or events for which the occurrence or impact is uncertain and that experience suggests will likely result in additional costs being incurred or additional time being required. The amount of contingency included in project control plans depends, at least in part, on the project leadership’s willingness to accept risk of project overruns. The less risk that project leadership is willing to accept the more contingency should be applied in the project control plans. The risk of overrun is expressed, in a probabilistic context, using confidence levels.

Contingency for the cost estimate has been developed using materials provided by the USACE Cost Center of Expertise located in Walla Walla District. The cost estimator assigned risk factors based upon the project Work Breakdown Structure. The contingency was developed using a condensed format since the total project cost is below the threshold for completing a Cost and Schedule Risk Analysis. The contingency was primarily affected by the weight of likely to mostly likely risks with regards to weather and difficulty of in water construction. Their impacts were marginal.

The primary steps, in functional terms, of the risk analysis process are described in the following subsections. Risk analysis results are provided in Appendix.

4.1 Identify and Assess Risk Factors

Identifying risk factors is considered a qualitative process that results in establishing a risk register that serves as the basis for the resulting contingency percentage. Risk factors are events and conditions that may influence or drive uncertainty in project performance. They may be inherent characteristics or conditions of the project or external influences, events, or conditions such as weather or economic conditions. Risk factors may have either favorable or unfavorable impacts on project cost and schedule. A risk brainstorming session was conducted November 08, 2016, to discuss all possible risks and impacts. The Project Delivery Team (PDT) attendees are listed on the PDT Involvement tab of the ARA spreadsheet.

Contingency is analyzed using formulas within the spreadsheet, as opposed to the more complex analysis of the Crystal Ball software's *Monte Carlo* simulations used in a formal cost and schedule risk analysis. Contingencies are calculated according to the likelihood and impact of each factor identified in the risk register.

The Abbreviate Risk Analysis was developed with input of the Project delivery team (PDT) and with the sponsor. The highest risk level identified during the development of the Risk Register was level 4. This risk was associated with the potential increase in cost due the possibility of encountering problems will constructing the perimeter of the islands on a large body of water while unprotected from the elements. The concern is expected to be address during the design and implementation phase of the project. The remainder of the risk levels are level 3 and under.

A. <u>Some of the concerns registered in the Risk Register are:</u>

1. Potential for claims during construction of island due to unforeseen erosion during placement.
2. Light loading of barges due to tides and water depths.
3. Accelerated schedule due to weather delays are greater when working unprotected on a large body of water exposed to the elements.
4. The timeframe for the settlement of fines could take longer than anticipated and slip the schedule.

This tool helped the development of the contingency for the project and provide essential information that could be used to establishment of control measures. The Risk Register will continue be updated during the project live cycle.

5.0 KEY ASSUMPTIONS AND LIMITATIONS

Key assumptions and limitations are those that are most likely to significantly affect the determinations of contingency presented in the CSRA. The key assumptions and limitations are important to help ensure that project leadership and other decision makers understand the steps, logic, and decisions made in the risk analysis, as well as any resultant implications on the use of outcomes and results.

A. Key assumptions:

1. Estimate assumes dredging work to be subcontracted.
2. Construction will be executed during day light hours and only five days a week with the exception of the dredging work and associated tasks resulting from dredging.
3. Contractor will maintain water quality monitoring during the construction and will maintain the turbidity barrier.
4. The contractor will provide daily water transportation.
5. The imported fill will be loaded onto a barge with a conveyor.
6. The imported fill material will be unloaded at the project site with an excavator clamshell and a flat barge.

6.0 RESULTS

6.1 Risk Register

An abbreviated risk register, provided in Appendix A, is a tool commonly used in project planning and risk analysis. It is important to note that a risk register can be an effective tool for managing identified risks throughout the project life cycle. As such, it is generally recommended that risk registers be updated as the designs, cost estimates, and schedule are further refined, especially on large projects with extended schedules.

Specific to this abbreviated risk register, it should be noted that there are events reported in the register, but not included in the calculations. That is, the risk register shows the risk events, but they do not contribute to the contingency calculations. In a formal risk analysis, such a practice is commonly used on risks/opportunity events with a Low Risk Level (typical for cost and schedule events with some combination of, for example, Very Unlikely/Unlikely Likelihoods and Negligible/Marginal Impacts). These are documented, but excluded from the calculations in order to better prevent skewed results. Under Risk Level, these show with a Zero (0).

As mentioned in the Executive Summary, tools/materials from the MCX were used throughout the process of acknowledging this risk, trying to account for it, running into the calculation issue, and coming up with the resolution.

6.2 Cost Contingency

The contingency was calculated based off the likelihood and impact of the risk concerns. Some of the major areas of concern were seen under the Construction Elements and External Project Risks categories. For example, the risks for Utilities could have a significant impact on the cost, as there has been a history of issues pertaining to Utilities for this project area.

Table 3 provides the raw contingencies percentages calculated based upon the factors assigned in the risk register.

Table 3: Project Cost Contingency Summary

Totals	% Contingency
Real Estate	15.0 %
Monitoring Plan	5.0 %
Construction	29.9 %
Planning, Engineering & Design	13.2 %
Construction Management	20.7 %
Combine Contingency (excluding Real Estate)	27.5 %

ATTACHMENT A – TOTAL PROJECT COST SUMMARY

WALLA WALLA COST ENGINEERING MANDATORY CENTER OF EXPERTISE

COST AGENCY TECHNICAL REVIEW CERTIFICATION STATEMENT

For Project No. 460643

SAJ – Pahokee Eco-Islands Section 1135
Project Modifications for Improvement of the Environment

The Pahokee Eco-Islands Section 1135 as presented by Jacksonville District, has undergone a successful Cost Agency Technical Review (Cost ATR), performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) team. The Cost ATR included study of the project scope, report, cost estimates, schedules, escalation, and risk-based contingencies. This certification signifies the products meet the quality standards as prescribed in ER 1110-2-1150 Engineering and Design for Civil Works Projects and ER 1110-2-1302 Civil Works Cost Engineering.

As of April 19, 2018, the Cost MCX certifies the estimated total project cost:

FY19 Project First Cost:	$12,005,000
Fully Funded Total Project Cost:	$12,701,000
Federal Cost of Project:	$9,925,000

It remains the responsibility of the District to correctly reflect these cost values within the Final Report and to implement effective project management controls and implementation procedures including risk management through the period of Federal participation.

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Michael P. Jacobs, PE, CCE
Chief, Cost Engineering MCX
Walla Walla District

PROJECT: **Pohakee (CAP 1135)**
PROJECT NO **460643**
LOCATION: **Pahokee, Florida**

DISTRICT: **Jacksonville District** PREPARED: **4/2/2018**

POC: **CHIEF, COST ENGINEERING, MATTHEW CUNNINGHAM**

This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
						Program Year (Budget EC): 2019 Effective Price Level Date: 1-Oct- 18									
WBS NUMBER	Civil Works Feature Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 9/30/2017 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
06	MONITORING PLAN	$85	$4	5.0%	$89	2.1%	$87	$4	$91		$91	4.0%	$90	$5	$95
09	CHANNELS CANALS	$7,464	$2,267	30.4%	$9,731	2.1%	$7,618	$2,313	$9,931		$9,931	5.2%	$8,030	$2,416	$10,447
18	CULTURAL RESOURCE PRESERVATION	$60	$8	13.2%	$68	2.1%	$61	$8	$69		$69	1.0%	$62	$8	$70
	CONSTRUCTION ESTIMATE TOTALS:	$7,609	$2,279	29.9%	$9,888	2.1%	$7,766	$2,326	$10,091		$10,091	5.2%	$8,182	$2,429	$10,611
01	LANDS AND DAMAGES	$35	$5	15.0%	$40	2.1%	$36	$5	$41		$41	1.0%	$36	$5	$41
30	PLANNING, ENGINEERING DESIGN	$984	$130	13.2%	$1,115	3.9%	$1,022	$135	$1,157		$1,157	9.9%	$1,123	$148	$1,271
31	CONSTRUCTION MANAGEMENT	$571	$118	20.7%	$689	3.9%	$593	$123	$716		$716	8.5%	$643	$133	$776
	PROJECT COST TOTALS:	$9,200	$2,532	27.5%	$11,732		$9,417	$2,589	$12,005		**$12,005**	5.8%	$9,985	$2,716	$12,701

________________ CHIEF, COST ENGINEERING, MATTHEW CUNNINGHAM

________________ PROJECT MANAGER, JAMES SUGGS

________________ CHIEF, REAL ESTATE, TIMOTHY MCQUILLEN

________________ CHIEF, PLANNING, ERIC SUMMA

________________ CHIEF, ENGINEERING, LAUREEN BOROCHANER

________________ CHIEF, OPERATIONS, CAROL BERNSTEIN

________________ CHIEF, CONSTRUCTION, STEPHEN DUBA

________________ ACTING CHIEF, CONTRACTING, RICARDO TORRES

________________ CHIEF, PM-PB, KAREN SMITH

________________ CHIEF, DPM, TIM MURPHY

ESTIMATED TOTAL PROJECT COST:		**$12,701**
ESTIMATED FEDERAL COST:	**75%**	$9,525
ESTIMATED NON-FEDERAL COST:	**25%**	$3,175
22 - FEASIBILITY STUDY (CAP studies):		**$700**
ESTIMATED FEDERAL COST:		$400
ESTIMATED NON-FEDERAL COST:		$300
ESTIMATED FEDERAL COST ALLOCATION		**$9,925**
ESTIMATED NON-FEDERAL COST ALLOCATION		**$3,475**

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