

# **APPENDIX B**

## **Cost Engineering and Risk Analysis**

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**US Army Corps  
of Engineers**  
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## **B. COST ESTIMATES**

### **B.1. GENERAL INFORMATION**

Corps of Engineers cost estimates for planning purposes are prepared in accordance with the following guidance:

- Engineer Technical Letter (ETL) 1110-2-573, Construction Cost Estimating Guide for Civil Works, 30 September 2008
- Engineer Regulation (ER) 1110-1-1300, Cost Engineering Policy and General Requirements, 26 March 1993
- ER 1110-2-1302, Civil Works Cost Engineering, 30 June 2016
- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999
- ER 1105-2-100, Planning Guidance Notebook, 11 April 2000, as amended
- Engineer Manual (EM) 1110-2-1304, Civil Works Construction Cost Index System, 30 September 2019
- CECW-CP Memorandum for Distribution, Subject: Initiatives to Improve the Accuracy of Total Project Costs in Civil Works Feasibility Studies Requiring Congress Authorization, 19 September 2007
- CECW-CE Memorandum for Distribution, Subject: Application of Cost Risk Analysis Methods to Develop Contingencies for Civil Works Total Project Costs, 3 July 2007
- Methods to Develop Contingencies for Civil Works Total Project Costs, 3 July 2007
- Cost and Schedule Risk Analysis Process, March 2008

The goal of the cost estimate prepared for the Puerto Coastal Storm Risk Management Study is to present a Total Project Cost (construction and non-construction costs) for the Tentatively Selected Plan (TSP) at the current price levels to be used for project justification/authorization and to escalate costs for budgeting purposes. In addition, the costing efforts are intended to produce a final product (cost estimate) that is reliable and accurate, and that supports the definition of the Federal and the Non-Federal Sponsor's obligations.

The cost estimating effort for the study produced a series of alternative plan formulation cost estimates for decision making and selection of the TSP. The final set of plan formulation cost estimates used for plan selection will rely on construction feature unit pricing and are prepared in Civil Works Work Breakdown Structure (CWWBS) format to the sub-feature level. The cost estimate supporting the National Economic Development (NED) plan (Recommended Plan) is prepared in Micro-computer Aided Cost Estimating System (MCACES) Second Generation (MII) to the CWWBS sub-feature level. This estimate is supported by the preferred labor, equipment, materials, and crew/production breakdown. A fully funded (escalated for inflation through project completion) cost estimate in the form of a Total Project Cost Summary has also been developed.

A contingency of 40% was applied to the TSP Estimates based on the ER 1110-2-1302 from 30 June 2016, page 18, for a Class 4 project with early concept technical design information. This applied contingency is supported by an Abbreviated Risk Analysis (ARA) for each study reach. The

contingency output from those ARAs range in the mid-30 percentiles to mid-40 percentiles. As a result, an aggregate of 40% was assumed for the TSP. All major risk components were similar between reaches and alternatives with little to no definable difference in the level of risk between one alternative and another.

**B.1.1 Plan Formulation Cost Estimates**

For the plan formulation cost estimates, unit prices for the construction features were developed based on historical pricing data from previous studies and/or constructed projects and then escalated to FY20 dollars using the current version of the CWCCIS. Below is a list of the projects and the respective features used for this study:

- St Johns County Feasibility Study (FL, FY15)
  - Breakwaters
- Sarasota County – Lido Key (FL, FY19)
  - Armor Stone Installation
- Miami-Dade County – Surfside / Hotspots Contracts (FL, FY19)
  - Beach Nourishment (Truck-Haul)
- CAP\_14 Loiza Shoreline Protection (PR, FY19)
  - Armor Stone
  - Marine Mattresses
  - Disposal Hauling & Fees
- Rio de La Plata Phase 1 Flood Damage Reduction (PR, FY10)
  - Earthwork

**B.1.2 Tentatively Selected Plan (TSP)**

The Economics Appendix fully describes the plan selection. The scope of work for the TSP is found in Appendix A, Engineering. The MII cost estimate for these plans were based on that scope and were formatted based upon the CWWBS in accordance with Cost Engineering Regulations. For project justification purposes, the estimated costs are categorized under the appropriate CWWBS code and include both construction and non-construction costs.

The Tentative Selected Plan (TSP) includes:

Segment	Alt. #	Measure
Rincon	2	Demolition and Stone Revetment
Condado Pocket Beach	3c	Beach Nourishment – 50-FT Berm (2028, 2040, 2060)
Punta Piedrita	2	Demolition and Stone Revetment
Ocean Park Pocket Beach	5b	Breakwaters + Beach Nourishment – 50-FT Berm (2028, 2053)
Punta Las Marias	2	Demolition and Stone Revetment

### **B.1.3 Estimating Methodology**

The MII cost estimate for this plan was based on the scope and was formatted based upon the CWWBS in accordance with cost engineering regulations. For project justification purposes, the estimated costs are categorized under the appropriate CWWBS code and include both construction and non-construction costs.

The construction costs fall under the following feature code:

- 06 - Fish & Wildlife Facilities
  - Hardbottom/Coral Mitigation
- 10 - Breakwaters and Seawalls
  - Breakwaters
- 16 – Bank Stabilization
  - Demolition
  - Stone Revetment
- 17 – Beach Replenishment
  - Dune/Beach Nourishment

The non-construction costs fall under the following feature codes:

- 01 - Lands and Damages
- 30 - Planning, Engineering and Design
- 31 - Construction Management

### **B.1.4 Construction Cost**

As the Project Delivery Team quickly transitioned from an array of alternatives to a TSP, the construction costs are still based upon historical pricing data from previously studied and/or constructed projects, escalated to FY20 dollars, and then entered into MCACES/MI. These costs include all major project components categorized under the appropriate CWWBS to the sub-feature level. Further refinements of these costs, to transition from a Class 4 to a Class 3 level of cost estimate will be completed as the study progresses through the various stages of review. As part of that process more refined costs, in the format of labor, equipment and materials will be developed in accordance with Cost Engineering Regulations. The Total Project Cost Summary (TPCS) of the TSP contains contingencies as noted in the estimate (below) and were determined based on ER 1110-2-1302 from 30 June 2016. Based upon the total project cost magnitude a full Cost and Schedule Risk Analysis (CSRA) will be performed to establish the project contingency before the Cost ATR and final cost certification. Oracle Crystal Ball Software will be utilized to perform the CSRA. Risk assumptions will be based upon a PDT brainstorming meeting to be held later in the study taking into consideration subsequent information provided during the planning process.

### **B.1.5 Non-Construction Cost**

Non-construction costs typically include Lands and Damages (Real Estate), Planning, Engineering and Design (PED), and Construction Management (S&A). These costs are provided by the PDT either as a lump sum cost or as a percentage of the total construction contract cost. Lands and Damages are provided by the Real Estate Division and are best described in the Real Estate Appendix. PED costs are for the preparation of contract plans and specifications (P&S) and include itemized costs that were provided by the PDT, as well as costs for Post-Construction Monitoring costs and percentages for Engineering During Construction (EDC) that were provided by the project manager. Construction Management (S&A) costs are for the supervision and administration of a contract and include Project Management and Contract Admin costs. These costs were provided by the project manager and are included as a percentage of the total construction contract cost.

The main report details both allocations and cost apportionment for the Federal Government and the non-Federal sponsor. Also included in the main report are the non-Federal sponsor's obligations (items of local cooperation).

### **B.1.6 Construction Schedule**

The construction schedule was prepared by the cost engineer in collaboration with Project Management. The construction duration and sequence were established based on Historical Data. The construction schedule will be changed as the design of the project proceeds into plans and specifications phase. Once the contract is awarded, the contractor will provide a construction schedule which may differ from this construction schedule.

### **B.1.7 Total Project Cost Summary**

The cost estimate for the Tentative Selected Plan (TSP) is prepared with an identified price level date and inflation factors are used to adjust the pricing to the construction schedule. This estimate is known as the Fully Funded Cost Estimate or Total Project Cost Summary. It includes all Federal and non-Federal costs: Lands, Easements, Rights of Way and Relocations, construction features, Planning Engineering and Design, Construction Management, Contingency, and Escalation.

## **B.2 RISK AND UNCERTAINTY ANALYSIS (to be completed in the following weeks)**

The CSRA will be developed according to the procedures outlined in the following documents and sources:

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering MCX.
- Engineer Regulation (ER) 1110-2-1302 CIVIL WORKS COST ENGINEERING, dated June 30, 2016.
- Engineer Technical Letter (ETL) CONSTRUCTION COST ESTIMATING GUIDE FOR CIVIL WORKS, dated September 30, 2008.

### **B.2.1 Risk Analysis Methods**

The risk analysis process for this study is intended to determine the probability of various cost outcomes and quantify the required contingency needed in the cost estimate to achieve the desired level of cost confidence.

For each of the TSP final array of alternatives, an Abbreviated Risk Analysis (ARA) was performed to assess the level of risk and to determine a reasonable contingency to be applied to each alternative. Based on the results of the ARAs, an average contingency of 40% was assumed across all alternatives. The same contingency percentage was assumed during the initial screening of construction measures and is reasonable for a Class 4 project with early concept technical design information.

As the study progresses and the recommended plan is selected a full Cost and Schedule Risk Analysis (CSRA) will be performed. As part of that process, the entire PDT will be engaged to participate in a risk analysis brainstorming session to identify risks associated with the Recommended Plan. The risks are to be documented on the risk register, which is a tool commonly used in project planning and risk analysis and evaluated by the PDT. Assumptions are made as to the likelihood and impact of each risk item, as well as the probability of occurrence and magnitude of the impact if it were to occur. A risk model is then developed to establish contingencies to be applied to the project cost. Risks to be evaluated for the following features of work:

- 01 - Lands and Damages
- 06 - Fish & Wildlife Facilities
- 10 - Breakwaters and Seawalls
- 16 – Bank Stabilization
- 17 – Beach Replenishment
- 30 - Planning, Engineering & Design
- 31 - Construction Management

The results will then be reviewed, and all parameters re-evaluated by the PDT as a sanity check of assumptions and inputs. Adjustments will be made to the analysis accordingly and the final contingency will be established. The contingency is to be applied to the Recommended Plan Estimate in the Total Project Cost Summary (TPCS) in order to obtain the Fully Funded Cost.

### **B.2.2 Risk Analysis Results**

Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as to provide tools to support decision making and risk management as projects progress through planning and implementation

## **B.3 TOTAL PROJECT COST SUMMARY**

The TPCS addresses inflation through project completion (accomplished by escalation to mid-point of construction per ER 1110-2-1302, Appendix C, Page C-2). It is based on the scope of

the Tentative Selected Plan (TSP) and the Recommended Plan (depending on the stage of the study) and the official project schedule. The TPCS includes Federal and Non-Federal costs for Lands and Damages, all construction features, PED, S&A, along with the appropriate contingencies and escalation associated with each of these activities. The TPCS is formatted according to the CWWBS and uses CWCCIS factors for escalation (EM 1110-2-1304) of construction costs and Office of Management and Budget (EC 11-2-18X, 20 Feb 2008) factors for escalation of PED and S&A costs.

The Total Project Cost Summary was prepared using the MCACES/MII cost estimate on the Recommended Plan, as well as the contingencies set by the risk analysis and the official project schedule. For this TSP a minimum and maximum TSP TPCS has been development based upon ranges of design measures and ranges for potential mitigation.

### **B.3.1 Total Project Cost Summary Spreadsheet**

Refer to the Total Project Cost Summary Spreadsheets in Section B.5 of this report.

### **B.4 COST MCX TPCS CERTIFICATION**

The Recommended Plan estimate, formal cost and schedule risk analysis and total project cost summary spreadsheet will be reviewed by the Walla Walla Mandatory Center of Expertise in conjunction with the Recommended Plan Draft Report Agency Technical Review. This review serves as Cost Agency Technical Review in order to obtain cost certification by the Cost MCX in support of this feasibility study in accordance with Cost Engineering Regulations and Smart Planning Guidelines.

### **B.5 TOTAL PROHECT COST SUMMARY**

See next page.

### **B.6 COST MCX TPCS CERIFICATION**

Cost certification will be obtained after final public review of the report per ER 1110-2-1302.