COST APPENDIX

Elizabeth River and Southern Navigation Improvements Draft Integrated General Reevaluation Report and Environmental Assessment

Appendix D

12 December 2017

U.S. Army Corps of Engineers
Norfolk District

THE PORT OF VIRGINIA®

COST APPENDIX
Elizabeth River and Southern Branch of the Elizabeth River Navigation Improvements

Table of Contents

1. Introduction 1
1.1. Purpose and Objectives 1
2. Project Description 2
2.1. Location 2
2.2. Plan Description 2
3. New Work 2
3.1. Elizabeth River Reach (ERR) 3
3.2. Lower Reach 3
3.3. Middle Reach 3
3.4. Upper Reach A 4
3.5. Project Component Details and Associated Basis of Costs 4
3.5.1. Code of Account 01 – Land and Damages 4
3.5.2. Code of Account 02 – Relocations 4
3.5.3. Code of Account 12 – Navigation, Ports and Harbors 4
3.5.4. Code of Account 18 – Cultural Resource Preservation 7
4. First Costs 7
4.1. Unit Costs 7
4.2. Labor Rates 8
4.3. Lump Sum Items 8
4.4. Contingencies 8
4.5. Estimates of Additional Costs 8
4.5.1. Engineering and Design 8
4.5.2. Construction Management 8

4.5.3. Monitoring Costs 8
4.6. Summary 8
5. Annual Costs 9
5.1. Period of Analysis 9
5.2. Maintenance Dredging 9
6. CEDEPs 10
7. Schedule 10

List of Tables

Table 1: Initial Costs for TSP 8
Table 2: Initial Cost for LPP 9
Table 3: Maintenance Dredging Costs - TSP 9
Table 4: Maintenance Dredging Costs - LPP 10

Figures

Figure 1: Elizabeth River Southern Branch Project Limits 3
Figure 2: ERSB Project Schedule 10
Figure 3: ERSB Cash Flow 11

Appendices

Appendix A – CEDEPs
Appendix B – Cost Schedule Risk Analysis
Appendix C – PED Cost Estimates

1. Introduction

This appendix outlines the development of the costs for the Elizabeth River Southern Branch Deepening Study (ERSB) in Hampton Roads, Virginia. The costs include activities related with new work to deepen the existing ship channels and the additional cost to maintain them over a 50-year economic analysis period. Costs also include consideration of related features such as Local Service Facility costs (berthing area deepening) and Lands, Easements and Relocations related to the project.

This navigation improvement project includes the following four reaches:

1. Elizabeth River Reach (ERR)
2. Lower Reach
3. Middle Reach
4. Upper Reach A

Cost Engineering Dredge Estimating Program (CEDEP) is the basis for estimating the unit cost for dredging. The CEDEP worksheets account for the efficiency of the dredges for each reach based upon the area being dredged, dredge volume, amount of pay, amount not dug on average, the amount dug in excess of the allowable pay amount and many other factors associated with dredging operations. CEDEP estimates are included in **Appendix A**.

1.1. Purpose and Objectives

The purpose of this Cost Appendix is to provide details of the cost estimates used for plan selection. Cost estimates were developed at a September 2017 price level for labor, material, and equipment. The estimate was created for the preferred plan at a $3.04 fuel cost. The dredged material quantities for the alternatives have been developed using AutoCAD Civil 3D software.

For the selected plan, this cost appendix provides descriptions of the following:

- Project Description (Section 2);
- New Work (Section 3);
- First Costs (Section 4);
- Annual Costs (Section 5);
- CEDEP Cost Estimates (Section 6);
- Schedule (Section 7)

Also included are supporting documents that provide details of:

- CEDEP Dredging Estimates for Each Reach – $3.04 Fuel Costs (Appendix A).
- Cost Risk Analysis (Appendix B)
- PED Cost Estimate (Appendix C)

2. Project Description

2.1. Location

The project consists of 8.9 miles of channels in the Elizabeth River Southern Branch located in Norfolk, Portsmouth, and Chesapeake, Virginia. An additional 2 miles of channels in Upper Reach B and C were also considered for the project, but were ruled out due to the lack of project benefits in these reaches.

2.2. Plan Description

The Tentatively Selected Plan (TSP) for the ERSB includes deepening of the ERR and Lower Reach to 44 feet, with the Middle Reach deepened to 44 ft up to the Perdue berth, with a depth of 42 feet after Perdue for the remainder of the Middle Reach. Upper Reach A is deepened to 39 feet. No widening is included in the proposed improvements.

The Locally Preferred Plan (LPP) is slightly different than the TSP for the ERSB. It involves deepening of the ERR and Lower Reach one foot further to 45 feet, with the Middle Reach deepened to 45 ft up to the Perdue berth as well. The channels beyond Perdue remain the same with a depth of 42 feet after Perdue for the remainder of the Middle Reach and Upper Reach A deepened to 39 feet. No widening is included in the proposed improvements.

3. New Work

The planned layout for new work material placement is presented in Figure 1: Elizabeth River Southern Branch Project Limits. The following is a summary of the new work dredging and placement of materials for the proposed NHC improvements.

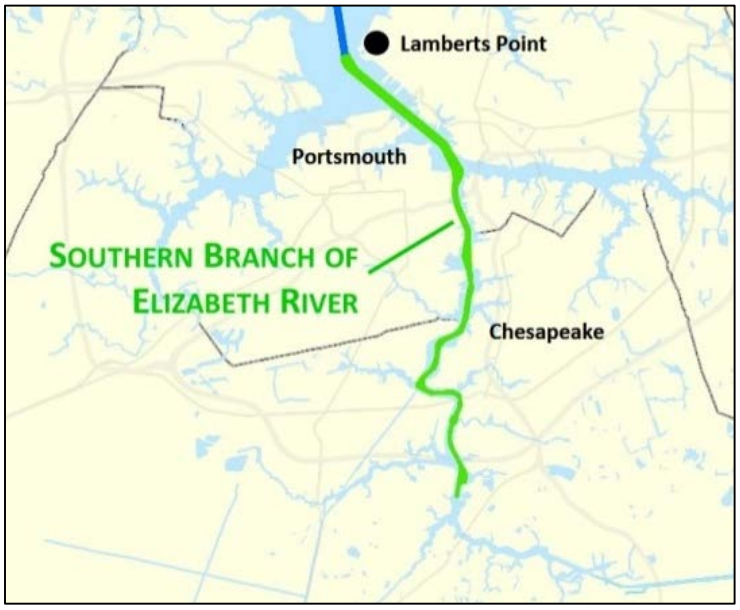


Figure 1: Elizabeth River Southern Branch Project Limits

3.1. Elizabeth River Reach (ERR)

Approximately 3.4 miles of existing channel will be deepened from 40 ft below MLLW to a nominal depth of 44 ft below MLLW for the TSP and 45 feet for the LPP. For the TSP, approximately 305,000 cubic yards (CY) of material will be placed in Craney Island Dredged Material Management Area (CIDMMA). The LPP will increase the volume to CIDMMA, with a total of approximately 424,000 CY placed.

3.2. Lower Reach

Approximately 1.9 miles of channel in the Lower Reach will be deepened from a depth of 40 ft below MLLW to a depth of 44 ft below MLLW for the TSP and 45 ft for the LPP. For the TSP, approximately 44,000 CY of material will be placed in CIDMMA, while the LPP requires about 61,000 CY of dredging.

3.3. Middle Reach

Approximately 0.8 miles of channel in the Middle Reach will be deepened from a depth of 40 ft below MLLW to a depth of 44 ft below MLLW for the TSP and 45 ft for the LPP. The remaining 0.2 miles of the channel past the Perdue facility berth will be dredged to 42 feet for both the TSP and LPP. Approximately 10,000 CY of material is estimated to be dredged in the Middle Reach after Perdue. Due to the anticipated contamination of the material, all material has been assumed to be disposed of in the Charles City County landfill via Port Weanack (material is barged approximately 70 nautical miles via the James River, unloaded at Port Weanack and trucked to the landfill. Approximately 54,000 CY of material is estimated to be dredged for the TSP up to Perdue and 95,000 CY for the LPP up to

Perdue (referred to as part of Segment 1A up to Purdue, and Segment 1B from Purdue to Upper Reach A). Both the TSP and LPP materials are assumed to require upland disposal at the Port Weanack site as well due to contamination levels too high to meet CIDMMA requirements.

3.4. Upper Reach A

Approximately 2.6 miles of channel in Upper Reach A will be deepened from a depth of 35 ft below MLLW to a depth of 39 ft below MLLW. The 724,000 CY of new work dredged material will be placed in upland disposal sites due to the anticipated contamination in the reach that will make the material unsuitable for CIDMMA. Material is estimated to be transported by barge to the Port Weanack site on the James River and trucked to Charles City County landfill for disposal.

3.5. Project Component Details and Associated Basis of Costs

Labor costs reflect labor costs in the Hampton Roads area as of September 2017. Equipment costs are also adjusted for this region.

3.5.1. Code of Account 01 – Land and Damages

No Lands and Damages are expected for this project, as no impacts to private property is expected. The project does not involve widening of channels. In areas were the channel near adjacent structures, one side of the channel may not be deepened to avoid adjacent impacts. This will be determined in final design.

3.5.2. Code of Account 02 – Relocations

No relocations are expected for the project.

3.5.3. Code of Account 12 – Navigation, Ports and Harbors

New work dredging quantities were based on hydrographic surveys provided by the USACE. Maintenance dredge quantities were determined using a desktop sedimentation model calibrated with historical dredging quantities and divided into reaches based on dredging frequency. All dredging costs and Mobilization/Demobilization were estimated using Corps of Engineers Dredge Estimating Programs (CEDEP) (**Appendix A**). Labor rates and overhead costs were adjusted to reflect the Hampton Roads area and reflect 2017 rates.

3.5.3.1. Elizabeth River Reach

With the quantities expected, a 24-inch hydraulic dredge was selected. The 24-inch dredge is assumed to have a 3,800 HP main engine and a crew of 46 people. This is industry standard for the area and consistent with other jobs within the ERSB. Key assumptions for the CEDEP estimate include:

- 8% Contractor Overhead
- 10% Contractor profit
- 1.5% Contractor Bond

- 0.45 ft / sq ft not dug
- 0.50 ft overdig
- 100% mud & silt
- 37,500 average pumping distance to CIDMMA
- 43,500 Total feet of pipeline required
- 2 Booster Pumps Required
- 10% Cleanup Dredging
- 80% Effective Working Time
- $3.04 / Gallon Fuel Price

The maintenance dredging assumes a similar dredge is used with the same assumptions.

3.5.3.2. Lower Reach

With the quantities expected, a 24-inch hydraulic dredge was selected. The 24inch dredge is assumed to have a 3800 HP main engine and a crew of 46 people. This is industry standard for the area and consistent with other jobs within the ERSB. Key assumptions for the CEDEP estimate include:

- 8% Contractor Overhead
- 10% Contractor profit
- 1.5% Contractor Bond
- 0.45 ft / sq ft not dug
- 0.50 ft overdig
- 100% mud & silt
- 45,000 average pumping distance to CIDMMA
- 49,500 Total feet of pipeline required
- 2 Booster Pumps Required
- 10% Cleanup Dredging
- 80% Effective Working Time
- $3.04 / Gallon Fuel Price

The maintenance dredging assumes a similar dredge is used with the same assumptions.

3.5.3.3. Middle Reach

With the quantities expected in this reach, a 10 CY clamshell dredge was selected. This material is assumed to have contamination, so an environmental bucket was assumed. Key assumptions for the CEDEP estimate include:

- 8% Contractor Overhead
- 10% Contractor profit
- 1.5% Contractor Bond

- 0.30 ft / sq ft not dug
- 0.50 ft overdig
- 100% Mud & Silt
- 81-Mile transport to Shirley Plantation
- 2040 Minutes for Unloading of Barge at Shirley Plantation
- 12 mph speed unloaded
- 8 mph speed loaded
- 2 scows per towing vessel
- 10% Cleanup Dredging
- 85% time efficiency
- $3.04 / Gallon Fuel Price
- $70.15 fee at Shirley Plantation for handling of material

A 10 CY mechanical dredge was assumed for the maintenance dredging activities. Maintenance dredging is expected to be suitable for CIDMMA, so the following assumptions are different:

- $1.38 CIDMMA toll
- 1 Scow per towing vessel
- 12-mile transport distance to CIDMMA

3.5.3.4. Upper Reach A

With the quantities expected in this reach, a 10 CY clamshell dredge was selected. This material is assumed to have contamination issues, so an environmental bucket was assumed. Key assumptions for the CEDEP estimate include:

- 8% Contractor Overhead
- 10% Contractor profit
- 1.5% Contractor Bond
- 0.30 ft / sq ft not dug
- 0.50 ft overdig
- 100% Mud & Silt
- 82 Mile transport to Shirley Plantation
- 2040 Minutes for Unloading of Barge at Shirley Plantation
- 12 mph speed unloaded
- 8 mph speed loaded
- 2 scows per towing vessel
- 10% Cleanup Dredging
- 85% time efficiency
- $3.04 / Gallon Fuel Price
- $70.15 fee at Shirley Plantation for handling of material

A 10 CY mechanical dredge was assumed for the maintenance dredging activities. Maintenance dredging is expected to be suitable for CIDMMA, so the following assumptions are different:

- $1.38 CIDMMA toll
- 1 scow per towing vessel
- 13 mile transport distance to CIDMMA

3.5.3.5. Aids to Navigation (ATON)

No ATON costs were assumed for the project, as the channel alignment is not being changed for the project.

3.5.3.6. Associated Cost, Local Service Facilities – Lower Reach

Cost associated with deepening the berths to US Gypsum, Transmontaigne, and Kerneous Aluminate Technologies were estimated for the local facility construction costs of the Lower Reach. Material was assumed to be contaminated and required upland disposal at Weanack.

3.5.3.7. Associated Cost, Local Service Facilities – Middle Reach

Cost associated with deepening the berths to Apex Oil Terminal, Perdue Farms, and Enviva Wood Pellets were estimated for the local facility construction costs of the Middle Reach. Material was assumed to be contaminated and required upland disposal at Weanack.

3.5.3.8. Associated Cost, Local Service Facilities – Upper Reach A

Cost associated with deepening the berths to Kinder Morgan South Hill, Hess Oil, Kinder Morgan Money Point Terminal, DCP Midstream Propane Terminal, and Elizabeth River Recycling were estimated for the local facility construction costs of the Middle Reach. Material was assumed to be contaminated and required upland disposal at Weanack.

3.5.4. Code of Account 18 – Cultural Resource Preservation

No costs associated with cultural resources are expected for the project.

4. First Costs

First costs include charges arising from the acquisition or construction of each individual component, as well as the cost of preconstruction engineering and design (PE&D), monitoring, engineering during construction, construction management (supervision & administration – S&A), and administration.

4.1. Unit Costs

Unit costs for the dredging was estimated using CEDEP, with assumptions as detailed in this report.

4.2. Labor Rates

The labor rates including fringe benefits for the estimates were taken from the prevailing Davis Bacon wage rates for the area.

4.3. Lump Sum Items

Mobilization and demobilization was estimated using the CEDEP spreadsheet.

4.4. Contingencies

Contingencies for the alternatives were developed using the Abbreviated Risk Assessment (ARA) methodologies outlined by the USACE. 12.45% has been used for the alternatives. The Cost Risk Analysis was then completed using Crystal Ball Software for the ERSB Project. The resulting Contingency of 14.80% was calculated and used for the costs of the NED and LPP plans.

4.5. Estimates of Additional Costs

The additional costs in and above dredging were also included to provide a more accurate estimate of the total costs associated with the ERSB project. These are described in more detail below.

4.5.1. Engineering and Design

Costs for Engineering and design were estimated by reach and include costs associated with environmental testing and development of the plans. Engineering and design costs were the same for a given reach for each depth. Please see Appendix C for detailed information on PED costs.

4.5.2. Construction Management

Costs associated with construction management were estimated on a reach by reach basis. Construction management costs for a given reach were the same for each depth.

4.5.3. Monitoring Costs

No monitoring costs were assumed for the project. Cost associated with turtle monitoring are included in the dredging operational costs including in the unit costs.

4.6. Summary

The total costs for the initial widening and deepening are included in **Tables 1 and 2** below.

Table 1: Initial Costs for TSP

Reach	Mobilization Cost	Dredging Cost	Total Initial Construction Capital Costs
Elizabeth River Reach	$2,830,323	$4,877,616	$7,562,105
Lower Reach	$0*	$421,734	$7,474,567
Middle Reach Up to Perdue	$836,436	$10,745,231	$27,513,550

Middle Reach After Perdue	$0[#]	$1,124,477	$1,852,144
Upper Reach A	$836,436	$74,555,436	$108,517,953

[*]Lower Reach assumed to be dredged in same contract with Elizabeth River Reach. Mobilization cost assigned to Elizabeth River Reach

[#]Middle Reach assumed to be dredged in one contract. Mobilization only assigned to Middle Reach before Perdue

Table 2: Initial Cost for LPP

Reach	Mobilization Cost	Dredging Cost	Total Initial Construction Capital Costs
Elizabeth River Reach	$2,830,323	$5,510,100	$8,288,197
Lower Reach	$0[*]	$524,260	$8,849,220
Middle Reach Up to Perdue	$836,436	$15,846,770	$35,690,832
Middle Reach After Perdue	$0[#]	$1,124,477	$1,852,144
Upper Reach A	$836,436	$74,555,436	$108,517,953

[*]Lower Reach assumed to be dredged in same contract with Elizabeth River Reach. Mobilization cost assigned to Elizabeth River Reach

[#]Middle Reach assumed to be dredged in one contract. Mobilization only assigned to Middle Reach before Perdue

5. Annual Costs

5.1. Period of Analysis

The period of analysis (project life) is 50 years.

5.2. Maintenance Dredging

Costs attributed to the maintenance of the navigation improvement project throughout the 50-year project life consist of periodic dredging of the improved reaches to maintain the project depth of 55 ft below MLLW. Refer to **Tables 3 and 4** for the increased dredging maintenance costs due to improvements for the TSP and LPP.

Table 3: Maintenance Dredging Costs - TSP

Reach	Current Annual Sedimentation, CY/Year	Estimated Annual Sedimentation, CY/Year	Additional Annual Maintenance Dredging Costs
Elizabeth River Reach	31,595	33,508	$32,357
Lower Reach	1,426	1,508	$4,259
Middle Reach	765	826	$32,448
Upper Reach A	17,696	19,643	$237,973

Table 4: Maintenance Dredging Costs - LPP

Reach	Current Annual Sedimentation, CY/Year	Estimated Annual Sedimentation, CY/Year	Additional Annual Maintenance Dredging Costs
Elizabeth River Reach	31,595	34,255	$44,995
Lower Reach	1,426	1,540	$5,901
Middle Reach	765	849	$45,080
Upper Reach A	17,696	19,643	$237,973

6. CEDEPs

Refer to **Appendix A.**

7. Schedule

The anticipated project schedule for the ERSB is included in Figure 2: ERSB Project Schedule. This includes the PED and construction of the deepened channel.

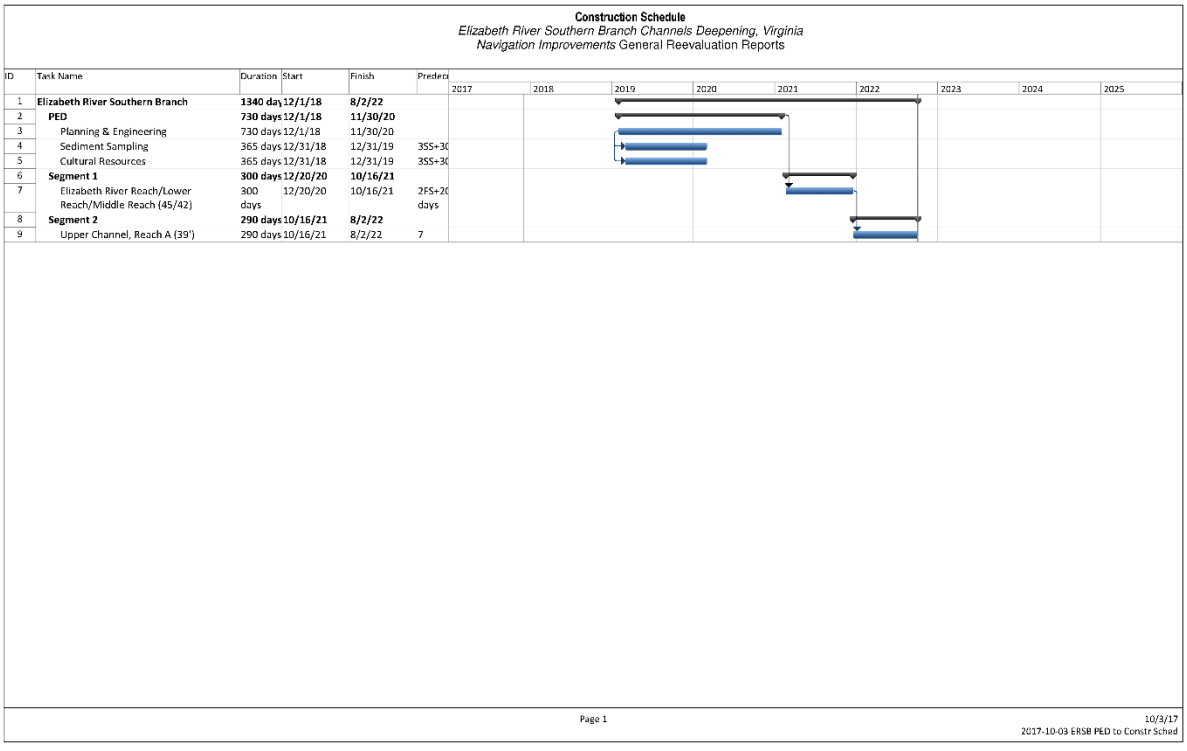


Figure 2: ERSB Project Schedule

The cash flow for the ERSB project is included in Figure 3: ERSB Cash Flow. It includes the anticipated midpoint of construction as quarter 4 of 2021.

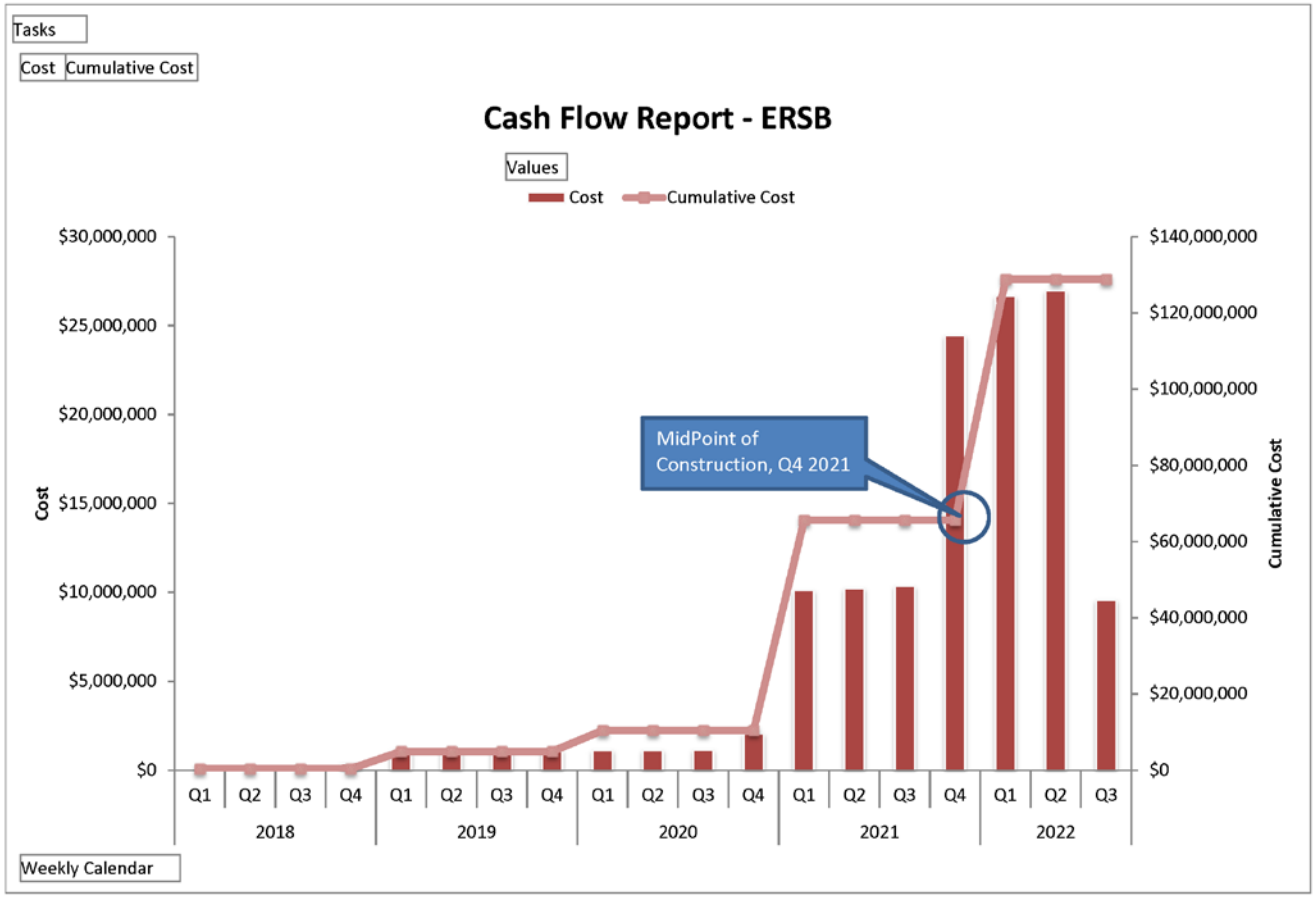


Figure 3: ERSB Cash Flow

Cost Appendix A: CEDEPs

1. Elizabeth River Reach – Hydraulic Dredge 45 ft Pay Depth
2. Lower Reach – Hydraulic Dredge 45 ft Pay Depth
3. Middle Reach – Mechanical Dredge 45 ft Pay Depth
4. Upper Reach A – Mechanical Dredge – 40 ft Pay Depth

527,158 pay c.y. per month	UNIT COST..	$8.77	PER C.Y.	**Select Dredge**
1,829 cy per hour	EXCAV. COST	$3,166,172		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.59	MONTHS	

PROJECT TITLES: PG 1 of 9

Project Name.....	GRR	Ver. 7.1
Project Location.....	Hampton Roads VA	For Information, Call:
Invit. or Contr. No.....	Preliminary	Fletcher: 904-232-3295
Date of Estimate.....	Revised: November 2016	
Estimator.....	SBJ	
Checked by.....		

(Input Project Descriptions on Sheet A) **Goto Sheet A**

Mobilization Bid Item.....	1	
Excavation Bid Item.....	2	Goto Input Page 1a

TYPE OF ESTIMATE PG 2 of 9

Type of Estimate..... 1 Planning Estimate

(1) Planning, (2) Bid, or (3) Mod **Estimate Descriptions**

INDIRECT COSTS:

Contractor's Overhead...	8.0	Percent of contract
Contractor's Profit.....	10.0	Percent of contract
Contractor's Bond.....	1.5	Percent of contract

ESTIMATED DREDGING QUANTITY: PG 3 of 9

Non-Pay Computation Method: 1

(1) Surface Area, (2) % of Pay O.D., (3) % of Net Pay, (4) % of Gross

DREDGING AREA: 3,009,688 SQ. FT.

DREDGING PRISM:

Required....	258,272	C.Y.		44' Required
+0.00-ft Pay O.D.	102,751	C.Y.		
Bid Quantity	361,023	C.Y.		
-0.45-ft Not Dug	50,000	C.Y.		AVE. BANK HEIGHT:
Net Pay	311,023	C.Y.	@	2.8 ft pay
+ Non-Pay	55,700	C.Y.	@	0.50 ft overdig
Gross Volume	366,723	C.Y.		3.3 FT. BANK HT.

527,158 pay c.y. per month	UNIT COST..	$8.77	PER C.Y.	Select Dredge: Norfolk Dredging 24"
1,829 cy per hour	EXCAV. COST	$3,166,172		
Norfolk Dredging 24" Dredge	TIME.....	0.59	MONTHS	

MATERIAL FACTORS: PG 4 of 9

DESCRIPTION	FACTOR	PERCENTAGE		
MUD & SILT	3	0	%	
MUD & SILT	2.5	100	%	
MUD & SILT	2	0	%	DIRECT ENTRY
LOOSE SAND	1.1	0	%	FACTOR= 0.00
LOOSE SAND	1	0	%	
COMP. SAND	0.9	0	%	
STIFF CLAY	0.6	0	%	
COMP. SHELL	0.5	0	%	RESULTANT MATERIAL
SOFT ROCK	0.4	0	%	FACTOR= 2.50
BLAST. ROCK	0.25	0	%	

PIPELINE CONSIDERATIONS: PG 5 of 9

MAXIMUM PIPELINE REQUIRED:

Floating Pipeline.....	33,200	Feet
Submerged Pipeline.....	8,300	Feet
Shore Pipeline.....	2,000	Feet
Total Pipeline on Job:	43,500	Feet

Ave Pumping Distance....	37,500	Feet of Pipeline
Pipeline Cost Category.....	0	MUD

(0) Computed from Material Factor,
(1) Mud, (2) Sand, or (3) Rock

Equivalent Pipe.....	500	Feet (Theoretical)
Description.....	Vertical Lift of Discharge Pipe.	
Basis of Production:	38,000	Feet (Ave + Equiv)

PRODUCTION ANALYSIS: PG 6 of 9

2 BOOSTER(S)

47,311 L.F. POSSIBLE based on 17200 Tot. H.P.
38,000 Ft Ave Pumping Distance
43,500 L.F. Max. on jobsite

65.0 % X 730 HRS/MO = EWT OF 475 HRS/MO (without Boosters)

Goto Input Page 6a

X 0.72 Booster Factor

46.8 % X 730 HRS/MO = EWT OF 342 HRS/MO (with Boosters)

527,158 pay c.y. per month	UNIT COST..	$8.77	PER C.Y.	**Select Dredge**
1,829 cy per hour	EXCAV. COST	$3,166,172		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.59	MONTHS	

OTHER PRODUCTION FACTORS: PG 7 of 9

CURRENT DREDGE SELECTED: Norfolk Dredging 24" Dredge

Bank Factor for 3.3 ft of Bank ---->		0.63	(From Chart)
Bank Factor Override....		0.63	(Used)
Description.....	>		
Other Factor.....	0.8		
Description.....	Weather, breakdowns		
Cleanup Dredging.....	10	Percent Additional Time	
		(Cleanup Factor = 0.91)	

HISTORICAL PRODUCTION OVERRIDES: PG 8 of 9

(In order to use this screen, Overrides must be entered for all three categories.)

	Override	Computed	Used
Production (Cy/Hr).....	0	1829	1,829
Operating Time (Hrs/Mo).	0	342	342
Number of Boosters.....	0	2	2

OTHER PRICING ADJUSTMENTS: PG 9 of 9

Other Monthly Costs:

1st Input..... Per Month
Description.....
(For Additional Inputs Go to Sheet D\4) Goto Sheet D\4

Fixed Costs:

1st Input..... $0 Lump Sum
Description.....
(For Additional Inputs Go to Sheet E) Goto Sheet E

(To Adjust Labor Go To Sheet DB_L) Goto Sheet DB_L

(To Adjust Equipment Go To Sheet DB_E) Goto Sheet DB_E

527,158 pay c.y. per month	UNIT COST..	$8.77	PER C.Y.	**Select Dredge**
1,829 cy per hour	EXCAV. COST	$3,166,172		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.59	MONTHS	

LOCAL AREA FACTORS: PG 1a of 9

Present Year.....	2015	(Equipment Calculations)
Economic Index.....	8678	(EP-1110-1-8, APP E)
Labor Adjustment Factor.	1.000	(EP-1110-1-8, APP B)
Full Cost of Money Rate.	2.38	Percent per Year
Dates for Money Rate....		
Annual Months Available for Dredging:		
Pipeline....	4.79	Months per Year
Bucket.....	n/a	Months per Year
Hopper.....	n/a	Months per Year
Current Fuel Price.....	$3.04	Per Gallon

Return

HP & BOOSTER FACTOR ADJUSTMENTS: PG 6a of 9

	Override	Database	Used
Total Available Pump Horsepower.....	0	10,000	10,000
Booster Pump HP.....		3,600	3,600
% Loss per booster, when job lasts:			
Less than 1 month (%)	0	15%	15%
More than 1 month (%)	0	10%	10%

Return

Without Booster Losses, this job would last 0.42 months, therefore, the 15% figure will be used.

CIDMMA TOLL $1.38 Per CY

408,210 pay c.y. per month	UNIT COST..	$11.20	PER C.Y.	**Select Dredge**
1,468 cy per hour	EXCAV. COST	$535,595		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.10	MONTHS	

PROJECT TITLES: PG 1 of 9

Project Name.....	GRR	Ver. 7.1
Project Location.....	Hampton Roads VA	For Information, Call:
Invit. or Contr. No.....	Preliminary	Fletcher: 904-232-3295
Date of Estimate.....	Revised: November 2016	
Estimator.....	SBJ	
Checked by.....		

(Input Project Descriptions on Sheet A) **Goto Sheet A**

Mobilization Bid Item.....	1	
Excavation Bid Item.....	2	Goto Input Page 1a

TYPE OF ESTIMATE PG 2 of 9

Type of Estimate..... 1 Planning Estimate

(1) Planning, (2) Bid, or (3) Mod **Estimate Descriptions**

INDIRECT COSTS:

Contractor's Overhead...	8.0	Percent of contract
Contractor's Profit.....	10.0	Percent of contract
Contractor's Bond.....	1.5	Percent of contract

ESTIMATED DREDGING QUANTITY: PG 3 of 9

Non-Pay Computation Method: 1

(1) Surface Area, (2) % of Pay O.D., (3) % of Net Pay, (4) % of Gross

DREDGING AREA: 425,192 SQ. FT.

DREDGING PRISM:

Required....	33,535	C.Y.		44' Required
+0.00-ft Pay O.D.	14,286	C.Y.		
Bid Quantity	47,821	C.Y.		
-0.45-ft Not Dug	7,000	C.Y.		AVE. BANK HEIGHT:
Net Pay	40,821	C.Y.	@	2.6 ft pay
+ Non-Pay	7,900	C.Y.	@	0.50 ft overdig
Gross Volume	48,721	C.Y.		3.1 FT. BANK HT.

408,210 pay c.y. per month	UNIT COST..	$11.20	PER C.Y.	Select Dredge: Norfolk Dredging 24"
1,468 cy per hour	EXCAV. COST	$535,595		
Norfolk Dredging 24" Dredge	TIME.....	0.10	MONTHS	

MATERIAL FACTORS: PG 4 of 9

DESCRIPTION	FACTOR	PERCENTAGE	
MUD & SILT	3	0	%
MUD & SILT	2.5	100	%
MUD & SILT	2	0	% DIRECT ENTRY
LOOSE SAND	1.1	0	% FACTOR= 0.00
LOOSE SAND	1	0	%
COMP. SAND	0.9	0	%
STIFF CLAY	0.6	0	%
COMP. SHELL	0.5	0	% RESULTANT MATERIAL
SOFT ROCK	0.4	0	% FACTOR= 2.50
BLAST. ROCK	0.25	0	%

PIPELINE CONSIDERATIONS: PG 5 of 9

MAXIMUM PIPELINE REQUIRED:

Floating Pipeline.....	38,000	Feet
Submerged Pipeline.....	9,500	Feet
Shore Pipeline.....	2,000	Feet
Total Pipeline on Job:	49,500	Feet

Ave Pumping Distance....	45,000	Feet of Pipeline
Pipeline Cost Category.....	0	MUD

(0) Computed from Material Factor,
(1) Mud, (2) Sand, or (3) Rock

Equivalent Pipe.....	500	Feet (Theoretical)
Description.....	Vertical Lift of Discharge Pipe.	
Basis of Production:	45,500	Feet (Ave + Equiv)

PRODUCTION ANALYSIS: PG 6 of 9

2 BOOSTER(S)

47,311 L.F. POSSIBLE based on 17200 Tot. H.P.
45,500 Ft Ave Pumping Distance
49,500 L.F. Max. on jobsite

65.0 % X 730 HRS/MO = EWT OF 475 HRS/MO (without Boosters)

Goto Input Page 6a

X 0.72 Booster Factor

46.8 % X 730 HRS/MO = EWT OF 342 HRS/MO (with Boosters)

408,210 pay c.y. per month	UNIT COST..	$11.20	PER C.Y.	**Select Dredge**
1,468 cy per hour	EXCAV. COST	$535,595		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.10	MONTHS	

OTHER PRODUCTION FACTORS: PG 7 of 9

CURRENT DREDGE SELECTED: Norfolk Dredging 24" Dredge

Bank Factor for 3.1 ft of Bank ---->		0.61	(From Chart)
Bank Factor Override....		0.61	(Used)
Description.....	>		
Other Factor.....	0.8		
Description.....	Weather, breakdowns		
Cleanup Dredging.....	10	Percent Additional Time	
		(Cleanup Factor = 0.91)	

HISTORICAL PRODUCTION OVERRIDES: PG 8 of 9

(In order to use this screen, Overrides must be entered for all three categories.)

	Override	Computed	Used
Production (Cy/Hr).....	0	1468	1,468
Operating Time (Hrs/Mo).	0	342	342
Number of Boosters.....	0	2	2

OTHER PRICING ADJUSTMENTS: PG 9 of 9

Other Monthly Costs:

1st Input..... Per Month
Description.....
(For Additional Inputs Go to Sheet D\4) Goto Sheet D\4

Fixed Costs:

1st Input..... $0 Lump Sum
Description.....
(For Additional Inputs Go to Sheet E) Goto Sheet E

(To Adjust Labor Go To Sheet DB_L) Goto Sheet DB_L

(To Adjust Equipment Go To Sheet DB_E) Goto Sheet DB_E

408,210 pay c.y. per month	UNIT COST..	$11.20	PER C.Y.	**Select Dredge**
1,468 cy per hour	EXCAV. COST	$535,595		Norfolk Dredging 24"
Norfolk Dredging 24" Dredge	TIME.....	0.10	MONTHS	

LOCAL AREA FACTORS: PG 1a of 9

Present Year.....	2015	(Equipment Calculations)
Economic Index.....	8678	(EP-1110-1-8, APP E)
Labor Adjustment Factor.	1.000	(EP-1110-1-8, APP B)
Full Cost of Money Rate.	2.38	Percent per Year
Dates for Money Rate....		
Annual Months Available for Dredging:		
Pipeline....	4.79	Months per Year
Bucket.....	n/a	Months per Year
Hopper.....	n/a	Months per Year
Current Fuel Price.....	$3.04	Per Gallon

Return

HP & BOOSTER FACTOR ADJUSTMENTS: PG 6a of 9

	Override	Database	Used
Total Available Pump Horsepower.....	0	10,000	10,000
Booster Pump HP.....		3,600	3,600
% Loss per booster, when job lasts:			
Less than 1 month (%)	0	15%	15%
More than 1 month (%)	0	10%	10%

Return

Without Booster Losses, this job would last 0.07 months, therefore, the 15% figure will be used.

CIDMMA TOLL $1.38 Per CY

38,004 pay c.y. per month	UNIT COST...	104.98	PER C.Y.	**Select Dredge**
303 c.y. per hour	EXCAV TIME..	2.17	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	3.09	MONTHS	

PROJECT TITLES: PG 1 of 9

Project Name.....	GRR	Ver. 7.1
Project Location.....	Hampton Roads, VA	For Information, Call:
Invit. or Contr. No.....	Preliminary	Fletcher: 904-232-3295
Date of Estimate.....	November 2016	
Estimator.....	SBJ	
Checked by.....	JF	
(Input Project Descriptions on Sheet A)		Goto Sheet A
Mobilization Bid Item.....	1	
Excavation Bid Item.....	2	Goto Input Page 1a

TYPE OF ESTIMATE PG 2 of 9

Type of Estimate.....	1	Planning Estimate
(1) Planning, (2) Bid, or (3) Mod		Estimate Descriptions

INDIRECT COSTS:

Contractor's Overhead...	8.0	Percent of contract
Contractor's Profit.....	10.0	Percent of contract
Contractor's Bond.....	1.5	Percent of contract

ESTIMATED DREDGING QUANTITY: PG 3 of 9

Non-Pay Computation Method: 1

(1) Surface Area, (2) % of Pay O.D., (3) % of Net Pay, (4) % of Gross

DREDGING AREA: 1,524,913 SQ. FT.

DREDGING PRISM:

Required....	83,475	C.Y.		
+0.00-ft Pay O.D.	50,957	C.Y.		O.D. Included in Volume
Bid Quantity	134,432	C.Y.		
-0.30-ft Not Dug	17,000	C.Y.		AVE. BANK HEIGHT:
Net Pay	117,432	C.Y.	@	2.1 ft pay
+ Non-Pay	28,200	C.Y.	@	0.50 ft overdig
Gross Volume	145,632	C.Y.		2.6 FT. BANK HT.

38,004 pay c.y. per month	UNIT COST...	104.98	PER C.Y.	Select Dredge: 10 CY CLAMSHELL
303 c.y. per hour	EXCAV TIME..	2.17	MONTHS	
10 CY CLAMSHELL Dredge	HAUL TIME...	3.09	MONTHS	

EXCAVATION PRODUCTION WORKSHEET: PG 4 of 9

CURRENT DREDGE SELECTED: 10 CY CLAMSHELL

Type of Material..... 1 MUD

(0) Unspecified Materials, (1) Mud, (2) Clays and Less-Dense Sand, or (3) Dense Clays, Hard-Packed Sand, Blasted Rock and Boulders

PRODUCTION FACTORS:	Override	Default	Used
Bucket Size (in CY).....	0	10	10
Bucket Fill Factor.....	0	1.00	1.00
Optimum Bank (in Feet)..	0	3.5	3.5
Bank Factor..... (based on 2.6 Ft of Bank Height)	0	0.74	0.74

EXCAVATION PRODUCTION WORKSHEET: PG 5 of 9

Bucket Cycle Time..... 72 Seconds See Messages Tab for breakdown

Other Factor..... 0.90
Description..... Weather

Cleanup Dredging..... 10 % Additional Time
(Cleanup Factor = 0.91)

Time Efficiency.....> 85.0 % of Effective Work Time
222 Hours Per Month

HAULING PRODUCTION WORKSHEET: PG 6 of 9

Towing Cycle: 3000 HP Diesel--Twin Screw

Prepare Scow for Tow....	20	Minutes	
One-Way Haul Distance...	81	Miles	81 miles to Shirley Plantation
Speed to Disposal Area..	6	Miles per hour = 810 Min	
Speed from Disposal Area	8	Miles per hour = 608 Min	
Dumping or Pumpout.....	2040	Minutes	Includes time for mixing cement (24 hours) and using excavators at Shirley Plantation (10 hours)
Disengage Scow Tow.....	15	Minutes	
Towing Time Efficiency..	95	Percent	

Scow Capacity: 3000 CY Split Hull Scow

Useable Volume.....	80	Percent
Percent Solids.....	83	Percent = 1,992 cys/load

38,004 pay c.y. per month	UNIT COST...	104.98	PER C.Y.	**Select Dredge**
303 c.y. per hour	EXCAV TIME..	2.17	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	3.09	MONTHS	

EQUIPMENT MATCHING: PG 7 of 9

	Override	Assumed	Used
# of Dredges.....	0	1	1
Scows per Dredge.....	2	1	2
# of Towing Vessels.....	0	1	1
Scows per Tow.....	2	1	2

Scows with Dredges: 2 (1 Dredge(s) x 2 Scow(s) Each)
Scows with Tows: 2 (1 Tug(s) x 2 Scow(s) Each)
Additional Scows..... 2

Total Scows on Job: 6

SPECIAL LABOR & EQUIPMENT: PG 8 of 9

(1 for Yes, 0 for No)	Override	Assumed	Used
Survey Boat?.....	0	NO	NO
Crew Boat?.....	0	NO	NO

OTHER PRICING ADJUSTMENTS: PG 9 of 9

Other Monthly Costs:

1st Input..... $11,250 Per Month
Description..... PM
(For Additional Inputs Go to Sheet D\4) Goto Sheet D/4

Fixed Costs:

1st Input..... $0 Lump Sum
Description..... 0
(For Additional Inputs Go to Sheet E) Goto Sheet E

(To Adjust Labor Go To Sheet DB_L) Goto Sheet DB_L

(To Adjust Equipment Go To Sheet DB_E) Goto Sheet DB_E

38,004 pay c.y. per month	UNIT COST...	104.98	PER C.Y.	**Select Dredge**
303 c.y. per hour	EXCAV TIME..	2.17	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	3.09	MONTHS	

LOCAL AREA FACTORS:

Present Year.....	2015	(Equipment Calculations)
Economic Index.....	8678	(EP-1110-1-8, APP E)
Labor Adjustment Factor.	1.000	(EP-1110-1-8, APP B)
Full Cost of Money Rate.	2.38	Percent per Year
Dates for Money Rate....		
Annual Months Available for Dredging:		
Pipeline....	n/a	Months per Year
Bucket.....	6.16	Months per Year
Hopper.....	n/a	Months per Year
Current Fuel Price.....	$3.04	Per Gallon

Return

Landfill Cost	$70.15	Includes wharfage fee at Shirley Plant. and land trans. to landfill
Landfill %	100%	
Shirley Plantation Cost	$24.22	Includes wharfage fee and costs for materials to mix with soil.
Shirley Plantation %	0%	
Avg Disposal Cost	70.15	
Total Cost	104.98	
CIDMMA Toll	1.38	
	106.36	

37,540 pay c.y. per month	UNIT COST...	104.3	PER C.Y.	**Select Dredge**
280 c.y. per hour	EXCAV TIME..	6.30	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	8.29	MONTHS	

PROJECT TITLES: PG 1 of 9

Project Name.....	GRR	Ver. 7.1
Project Location.....	Hampton Roads, VA	For Information, Call:
Invit. or Contr. No.....	Preliminary	Fletcher: 904-232-3295
Date of Estimate.....	November 2016	
Estimator.....	SBJ	
Checked by.....	JF	

(Input Project Descriptions on Sheet A) Goto Sheet A

Mobilization Bid Item..... 1

Excavation Bid Item..... 2 Goto Input Page 1a

TYPE OF ESTIMATE PG 2 of 9

Type of Estimate..... 1 Planning Estimate

(1) Planning, (2) Bid, or (3) Mod — Estimate Descriptions

INDIRECT COSTS:

Contractor's Overhead...	8.0	Percent of contract
Contractor's Profit.....	10.0	Percent of contract
Contractor's Bond.....	1.5	Percent of contract

ESTIMATED DREDGING QUANTITY: PG 3 of 9

Non-Pay Computation Method: 1

(1) Surface Area, (2) % of Pay O.D., (3) % of Net Pay, (4) % of Gross

DREDGING AREA: 4,326,385 SQ. FT.

DREDGING PRISM:

Required....	109,345	C.Y.		
+0.00-ft Pay O.D.	249,860	C.Y.		O.D. Included in Volume
Bid Quantity	359,205	C.Y.		
-0.30-ft Not Dug	48,000	C.Y.		AVE. BANK HEIGHT:
Net Pay	311,205	C.Y.	@	1.9 ft pay
+ Non-Pay	80,100	C.Y.	@	0.50 ft overdig
Gross Volume	391,305	C.Y.		2.4 FT. BANK HT.

37,540 pay c.y. per month	UNIT COST...	104.3	PER C.Y.	**Select Dredge**
280 c.y. per hour	EXCAV TIME..	6.30	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	8.29	MONTHS	

EXCAVATION PRODUCTION WORKSHEET: PG 4 of 9

CURRENT DREDGE SELECTED: 10 CY CLAMSHELL

Type of Material..... 1 MUD

(0) Unspecified Materials, (1) Mud, (2) Clays and Less-Dense Sand, or (3) Dense Clays, Hard-Packed Sand, Blasted Rock and Boulders

PRODUCTION FACTORS:	Override	Default	Used
Bucket Size (in CY).....	0	10	10
Bucket Fill Factor.....	0	1.00	1.00
Optimum Bank (in Feet)..	0	3.5	3.5
Bank Factor.....	0	0.69	0.69
(based on 2.4 Ft of Bank Height)			

EXCAVATION PRODUCTION WORKSHEET: PG 5 of 9

Bucket Cycle Time..... 72 Seconds See Messages Tab for breakdown

Other Factor..... 0.90
Description..... Weather

Cleanup Dredging..... 10 % Additional Time
(Cleanup Factor = 0.91)

Time Efficiency.....> 85.0 % of Effective Work Time
222 Hours Per Month

HAULING PRODUCTION WORKSHEET: PG 6 of 9

Towing Cycle: 3000 HP Diesel--Twin Screw

Prepare Scow for Tow....	20	Minutes	
One-Way Haul Distance...	82	Miles	82 miles to Shirley Plantation
Speed to Disposal Area..	6	Miles per hour = 820 Min	
Speed from Disposal Area	8	Miles per hour = 615 Min	
Dumping or Pumpout.....	2040	Minutes	Includes time for mixing cement (24
Disengage Scow Tow.....	15	Minutes	hours) and using excavators at Shirley
Towing Time Efficiency..	95	Percent	Plantation (10 hours)

Scow Capacity: 3000 CY Split Hull Scow

Useable Volume..... 80 Percent
Percent Solids..... 83 Percent = 1,992 cys/load

37,540 pay c.y. per month	UNIT COST...	104.3	PER C.Y.	**Select Dredge**
280 c.y. per hour	EXCAV TIME..	6.30	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	8.29	MONTHS	

EQUIPMENT MATCHING: PG 7 of 9

	Override	Assumed	Used
# of Dredges.....	0	1	1
Scows per Dredge.....	2	1	2
# of Towing Vessels.....	0	1	1
Scows per Tow.....	2	1	2

Scows with Dredges: 2 (1 Dredge(s) x 2 Scow(s) Each)
Scows with Tows: 2 (1 Tug(s) x 2 Scow(s) Each)
Additional Scows..... 1

Total Scows on Job: 5

SPECIAL LABOR & EQUIPMENT: PG 8 of 9

(1 for Yes, 0 for No)	Override	Assumed	Used
Survey Boat?.....	0	NO	NO
Crew Boat?.....	0	NO	NO

OTHER PRICING ADJUSTMENTS: PG 9 of 9

Other Monthly Costs:

1st Input..... $11,250 Per Month
Description..... PM
(For Additional Inputs Go to Sheet D\4) Goto Sheet D/4

Fixed Costs:

1st Input..... $0 Lump Sum
Description..... 0
(For Additional Inputs Go to Sheet E) Goto Sheet E

(To Adjust Labor Go To Sheet DB_L) Goto Sheet DB_L

(To Adjust Equipment Go To Sheet DB_E) Goto Sheet DB_E

37,540 pay c.y. per month	UNIT COST...	104.3	PER C.Y.	**Select Dredge**
280 c.y. per hour	EXCAV TIME..	6.30	MONTHS	10 CY CLAMSHELL
10 CY CLAMSHELL Dredge	HAUL TIME...	8.29	MONTHS	

LOCAL AREA FACTORS:

PG 1a of 9

Present Year.....	2015	(Equipment Calculations)
Economic Index.....	8678	(EP-1110-1-8, APP E)
Labor Adjustment Factor.	1.000	(EP-1110-1-8, APP B)
Full Cost of Money Rate.	2.38	Percent per Year
Dates for Money Rate....		
Annual Months Available for Dredging:		
Pipeline....	n/a	Months per Year
Bucket.....	6.16	Months per Year
Hopper.....	n/a	Months per Year
Current Fuel Price.....	$3.04	Per Gallon

Return

Landfill Cost	$70.15	Includes wharfage fee at Shirley Plantation and trans. to landfill
Landfill %	100%	
Shirley Plantation Cost	$24.22	Includes wharfage fee and costs for materials to mix with soil.
Shirley Plantation %	0%	
Avg Disposal Cost	70.15	
Total Cost	104.3	
CIDMMA Toll	1.38	
	105.68	

MOB & DEMOB COST	$ 836,436	

SPECIAL ITEMS (USED FOR BOTH MOB & DEMOB):

Supplies & small tools @	$ 100	/day
Support equipment with operators @	$ 500	/day
Fuel (Plant Idle)	$ 100	per Day
Subsistence	$ 25	per Man

MOBILIZATION ITEMS:

1. PREPARE DREDGE FOR TRANSFER TO JOBSITE:

Time Required.....	10	Days
Crew Size.....	10	Men
Work Schedule.....	8	Hrs per Day

2. TRANSFER PLANT TO JOBSITE:

Distance.....	600	Miles
Towing Speed.....	100	Miles per Day
Crew Size.....	5	Men per Shift

3. RELOCATE PERMANENT PERSONNEL & MISC. TO JOBSITE:

Crew Size.....	4	Men
Travel Time.....	8	Hrs per Man
Travel Expenses...	$ 500	Per Man
Local Hire.....	$ 200	(Lump Sum)

4. PREPARE DREDGE FOR WORK AT JOBSITE:

Time Required.....	8	Days
Crew Size.....	10	Men
Work Schedule.....	8	Hrs per Day

5. OTHER:

Description.....	Survey & Rigging	
Lump Sum Cost.....	$ 51,385	

DEMOBILIZATION ITEMS:

1. PREPARE DREDGE FOR TRANSFER AWAY FROM JOBSITE:
   Time Required..... 10 Days

2. TRANSFER PLANT AWAY FROM JOBSITE:
   Distance..... 600 Miles

3. RELOCATE PERMANENT PERSONNEL & MISC. AWAY FROM JOBSITE:
   Include Computed Costs?.... 1 YES (0=NO)

4. PREPARE DREDGE FOR STORAGE..... 2 Days

5. OTHER:
   Description..... Survey & Misc.
   Lump Sum Cost..... $ 20,000

MOBIL & DEMOB COST:	$836,436		BID QUANTITY	359,205	C.Y.
			UNIT COST...	$34.15	PER C.Y.
	GRR		EXCAV. COST.	$12,266,851	
CHECKLIST FOR INPUT DATA.			TIME.....	8.29	MONTHS

PG 1 OF 9: PROJECT TITLES

PROJECT -	GRR	
LOCATION -	Hampton Roads, VA	
INVIT # -	Preliminary	
DATE OF EST. -	November 2016	
EST. BY -	SBJ	
MOB. BID ITEM # -	1	
EXCAV. BID ITEM # -	2	

PG 1a OF 9: LOCAL AREA FACTORS

PRESENT YEAR -	2015	
ECONOMIC INDEX -	8678	
LAF -	1.000	
INTEREST RATE -	2.375%	/yr
TIME PERIOD -	0	
PIPELINE AVAILABILITY -	n/a	mos/yr
BUCKET AVAILABILITY -	6.16	mos/yr
HOPPER AVAILABILITY -	n/a	mos/yr
FUEL PRICE -	$3.04	/gal

PG 2 OF 9: TYPE OF EST & INDIRECT COSTS

TYPE OF EST. -	Planning Estimate
CONTRACTOR'S O.H. -	8.0%
CONTRACTOR'S PROFIT -	10.0%
CONTRACTOR'S BOND -	1.5%

PG 3 OF 9: EXCAVATION QTY'S

DREDGING AREA -	4,326,385	sf
REQ'D EXCAVATION -	109,345	cyds
PAY OVERDEPTH -	249,860	cyds
CONTRACT AMOUNT -	359,205	cyds
NOT DREDGED -	48,000	cyds
NET PAY -	311,205	cyds
NONPAY YARDAGE -	80,100	cyds
GROSS YARDAGE -	391,305	cyds
NONPAY HEIGHT -	0.5	ft overdig
TOTAL BANK HEIGHT -	2.4	ft

PG 4 OF 9: EXCAVATION PRODUCTION WORKSHEET

DREDGE SELECTED -	10 CY CLAMSHELL
TYPE OF MATERIAL -	MUD
BUCKET SIZE -	10
BUCKET FILL FACTOR -	1.00
OPTIMUM BANK -	3.5
BANK FACTOR -	0.69

PG 5 OF 9: EXCAVATION PRODUCTION WORKSHEET

BUCKET CYCLE TIME -	72	Seconds
OTHER FACTOR -	0.90	Weather
CLEANUP -	10%	More Time
TIME EFFICIENCY -	85.0%	of EWT

PG 6 OF 9: HAULING PRODUCTION WORKSHEET

TUG DESCRIPTION -	3000	HP Diesel--Twin Screw
PREPARE SCOW TOW -	20	min
HAUL DIST -	82	mi
SPEED TO D/A -	6	mph
SPEED FROM D/A -	8	mph
DUMP OR PUMPOUT -	2040	min
DISENGAGE TOW -	15	min
TOW EFFICIENCY -	95	%
SCOW DESCRIPTION -	3000	CY Split Hull Scow
USEABLE VOLUME -	80	%
% SOLIDS -	83	%

PG 7 OF 9: EQUIPMENT MATCHING

# OF PIECES:	Used
DREDGES -	1
SCOWS PER DREDGE -	2
TOWING VESSELS -	1
SCOWS PER TOW -	2
ADDITIONAL SCOWS -	1
TOT SCOWS ON JOB -	5

PG 8 OF 9: SPECIAL LABOR & EQUIPMENT

QUARTERS ON DREDGE? -	NO
SURVEY BOAT? -	NO
CREW BOAT? -	NO

PG 9 OF 9: OTHER ADJUSTMENTS

SPECIAL COST/MO (1ST) -	$11,250	PM	
SP COST/MO (2ND-14TH) -	$121,070	From Sheet D\4	
SPECIAL COST LS (1ST) -	$0		$0
SP COST LS (2ND-14TH) -	$0	From Sheet E	

PRODUCTION -	280	gross cy per hour
OPERATING TIME -	169	hours per month
GROSS PRODUCTION -	47,192	cy per month
PAY PRODUCTION -	37,540	pay cy per month

Cost Appendix B – Cost Risk Analysis

COST RISK ANALYSIS
Elizabeth River and Southern Branch of the Elizabeth River Navigation Improvements

Table of Contents

1. Executive Summary 1
2. Introduction 1
3. Purpose and Objectives 1
3.1 USACE Risk Analysis Process 1
4. Methodology / Process 2
4.1 Identify and Assess Risk Factors 2
4.2 Quantify Risk Factor Impacts 3
4.3 Analyze Cost Estimate and Schedule Contingency 4
5. Key Assumptions 4
6. Risk Analysis Results 4
6.1 Risk Register 5
6.2 Cost Risk Analysis - Cost Contingency Results 8
7. Findings 11
8. Recommendations 11
Appendix A: Risk Register 12
Appendix B: Crystal Ball Report – ERSB Risk Analysis 13

List of Tables

Table 1: High and Moderate Risk Items Identified in the Risk Register 5
Table 2: Confidence Table of Total Project Costs 10
Table 3: Contingency for Project Cost Levels 11

1. Executive Summary

The United States Army Corps of Engineers (USACE) require a risk analysis be completed for projects over $40 million. Preliminary estimates for the Elizabeth River Southern Branch (ERSB) Deepening Study and associated maintenance dredging cost is well over the $40 million limit, requiring this risk analysis to be completed.

To analyze the ERSB cost risk, *Crystal Ball* Risk Analysis Software was used to create simulations of multiple scenarios of the project's cost and schedule. *Crystal Ball* software uses a mathematical modeling technique called a Monte Carlo Simulation to create a range of possible cost and schedule outcomes and confidence intervals including the most likely cost for a given project. The current preliminary estimate for the base cost for the project with refined quantities and unit costs is $159.9M. Using the 80% confidence interval from the simulation, the maximum probable cost for the project was determined to be $183.5M. The contingency, based on this cost risk analysis, is 14.80%.

A sensitivity analysis of the cost estimate was created using the *Crystal Ball* software. This analysis, together with the Risk Register, shows that two key items impact the project cost the most; the volume of contaminated materials in the Southern Branch that require upland disposal and the availability of the Weanack Site (along the James River) for transfer of dredged material for upland disposal. These two items represented over 80% of the project cost variance, with no other item above 6%.

Conducting additional environmental testing to determine the exact limits of the contamination in the ERSB, as proposed for PED, is thus the top priority for mitigating the cost increases for the project. In addition, maintaining contact with the Weanack site so that they maintain their permit and are available to take the material is also vital to mitigating the project's potential cost increases.

2. Introduction

This cost risk analysis report outlines the development of the cost risk for the Elizabeth River Southern Branch (ERSB) deepening study in Hampton Roads, Virginia. This report will detail the assumptions used in developing the magnitude of the risks, as well as how the risks were modeled and the results of the model.

3. Purpose and Objectives

The scope of the risk analysis report is to calculate and present the cost contingencies at the 80 percent confidence level using the risk analysis processes as mandated by 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.

3.1 USACE Risk Analysis Process

The risk analysis process follows the USACE Headquarters requirements as well as the guidance provided by the Cost Engineering Directory of Expertise for Civil Works (Cost Engineering DX). The risk analysis process uses probabilistic cost and schedule risk analysis methods within the framework of the *Crystal Ball* software. The risk analysis results are intended to serve several functions, one being the establishment of reasonable contingencies reflective of an 80 percent confidence level to successfully accomplish the project work within that established contingency amount. Furthermore, the scope of the report includes the identification and communication of important steps, logic, key assumptions, limitations, and decisions to help ensure that risk analysis results can be appropriately interpreted.

Risk analysis results are also intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes, as well as provide tools to support decision making and risk management as the project progresses through planning and implementation. To fully recognize its benefits, cost and schedule risk analyses should be considered as an ongoing process conducted concurrent to, and along with, other important project processes such as scope and execution plan development, resource planning, procurement planning, cost estimating, budgeting, and scheduling.

In addition to broadly defined risk analysis standards and recommended practices, the risk analysis is performed to meet the recommendations of the following documents and sources:

- ER 1110-2-1150, Engineering and Design for Civil Works Projects.
- ER 1110-2-1302, Civil Works Cost Engineering.
- ETL 1110-2-573, Construction Cost Estimating Guide for Civil Works.

- Cost and Schedule Risk Analysis Process guidance prepared by the USACE Cost Engineering DX.

4. Methodology / Process

The purpose of the risk analysis process is to determine what can be expected for the project as a whole, allowing variation within the individual project components. Natural variation allows the simulation to mimic real world scenarios more closely, accounting for unforeseen changes that could affect a project, but within reason for the given distributions.

As recommended in the above references, *Crystal Ball* Risk Analysis Software was selected to run the risk analysis for the project. *Crystal Ball* uses a mathematical modeling technique called a Monte Carlo Simulation that takes distributions of assumed unit costs, quantities and production rates and runs thousands of trials, taking one input from each distribution in each simulation, adding in natural variation when selecting the points. The input data was based on the Risk Register, MII Cost Estimate, Project schedule, and PDT involvement.

Crystal Ball allows multiple trials, 5,000 trials were used for the analysis, in order to model the distribution given to that assumption. All of the individual assumptions (i.e. cost, volumes, etc.) are then summed for each trial and plotted to show cost and schedule versus probability. The median is the most likely project cost/schedule and, based on USACE policy, the 80% confidence value is the probable upper bound cost/schedule. The software is also used to create sensitivity plots that show which risk items have the greatest impacts in the overall project cost distribution.

4.1 Identify and Assess Risk Factors

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.

Checklists or historical databases of common risk factors are sometimes used to facilitate risk factor identification. However, key risk factors are often unique to a project and not readily derivable from historical information. Therefore, input from the entire PDT is obtained using creative processes such as brainstorming or other facilitated risk assessment meetings. In practice, a combination of professional judgment from the PDT and empirical data from similar projects is desirable and is considered. Identifying the risk factors is considered a qualitative process that results in establishing a list of risks that serves as the document for the further study using the Crystal Ball risk software.

The risk analysis process, for this project, began by gathering input from the PDT. The PDT identified potential risks associated with each part of the project and designated each risk. In accordance with the current *Cost and Schedule Risk Analysis Guidance* (May 2009), all risks were

then identified as low, moderate, or high risks based on their respective likelihoods and overall effects, as defined in the risk matrix shown below (Figure 1). These were used to identify what the PDT felt are the key risks of the project and the degree that these risks might affect the final cost and schedule.

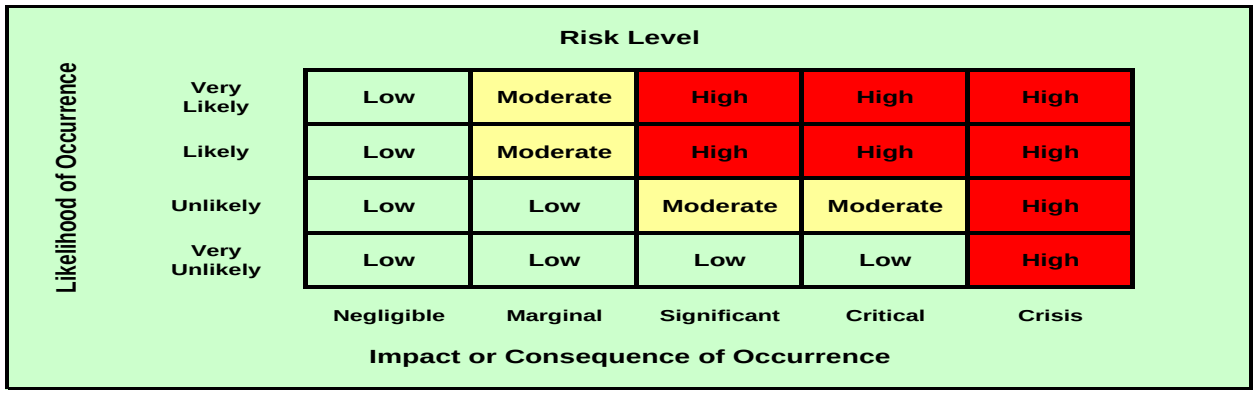


Figure 1: Risk Level Matrix

The risk register records the PDT's risk concerns, discussions related to those concerns, and potential impacts to the current cost and schedule estimates. The concerns and discussions are meant to support the team's decisions related to event likelihood, impact, and the resulting risk levels for each risk event.

4.2 Quantify Risk Factor Impacts

The quantitative impacts of risk factors on project plans are analyzed using a combination of professional judgment, empirical data, and analytical techniques. Risk factor impacts are quantified using probability distributions (density functions), because risk factors are entered into the *Crystal Ball* software in the form of probability density functions.

Similar to the identification and assessment process, risk factor quantification involved multiple project team disciplines. For each of the risks identified, quantifying risk factor impacts were determined to include:

- Maximum possible value for the risk factor.
- Minimum possible value for the risk factor.
- Most likely value (the statistical mode), if applicable.
- Nature of the probability density function used to approximate risk factor uncertainty.

The resulting risk register includes discussion of the above.

4.3 Analyze Cost Estimate and Schedule Contingency

Contingency is analyzed using the *Crystal Ball* software, an add-in to the *Microsoft Excel* format of the cost estimate and schedule. Monte Carlo simulations are performed by applying the risk factors (quantified as probability density functions) to the appropriate estimated cost and schedule elements identified by the PDT. Contingencies are calculated by applying risks identified.

For the cost estimate, the contingency is calculated as the difference between the P80 cost forecast and the base cost estimate. P80 is the value that with 80% confidence we can conclude the project will not exceed, or 80% of the Monte Carlo simulations were less than or equal to that number. Each option-specific contingency is then allocated on a civil works feature level based on the dollar-weighted relative risk of each feature as quantified by Monte Carlo simulation. Standard deviation is used as the feature-specific measure of risk for contingency allocation purposes. This approach results in a relatively larger portion of all the project feature cost contingency being allocated to features with relatively higher estimated cost uncertainty.

5. Key Assumptions

The following section is an overview of key assumptions determined to be important to document the steps, logic, limitations, and decisions made in the risk analysis, as well as any resultant limitations on the use of outcomes and results.

- Design scope. Scope of project is well defined. The design documents represent a well-coordinated project consistent through the development of the project.
- Critical inclusions or exclusions of scope or risk. There was no exclusion in preparing the risk register.
- Feature cost account code for the project uses Feature Code 12 – Navigation Ports & Harbors.
- Cost estimates have been developed in detail. All dredging costs are developed in CEDEP
- Contingency confidence level will be based on the P80 as recommended in the USACE guidance.
- Risks studied include those with high and moderate risk levels. Due to some of the large volumes on the project

6. Risk Analysis Results

This section discusses the major components of the risk register, data used to develop the distributions for the risk analysis and results.

6.1 Risk Register

During development of the risk register, risk items were discussed and evaluated by the design team. A risk register is a tool commonly used in project planning and risk analysis and serves as the basis for the risk studies and *Crystal Ball* risk models. The risk register reflects the results of risk factor identification and assessment, risk factor quantification, and contingency analysis. From this process, 11 items were determined by the PDT to warrant inclusion in the risk analysis. Each of the risks was then evaluated in detail to determine the variability and distribution in quantities and cost so they could be evaluated in *Crystal Ball*. The detailed risk register is provided in the Appendices to this report, and summarized below.

Table 1: High and Moderate Risk Items Identified in the Risk Register

Risk No.	PDT-Developed Risk/Opportunity Event
PPM-3	Congressional Funding - Construction
T-6	Scour
T-7	Utilities
ENV-5	Contaminated Materials
ENV-8	Contaminated Materials - Opportunity
EST-3	Dredge Productivity
EST-4	Dredge disposal Location Assumptions
EST-5	Dredge Mobilization Costs
EST-6	Contaminated Dredge Volume
EXT-4	Escalation exceeds CWCCIS values
EXT-5	Fuel Prices Increase Higher than Inflation

Based on the above, 11 different variables were used in the *Crystal Ball* Cost Risk analysis to model the above risks. These assumptions consider values from the CEDEPs, and the assumed values are described in further detail in the risk register.

Following is a discussion of the 11 more significant risks shown above, and assumptions used in developing the analysis. Crystal ball reports show details on ranges and distributions.

PPM-3. Congressional Funding - Construction

The construction funding stream will likely be less than optimal from the Federal side. This will influence the size, number, and length of the deepening contracts, which will impact both the total project cost and project schedule. This was modeled with a high cost of a 10% increase in construction costs for the projects due to additional mobilization and demobilization costs and less efficient, shorter, dredging contracts, with the expected and

low costs of $0, representing no change from the expected project schedule. It was not assumed that this would have an impact on the maintenance dredging.

T-6 Scour

The ERSB has three bridges along the proposed dredging route. These highway and rail bridges may not have been designed for the depths of the dredging included in the project. This risk includes providing scour protection to offset any risk due to a deeper channel depth. This risk was estimated with a high cost of $4 million to cover the cost of scour protection or other improvements that may be needed to the adjacent bridge foundations along the ERSB dredging route. The expected and low cost was $0, as the minor increase in depth (2 to 3 feet around the bridges) is not expected to have an impact on the adjacent structures.

T-7 Utilities

The ERSB has many utility lines crossing the proposed dredging area including water and communications lines. Although there are no utility relocations identified, this risk account for sometimes the utilities are not installed as deep as they are permitted to. A high cost of $5 million has been estimated to cover potential relocations. This cost would also cover any delays in construction due to encountering a utility during construction. The expected and low cost has been modeled as $0, as no utility relocations are expected.

ENV-5 Contaminated Material Volume

It was assumed that all material in the Elizabeth River Reach and Lower Reach was not contaminated and suitable for placement in Craney Island Dredged Material Management Area (CIDMMA) – as was the case for the recent Navy deepening project. If any of this material is contaminated, it would cost about $60 / CY more for upland placement of this material, a total cost to the project of approximately $21 million. The expected and low cost was estimated as $0, as the project estimate includes the cost for the material to go to CIDMMA at this time.

ENV-8 Contaminated Material Volume Reduction

All material in the Middle Reach and Upper Reach A was assumed to be contaminated for the initial deepening. This is about $85/CY more expensive than placement in CIDMMA, a total cost of about $127.5 million for the whole project. Previous testing has shown this material has extensive contamination, but once environmental testing has been completed, some of the material may be suitable for CIDMMA, with the unsuitable material disposed upland. It was assumed for this cost risk item that a savings of $38,760,000 was possible if 456,000 CY is suitable for Craney. It was modeled as a triangular distribution, with the low of

-$38,760,000, and the expected and high cost of $0, as the estimate currently has all of the material being disposed of at upland disposal sites.

EST-3 Dredge Productivity

Large mechanical dredges were assumed for the significant volumes required for the project. Using smaller dredge may increase the unit prices by approximately $3 / CY. It was assumed for the cost risk analysis that the high value corresponded to the $3 / CY increase, while the expected value was $0, representing the current estimate. The low value assumed a $0.60 / CY decrease in unit prices due to a more productive dredge being used compared to dredges estimated in CEDEP.

EST-4 Dredge Disposal Location Assumptions

The Weanack site is assumed to be used for upland disposal, with the Charles City County Landfill used after processing at the Weanack site. If this option becomes unavailable and the material either requires trucking to a site in Virginia, or barging farther away than Weanack (Shirely Plantation), this would cause a significant increase to the project costs. To model this, the low and expected values were estimated as $0, representing the current estimate, while the high cost of $36,213,000 was estimated assuming a $50 / CY increase to all material going to upland disposal sites.

EST-5 Dredge Mobilization Costs

Mobilization costs have been estimated assuming the dredge is mobilized from outside the Mid-Atlantic for the hydraulic dredges and within the Hampton Roads area for the mechanical dredges. However, mobilization costs for some recent dredging contracts have exceeded anticipated CEDEP estimates for the mobilization. The high cost in the cost risk model assumes an additional $1.5 million in mobilization costs for three separate mobilization and demobilizations required for the deepening project. The low and expected values were $0, representing the current cost estimate.

EST-6 Contaminated Dredge Volume

From within the Middle Reach and Upper Reach A, an additional 257,000 CY of material has been assumed to be dredged below the required depth for navigation to remove additional contaminated material and not expose the bottom of the river to these sediments. This item is actually a potential savings (opportunity cost), as the low value represents a case where half of the area with overdredge does not require the additional foot of dredging and can be left in place. This saves approximately $26.2 million. The expected and high values are $0, matching the current estimate that 1 additional foot is removed from the Middle Reach and Upper Reach A.

EXT-4 Escalation Exceeds CWCCIS Values

The CWCCIS numbers account for background inflation, so any exceedance of this will be minimal. Assume 5% increase in total project cost for the high value and a 3.3% decrease for the low value if background inflation is higher than the project's inflation. The expected value is $0, representing inflation matching the CWCCIS values.

EXT-5 Fuel Prices Increase Higher than Inflation

The Civil Works Construction Cost Index System (CWCCIS) numbers account for background inflation, so any exceedance of this will be mitigated, but fuel is more volatile than most other commodities. Assume a 30% increase is fuel, which accounts for a 10.2% increase in dredging costs for the high value, while the low value represents a 10% decrease in fuel costs, representing a 3.4% decrease in unit costs. The expected value was $0, representing fuel costs in the future as expected.

Distributions – For this analysis, unit costs were modeled as triangular functions. The triangular distribution was used as expected, low, and high values were known for all major variables. The *Crystal Ball* Software Output contains all of the assumptions and distributions used for each element in the analysis, as well as descriptive statistics for the distributions.

The full risk register and *Crystal Ball* reports are included in the appendices and contain additional details.

6.2 Cost Risk Analysis - Cost Contingency Results

Based on the *Crystal Ball* Analysis of the preliminary costs, the most probable project cost (50 percentile) is $170.6 million for the federal portion of the project. The project cost at the 80% confidence interval is $183.5 million. The confidence interval and total project distribution are shown in Figure 2 below. Detailed figures and statistical analysis from the simulation are contained in the Appendix. The range from the minimum total cost to the maximum cost is approximately $107.9 million and the range from the 80% upper limit to the minimum value is approximately $70.7 million.

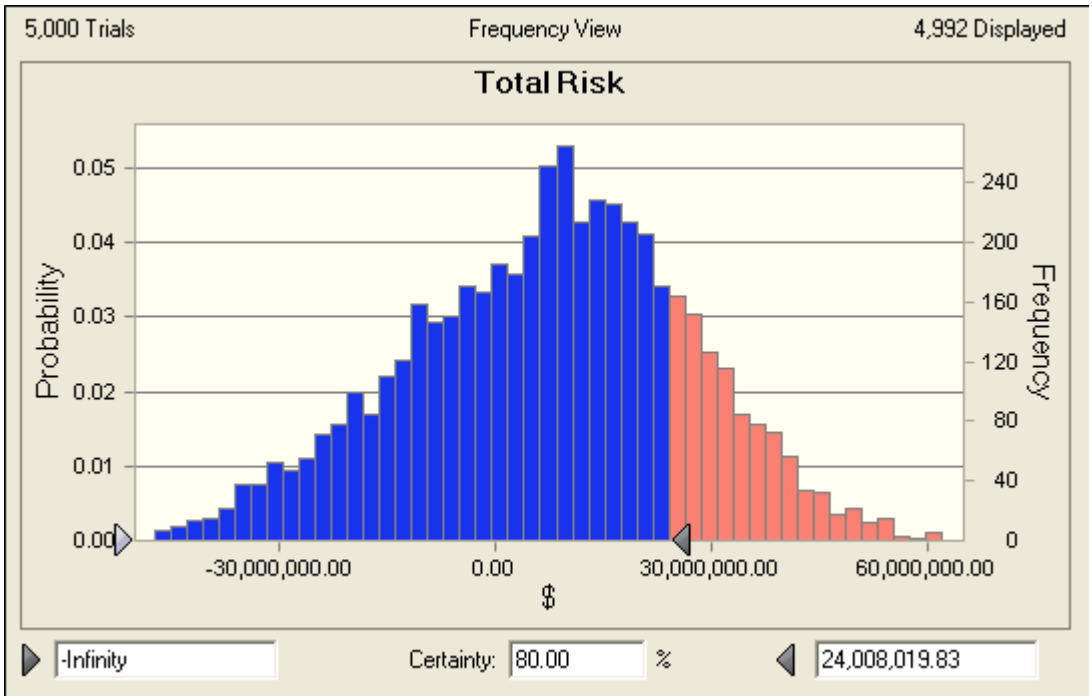


Figure 2: 80% Risk Value Above Expected Project Cost

A sensitivity analysis was conducted to determine which items cause the greatest change in overall project cost. This analysis shows that two key items impact the project cost the most; the amount of contaminated materials in the Southern Branch that require upland disposal and the availability of the Weanack Site for upland disposal. These two items represented over 80% of the project cost variance, with no other item above 6%.

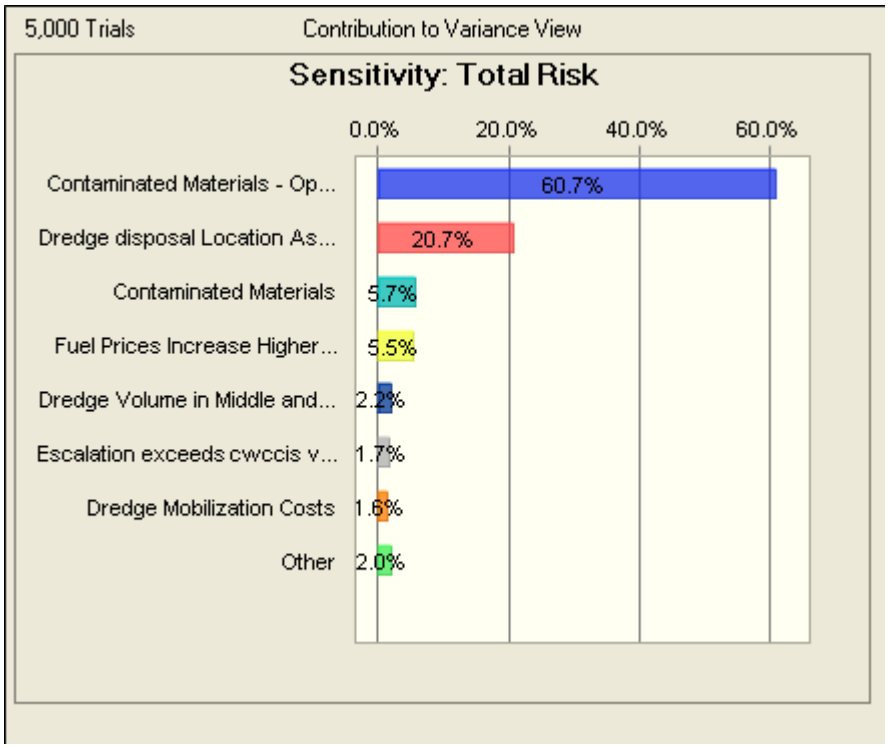


Figure 3: Sensitivity Analysis

Note that these results reflect only those contingencies established from the cost risk analysis.

Table 2: Confidence Table of Total Project Costs

Percentiles:	Forecast values ($)
0%	112,869,506
10%	149,253,846
20%	156,710,461
30%	161,699,611
40%	166,253,135
50%	170,559,934
60%	174,650,730
70%	178,630,044
80%	183,522,898
90%	190,896,078
100%	220,738,549

The cost risk analysis determined that a 14.80% contingency (calculated as the difference from the 80% to the base case divided by the base case of $159.9 million) should be expected for the project as a whole. This percentage represents the funds that should be allocated to complete this project based on the risks developed by the PDT. Table 3 shows the change in contingency with different confidence levels of the cost estimate.

Table 3: Contingency for Project Cost Levels

Confidence Level	Project Cost ($)	Contingency ($)	Contingency (%)
P0	112,869,506	-46,988,107	-29.39%
P10	149,253,846	-10,603,767	-6.63%
P20	156,710,461	-3,147,152	-1.97%
P30	161,699,611	1,841,998	1.15%
P40	166,253,135	6,395,522	4.00%
P50	170,559,934	10,702,321	6.69%
P60	174,650,730	14,793,117	9.25%
P70	178,630,044	18,772,431	11.74%
P80	**183,522,898**	**23,665,285**	**14.80%**
P90	190,896,078	31,038,465	19.42%
P100	220,738,549	60,880,936	38.08%

7. Findings

Based on this cost risk analysis, the most probable project cost is currently estimated to be $170.6 million with an 80% confidence interval for the cost to not exceed $183.5 million.

8. Recommendations

Although project risk is unavoidable, identifying ways to mitigate their effect on the final project cost is essential to the success of the project and has been pursued through project development by the PDT. Efforts to reduce risk continue as described below.

Environmental Testing – Extensive testing of the materials in the ERSB will be completed during PED to get a full understanding of which materials are suitable for CIDMMA and which must be taken upland. Completion of this testing will mitigate the potential cost increases as it will be known where the material needs to be disposed.

Upland Disposal Coordination – Continued coordination with Port Weanack is recommended to verify the transfer site remains open, keeping their permits to handle the material.

Mitigating these risks will reduce the variation for the entire project and lower the range of possible values for the project cost.

Appendix A: Risk Register

Elizabeth River Southern Branch

Risk Matrix

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
	Impact or Consequence of Occurrence				
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope
XXX

-
SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			$4,001,760		3 Months
Marginal ---*between*	$4,001,761	and	$8,003,520	3 Months	and 4 Months
Significant ---*between*	$8,003,521	and	$16,007,040	4 Months	and 9 Months
Critical--- *between*	$16,007,041	and	$32,014,080	9 Months	and 18 Months
Crisis ---*Over*	$32,014,081			18 Months	

Risk No.	Risk/Opportunity Event	Concerns	PDT Risk Conclusions, Justification	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
Contract Risks (Internal Risk Items are those that are generated, caused, or controlled within the PDT's sphere of influence.)															
	PROJECT & PROGRAM MGMT														
PPM-1	Congressional Funding - PED	Concern is that the PED Congressional funding is uncertain, post feasibility.	PED funding may not come in a timely manner. This would impact the project schedule significantly, but is unlikely to occur at this time. Estimated cost is a 25% increase to the PED costs.	Unlikely	Negligible	LOW	$1,986,250	Unlikely	Significant	MODERATE	6 Months	Triangular		District Management	Project Cost
PPM-2	Local Sponsor Funding - PED	Concern is that PED funding from local sponsor could be delayed or rejected.	PED funding may not come in a timely manner. This would impact the project schedule significantly, but is very unlikely to occur at this time, as the deepening is a priority for the port and the state. The port also has greater flexibility with regards to access to their money. Estimated cost is a 25% increase to the PED costs.	Very Unlikely	Negligible	LOW	$1,986,250	Very Unlikely	Significant	LOW	6 Months	Triangular		District Management	Project Cost
PPM-3	Congressional Funding Construction	Concern is that construction funding is incremental per FY and can be impacted by budget delays such as continuing resolutions. We can no longer award a continuing contract.	This could cause a 10% increase in the Federal Share of project costs.	Likely	Marginal	MODERATE	$8,106,675	Likely	Crisis	HIGH	3 Years	Triangular		District Management	Project Cost & Schedule
PPM-4	Local Sponsor funding capability	Concern is that construction funding is incremental per FY and can be impacted by budget delays such as continuing resolutions. We can no longer award a continuing contract.	The construction funding stream will likely be less than optimal. This is unlikely, but will influence the size, number, and length of the contracts, that will impact both the total project cost and project schedule. This could represent a 10% increase in construction costs for the projects due to additional mobilization and demobilization costs and less efficient, shorter, dredging contracts.	Unlikely	Marginal	LOW	$8,106,675	Unlikely	Crisis	HIGH	2 Years	Triangular		District Management	Project Cost & Schedule
PPM-5	Adequate PDT Resources / Loss of Key Staff	Several PDT members scheduled for near term retirement.	Loss of key staff could lead to delays in the project, that would impact the project schedule, with corresponding impacts to cost. Assumed cost increase is 25% of PED costs.	Very Likely	Negligible	LOW	$1,986,250	Very Likely	Marginal	MODERATE	3 Months	Triangular		District Management	Project Cost
PPM-6	Schedule quality	Concern whether current schedule is realistic, optimistic.	Schedule is likely to be delayed due to potential for different disposal site options, including CIDMMA dikes adequate for volume of material. This will impact both the project schedule and costs. Estimated additional costs equal 5% of deepening costs.	Unlikely	Marginal	LOW	$7,992,881	Unlikely	Marginal	LOW	3 Months	Triangular		Cost Engineering	Project Cost
PPM-7	PED Schedule	Additional permitting or archeological issues can lead to additioanal time required for PED	Due to coordination constraints between agencies (EPA, NMFS), PED delays could be up to 1 year of delays. Assumed cost increase is 15% of PED costs.	Unlikely	Negligible	LOW	$1,191,750	Unlikely	Significant	MODERATE	1 Year	Triangular		Cost Engineering	Project Cost
	Contract Acquisition														
CA-1	Contract Acquisition Strategy	The acquisition strategy could impact the construction cost and schedule.	Port works with USACE frequently and will provide matching funds to allow the USACE to effieciently manage projects. Port may also provide additional / advanced funds to get project constructed faster. Contract method is standard for dredging, with no unique contracting methods. Estimated costs are 5% of capital construction costs.	Unlikely	Marginal	LOW	$7,992,881	Unlikely	Negligible	LOW	1 Month	Triangular		Contracting	Project Cost

Elizabeth River Southern Branch

Risk Matrix

Likelihood of Occurrence	Impact or Consequence of Occurrence				
	Negligible	Marginal	Significant	Critical	Crisis
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope
XXX

-
SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			$4,001,760		3 Months
Marginal ---*between*	$4,001,761	and	$8,003,520	3 Months	and 4 Months
Significant ---*between*	$8,003,521	and	$16,007,040	4 Months	and 9 Months
Critical--- *between*	$16,007,041	and	$32,014,080	9 Months	and 18 Months
Crisis ---*Over*	$32,014,081			18 Months	

				Project Cost				Project Schedule								
Risk No.	Risk/Opportunity Event	Concerns	PDT Risk Conclusions, Justification	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
CA-2	Number of Contracts	Possibility of single or mutiple contracts.	Currently assumed to have separate contracts for each reach. There could be a small risk or small savings associated with combining reaches into a single contract. This is more likely for the cutterhead dredging contracts. Cost assumes 1 additional mechanical and 1 additional cutterhead dredging mobilizations	Likely	Negligible	LOW	$3,666,759	Likely	Negligible	LOW	1 Month	Triangular		Contracting	Project Cost
CA-3	Bid Protest	Possibility of a bid protest	USACE gets bid protests frequently. This is not a big issue, with a negligble impact to the project cost. $1 million estimated cost over the lifetime of the project.	Unlikely	Negligible	LOW	$1,000,000	Unlikely	Negligible	LOW	1 Month	Triangular		Contracting	Project Cost
CA-4	Small Business Goals	Small business goals may cause an extra high unit cost, as dredging tends to be difficult for small businesses due to the high capital costs of the equipment.	Small business goals could be used for the maintenance dredging contracts. Rule of 2 would need to be met for a contract to be issue as small business. Assume 50% additional cost of maintenance volume.	Unlikely	Negligible	LOW	$1,137,942	Unlikely	Negligible	LOW	1 Month	Triangular		Contracting	Project Cost
	Technical														
T-1	Confidence in O&M Volumes during Initial Side Slope Equilibration Period (First 10 Years)	Variability in estimated quantities versus actual quantities could vary significantly based on the uncertainty of the equilibrium processes affecting sides slope equilibium after initial dredging.	time to reach equilibrium is expected, provided contractor dredges to required 3:1 slopes. The future O&M volumes have been calculated based upon expected increase in sedimentation. Projected sedimentation rates are conservative, resulting in a low risk for the project. Costs assume a 20% increase in maintenance volume dredging costs.	Unlikely	Negligible	LOW	$455,177	Unlikely	Negligible	LOW	2 Months	Triangular		Project Manager	Project Cost
T-2	Confidence in O&M Volumes over Long-Term (Final 40 Years/Post Equilibration) O&M Volumes	Variability in estimated quantities versus actual quantities could vary based on the shoaling rate.	The future O&M volumes have been calculated based upon expected increase in sedimentation. Projected sedimentation rates are conservative, resulting in a low risk for the project. Costs assume a 100% increase in additional maintenance volume dredging.	Unlikely	Negligible	LOW	$2,275,884	Unlikely	Negligible	LOW	3 Months	Triangular		Project Manager	Project Cost
T-3	CIDMMA Capacity	Project could lead to CIDMMA reaching capacity and require need for an additional disposal site.	Current project DMMP shows that CIDMMA has adequate capacity for intial construction, but will be filled for O&M. The additional cost is for taking material to NODS sooner than expected. Additional cost would be about $2.5 / CY for approximately 10 years (60,000 CY)	Unlikely	Negligible	LOW	$150,000	Unlikely	Significant	MODERATE	8 Months	Triangular		Project Manager	Project Cost
T-4	Upland Disposal Site Availability	Capacity of the upland disposal site to handle the material is reached or they lose their permit to accept material.	Covered in EST-4												
T-5	Impacts to existing structures	Deepening the channel in narrow areas will cause the side slopes to widen, potentially impacting adjacent shorelines and structures.	The fender systems will likely be impacted, and existing bulkheads along the river may be impacted. This is likely to occur and marginal. Estimated costs to structures, $2 million.	Likely	Negligible	LOW	$2,000,000	Likely	Negligible	LOW	3 Months	Triangular		Project Manager	Project Cost
T-6	Scour	The deeper channels may cause more issues with scour on the bridges in the ERSB.	The deepening of the channels may lead to additional scour on the bridges. This is likely, but marginal. Additional cost expected to be about $4 million.	Likely	Marginal	MODERATE	$4,000,000	Likely	Negligible	LOW	3 Months	Triangular		Project Manager	Project Cost

Elizabeth River Southern Branch

Risk Matrix

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
	Impact or Consequence of Occurrence				
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope
XXX

-
SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			$4,001,760		3 Months
Marginal ---*between*	$4,001,761	and	$8,003,520	3 Months	and 4 Months
Significant ---*between*	$8,003,521	and	$16,007,040	4 Months	and 9 Months
Critical--- *between*	$16,007,041	and	$32,014,080	9 Months	and 18 Months
Crisis ---*Over*	$32,014,081			18 Months	

				Project Cost				Project Schedule							
Risk No.	Risk/Opportunity Event	Concerns	PDT Risk Conclusions, Justification	Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)	Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
						MODERATE	$5,000,000			LOW	3 Months	Triangular		Project Manager	Project Cost
T-7	Utilities	Innaccurate as-builts could lead to issues with the deepening.	Several known utilities are within the proposed dredging area. Project could be delayed if utilities are hit. Estimated costs of about $5 million for all utilities.	Likely	Marginal			Likely	Negligible						
	Real Estate														
RE-1															
RE-2															
	Environmental														
ENV-1	Encountering UXOs	Encountering unexploded ordinances during dredging.	UXOs have not been found in the southern branch. Cost would be minor if encountered. $50,000 estimated cost.	Very Unlikely	Negligible	LOW	$50,000	Very Unlikely	Negligible	LOW	1 Month	Triangular		Environmental	Project Cost
ENV-2	Bird Nesting	Bird nesting at CIDMMA limiting disposal capacity.	Bird nesting can limit operations at CIDMMA, but not likely impact maintenance activities. Estimated to increase hydraulic dredging costs 5%.	Likely	Negligible	LOW	$850,238	Likely	Negligible	LOW	1 Month	Triangular		Environmental	Project Cost
ENV-3	Environmental Monitoring	Environmental monitoring required during dredging.	This is a minor cost that will have a negligible impact to the project cost. Estimated cost of $50,000	Unlikely	Negligible	LOW	$50,000	Unlikely	Negligible	LOW	1 Month	Triangular		Environmental	Project Cost
ENV-4	Archeological	Concern that there may be uncovered archeological finds during the underwater excavations.	The current allocations for funding of archeological surveys in the PED costs appear to be sufficient for Phase 1 and Phase 2 for the project, so there could be an opportunity for project savings. $50,000 additional cost expected. Potential savings of $250,000	Unlikely	Negligible	LOW	$50,000	Unlikely	Marginal	LOW	6 Months	Triangular		Environmental	Project Cost
ENV-5	Contaminated Materials	Contamined materials are in the channel. The volume of material requiring upland disposal will greatly impact the project cost.	Is is assumed that the Middle Reach and Upper Reach A have contamined materials that require upland disposal. If additional contaminated materials are found in the ERR or Lower Reach, this would represent a significant increase in project costs. The NAVY has already dredge these areas and been able to use CIDMMA. Cost estimated assuming 350,000 CY of material to upland disposal instead of CIDMMA. Estimated cost difference is $60 / CY. Total cost is $21 million.	Unlikely	Critical	MODERATE	$21,000,000	Unlikely	Marginal	LOW	6 Months	Triangular		Environmental	Project Cost
ENV-6	Water quality issues during dredging	Risk that turbidity issues could occur during O&M dredging, and could delay dredging progress. This potentially could be due to future regulations that reduce allowed levels of turbidity.	Disolved oxygen is currently not monitored for the Elizabeth River Southern Branch, but could be in the future. This is very unlikely to occur, but would represent a marginal cost. Estimated cost of $3,000,000 expected over the lifetime of the project.	Unlikely	Negligible	LOW	$3,000,000	Unlikely	Negligible	LOW	1 Month	Triangular		Environmental	Project Cost
ENV-7	Archeological Mitigation	Environmental mitigation for the project could be expensive	Authorization limitiation is 1% of construction costs. This will apply to the meeting areas, AOC, and Newport News channel, as areas of them have not been dredged previously.	Unlikely	Negligible	LOW	$1,621,335	Unlikely	Negligible	LOW	1 Month	Triangular		Environmental	Project Cost
Savings															

Elizabeth River Southern Branch

Risk Matrix

Likelihood of Occurrence	Negligible	Marginal	Significant	Critical	Crisis
	Impact or Consequence of Occurrence				
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope
XXX

-
SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			$4,001,760	3 Months	
Marginal ---*between*	$4,001,761	and	$8,003,520	3 Months	and 4 Months
Significant ---*between*	$8,003,521	and	$16,007,040	4 Months	and 9 Months
Critical--- *between*	$16,007,041	and	$32,014,080	9 Months	and 18 Months
Crisis ---*Over*	$32,014,081			18 Months	

Risk No.	Risk/Opportunity Event	Concerns	PDT Risk Conclusions, Justification	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
ENV-8	Contaminated Materials - Opportunity	Materials in the Middle Reach or Upper Reach A are able to go to CIDMMA	Estimate assumes all material in MR and UR A go to upland disposal. If testing during PED allows some of the material to go to CIDMMA, this would represent a signficiant savings to the project. Could reduce upland material by 456,000 CY if 50% of the material is suitable for Craney. Estimated savings is $85 / CY. Total savings of $63,750,000				($38,760,000)								
	Estimate														
EST-1	Dredge Availability	Estimate choice can effect efficiency and productivity, causing a change to the estimate.	Mechanical dredging is anticipated to have sufficient competition, as there are multiple contractors able to complete the work. Very unlikly that there would be inadequate bidding competition. Assume an extra 20% cost to the project for the hydraulic dredging. Estimated to be about 14 million in hydraulic dredging in the ERR and Lower Reach, with $3.3 million in additional maintenance dredging over the 50 year lifetime considered.	Very Unlikely	Negligible	LOW	$3,307,428	Very Unlikely	Marginal	LOW	4 Months	Triangular		Cost Engineering	Project Cost
EST-2	Fuel	Fuel fluctuations can impact dredging costs.	Covered in EXT -5							0				Cost Engineering	Project Cost
EST-3	Dredge Productivity		CEDEP assumes large mechanical and cutterheads utilized for the project. If less efficient equipment is used, unit prices will be higher than estimated. Assume a $3 unit price increase from CEDEP assumptions to contractor bids. Assume a savings equal to 2/3 of the potential risk for using more efficient dredges than estimated in CEDEP.	Likely	Marginal	MODERATE	$4,305,024	Likely	Significant	HIGH	1 Year	Triangular		Cost Engineering	Project Cost
EST-4	Dredge disposal Location Assumptions	The estimate makes assumptions as to which disposal areas will be used to support the project.	Weanack and the Charles City County landfill is assumed for contaminated materials. If these are unavailable for upland disposal, this would cause a signficiant increase in project costs. Estimated increase is $50 / CY for 724,260 CY	Unlikely	Crisis	HIGH	$36,213,000	Unlikely	Significant	MODERATE	1 Year	Triangular		Cost Engineering	Project Cost
EST-5	Dredge Mobilization Costs	The estimate makes assumptions as to where the dredges are mobilizing from, but farther away dredges may have a larger mob.	Mobilization costs have been estimated with far distances for mob, but costs for some dredging contracts have exceeded anticipated dredging costs. Assume $1.5 million additional mobilization costs for 3 total mobilizations in the Southern Branch expected to increase.	Likely	Marginal	MODERATE	$4,500,000	Likely	Negligible	LOW	1 Month	Triangular		Cost Engineering	Project Cost
Opportunity															
EST-6	Dredge Volume in Middle an	The cost estimate assumes that an additional foot of material will be dredged in the Middle Reach and Upper Reach A to account for dredged material.	This material may not be required once material testing is completed. Removing this additional foot would reduce volumes by approximately 257,000 CY. At $102 / CY, that represents about $26.2 million in savings.				($26,200,000)					Triangular			
	Construction														

Elizabeth River Southern Branch

Risk Matrix

Likelihood of Occurrence	Impact or Consequence of Occurrence				
	Negligible	Marginal	Significant	Critical	Crisis
Certain	Moderate	Moderate	High	High	High
Very Likely	Low	Moderate	High	High	High
Likely	Low	Moderate	High	High	High
Unlikely	Low	Low	Moderate	Moderate	High
Very Unlikely	Low	Low	Low	Low	Moderate

Overall Project Scope
XXX

-
SEE ASSUMPTIONS TAB FOR COST VALUE RANGES DEVELOPMNENT

Negligible--- *Less than*			$4,001,760	3 Months	
Marginal ---*between*	$4,001,761	and	$8,003,520	3 Months	and 4 Months
Significant ---*between*	$8,003,521	and	$16,007,040	4 Months	and 9 Months
Critical--- *between*	$16,007,041	and	$32,014,080	9 Months	and 18 Months
Crisis ---*Over*	$32,014,081			18 Months	

Risk No.	Risk/Opportunity Event	Concerns	PDT Risk Conclusions, Justification	Project Cost				Project Schedule				Variance Distribution	Correlation to Other(s)	Responsibility/POC	Affected Project Component
				Likelihood*	Impact*	Risk Level*	Rough Order Impact ($)	Likelihood*	Impact*	Risk Level*	Rough Order Impact (mo)				
CON-1	Contract Modifications	There may be modification issues that have not been captured in current risks.	The nature of this project is straightforward work that is common in the area. Quantity mods are common, but the impact of these mods are negligible. Estimated cost is $2 million.	Likely	Negligible	LOW	$2,000,000	Likely	Negligible	LOW		Triangular		Contracting	Project Cost

External Risk Items are those that are generated, caused, or controlled exclusively outside the PDT's sphere of influence.)

Risk No.	Risk/Opportunity Event	Concerns	PDT Discussions	Project Cost			Project Schedule			COMPLETED BY RISK ANALYST				
				Likelihood*	Impact*	Risk Level*	Likelihood*	Impact*	Risk Level*	Cost Impact ($)	Variance Distribution (Cost)	Schedule Impact (mo)	Variance Distribution (Schedule)	Correlation to Others)
EXT-1	Market Conditions	Market conditions and competing projects may impact bid competition.	Covered under EST-1											
EXT-2	External Opposition	External opposition may cause scope or schedule change.	Stakeholders delay approvals for dredging. Likelihood is very unlikely, as dredging is common in the area. Impact to the project negligible. Estimated cost of $250,000	Very Unlikely	Negligible	LOW	Very Unlikely	Negligible	LOW					
EXT-3	Acts of God	Severe weather may impact cost or schedule.	Weather delays are accounted for in CEDEP. A major event would not substatially impact a project of this size. Estimated project risk of $250,000	Unlikely	Negligible	LOW	Unlikely	Negligible	LOW					
EXT-4	Escalation exceeds cwccis values	Escalation over the 50 year project life may lead to higher costs in the future for the maintenance dredging	The CWCCIS numbers account for background inflation, so any exceedence of this will be minimal. Estimated cost is 5% of the project cost, which totals $7,992,881	Likely	Significant	HIGH	Likely	Negligible	LOW					
EXT-5	Fuel Prices Increase Higher than Inflation	Fuel prices increasing rapidly, causing the fuel depending dredging prices to increase rapidly.	The CWCCIS numbers account for background inflation, so any exceedence of this will be mitigated, but fuel is more volitale than most other commodities. Assumes a 30% increase in fuel, which leads to a 10.2% increase in dredging costs. This totals $16,305,477 for the project.	Likely	Significant	HIGH	Likely	Negligible	LOW					EST-3

*Likelihood, Impact, and Risk Level to be verified through market research and analysis (conducted by cost engineer).

1. Risk/Opportunity identified with reference to the Risk Identification Checklist and through deliberation and study of the PDT.
2. Discussions and Concerns elaborates on Risk/Opportunity Events and includes any assumptions or findings (should contain information pertinent to eventual study and analysis of event's impact to project).
3. Likelihood is a measure of the probability of the event occurring -- **Very Unlikely**, **Unlikely**, **Moderately Likely**, **Likely**, **Very Likely.** The likelihood of the event will be the same for both Cost and Schedule, regardless of impact.
4. Impact is a measure of the event's effect on project objectives with relation to scope, cost, and/or schedule -- **Negligible**, **Marginal**, **Significant**, **Critical**, or **Crisis.** Impacts on Project Cost may vary in severity from impacts on Project Schedule.
5. Risk Level is the resultant of Likelihood and Impact **Low**, **Moderate**, or **High**. Refer to the matrix located at top of page.
6. Variance Distribution refers to the behavior of the individual risk item with respect to its potential effects on Project Cost and Schedule. For example, an item with clearly defined parameters and a solid most likely scenario would probably follow a triangular or normal distribution. A risk item for which the PDT has little data or probability of modeling with respect to effects on cost or schedule (i.e. "anyone's guess") would probably follow a uniform or discrete uniform distribution.
7. The responsibility or POC is the entity responsible as the Subject Matter Expert (SME) for action, monitoring, or information on the PDT for the identified risk or opportunity.
8. Correlation recognizes those risk events that may be related to one another. Care should be given to ensure the risks are handled correctly without a "double counting."
9. Affected Project Component identifies the specific item of the project to which the risk directly or strongly correlates.
10. Project Implications identifies whether or not the risk item affects project cost, project schedule, or both. The PDT is responsible for conducting studies for both Project Cost and for Project Schedule.
11. Results of the risk identification process are studied and further developed by the Cost Engineer, then analyzed through the Monte Carlo Analysis Method for Cost (Contingency) and Schedule (Escalation) Growth.

Initial Risk Register Development Meeting

Date: Wednesday, August 30, 2017

Attendance	Name	Office	Representing
	Steve Powell	USACE, Norfolk District	Operations
	Mike Hall	USACE, Norfolk District	Cost
	Robert Pretlow	USACE, Norfolk District	PM
	John Haynes	USACE, Norfolk District	Cultural Resources
	Ira Brotman	M&N, Norfolk	PM
	Sean Jessup	M&N, Norfolk	Cost

Appendix B: Crystal Ball Report – ERSB Risk Analysis

Crystal Ball Report - Elizabeth River Southern Branch Cost Risk Analysis

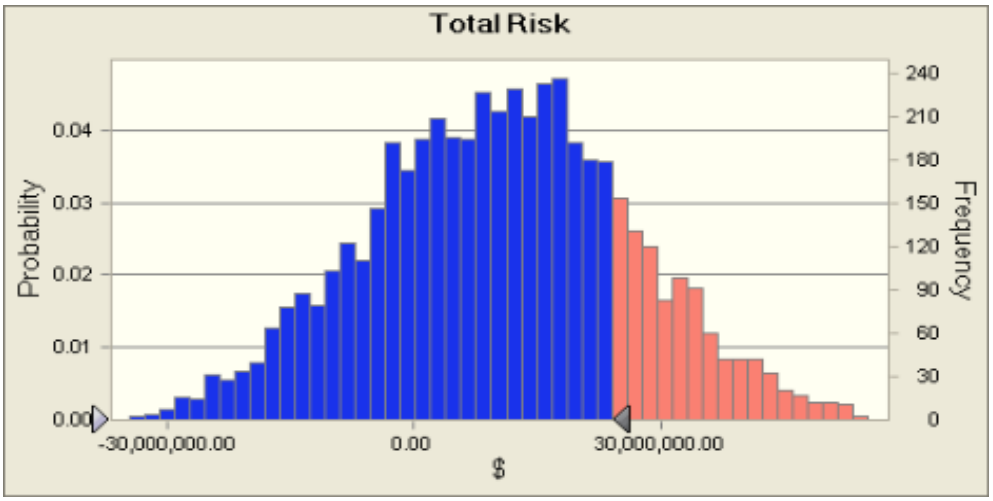
Run preferences:	
Number of trials run	5,000
Monte Carlo	
Random seed	
Precision control on	
Confidence level	95.00%
Run statistics:	
Total running time (sec)	5.23
Trials/second (average)	957
Random numbers per sec	18,182
Crystal Ball data:	
Assumptions	11
Correlations	0
Correlated groups	0
Decision variables	0
Forecasts	1

Forecasts

Worksheet: [Cost Risk Analysis - Elizabeth River 3.xlsx]Analysis

Forecast: Total Risk

Summary:
Certainty level is 80.00%
Certainty range is from -Infinity to 23,665,284.71
Entire range is from -46,988,107.33 to 60,880,936.39
Base case is 0.00
After 5,000 trials, the std. error of the mean is 226,417.57



Statistics:	Forecast values
Trials	5,000
Mean	10,344,955.10
Median	10,706,351.03
Standard Deviation	16,010,139.61
Minimum	-46,988,107.33
Maximum	60,880,936.39
Range Width	107,869,043.72

Forecast: Total Risk (cont'd)

Percentiles:	Forecast values
0%	-46,988,107.33
10%	-10,603,766.60
20%	-3,147,151.70
30%	1,841,997.88
40%	6,395,522.25
50%	10,702,321.33
60%	14,793,116.79
70%	18,772,430.97
80%	23,665,284.71
90%	31,038,464.61
100%	60,880,936.39

Total Project Cost

Percentiles:	
0%	112,869,505.67
10%	149,253,846.40
20%	156,710,461.30
30%	161,699,610.88
40%	166,253,135.25
50%	170,559,934.33
60%	174,650,729.79
70%	178,630,043.97
80%	183,522,897.71
90%	190,896,077.61
100%	220,738,549.39

End of Forecasts

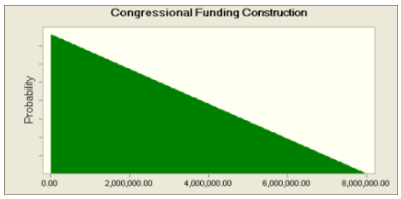
Assumptions

Worksheet: [Cost Risk Analysis - Elizabeth River 3.xlsx]Analysis

Assumption: Congressional Funding Construction

Triangular distribution with parameters:

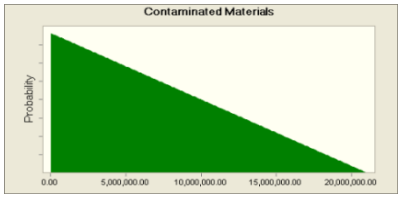
Minimum	0.00
Likeliest	0.00
Maximum	7,992,880.65



Assumption: Contaminated Materials

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	21,000,000.00

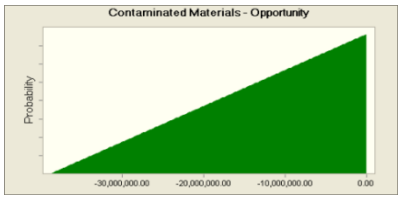


Assumption: Contaminated Materials - Opportunity

Triangular distribution with parameters:

Minimum	-38,760,000.00
Likeliest	0.00
Maximum	0.00

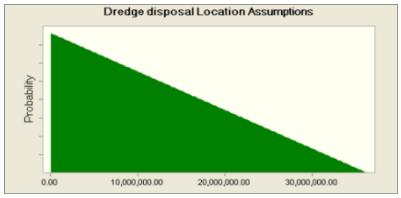
Assumption: Contaminated Materials - Opportunity (cont'd)



Assumption: Dredge disposal Location Assumptions

Triangular distribution with parameters:

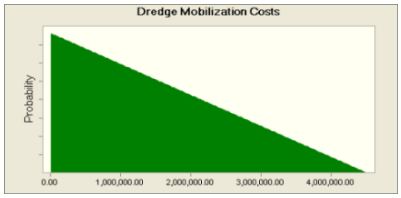
Minimum	0.00
Likeliest	0.00
Maximum	36,213,000.00



Assumption: Dredge Mobilization Costs

Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	4,500,000.00

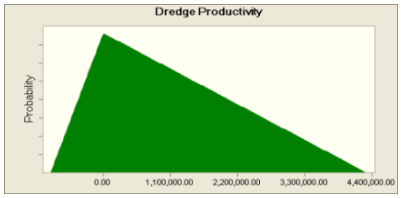


Assumption: Dredge Productivity

Triangular distribution with parameters:

Minimum	-861,004.80
Likeliest	0.00
Maximum	4,305,024.00

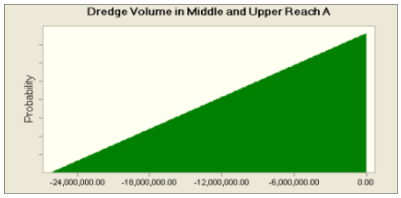
Assumption: Dredge Productivity (cont'd)



Assumption: Dredge Volume in Middle and Upper Reach A

Triangular distribution with parameters:

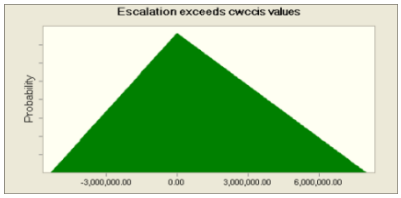
Minimum	-26,214,000.00
Likeliest	0.00
Maximum	0.00



Assumption: Escalation exceeds cwccis values

Triangular distribution with parameters:

Minimum	-5,328,587.10
Likeliest	0.00
Maximum	7,992,880.65

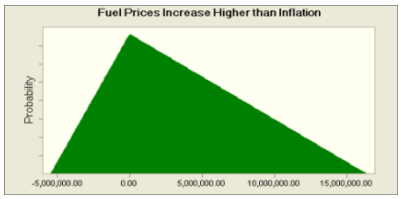


Assumption: Fuel Prices Increase Higher than Inflation

Triangular distribution with parameters:

Minimum	-5,435,158.84
Likeliest	0.00
Maximum	16,305,476.53

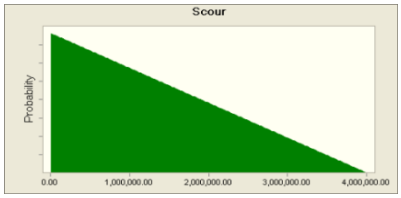
Assumption: Fuel Prices Increase Higher than Inflation (cont'd)



Assumption: Scour

Triangular distribution with parameters:

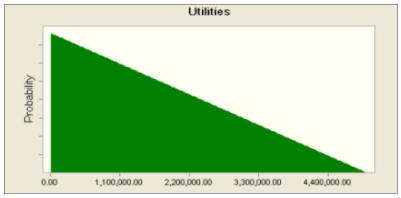
Minimum	0.00
Likeliest	0.00
Maximum	4,000,000.00



Assumption: Utilities

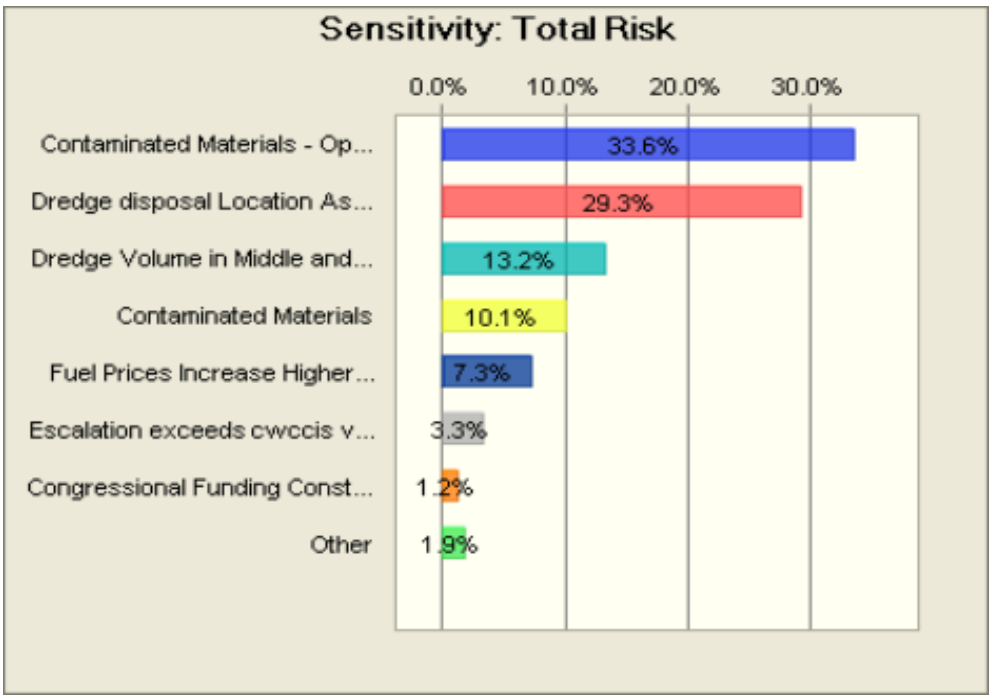
Triangular distribution with parameters:

Minimum	0.00
Likeliest	0.00
Maximum	5,000,000.00



End of Assumptions

Sensitivity Charts



End of Sensitivity Charts

Cost Appendix C – PED Cost Estimates

PED

	Elizabeth River Southern Branch Segment 1 Eliz Riv, Low and Mid	Segment 2 Upper Reach A	~~Segment 3~~ ~~Upper Reach B & C~~	Comments/Assumptions
Cultural Resources				
Field Work (Phase 1) TAR	$ 75,000	$ 75,000	~~$ 75,000~~	Based roughly on TAR proposal
Admin/Consultation	$ 20,000	$ 20,000	~~$ 20,000~~	
				Offshore Placement Assumptions
Geotechnical (includes EPA testing & cord in offshore channels)				**Est CY**
Seg 1: Eliz Riv, Lamberts & Middle Reach	$ 2,250,000			1,500,000 **Assume: $1.5M/1MCY - Eliz River, Upland Testing Criteria**
Seg 2: Upper Reach A		$ 1,500,000		1,000,000 $ 1,500,000 1,000,000
Seg 3: Upper Reach B & C			~~$ 2,700,000~~	1,800,000

Engineering/Plans/Specs: (1) Pre-dredge Survey and Processing and (2) Develop P&S				*Assumptions, $10k/sheet*		*$ 10,000*		
				No. of Sheets:	Pre-dredge survey (from District)	Processing/Mapping Labor	Addtl Eng & Permit Support	
Constraints (Utility Location/bridge foundation)	$ 1,000,000	$ 500,000	~~$ 500,000~~					
Seg 1: Eliz Riv, Lamberts & Middle Reach	$ 1,341,250			50	$ 33,000	$ 8,250.00	$ 800,000	Added $ for upland cord.
Seg 2: Upper Reach A		$ 1,163,750		40	$ 11,000	$ 2,750.00	$ 750,000	Added $ for upland cord.
Seg 3: Upper Reach B & C			~~$ 927,500~~	40	$ 22,000	$ 5,500.00	$ 500,000	

PCASE (Constr Mgmt): Progress Survey, Post Dredge Survey and PCASE labor				One Survey, field cost	Survey Processing/Mapping Labor	Estimated Months	PCASE Labor, HRs	PCASE, Labor $	
Seg 1: Eliz Riv, Lamberts & Middle Reach	$ 442,500			$ 33,000	$ 8,250.00	10	2,400	$	360,000
Seg 2: Upper Reach A		$ 315,500		$ 11,000	$ 2,750.00	6	1,920	$	288,000
Seg 3: Upper Reach B & C			~~$ 631,000~~	$ 22,000	$ 5,500.00	12	3,840	$	576,000
				Assume 1.5 people 40hrs/wk (except 2 people on Seg 2 and 3 due to upland placement)					
				Assume $150/hr					
				higher to monitor upland placement/WQ					

Sub-Total	**$ 5,128,750**	**$ 3,574,250**	**~~$ 4,853,500~~**
Break Out Summary:	**Segment 1** Eliz Riv, Low and Mid	**Segment 2** Upper Reach A	**~~Segment 3~~** ~~Upper Reach B & C~~
Cultural Resources	$ 95,000	$ 95,000	~~$ 95,000~~
CBBT Cover Design	$ -	$ -	~~$ -~~
Geotech/Env Sampling	$ 2,250,000	$ 1,500,000	~~$ 2,700,000~~
Engineering & Surveys	$ 2,341,250	$ 1,663,750	~~$ 1,427,500~~
Construction Mgmt	$ 442,500	$ 315,500	~~$ 631,000~~
Sub-Total:	**$ 5,128,750**	**$ 3,574,250**	**~~$ 4,853,500~~**
PLANNING, ENGINEERING & DESIGN	**$ 4,686,250**	**$ 3,258,750**	**~~$ 4,222,500~~**
CONSTRUCTION MANAGEMENT	**$ 442,500**	**$ 315,500**	**~~$ 631,000~~**

Summary of Assumptions

Cultural Resources	Based roughly on costs provided by TAR for areas needing surveys
Geotech	Based on prior investigations averaging $1M for 2MCY project, and applying to the estimated CY to be dredged
Eng, Plans and Specs	Includes a condition survey for design (cost from District for the survey), and an estimated number of sheets at $10k per sheet (engineering estimate)
Constr Mgmt	Function of estimated dredge/contract time for labor, and includes two surveys (cost to survey from the District) of the area (pre and post)